FINAL DRAINAGE REPORT

for

SETTLERS RANCH SUBDIVISION
FILING NO. 3

Prepared for:

Hodgen Settlers Ranch, LLC
PO Box 1488
Monument, CO 80908

April 22, 2024
Revised July 27, 2024
Revised August 26, 2024

Prepared by:

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

JPS Project No. 030501
El Paso County PCD File No. SF-249

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DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report.

COLORADO REGISTERED
JOHN P. SCHWAB
8/26/24
29891
PROFESSIONAL ENGINEER

John P. Schwab, P.E. #29891

Developer's Statement:

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

By: _____ 8/26/24

Printed Name: Mark Davis, Manager — Date
Hodgen Settlers Ranch, LLC
P.O. Box 1488, Monument, CO 80132

El Paso County's Statement

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

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

Conditions:

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Settlers Ranch is a rural residential subdivision located in northeastern El Paso County, Colorado. The Settlers Ranch property is located on the north side of Hodgen Road, east of State Highway 83 (SH83), as shown in Figure A1 (Appendix F)**.** The originally approved 2005 Preliminary Plan and PUD for Settlers Ranch Subdivision consisted of 86 low-density residential lots (2.5-acre minimum size) on a 307-acre parcel. Previous development of the subdivision has been completed in several phases including Filing No. 1 (43 lots), Filing No. 2A (7 lots), Filing No. 2B (7 lots), and Filing No. 2C (11 lots).

Filing No. 3 is a replat of Tracts A-2, A-3, B, and C of Filing No. 2C. The proposed Filing No. 3 will complete development of the Settlers Ranch Subdivision. Filing No. 3 consists of 24 residential lots on the easterly 78.7 acres of the site, including 16 lots along easterly extension of Settlers Ranch Road to Steppler Road at the east end of the site. An additional 8 lots will be platted along a new cul-de-sac (Boundary Basin Court) extending south from Settlers Ranch Road in the southeasterly corner of the subdivision. Concurrently with the final plat for Filing No. 3, a re-zoning is being processed which will increase the number of lots in the easterly area of Filing No. 3 from 10 lots shown in the original Preliminary Plan to 16 lots currently proposed, while maintaining 2.5-acre minimum lot sizes.

B. Scope

This report is intended to fulfill the El Paso County requirements for a Final Drainage Report (FDR) for submittal with the final plat application for Filing No. 3. The report provides a summary of site drainage issues impacting the proposed development, including analysis of impacts from upstream drainage areas, site-specific developed drainage patterns, and impacts on downstream facilities. This FDR report has been prepared based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual.

Drainage planning for the Filing No. 3 area was previously studied in the "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2" prepared by JPS Engineering, dated May 30, 2008. The proposed road layout for Filing No. 3 is entirely consistent with the road layout in the previously approved Filing No. 2 FDR.

C. Site Location and Description

The Settlers Ranch parcel is located in Section 23 and the northwest quarter (NW1/4) of Section 24, Township 11 South, Range 66 West of the 6th Principal Meridian. The Filing No. 3 site is currently a vacant meadow area.

The west side of the Filing No. 3 area adjoins previously platted filings of Settlers Ranch Subdivision. The north boundary of Filing No. 3 adjoins the previously platted rural subdivisions of Settlers View and Abert Ranch. The east boundary of Filing No. 3 adjoins Steppler Road, and

the southeast boundary adjoins existing rural ranch properties. The adjoining Stewart parcel to the southeast was recently re-zoned to RR-2.5 (2.5-acre minimum lot sizes).

Access to Settlers Ranch Filing No. 3 will be provided by the extension of Settlers Ranch Road easterly to a connection with Steppler Road at the easterly subdivision boundary. This filing will also include connection of Settlers Ranch Road to Abert Ranch Drive along the north boundary of the property.

Subdivision improvements will include paving of the new public roadways through the site, as well as grading, drainage, and utility service improvements for the proposed residential lots. Local roads will be classified as rural local public roads, with 60-feet rights-of-way and paved widths of 28-feet.

Surface drainage from this area flows northerly towards tributaries of West Cherry Creek and East Cherry Creek. The terrain is rolling with south to north slopes ranging from 2% to 12%. Existing vegetation is typical eastern Colorado prairie grass.

D. General Soil Conditions

As detailed in the previously approved "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2" prepared by JPS Engineering, dated May 30, 2008, on-site soils are comprised of the following soil types (according to the NRCS Soil Survey of El Paso County):

- Type 41 – "Kettle gravelly loamy sand": medium surface runoff, moderate erosion hazard (Hydrologic Group B)
- Type 67 – "Peyton sandy loam": medium surface runoff, moderate erosion hazard (Hydrologic group B)
- Type 92 - "Tomah-Crawfoot loamy sands": slow surface runoff, slight to moderate erosion hazard (Hydrologic Group B)

The soils within this property are characterized as hydrologic soils group B (moderate infiltration rates).

E. References

City of Colorado Springs and El Paso County "Drainage Criteria Manual, Volumes 1 and 2," revised October 31, 2018.

El Paso County "Engineering Criteria Manual," revised December 13, 2016.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0305G, December 7, 2018.

Front Range Geotechnical Inc., "Soils and Geology Report for Hodgen Settlers Ranch, LLC," February, 2004.

JPS Engineering, Inc., "Drainage Letter Report for Settlers Ranch Subdivision Filing No. 2B," revised February 19, 2016 (approved by El Paso County 4/12/16; PCD File No. SF1512).

JPS Engineering, Inc., "Drainage Letter Report for Settlers Ranch Subdivision Filing No. 2C," March 22, 2019 (approved by El Paso County 6/18/19; PCD File No. SF1818).

JPS Engineering, Inc., "Final Drainage Report for Abert Ranch Subdivision," revised April 15, 2020 (approved by El Paso County 6/9/20; PCD File No. SF1911).

JPS Engineering, Inc., "Final Drainage Report for Settlers Ranch Subdivision Filing No. 1," October 18, 2005 (approved by El Paso County 10/19/05).

JPS Engineering, Inc., "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2," revised May 30, 2008 (approved by El Paso County 5/31/09; PCD File No. SF06026).

JPS Engineering, Inc., "Final Drainage Report for Settlers View Subdivision," revised March 5, 2019 (approved by El Paso County 3/11/19; PCD File No. SF1841).

M.V.E., Inc., "Settlers Ranch Preliminary Drainage Report," December 13, 2004.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The Settlers Ranch Subdivision lies within both the West Cherry Creek Drainage Basin (CYCY 0400) and East Cherry Creek Drainage Basin (CYCY 0200), as classified by El Paso County. Drainage from the west part of Filing No. 3 flows northerly to an eastern tributary of West Cherry Creek, which flows to a confluence with the main channel north of Walker Road. Downstream agricultural areas generally drain northerly towards the main channel of West Cherry Creek. Drainage from the east part of Filing No. 3 generally flows northeasterly to a tributary of East Cherry Creek.

No drainage planning study has been completed for this drainage basin, or any adjacent drainage basins. The Settlers Ranch parcel is located near the southerly limits of the West Cherry Creek and East Cherry Creek Drainage Basins, each of which comprise total drainage areas in excess of 30 square miles. As such, the proposed 307-acre Settlers Ranch Subdivision represents less than 2 percent of the total basin area, which is primarily agricultural land.

B. Floodplain Impacts

Settlers Ranch Filing No. 3 is located beyond the limits of any 100-year floodplain delineated by the Federal Emergency Management Agency (FEMA). The floodplain limits in the vicinity of the site are shown in Flood Insurance Rate Map (FIRM) Number 08041C0305G dated December 7, 2018, as shown in the enclosed Firmette exhibit (Appendix F).

C. Sub-Basin Description

The developed drainage basins lying within the proposed development are depicted on Figure D1-SR. The developed site layout has been divided into sub-basins based on the proposed road layout within the site. The natural drainage patterns will be impacted through development by site grading and concentration of runoff in subdivision roadside ditches and channels. On-site flows will be conveyed to the existing natural drainage swales and channels running through the property, following historic drainage paths.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

No Drainage Basin Planning Study (DBPS) has been completed for either the West Cherry Creek Drainage Basin or the East Cherry Creek Drainage Basin. Previous drainage reports for recently completed subdivision filings have proposed to provide on-site detention for mitigation of developed flows.

Drainage planning for the Filing No. 3 area was previously studied in the "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2" prepared by JPS Engineering, dated May 30, 2008. The proposed road layout for Filing No. 3 is entirely consistent with the road layout in the previously approved Filing No. 2 FDR.

B. Hydrologic Criteria

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

- Design storm (minor) — 5-year
- Design storm (major) — 100-year
- Rainfall Intensities — El Paso County I-D-F Curve
- Hydrologic soil type — B

	C5	C100
• Runoff Coefficients - undeveloped: Existing pasture/range areas	0.25	0.35
• Runoff Coefficients - developed: Proposed lot areas (2.5-acre lots)	0.170	0.417

Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage basin drawings.

IV. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls. As stated in DCM Volume 2, the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Minimize Impacts: The proposed rural residential subdivision development with 2.5-acre minimum lot sizes provides for inherently minimal drainage impacts based on the limited impervious areas associated with rural residential development.
- Minimize Directly Connected Impervious Areas (MDCIA): The rural residential development will have roadside ditches along all roads, providing for impervious areas to drain across pervious areas. Based on the roadside ditches throughout the subdivision, the subdivision is classified as MDCIA Level One.
- Grass Swales: The proposed roadside ditches will drain to existing and proposed grass-lined drainage swales following historic drainage patterns through the property.

Step 2: Stabilize Drainageways

- There are no major drainageways within the Filing No. 3 site. Vegetated buffer strips will be maintained between developed areas of the site and downstream drainage channels.
- Proper erosion control measures will be implemented along the roadside ditches and grass-lined drainage channels to provide stabilized drainageways within the site.

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: Extended Detention Basin (EDB) facilities mitigate developed drainage impacts by providing stormwater detention and water quality capture volume (WQCV).
- The existing Settlers Ranch Detention Pond #4 was previously completed with Filing No. 2B and also serves the westerly part of Filing No. 3. The existing Settlers View Detention Pond #S3 and Abert Ranch Detention Pond #I provide detention and water quality for the northern areas of Settlers Ranch Filing No. 3.
- The proposed Settlers Ranch Detention Pond #5 provides detention and water quality for the southeasterly part of Settlers Ranch Filing No. 3.
- All drainage basins within Filing No. 3 drain to the existing and proposed detention ponds, with the exception of Basin D13 which is excluded from permanent water quality requirements based on ECM Appendix I.7.1.C.1 (which allows for 20%, not to exceed 1-acre, of the applicable development site area to not be captured).

Step 4: Consider Need for Industrial and Commercial BMPs

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

V. GENERAL DRAINAGE RECOMMENDATIONS

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

Individual lot grading and drainage is the sole responsibility of the individual builders and property owners. Final grading of each home site should establish proper protective slopes and positive drainage in accordance with HUD guidelines and building codes. In general, main floor elevations for each home should be established a minimum of 2 feet above the top of curb (or pavement) of the adjoining street.

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

VI. DRAINAGE FACILITY DESIGN

A. General Concept

Development of the Settlers Ranch Subdivision will require site grading and paving, resulting in additional impervious areas across the site. The general drainage pattern will consist of grading away from home sites to swales and roadside ditches along the roads within the subdivision, conveying runoff flows through the site. Runoff from the site will flow by roadside ditches to cross culverts at low points in the road profiles, and grass-lined channels connecting to existing natural swales at the site boundaries.

The stormwater management concept for the Settlers Ranch development will be to provide roadside ditches and natural swales as required to convey developed drainage through the site to existing natural outfalls. Individual lot grading will provide positive drainage away from building sites, and direct developed flows into the system of roadside ditches and drainage swales running through the subdivision.

An existing stock pond within Settlers Ranch Filing No. 2 was previously upgraded to serve as "Detention Pond #4", which mitigates developed drainage impacts from the west side of Filing

No. 3. Existing detention ponds within the adjoining Settlers View and Abert Ranch Subdivisions were designed to accept developed flows from the north side of Filing No. 3. The proposed "Detention Pond #5" will be constructed on the west side of Steppler Road to mitigate the impact of developed flows from the east side of Filing No. 3.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions are detailed in the previously approved "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2" prepared by JPS Engineering, dated May 30, 2008 (see Existing Drainage Plans, Sh. EX1 and EX2 in Appendix A).

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in the attached "Figure D1-SR: Developed Drainage Plan" (Appendix F). The proposed Filing No. 3 area lies within Basins D5-D14.

Filing No. 3 – Lots 17-24 (Boundary Basin Court)

Th westerly part of the Filing No. 3 area lies within parts of Basins D5 and D7, and these basins flow northwesterly to existing grass-lined drainage swales along the northern subdivision boundary. Water quality for Basins D5-D7 (including Filing No. 3 Sub-Basins D5a-D5c and D7a-D7b) is provided in the existing downstream Settlers Ranch Detention Pond #4.

The proposed Filing No. 3 lots on the northeast side of Boundary Basin Court lie within Basin D5c, which flows to the existing Culvert D5c (36" RCP). Culvert D5c crosses Settlers Ranch Road on the north side of Boundary Basin Court, ultimately flowing to the existing downstream Detention Pond #4. Developed peak flows at Design Point #D5c are calculated as Q_5 = 11.0 cfs and Q_{100} = 45.4 cfs.

The proposed Filing No. 3 lots at the southeast end of Boundary Basin Court lie within Basins D5b and D7b, and these basins flow westerly to the proposed Culvert D7b (18" RCP), which flows westerly across Boundary Basin Court. Developed peak flows at Design Point #D7b are calculated as of Q_5 = 2.8 cfs and Q_{100} = 11.6 cfs.

The proposed Filing No. 3 lots along the west side of Boundary Basin Court lie within Basins D5a and D7a, and these basins flow northwesterly to the existing Culvert D5a (36" RCP). Culvert D5a crosses Settlers Ranch Road on the south side of Boundary Basin Court and flows to the existing downstream Detention Pond #4. Developed flows from Basins D5a, D5b, D7a, and D7b combine at Design Point #D5a, with peak flows calculated as Q_5 = 15.0 cfs and Q_{100} = 61.6 cfs.

The existing stock pond near the north boundary of Settlers Ranch Subdivision was previously upgraded to serve as "Detention Pond #4," mitigating the impact of developed flows from the west part of the Filing No. 3 area (including Design Points #5a and #D5c). Detention Pond #4 is an Extended Detention Basin (EDB) located within Tract A of Settlers Ranch Filing No. 2A, and this pond provides both stormwater detention and water quality. Detention Pond #4 improvements were previously completed as part of Filing No. 2B.

Filing No. 3 – Lot 1 (NW side of Settlers Ranch Road)

The proposed Lot 1 of Filing No. 3 lies within Basin D9a along the northwest side of Settlers Ranch Road. The west edge of proposed Lots 2 and 3 of Filing No. 3 lies within Basin D9b along the east side of Settlers Ranch Road. Water quality for Basin D9 (including Filing No. 3 Sub-Basins D9a-D9b) is provided in the existing downstream Settlers View Detention Pond #S3.

Settlers Ranch Road has been constructed by previous phases of the subdivision to a temporary cul-de-sac along the frontage of Lot 1, and the temporary cul-de-sac will be removed as the roadway is completed to the east with Filing No. 3. Basins D9a-D9c flow northwesterly to Design Pont #D9, with peak flows calculated as Q_5 = 9.4 cfs and Q_{100} = 38.6 cfs. The developed flows from Basins D9a-D9c have been fully accounted for in the previously developed Settlers View Subdivision which adjoins Settlers Ranch to the northwest, and there is no change in the Filing No. 3 lot layout impacting this area.

Filing No. 3 – Lots 2-16 (Easterly extension of Settlers Ranch Road)

The proposed lots on the east side of Filing No. 3 lie within Basins D10-D14. Basins D11a and D11b drain northeasterly to Design Point #D11, with developed peak flows calculated as Q_5 = 8.9 cfs and Q_{100} = 36.7 cfs.

Basin D12 will continue to drain northerly to Design Point #D12 along the northern subdivision boundary, with developed peak flows calculated as Q_5 = 7.3 cfs and Q_{100} = 29.9 cfs.

Developed Basins D11 and D12 will continue to drain northeasterly through existing natural swales, with combined peak flows of Q_5 = 15.2 cfs and Q_{100} = 62.7 cfs at Design Point #4. Water quality for Basins D11 and D12is provided in the existing downstream Abert Ranch Detention Pond #I.

Developed flows from Basins D11-D12 have been accounted for in the drainage planning for Abert Ranch Subdivision which adjoins Settlers Ranch to the north. Development of Abert Ranch Subdivision included upgrade of an existing stock pond to serve as "Detention Pond #I." While the proposed Filing No. 3 increases the number of rural residential lots within Basins D11-D12 from 3 to 5, the 2.5-acre minimum lot sizes result in a negligible drainage

impact. As detailed in Appendix D1, the existing Abert Ranch Detention Pond #I has ample capacity to accept developed flows from the currently proposed 2.5-acre lot sizes within Basins D11-D12 of Settlers Ranch Filing No. 3.

Developed Basins D10 and D14 will continue to drain southeasterly through existing grass-lined swales. Developed flows from Basins D10 and D14 combine at Design Point #5, with peak flows calculated as Q_5 = 10.2 cfs and Q_{100} = 41.8 cfs. The proposed "Pond #5" near the southeast corner of the site has been designed to provide stormwater detention and water quality for Basins D10 and D14. Detained peak flows at Design Point #5 are calculated as Q_5 = 4.1 cfs and Q_{100} = 18.6 cfs.

Basin D13 will continue to drain easterly towards Steppler Road, with developed peak flows calculated as Q_5 = 3.8 cfs and Q_{100} = 15.6 cfs. These flows are conveyed easterly across Steppler Road in an existing 24" RCP culvert.

The majority of Basin D13 (Sub-Basin D13.1) is excluded from permanent water quality requirements based on ECM Appendix I.7.1.B.5, which is the large lot exclusion. The roadway improvement area within Basin D13 (Sub-Basin D13.2) is excluded from permanent water quality requirements based on ECM Appendix I.7.1.C.1, which allows for 20%, not to exceed 1-acre, of the applicable development site area to not be captured (see Sh. PBMP in Appendix F and additional discussion in Section D).

D. Detention Ponds

Stormwater detention and water quality for the majority of the subdivision will be provided by a combination of existing and proposed detention ponds.

Settlers Ranch Detention Pond #4

Settlers Ranch Detention Pond #4 is an existing stock pond located along the drainage channel running through the westerly part of the Filing No. 2 property, and this pond was previously upgraded to serve as a detention pond serving the westerly parts of Filing No. 3.

Detention Pond #4 was designed to provide stormwater detention and water quality for Basins D5-D7, accepting developed flows from the 2.5-acre lots (impervious area of 11%) on the west side of Settlers Ranch Filing No. 3.

The existing Settlers Ranch Detention Pond #4 was sized to accept developed flows from the tributary areas within proposed Filing No. 3 (parts of Basin D5 and D7), and the existing pond is functioning as intended.

Settlers View Detention Pond #S3

Detention Pond #S3 within the adjoining Settlers View Subdivision was designed to provide stormwater detention and water quality, accepting developed flows from the 2.5-acre lots (impervious area of 11%) within Settlers Ranch Basin D9.

The existing Settlers View Detention Pond #S3 was sized to accept developed flows from the tributary areas within proposed Settlers Ranch Filing No. 3 (parts of Basin D9), and the existing pond is functioning as intended.

Abert Ranch Detention Pond #I

Detention Pond #I within the adjoining Abert Ranch Subdivision was designed to provide stormwater detention and water quality, accepting developed flows from the 5-acre lots anticipated within Settlers Ranch Basins D11-D12. As detailed in Appendix D1, the impervious area impact of the currently proposed Filing No. 3 has been evaluated, confirming that the existing Detention Pond #I has ample capacity to accept the developed flows from the currently proposed 2.5-acre minimum lot sizes in Basins D11-D12. The currently proposed Settlers Ranch Filing No. 3 increases the total impervious area tributary to Detention Pond #I from 8.6% to 9.8%, resulting in a required 100-year detention volume increase from 3.3 acre-feet to 3.5 acre-feet, which is well below the existing design volume of 4.4 acre-feet.

The existing Abert Ranch Detention Pond #I was sized to accept developed flows from the tributary areas within proposed Settlers Ranch Filing No. 3 (Basins D11 and D12), and the existing pond is functioning as intended. According to the calculations in Appendix D1, the existing Pond #I will still drain and function as intended with the slight increase in tributary impervious area.

Settlers Ranch Detention Pond #5

Filing No. 3 drainage improvements will include construction of the proposed Detention Pond #5 at the southeast corner of the subdivision, providing stormwater detention and water quality at Design Point #5 (including Basins D10 and D14). Detention Pond #5 has been designed as a Private Full-Spectrum Extended Detention Basin (EDB) to meet current full-spectrum detention design standards. The proposed Detention Basin has been designed utilizing the Denver Mile High Flood District's "MH-Detention_v4.06" software package.

The required 100-year Full-Spectrum Detention (FSD) volume for Pond #5 has been calculated as 0.7 acre-feet, and Pond #5 provides a storage volume of 0.8 acre-feet, which meets the required 100-year detention and WQCV volume (see calculations in Appendix D2).

The proposed detention pond will include an outlet structure with a water quality orifice plate to maintain discharges below the allowable release rates. The pond outlet structure has been designed for a 40-hour release of the WQCV, with outlet sizing to maintain maximum allowable release rates

from the pond. The detention pond will have a grass-lined bottom to encourage infiltration of stormwater prior to discharging into the downstream drainage system.

A concrete forebay has been designed at the entrance to the proposed detention pond (see "UD-BMP" calculation in Appendix D2). A concrete trickle channel will be provided along the bottom of the pond between the forebay and outlet structure.

A buried riprap spillway will be provided for stabilization of the pond overflow spillway, which has been sized to convey the fully-developed flow entering the detention pond in the event of a fully clogged condition. Based on the relatively low developed peak flow entering the pond at Design Point No. 5 (Q_{100} = 41.8 cfs), buried riprap will provide appropriate stabilization and there is no need for concrete cutoff walls for the spillway or underground piping.

The proposed detention pond will be privately owned and maintained by the subdivision homeowners association (HOA), and a 15-foot wide gravel maintenance access driveway will be provided from Steppler Road along the east boundary of the site.

As detailed in the detention basin calculations in Appendix D2, detained peak flows from Detention Basin #5 are calculated as Q_5 = 4.1 cfs and Q_{100} = 18.6 cfs, and the detained flows are below the calculated existing condition flows at Design Point No. 5 (Q_5 = 10.4 cfs and Q_{100} = 25.5 cfs).

Detention Pond Summary

Design parameters for the existing and proposed stormwater detention basins serving Settlers Ranch Filing No. 3 are summarized as follows:

Detention Basin	Tributary Drainage Basins	Total Tributary Area (ac)	Flg. 3 Tributary Area [2] (ac)	Impervious Percentage	Min. 100-Yr FSD Vol. (af)	Design Volume (af)
Existing Detention Ponds: [1]						
SR #4	D5-D7	86.3	42.6	11.0	1.6	2.9
SV #S3	D9	28.5	14.3	11.0	1.1	1.3
AR #I [3]	D11,D12	26.6	26.6	9.8	3.5	4.4
Proposed Detention Pond:						
SR #5	D10,D14	18.9	18.9	11.0	0.7	0.8

[1] Existing Detention Ponds will not be altered and have adequate capacity for Flg. 3 developed flows
[2] Includes Sub-Basin areas extending into adjoining filings
[3] Abert Ranch Det. Pond #I Imp. area increased from 8.6% to 9.8%; existing pond capacity sufficient

Areas Excluded from Water Quality Facilities

Parts of Basin D8a and Basin D13 (see areas identified as Sub-Basins D8a.1 and D13.1 on Sh. PBMP in Appendix F) are excluded from permanent water quality requirements based on the ECM large lot exclusion. According to ECM Appendix I Section I.7.1.B.5, a single-family residential lot greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent is excluded from permanent WQ control measures.

The portion of Basin D13 comprising the new roadway improvements for Settlers Ranch Road is excluded from permanent water quality requirements based on ECM Appendix I.7.1.C.1, which allows for 20%, not to exceed 1-acre, of the applicable development site area to not be captured. Within Basin D13, the applicable soil disturbance area associated with roadway improvements is limited to approximately 0.6 acres (calculated based on half of the ROW width of 790 feet of proposed Settlers Ranch Road length), which is below the 1-acre limit for exclusion (see area identified as Sub-Basin D13.2 on Sh. PBMP in Appendix F).

E. On-Site Drainage Facility Design / Hydraulic Calculations

Developed sub-basins and proposed drainage improvements are depicted in the enclosed Drainage Plan (Sheet D1-SR). On-site drainage facilities will consist of roadside ditches and culverts. Hydraulic calculations for the proposed Filings No. 3 drainage facilities (roadside ditches and culvert) are enclosed in Appendix C1 and C2.

F. Anticipated Drainage Problems and Solutions

The existing Settlers Ranch Detention Pond #4, Settlers View Detention Pond #S3, Abert Ranch Detention Pond #I, and proposed Settlers Ranch Detention Pond #5 have been designed to mitigate the impacts of developed drainage from this project. The overall drainage plan for the subdivision includes a system of roadside ditches, channels, and culverts to convey developed flows through the site. The primary drainage problems anticipated within this development will consist of maintenance of these drainage channels, culverts, and detention pond facilities. Care will need to be taken to implement proper erosion control measures in the roadside ditches, channels, and swales. Ditches have been designed to meet allowable velocity criteria. Erosion control mats have been specified where necessary to minimize erosion concerns. Proper construction and maintenance of the detention facilities will minimize downstream drainage impacts. Public roadway improvements and ditches within the public right-of-way are owned and maintained by El Paso County. The stormwater detention ponds are owned and maintained by the applicable subdivision HOA.

VII. EROSION / SEDIMENT CONTROL

The Contractor will be required to implement control measures for erosion and sediment control through the course of construction. Sediment control measures will include installation of silt fence at the toe of disturbed areas along with straw bales and other control measures. Cut slopes will be stabilized during excavation as necessary and vegetation will be established for

stabilization of disturbed areas as soon as possible. All ditches have been designed to meet El Paso County criteria for slope and velocity. The proposed detention pond will also serve as a temporary sediment basin during the construction phase of the project.

VIII. COST ESTIMATE AND DRAINAGE FEES

Cost estimates for the proposed drainage improvements are enclosed in Appendix E. The estimated cost for the on-site drainage improvements is approximately $9,067.

The estimated cost of the proposed private detention facilities (Detention Pond #5) is approximately $53,284.

The developer will be responsible for all construction costs for proposed roadway and drainage improvements, and public facilities will be owned and maintained by El Paso County upon final acceptance. Private drainage facilities will be owned and maintained by the subdivision HOA.

This parcel is located in the West Cherry Creek and East Cherry Creek Drainage Basins. No drainage and bridge fees will be due at the time of recordation of the final plat as the subject site is not located in a fee basin.

IX. SUMMARY

Settlers Ranch Filing No. 3 is the final phase of the Settlers Ranch Subdivision in northeastern El Paso County. The proposed Filing No. 3 consists of 24 lots in the easterly part of the site. Development of this subdivision will generate an increase in developed runoff from the site, which will be mitigated through a combination of existing and proposed stormwater detention facilities. The proposed drainage patterns will remain consistent with historic conditions, and new drainage facilities constructed to El Paso County standards will safely convey runoff to suitable outfalls.

The existing downstream Settlers Ranch Detention Pond #4, Settlers View Detention Pond #S3, and Abert Ranch Detention Pond #I will provide stormwater detention and water quality for the west and north parts of Filing No. 3. The existing off-site ponds and drainage pathways that this development will drain to have been designed to account for the developed flows from Filing No. 3, and the existing drainage facilities are functioning properly.

The proposed Settlers Ranch Detention Pond #5 will provide stormwater detention and water quality for the southeast part of Filing No. 3.

The proposed development of Settlers Ranch Filing No. 3 fully conforms to the previously approved drainage plan for this subdivision, as detailed in the "Final Drainage Report for Settlers Ranch Filing No. 2." Construction and proper maintenance of the proposed drainage and erosion control facilities will ensure that this subdivision will not adversely affect downstream or surrounding areas.

APPENDIX A

EXCERPTS FROM ADJOINING SUBDIVISION DRAINAGE REPORTS

DRAINAGE LETTER REPORT

for

SETTLERS RANCH FILING NO. 2C

Prepared for:

Hodgen Settlers Ranch LLC
PO Box 1488
Monument, CO 80132

March 22, 2019

Prepared by:

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

JPS Project No. 111603
PCD File No.: SF-18-018

DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report.

COLORADO REGISTERED JOHN P. SCHWAB 29891 PROFESSIONAL ENGINEER

5/20/19

John P. Schwab, P.E. #29891

Developer's Statement:

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

By: MH 3/25/19

Printed Name: Mark Davis, Manager Date
Hodgen Settlers Ranch, LLC
P.O. Box 1488, Monument, CO 80132

El Paso County's Statement

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

Approved
By: Elizabeth NijKamp
Date:06/18/2019
El Paso County Planning & Community Development

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

Conditions:

JPS ENGINEERING
19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
(719)-471-0766 fax

SETTLERS RANCH FILING NO. 2 – FILING NO. 2C
DRAINAGE LETTER REPORT
PCD File No. SF-18-018

A. Background

This Drainage Letter Report has been prepared in support of the final plat submittal for Phase 2C of Settlers Ranch Filing No. 2. The proposed Phase 2C consists of 11 single-family residential lots on a 33.6-acre parcel along Settlers Ranch Road, with minimum lot sizes of 2.5 acres.

El Paso County previously approved the "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2" prepared by JPS Engineering, dated May 30, 2008. As shown in the attached "Figure D1: Developed Drainage Plan," the majority of the area within Phase 2C of Filing No. 2 lies within Sub-Basins D8a-D8d and D9a-D9c. This area generally sheet flows northwesterly to existing grass-lined drainage swales at Design Points #D8 and #D9. As discussed in the approved subdivision drainage report, the existing stock pond near the north boundary of the Settlers Ranch property will be upgraded to serve as "Detention Pond #4," mitigating the impact of developed flows from this part of the site (including Design Points #3, D8, and D9). Detention Pond No. 4 is an Extended Detention Basin (EDB) located within Tract A of Settlers Ranch Filing No. 2A, and this pond provides both stormwater detention and water quality. The proposed detention pond improvements were included as part of the previous Filing No. 2B.

B. Drainage Planning Four-Step Process

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

As stated in DCM Volume 2, the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development.

The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Minimize Impacts: The proposed rural residential subdivision development with 2.5-acre minimum lot sizes provides for inherently minimal drainage impacts based on the limited impervious areas associated with rural residential development.
- Minimize Directly Connected Impervious Areas (MDCIA): The rural residential development will have roadside ditches along all roads, providing for impervious areas to drain across pervious areas. Based on the roadside ditches throughout the subdivision, the subdivision is classified as MDCIA Level One.
- Grass Swales: The proposed roadside ditches will drain to existing and proposed grass-lined drainage swales following historic drainage patterns through the property.

Step 2: Stabilize Drainageways

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

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: An existing Extended Detention Basin (EDB) mitigates developed drainage impacts from this filing. Detention Pond #4 was previously upgraded with Filing No. 2B.

Step 4: Consider Need for Industrial and Commercial BMPs

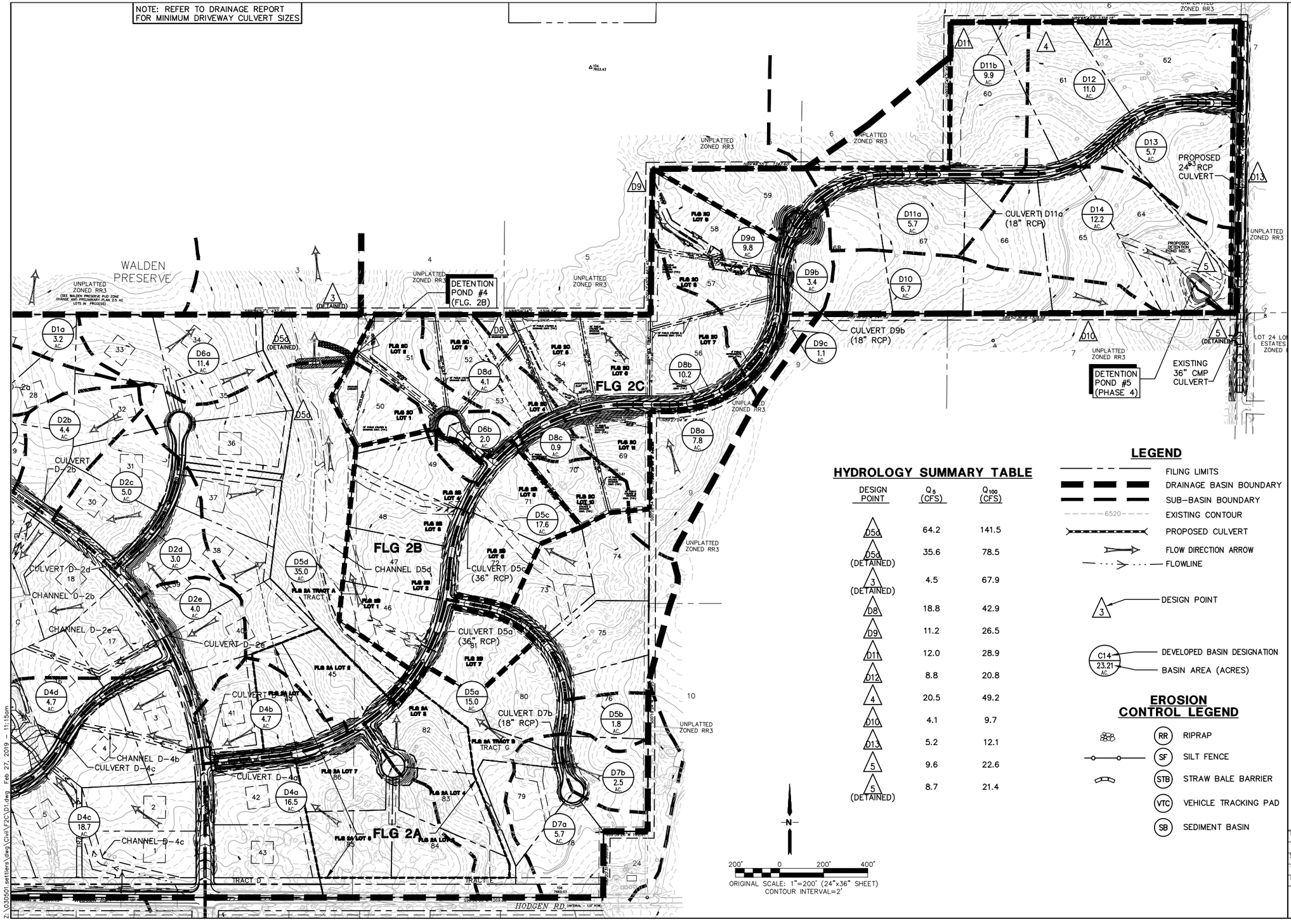
- No industrial or commercial land uses are proposed within this rural residential subdivision.

C. Summary

In summary, the proposed development of Settlers Ranch Filing No. 2C conforms to the previously approved drainage plan for this subdivision as detailed in the "Final Drainage Report for Settlers Ranch Filing No. 2." This phase of development will include culverts and drainage improvements as detailed in the approved subdivision drainage report.

As noted in the previously approved report, this part of the Settlers Ranch site lies within the West Cherry Creek Drainage Basin, and no drainage basin fees or bridge fees are applicable in this basin.

NOTE: REFER TO DRAINAGE REPORT FOR MINIMUM DRIVEWAY CULVERT SIZES



HYDROLOGY SUMMARY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
D5a	64.2	141.5
D5a (DETAINED)	35.6	78.5
3 (DETAINED)	4.5	67.9
D8	18.8	42.9
D9	11.2	26.5
D11	12.0	28.9
D12	8.8	20.8
4	20.5	49.2
D10	4.1	9.7
D13	5.2	12.1
5	9.6	22.6
5 (DETAINED)	8.7	21.4

LEGEND

- FILING LIMITS
- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- PROPOSED CULVERT
- FLOW DIRECTION ARROW
- FLOWLINE
- 3 DESIGN POINT
- C14 / 23.21 AC. DEVELOPED BASIN DESIGNATION / BASIN AREA (ACRES)

EROSION CONTROL LEGEND

- RR RIPRAP
- SF SILT FENCE
- STB STRAW BALE BARRIER
- VTC VEHICLE TRACKING PAD
- SB SEDIMENT BASIN

N

200' 0 200' 400'

ORIGINAL SCALE: 1"=200' (24"x36" SHEET)
CONTOUR INTERVAL=2'

Z:\030501.settlers\dwg\Civil\F2C\D1.dwg Feb 27, 2019 - 11:15am

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

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

REVISION	BY	DATE

SETTLERS RANCH - FILING NO. 2

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=200'	DRAWN: RMD
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RAMPART	CHECKED: JPS
CREATED: 5/2/06	LAST MODIFIED: 2/27/19
PROJECT NO: 030501	MODIFIED BY: BJJ

SHEET: D1

DRAINAGE LETTER REPORT

for

SETTLERS RANCH SUBDIVISION FILING NO. 2B

Prepared for:

Hodgen Settlers Ranch, LLC
PO Box 1488
Monument, CO 80908

December 30, 2015
Revised February 18, 2016

Prepared by:

19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
(719)-471-0766 fax
www.jpsengr.com

JPS Project No. 030501

DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report.

COLORADO REGISTERED JOHN P. SCHWAB 29891 PROFESSIONAL ENGINEER 3/14/16

John P. Schwab, P.E. #29891

Developer's Statement:

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

By: Dan Ramger 3/10/16

Printed Name: Mark Davis, Manager Date

Hodgen Settlers Ranch, LLC
PO Box 1488
Monument, CO 80132

El Paso County's Statement

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

4-12-16

Andre P. Brackin, P.E. Date
County Engineer / ECM Administrator

Conditions:

JPS ENGINEERING
19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
(719)-471-0766 fax

SETTLERS RANCH FILING NO. 2 – FILING NO. 2B
DRAINAGE LETTER REPORT
December, 2015

This Drainage Letter Report has been prepared in support of the final plat submittal for Phase 2B of Settlers Ranch Filing No. 2. The proposed Phase 2B consists of 7 single-family residential lots along Settlers Ranch Road, with minimum lot sizes of 2.5 acres.

El Paso County previously approved the "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2" prepared by JPS Engineering, dated May 30, 2008. As shown in the attached "Figure D1: Developed Drainage Plan," the majority of the area within Phase 2B of Filing No. 2 lies within Sub-Basins D5a, D5c, and D5d. This area drains northwesterly through an open space tract to an existing stock pond, which then flows northerly through two existing downstream ponds within the Walden Subdivision to the north. As detailed in the approved subdivision drainage report, the existing stock pond near the north boundary of the Settlers Ranch property will be upgraded to serve as "Detention Pond #4," and the proposed pond improvements will be constructed as part of Filing No. 2B.

The detention pond calculations for Pond #4 have been updated with this Drainage Letter Report providing for full-spectrum detention as required by current County drainage criteria. Updated pond design calculations using the Denver Urban Drainage & Flood Control District's "UD-Detention" software are attached to this report.

In summary, the proposed development of Settlers Ranch Filing No. 2B conforms to the previously approved drainage plan for this subdivision as detailed in the "Final Drainage Report for Settlers Ranch Filing No. 2." This phase of development will include construction of Detention Pond #4 and related culverts and drainage channel improvements as detailed in the approved subdivision drainage report.

As noted in the previously approved report, this part of the Settlers Ranch site lies within the West Cherry Creek Drainage Basin, and no drainage basin fees or bridge fees are applicable in this basin.

DETENTION VOLUME BY THE FULL SPECTRUM METHOD

Project: SETTLERS RANCH FILING 2B
Basin ID: POND #4 (DP-D5d)

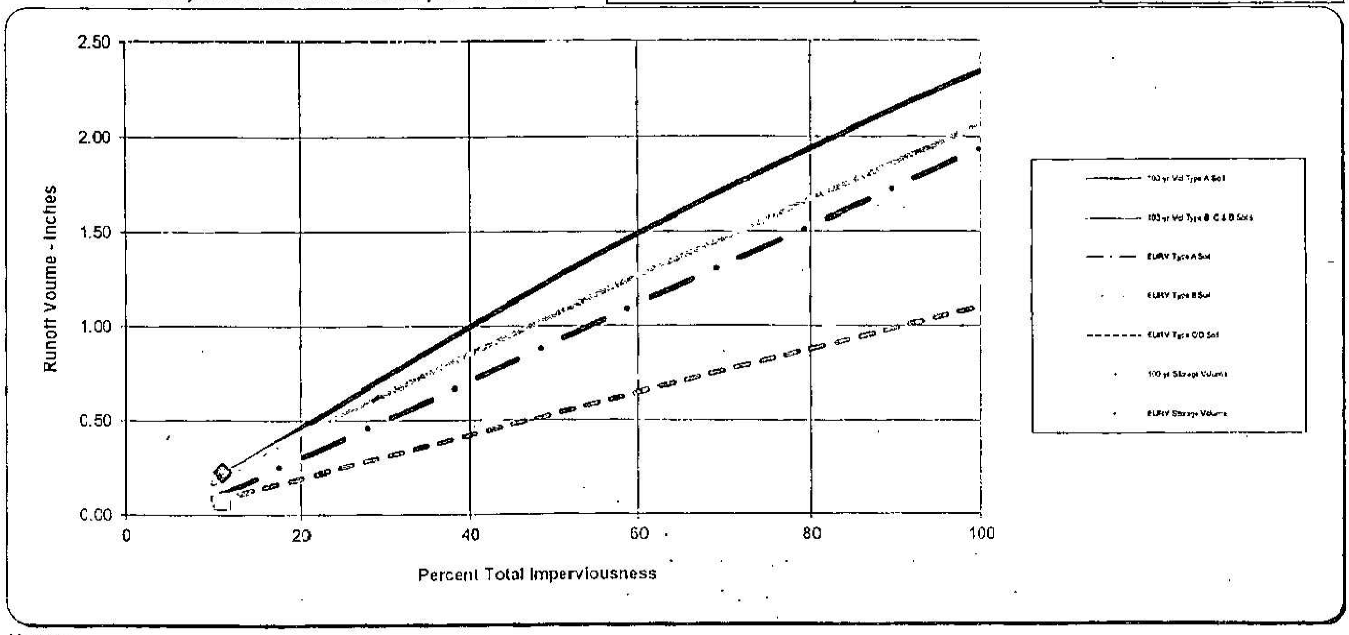
* User input data shown in blue.

Area of Watershed (acres)	86.30	
Subwatershed Imperviousness	11.0%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	1	
Effective Imperviousness[1]	8.6%	

Hydrologic Soil Type	Percentage of Area	Area (acres)
Type A		0.0
Type B	100.0%	86.3
Type C or D		0.0

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		Decay Coefficient--$\Box$
Initial--f_i	Final--f_o	
4.5	0.6	0.0018

	Detention Volumes [2,5]		Maximum Allowable Release Rate, cfs[3]
	(watershed inches)	(acre-feet)	
Excess Urban Runoff Volume[4]	0.07	0.50	Design Outlet to Empty EURV in 72 Hours
100-year Detention Volume plus 1/2 WQCV [5]	0.23	1.62	73.36



Notes:

1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).

2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.

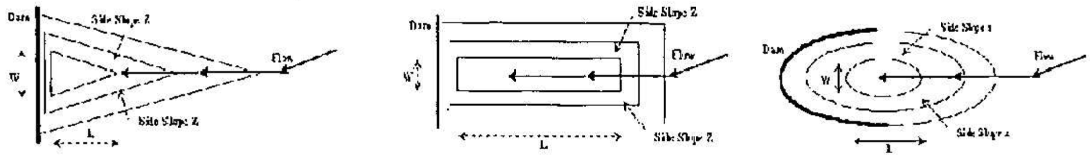
3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.

4) EURV approximates the difference between developed and pre-developed runoff volume.

5) User has opted to add 1/2 the WQCV to the 100-year detention volume to satisfy local regulations. This is not required per the USDCM.

STAGE-STORAGE SIZING FOR DETENTION BASINS

Project: SETTLERS RANCH FILING 2B
Basin ID: POND #4



Design Information (Input):

Width of Basin Bottom, W = ____ ft
Length of Basin Bottom, L = ____ ft
Dam Side-slope (H:V), Z_d = ____ ft/ft

Check Basin Shape

Right Triangle		OR...
Isosceles Triangle		OR...
Rectangle		OR...
Circle / Ellipse		OR...
Irregular	X	(Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':			acre-ft.
Storage Requirement from Sheet 'Hydrograph':			acre-ft.
Storage Requirement from Sheet 'Full-Spectrum':	0.50	1.62	acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Water Surface Elevation ft (input)	Side Slope (H:V) ft/ft Below El. (input)	Basin Width at Stage ft (output)	Basin Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
BOTTOM	7558.00					8,635		0.198	0.000	
	7558.50		0.00	0.00		10,102	4,684	0.232	0.108	
	7559.00		0.00	0.00		11,568	10,102	0.266	0.232	
	7559.50		0.00	0.00		13,034	16,252	0.299	0.373	
EURV EL	7560.00		0.00	0.00		14,500	23,136	0.333	0.531	
	7560.50		0.00	0.00		16,960	31,001	0.389	0.712	
	7561.00		0.00	0.00		19,419	40,096	0.446	0.920	
	7561.50		0.00	0.00		21,879	50,420	0.502	1.157	
	7562.00		0.00	0.00		24,338	61,974	0.559	1.423	
100-YR WSL	7562.50		0.00	0.00		28,714	75,237	0.659	1.727	
	7563.00		0.00	0.00		33,090	90,688	0.760	2.082	
	7563.50		0.00	0.00		37,466	108,327	0.860	2.487	
SPILLWAY	7564.00		0.00	0.00		41,842	128,154	0.961	2.942	
TOP OF BERM	7566.00		0.00	0.00		59,346	229,342	1.362	5.265	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
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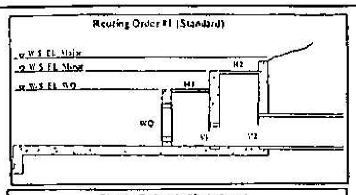
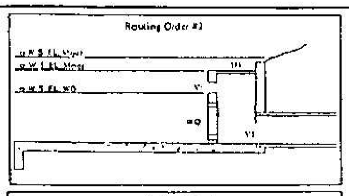
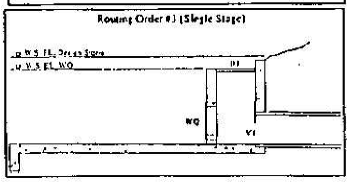
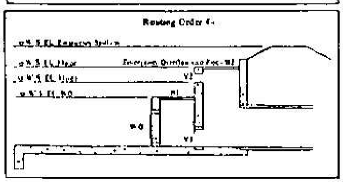
STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: SETTLERS RANCH FILING 2B
Basin ID: POND #4









Current Routing Order is #3

Design Information (Input):

			#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Circular Opening:	Diameter in Inches	Dia. =					inches
OR							
Rectangular Opening:	Width in Feet	W =	5.67		1.99		ft.
	Length (Height for Vertical)	L or H =	2.92		2.45		ft.
	Percentage of Open Area After Trash Rack Reduction	% open =	63		100		%
	Orifice Coefficient	C_o =	0.60		0.60		
	Weir Coefficient	C_w =	3.00				
	Orifice Elevation (Bottom for Vertical)	E_o =	7560.00		7,556.00		ft.

Calculation of Collection Capacity:

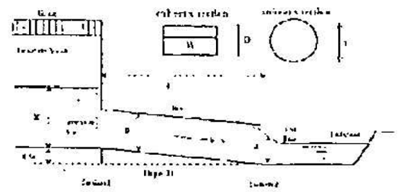
Net Opening Area (after Trash Rack Reduction)	A_o =	10.43		4.88	sq. ft.
OPTIONAL: User-Overide Net Opening Area	A_o =				sq. ft.
Perimeter as Weir Length	L_w =	12.98	ft.		
OPTIONAL: User-Overide Weir Length	L_w =		ft.		
Top Elevation of Vertical Orifice Opening, Top =			7558.45		ft.
Center Elevation of Vertical Orifice Opening, Cen =			7557.23		ft.

Routing 3: Single Stage - Water flows through WQCV plate and #1 horizontal opening into #1 vertical opening. This flow will be applied to culvert sheet (#2 vertical & horizontal openings is not used).

			Horizontal Orifices				Vertical Orifices			
Labels for WQCV, Minor, & Major Storage W.S. Elevations (input)	Water Surface Elevation ft (linked)	WQCV Plate/Riser Flow cfs (User-linked)	#1 Horiz. Weir Flow cfs (output)	#1 Horiz. Orifice Flow cfs (output)	#2 Horiz. Weir Flow cfs (output)	#2 Horiz. Orifice Flow cfs (output)	#1 Vert. Collection Capacity cfs (output)	#2 Vert. Collection Capacity cfs (output)	Total Collection Capacity cfs (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (link for goal seek)
	7558.00	0.00	0.00	0.00	0.00	0.00	19.18	0.00	0.00	
	7558.50	0.05	0.00	0.00	0.00	0.00	26.53	0.00	0.05	
	7559.00	0.10	0.00	0.00	0.00	0.00	31.50	0.00	0.10	
	7559.50	0.18	0.00	0.00	0.00	0.00	35.44	0.00	0.18	
EURV EL	7560.00	0.26	0.00	0.00	0.00	0.00	39.14	0.00	0.26	
	7560.50	0.31	13.77	35.51	0.00	0.00	42.52	0.00	14.08	
	7561.00	0.36	38.95	50.22	0.00	0.00	45.65	0.00	39.31	
	7561.50	0.40	71.56	61.51	0.00	0.00	48.58	0.00	48.58	
	7562.00	0.44	110.17	71.03	0.00	0.00	51.35	0.00	51.35	
100-YR WSL	7562.50	0.47	153.97	79.41	0.00	0.00	53.97	0.00	53.97	
	7563.00	0.50	202.40	86.99	0.00	0.00	56.47	0.00	56.47	
	7563.50	0.53	255.06	93.96	0.00	0.00	58.86	0.00	58.86	
SPILLWAY	7564.00	0.56	311.62	100.45	0.00	0.00	61.16	0.00	61.16	
TOP	7566.00	#N/A	572.48	123.02	0.00	0.00	69.60	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	

STAGE-DISCHARGE SIZING OF THE OUTLET CULVERT (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: SETTLERS RANCH FILING 2B
Basin ID: POND #4



Status: Culvert Data is valid!

Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	30	in.
Circular Culvert:	Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
Box Culvert:	Barrel Width (Span) in Feet	Width (Span) =		ft.
Box Culvert:	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	I_{elev} =	7556.00	ft. elev.
	Outlet Elevation at Culvert Invert	O_{elev} =	7555.00	ft. elev.
	Culvert Length in Feet	L =	66.0	ft.
	Manning's Roughness	n =	0.0130	
	Bend Loss Coefficient	K_b =	0.00	
	Exit Loss Coefficient	K_x =	1.00	

Design Information (calculated):

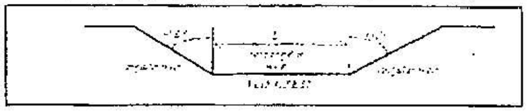
Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.61
Sum of All Loss Coefficients	K_s =	1.81
Orifice Inlet Condition Coefficient	C_d =	0.99
Minimum Energy Condition Coefficient	KE_{low} =	-0.04

Calculations of Culvert Capacity (output):

Water Surface Elevation From Sheet "Basin" (ft., linked)	Tailwater Surface Elevation ft (Input if known)	Culvert Inlet-Control Flowrate cfs (output)	Culvert Outlet-Control Flowrate cfs (output)	Flowrate Into Culvert From Sheet "Outlet" (cfs, linked)	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used (output)
7558.00	0.00	17.30	21.15	0.00	0.00	Regression Eqn.
7558.50	0.00	24.90	23.93	0.05	0.05	Regression Eqn.
7559.00	0.00	31.70	28.98	0.10	0.10	Regression Eqn.
7559.50	0.00	37.50	33.27	0.18	0.18	Regression Eqn.
7560.00	0.00	42.60	37.21	0.26	0.26	Regression Eqn.
7560.50	0.00	47.10	40.74	14.08	14.08	Regression Eqn.
7561.00	0.00	51.20	44.03	39.31	39.31	Regression Eqn.
7561.50	0.00	55.10	47.06	48.58	47.06	Regression Eqn.
7562.00	0.00	58.80	49.91	51.35	49.91	Regression Eqn.
7562.50	0.00	62.30	52.61	53.97	52.61	Regression Eqn.
7563.00	0.00	65.70	55.16	56.47	55.16	Regression Eqn.
7563.50	0.00	68.90	57.63	58.86	57.63	Regression Eqn.
7564.00	0.00	71.70	59.98	61.16	59.98	Orifice Eqn.
7566.00	0.00	81.60	68.59	#N/A	#N/A	Orifice Eqn.
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)

STAGE-DISCHARGE SIZING OF THE SPILLWAY

Project: SETTLERS RANCH FILING 2B
Basin ID: POND #4



Design Information (input):

Bottom Length of Weir	L =	15.00	feet
Angle of Side Slope Weir	Angle =	68.20	degrees
Elev. for Weir Crest	EL. Crest =	7,564.00	feet
Coef. for Rectangular Weir	C_w =	3.00	
Coef. for Trapezoidal Weir	C_t =	3.00	

Calculation of Spillway Capacity (output):

Water Surface Elevation ft. (linked)	Rect. Weir Flowrate cfs (output)	Triangle Weir Flowrate cfs (output)	Total Spillway Release cfs (output)	Total Pond Release cfs (output)
7558.00	0.00	0.00	0.00	0.00
7558.50	0.00	0.00	0.00	0.05
7559.00	0.00	0.00	0.00	0.10
7559.50	0.00	0.00	0.00	0.18
7560.00	0.00	0.00	0.00	0.26
7560.50	0.00	0.00	0.00	14.08
7561.00	0.00	0.00	0.00	39.31
7561.50	0.00	0.00	0.00	47.06
7562.00	0.00	0.00	0.00	49.91
7562.50	0.00	0.00	0.00	52.61
7563.00	0.00	0.00	0.00	55.16
7563.50	0.00	0.00	0.00	57.63
7564.00	0.00	0.00	0.00	59.98
7566.00	127.28	42.43	169.71	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
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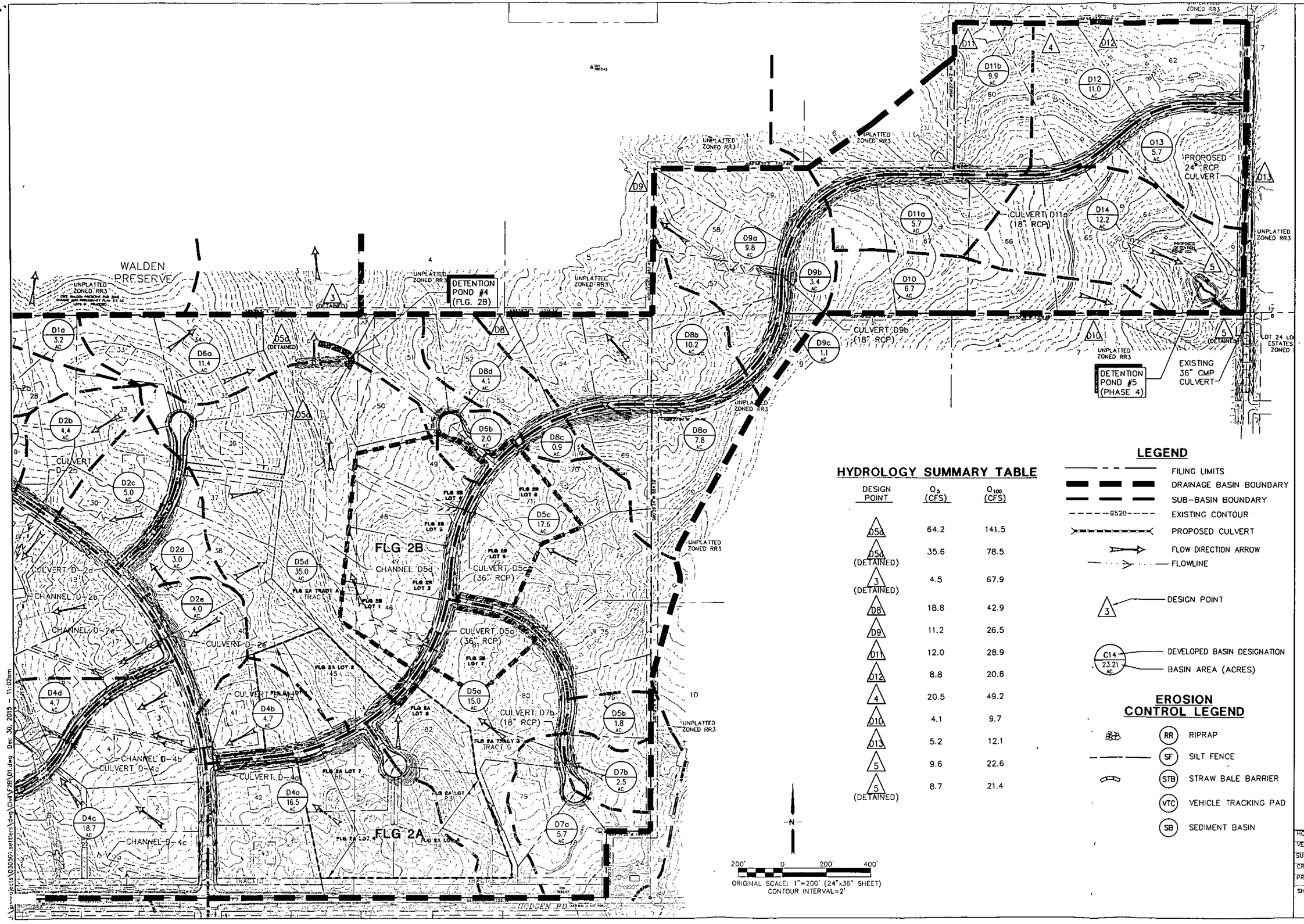
#N/A	#N/A	#N/A	#N/A	#N/A



HYDROLOGY SUMMARY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
D5d	64.2	141.5
D5d (DETAINED)	35.6	78.5
3 (DETAINED)	4.5	67.9
D8	18.8	42.9
D9	11.2	26.5
D11	12.0	28.9
D12	8.8	20.8
4	20.5	49.2
D10	4.1	9.7
D13	5.2	12.1
5	9.6	22.6
5 (DETAINED)	8.7	21.4

LEGEND

- FILING LIMITS
- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- PROPOSED CULVERT
- FLOW DIRECTION ARROW
- FLOWLINE
- 3 DESIGN POINT
- C14 23.21 AC DEVELOPED BASIN DESIGNATION / BASIN AREA (ACRES)

EROSION CONTROL LEGEND

- RR RIPRAP
- SF SILT FENCE
- STB STRAW BALE BARRIER
- VTC VEHICLE TRACKING PAD
- SB SEDIMENT BASIN

N

200' 0 200' 400'

ORIGINAL SCALE: 1"=200' (24"x36" SHEET)
CONTOUR INTERVAL=2'

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

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

SETTLERS RANCH - FILING NO. 2

DEVELOPED DRAINAGE PLAN

No.	REVISION	BY	DATE

HORZ. SCALE: 1"=200'	DRAWN: RMD
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RAMPART	CHECKED: JPS
CREATED: 5/2/06	LAST MODIFIED: 12/30/15
PROJECT NO: 030501	MODIFIED BY: BJJ
SHEET:	D1

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FINAL DRAINAGE REPORT

for

SETTLERS RANCH SUBDIVISION
FILING NO. 2

Prepared for:

Hodgen Settlers Ranch, LLC
5975 Hodgen Road
Colorado Springs, CO 80908

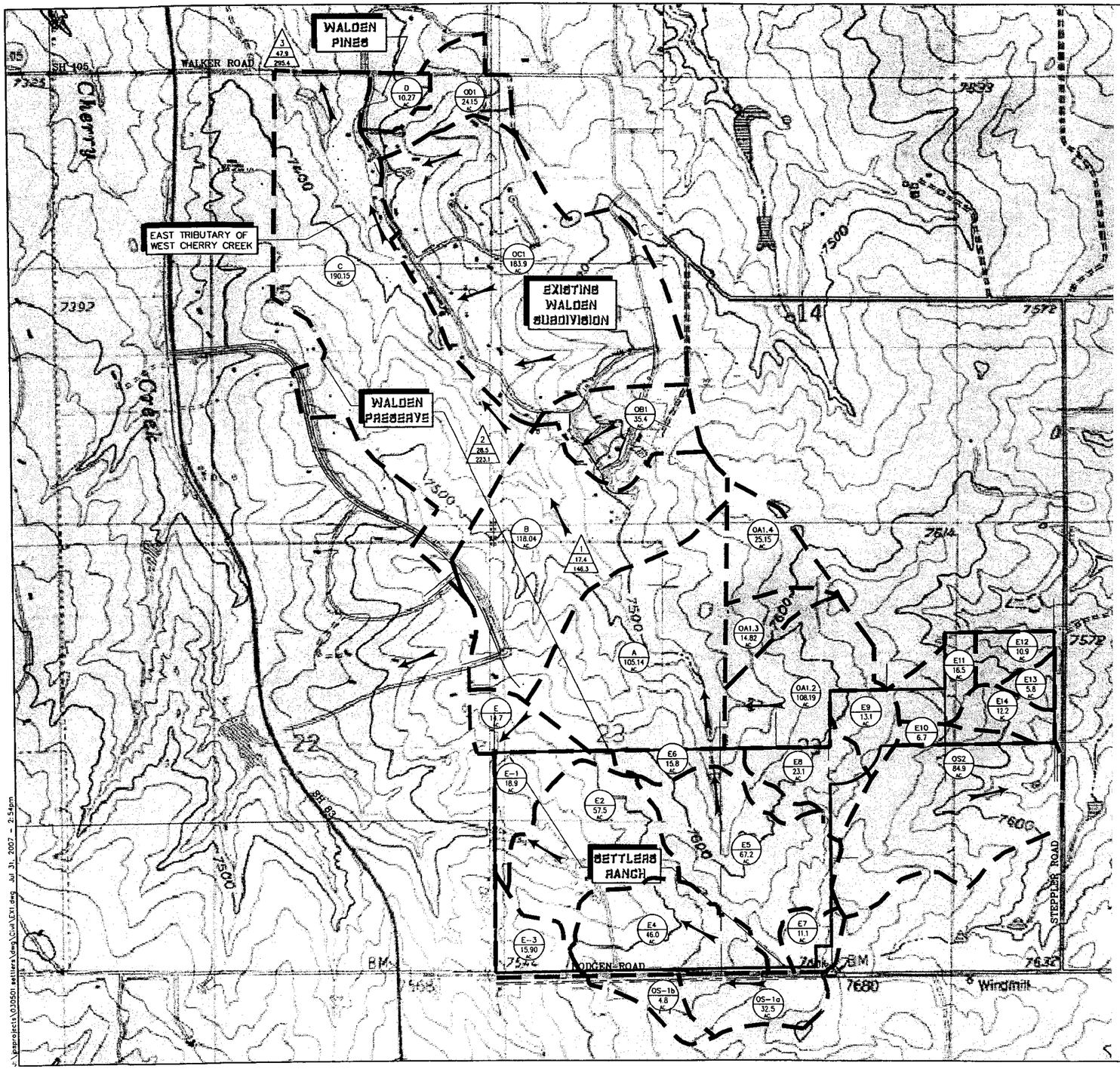
August 31, 2006
Revised December 29, 2006
Revised December 21, 2007
Revised May 30, 2008

Prepared by:

JPS ENGINEERING

19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
(719)-471-0766 FAX

JPS Project No. 030501



LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- EXISTING CONTOUR
- FLOWLINE
- PROPOSED FLOW DIRECTION ARROW
- DESIGN POINT
- Q_5 (cfs)
- Q_{100} (cfs)
- BASIN DESIGNATION
- BASIN AREA (ACRES)

SETTLERS RANCH SUBDIVISION

MAJOR BASIN / HISTORIC DRAINAGE PLAN

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

NO.	REVISION	BY	DATE

HORZ. SCALE:	1"=600'	DRAWN:	MJP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:		CHECKED:	JPS
CREATED:	4/24/05	LAST MODIFIED:	12/29/06
PROJECT NO:	030501	MODIFIED BY:	MJP
SHEET:	EX1		

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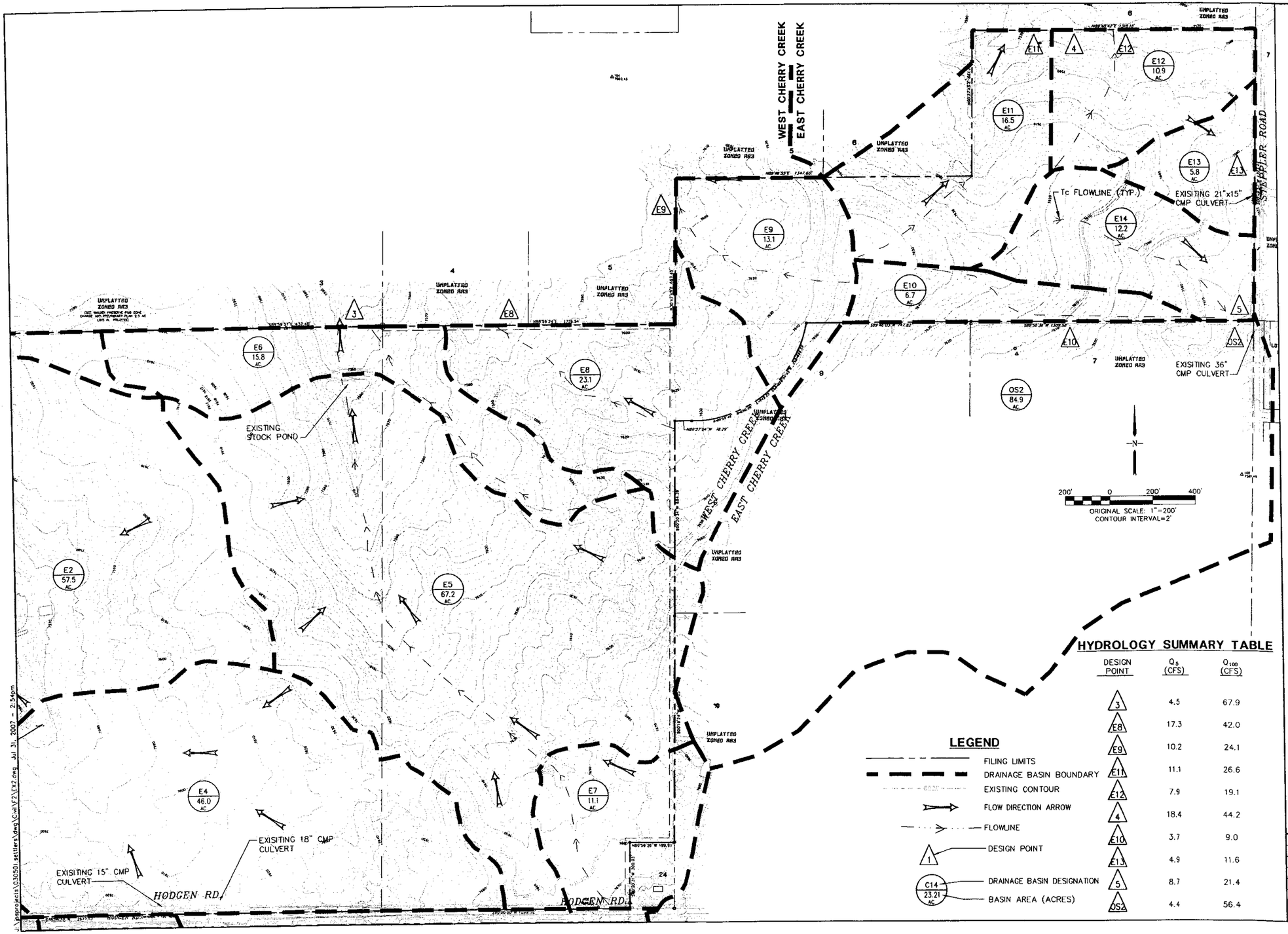

HYDROLOGY SUMMARY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
3	4.5	67.9
E8	17.3	42.0
E9	10.2	24.1
E11	11.1	26.6
E12	7.9	19.1
4	18.4	44.2
E10	3.7	9.0
E13	4.9	11.6
5	8.7	21.4
OS2	4.4	56.4

LEGEND

- FILING LIMITS
- DRAINAGE BASIN BOUNDARY
- EXISTING CONTOUR
- FLOW DIRECTION ARROW
- FLOWLINE
- 1 — DESIGN POINT
- C14 / 23.21 AC — DRAINAGE BASIN DESIGNATION / BASIN AREA (ACRES)

SETTLERS RANCH – FILING NO. 2

HISTORIC DRAINAGE PLAN

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

NO.	REVISION	BY	DATE

HORZ. SCALE: 1"=200'
VERT. SCALE: N/A
SURVEYED: RAMPART
CREATED: 5/2/06
PROJECT NO: 030501
SHEET: EX2

DRAWN: MJP
DESIGNED: JPS
CHECKED: JPS
LAST MODIFIED: 12/26/06
MODIFIED BY: MJP

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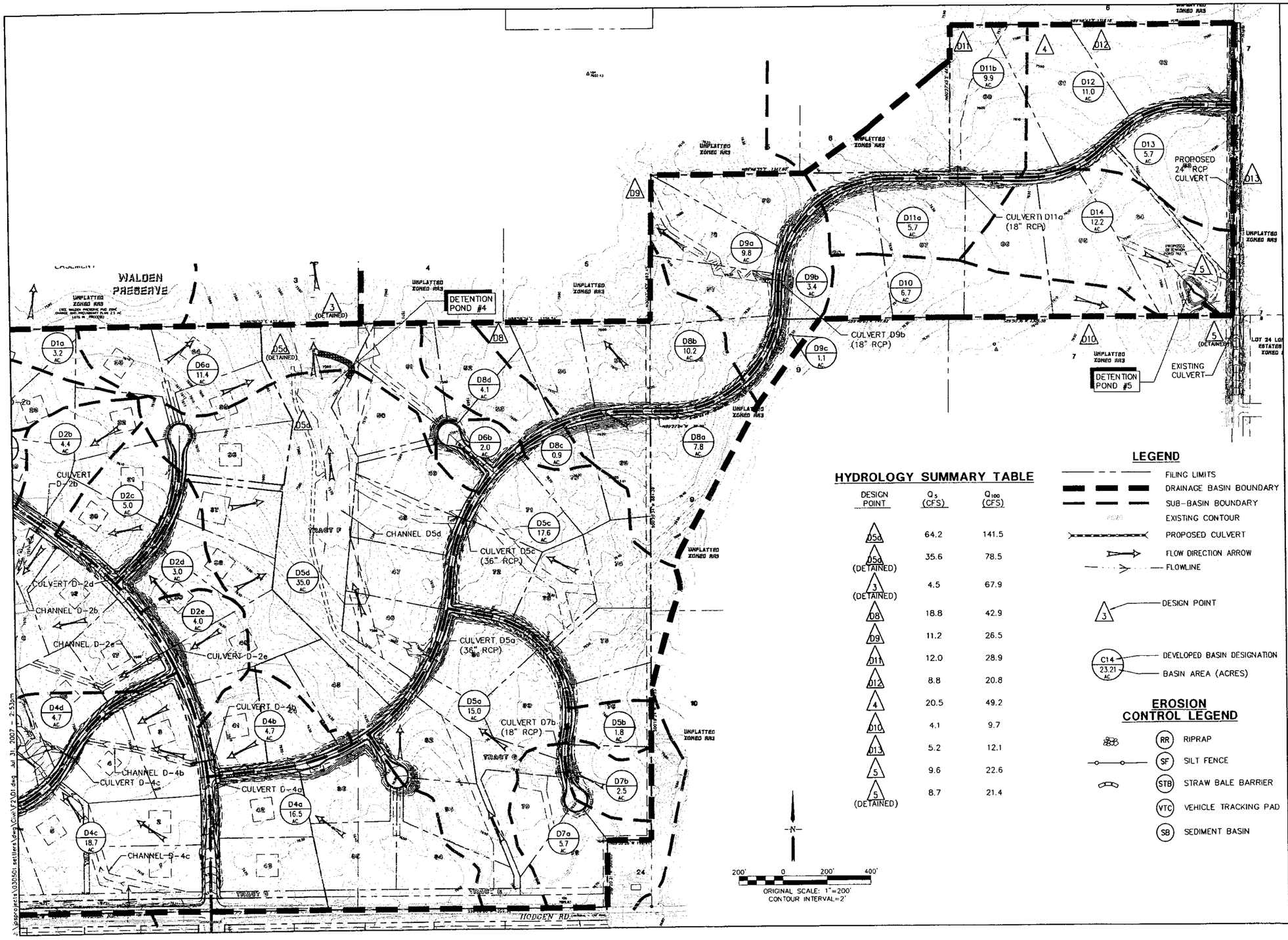


HYDROLOGY SUMMARY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
D5a	64.2	141.5
D5a (DETAINED)	35.6	78.5
3 (DETAINED)	4.5	67.9
D8	18.8	42.9
D9	11.2	26.5
D11	12.0	28.9
D12	8.8	20.8
4	20.5	49.2
D10	4.1	9.7
D13	5.2	12.1
5	9.6	22.6
5 (DETAINED)	8.7	21.4

LEGEND

- FILING LIMITS
- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- EXISTING CONTOUR
- PROPOSED CULVERT
- FLOW DIRECTION ARROW
- FLOWLINE
- DESIGN POINT
- DEVELOPED BASIN DESIGNATION
- BASIN AREA (ACRES)

EROSION CONTROL LEGEND

- RR — RIPRAP
- SF — SILT FENCE
- STB — STRAW BALE BARRIER
- VTC — VEHICLE TRACKING PAD
- SB — SEDIMENT BASIN

-N-

200' 0 200' 400'

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

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

SETTLERS RANCH – FILING NO. 2

DEVELOPED DRAINAGE PLAN

NO.	REVISION	BY	DATE

HOR. SCALE: 1"=200'	DRAWN: RMD
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RAMPART	CHECKED: JPS
CREATED: 5/2/06	LAST MODIFIED: 7/31/07
PROJECT NO: 030501	MODIFIED BY: RMD
SHEET: D1	

J:\projects\030501 settlers ranch\Civil\F2\D1.dwg Jul 31, 2007 - 2:53pm

FINAL DRAINAGE REPORT

for

SETTLERS VIEW SUBDIVISION

Prepared for:

Hannigan and Associates, Inc.
19360 Spring Valley Road
Monument, CO 80132

July 31, 2018
Revised January 28, 2019
Revised March 5, 2019

Prepared by:

19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
(719)-471-0766 fax
www.jpsengr.com

JPS Project No. 111603
PCD File No.: SF-18-041

Basin S discharges to an existing grass-lined drainage swale flowing westerly across the adjoining 40-acre property to the existing downstream drainage channel and series of ponds within the Walden Preserve Subdivision.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in Figure D1, and hydrologic calculations are enclosed in Appendix B.

The east side of the property has been delineated as Basins A, B, and C in the developed condition, and these basins will continue to sheet flow easterly through the proposed Abert Ranch Subdivision.

Basin A flows easterly to Design Point #A, with developed peak flows calculated as Q_5 = 5.5 cfs and Q_{100} = 22.4 cfs. Basin B flows easterly to Design Point #B, with developed peak flows calculated as Q_5 = 1.7 cfs and Q_{100} = 6.8 cfs. Basin C flows easterly to Design Point #C, with developed peak flows calculated as Q_5 = 0.8 cfs and Q_{100} = 3.1 cfs. Combined developed flows from Basins A, B, and C are calculated as Q_5 = 7.6 cfs and Q_{100} = 31.2 cfs (Design Point #A1).

Development plans for the proposed Abert Ranch Subdivision on the adjoining ranch property to the east include upgrade of an existing stock pond to meet stormwater detention requirements for the Abert Ranch site, including the minimal developed drainage contribution from Settlers View Basins A, B, and C. Recognizing the minimal developed area along the east side of Settlers View Subdivision, there will be no significant adverse impact on the Abert Ranch property if Settlers View is fully developed before development of Abert Ranch Subdivision and the upgrade to the existing stock pond.

The west side of the property has been delineated as Basins S1-S4 based on the developed road configuration, and these basins will continue to flow westerly to the existing drainage swale at the western property boundary.

Developed Basin S1 will flow southwesterly to the proposed Culvert S1 crossing Silver Nell Drive at Design Point #S1. Culvert S1 will flow southwesterly along Ditch S3 on the west side of Settlers View Road to a proposed Full-Spectrum Detention Pond (Pond S3) at the west boundary of the subdivision. Ditch S3 will be stabilized with erosion control blanket lining.

Off-site drainage from Basin D9 of the adjoining Settlers Ranch Subdivision will flow northwesterly through Basin S2 to the proposed Culvert S2 crossing Settlers View Road at Design Point #S2, continuing through a grass-lined channel to Detention Pond S3.

Flows from Basins D9 and S1-S3 combine at Design Point #S3, with developed peak flows of Q_5 = 19.0 cfs and Q_{100} = 78.1 cfs. Developed flow impacts from the subdivision will be mitigated by routing flows through Detention Pond #S3.

Off-site Basin OS1 will continue to flow northwesterly through Basin S4 to the west boundary of the site.

Flows from Basins D9, OS1, and S1-S4 ultimately combine at downstream Design Point #S, with developed peak flows calculated as Q_5 = 22.0 cfs and Q_{100} = 90.6 cfs.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the proposed development will result in developed flows exceeding historic flows from the parcel. The increase in developed flows will be mitigated through on-site stormwater detention facilities.

The comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow			Developed Flow			Comparison of Developed to Historic Flow (Q_5%/Q_{100}%)
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
A1	15.0	3.0	21.6	15.0	7.6	31.2	253% / 144% (increase)
S	46.8	10.0	73.1	46.8	22.0	90.6	220% / 124% (increase)

D. Detention Ponds

The Developed storm runoff downstream of the proposed subdivision will be maintained at historic levels by routing flows through a proposed detention pond at the west boundary of the property. Pond #S3 will be constructed as a Full-Spectrum Detention (FSD) Pond to mitigate developed flow impacts from the proposed subdivision. The pond outlet structure has been designed with multiple orifice openings to detain the full spectrum of storm events.

Detailed pond routing calculations have been performed utilizing the Denver Urban Drainage "UD-Detention" software package (see Appendix C). The pond outlet structure configuration has been designed to maintain the calculated pond discharge below the target outflow, while maintaining the maximum water surface elevation below the pond spillway. Final detention pond design parameters are summarized as follows:

Pond	Inflow (Q_{100}, cfs)	Outflow (Q_{100}, cfs)	Volume (ac-ft)	Outlet Structure
Pond #S3	68.2	39.0	1.3	30-inch SD w/ orifice plates

SETTLERS VIEW SUBDIVISION
COMPOSITE RUNOFF COEFFICIENTS - TYPICAL RURAL RESIDENTIAL LOTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	0.90	89.00	LANDSCAPED	0.08				0.170
5-ACRE LOTS	2.50	7.00	BUILDING / PAVEMENT	0.90	93.00	LANDSCAPED	0.08				0.137

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	0.96	89.00	LANDSCAPED	0.35				0.417
5-ACRE LOTS	2.50	7.00	BUILDING / PAVEMENT	0.96	93.00	LANDSCAPED	0.35				0.393

IMPERVIOUS AREAS

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	100	89.00	LANDSCAPED	0				11.000
5-ACRE LOTS	2.50	7.00	BUILDING / PAVEMENT	100	93.00	LANDSCAPED	0				7.000

SETTLERS VIEW
RATIONAL METHOD

DEVELOPED FLOWS

					Overland Flow			Channel flow									
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR[7]	C 100-YEAR[7]	LENGTH (FT)	SLOPE (FT/FT)	Tco[1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS[2] VELOCITY (FT/S)	Tt[3] (MIN)	TOTAL Tc[4] (MIN)	TOTAL Tc[4] (MIN)	INTENSITY[5] 5-YR (IN/HR)	INTENSITY[5] 100-YR (IN/HR)	PEAK FLOW Q5[6] (CFS)	PEAK FLOW Q100[6] (CFS)
WEST CHERRY CREEK BASIN																		
OS1	OS1	4.01	0.170	0.417	300	0.073	15.2	450	15.00	0.058	3.61	2.1	17.3	17.3	3.31	5.55	2.25	9.28
S4		2.46	0.080	0.350			0.0	200	15.00	0.05	3.35	1.0	1.0	5.0	5.17	8.68	1.02	7.47
OS1,S4	S4	6.47	0.136	0.392									18.3	18.3	3.22	5.41	2.83	13.71
S1	S1	4.30	0.170	0.417	300	0.033	19.8	0				0.0	19.8	19.8	3.10	5.21	2.27	9.34
D9	D9	14.30	0.170	0.417	250	0.080	13.5	700	15.00	0.074	4.08	2.9	16.3	16.3	3.39	5.70	8.25	33.97
S2	S2a	9.04	0.170	0.417	300	0.073	15.2	650	15.00	0.049	3.33	3.3	18.4	18.4	3.21	5.39	4.93	20.32
Tc Channel S2							0.0	280	15.00	0.025	2.37	2.0	2.0	5.0				
D9,S2	S2	23.34	0.170	0.417									18.4	18.4	3.21	5.39	12.74	52.46
S3	S3a	12.67	0.170	0.417	300	0.060	16.2	1000	15.00	0.049	3.31	5.0	21.3	21.3	3.00	5.03	6.46	26.58
Tc Channel S3							0.0	1000	15.00	0.050	3.35	5.0	5.0	5.0				
D9,S1-S3	S3	40.31	0.170	0.417									24.8	24.8	2.77	4.65	18.97	78.09
OS1,D9,S1-S4	S	46.78	0.170	0.417									24.8	24.8	2.77	4.65	22.01	90.62
EAST CHERRY CREEK BASIN																		
A	A	10.74	0.170	0.417	300	0.033	19.8	400	15.00	0.075	4.11	1.6	21.4	21.4	2.99	5.01	5.45	22.44
B	B	2.93	0.170	0.417	300	0.050	17.3	0				0.0	17.3	17.3	3.31	5.56	1.65	6.79
C	C	1.28	0.170	0.417	300	0.067	15.7	0				0.0	15.7	15.7	3.45	5.80	0.75	3.10
A,B,C	A1	14.95	0.170	0.417									21.4	21.4	2.99	5.01	7.59	31.24

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

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

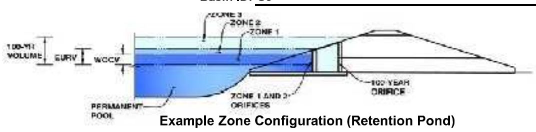
7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: SETTLERS VIEW

Basin ID: S3



Example Zone Configuration (Retention Pond)

Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	EDB			
Watershed Area =	28.50	acres		
Watershed Length =	1,300	ft		
Watershed Slope =	0.046	ft/ft		
Watershed Imperviousness =	11.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.172	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.297	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.206	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.318	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.694	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.763	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.433	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.308	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	5.008	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.191	acre-feet		
Approximate 5-yr Detention Volume =	0.298	acre-feet		
Approximate 10-yr Detention Volume =	0.594	acre-feet		
Approximate 25-yr Detention Volume =	0.816	acre-feet		
Approximate 50-yr Detention Volume =	0.856	acre-feet		
Approximate 100-yr Detention Volume =	1.100	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.172	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.124	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.803	acre-feet
Total Detention Basin Volume =	1.100	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Depth Increment = 2 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Bottom=7572.0	--	1.00	--	--	--	4,820	0.111	2,367	0.054
	--	3.00	--	--	--	7,192	0.165	14,427	0.331
	--	5.00	--	--	--	9,989	0.229	31,608	0.726
100-YR WSL	--	7.00	--	--	--	13,230	0.304	54,827	1.259
Top EL =7580.0	--	9.00	--	--	--	16,000	0.367	84,057	1.930
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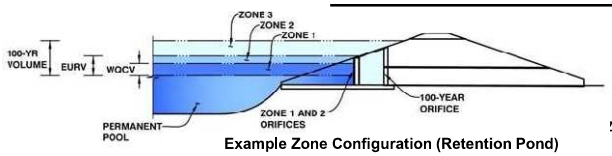
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: SETTLERS VIEW

Basin ID: S3



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.95	0.172	Orifice Plate
Zone 2 (EURV)	2.79	0.124	Orifice Plate
Zone 3 (100-year)	6.47	0.803	Weir&Pipe (Restrict)
		1.100	Total

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.79	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	11.20	inches
Orifice Plate: Orifice Area per Row =	1.18	sq. inches (diameter = 1-3/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	8.194E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.93	1.86					
Orifice Area (sq. inches)	1.18	1.18	1.18					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.50	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.00	N/A	feet
Over Flow Weir Slope Length =	2.50	N/A	feet
Grate Open Area / 100-yr Orifice Area =	1.89	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	7.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.50	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	21.20		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	3.71	N/A	ft^2
Outlet Orifice Centroid =	0.98	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.00	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	23.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.91	feet
Stage at Top of Freeboard =	8.91	feet
Basin Area at Top of Freeboard =	0.36	acres

Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
Calculated Runoff Volume (acre-ft) =	0.172	0.297	0.206	0.318	0.694	1.763	2.433	3.308	5.008
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.172	0.296	0.205	0.317	0.693	1.761	2.430	3.305	4.996
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.02	0.03	0.28	0.87	1.20	1.59	2.34
Predevelopment Peak Q (cfs) =	0.0	0.0	0.5	0.8	7.8	24.7	34.1	45.4	66.7
Peak Inflow Q (cfs) =	3.7	6.3	4.4	6.7	14.6	36.7	50.4	68.2	102.3
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.2	8.0	24.6	31.4	39.0	83.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	1.0	1.0	0.9	0.9	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	1.1	3.5	4.5	5.5	6.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	47	41	49	47	36	32	27	19
Time to Drain 99% of Inflow Volume (hours) =	40	51	43	52	53	48	45	42	37
Maximum Ponding Depth (ft) =	1.86	2.68	2.09	2.80	3.43	4.48	5.41	6.71	7.65
Area at Maximum Ponding Depth (acres) =	0.13	0.16	0.14	0.16	0.18	0.21	0.24	0.29	0.32
Maximum Volume Stored (acre-ft) =	0.161	0.278	0.192	0.299	0.403	0.611	0.820	1.172	1.463

PRELIMINARY & FINAL DRAINAGE REPORT

for

ABERT RANCH SUBDIVISION

Prepared for:

Hannigan and Associates, Inc.
19360 Spring Valley Road
Monument, CO 80132

March 27, 2017
Revised November 16, 2017
Revised April 5, 2019
Revised November 15, 2019
Revised April 15, 2020

Prepared by:

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

JPS Project No. 111604
PCD File No. SP-17-007 / SF-1911

DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report.

5/11/20

John P. Schwab, P.E. #29891

Developer's Statement:

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

By: Eric Leffler 5/14/20

Printed Name: Eric Leffler Date
BF Ranch Trust 2015
11730 Timberlane Court, Colorado Springs, CO 80908

El Paso County's Statement

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

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

Conditions:

The stormwater management concept for the Abert Ranch development will be to provide roadside ditches and natural swales as required to convey developed drainage through the site to existing natural outfalls. Individual lot grading will provide positive drainage away from building sites, and direct developed flows into the system of roadside ditches and drainage swales running through the subdivision.

An existing stock pond near the east boundary of the subdivision will be upgraded to serve as a stormwater detention pond to mitigate the impact of developed flows and maintain historic peak flows downstream of the property.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions within the site are depicted in Figure EX1. The on-site area has been identified as Basin I, which is impacted by upstream off-site drainage basins to the north, west, and south.

Basin OI1 is the off-site area to the north within the existing Grandview Subdivision. Basin A is the off-site area to the west within the proposed Settlers View Subdivision. Basins D11 and D12 are the off-site areas to the south within the proposed Settlers Ranch Subdivision.

Off-site flows from Basins OI1, A, D11, and D12 enter the Abert Ranch property and drain easterly in an existing grass-lined drainage channel, flowing through an existing stock pond, and ultimately crossing Steppler Road in an existing 48-inch RCP culvert at the eastern site boundary.

Flows from Basins OI1, A, D11, D12, and I combine at Design Pont #I, with historic peak flows calculated as Q_5 = 16.3 cfs and Q_{100} = 119.9 cfs.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in Figure D1, and hydrologic calculations are enclosed in Appendix A.

Basins A, B, and C represent developed basins within the adjoining Settlers View Subdivision, and these basins will continue to sheet flow easterly through the proposed Abert Ranch Subdivision.

Basin C will flow easterly along the south side of Silver Nell Drive, combining with Basin E at Design Point #E, with developed peak flows calculated as Q_5 = 2.5 cfs and Q_{100} = 10.2 cfs. An 18-inch RCP culvert will convey flows at Design Point #E northerly across Silver Nell Drive on the west side of Abert Ranch Drive.

Basins G, D11, and H will flow northeasterly to the low point in the roadway profile at Design Point #H, combining with upstream flows from DP-F, with total developed peak flows calculated as Q_5 = 14.6 cfs and Q_{100} = 64.4 cfs. A 30-inch RCP culvert will convey flows from Design Point #H northerly across Abert Ranch Drive.

Basins A, D12, OI1, and I combine with flows from DP-H at Design Point #I, with total developed peak flows calculated as Q_5 = 32.8 cfs and Q_{100} = 147.9 cfs.

The existing stock pond within Basin I near the eastern site boundary will be upgraded to serve as "Detention Pond I," mitigating the impact of developed flows from the subdivision. This pond will reduce flows to historic levels prior to discharging to the existing natural drainage swale downstream.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix A, the proposed development will result in calculated flows exceeding historic flows from the parcel. The increase in developed flows will be mitigated through on-site stormwater detention facilities. The comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow			Developed Flow			Comparison of Developed to Historic Flow (Q_5%/Q_{100}%)
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
I (Developed)	95.1	16.3	119.9	95.1	32.8	147.9	201% / 123% (increase)
I (Detained)				95.1	0.4	113.9	2.5% / 95% (decrease)

D. Detention Ponds

The Developed storm runoff downstream of the proposed subdivision will be maintained at historic levels by routing flows through the proposed detention pond at the east boundary of the property. The existing stock pond will be upgraded to serve as Full-Spectrum Detention (FSD) Pond #I to mitigate developed flow and water quality impacts from the proposed subdivision. The pond outlet structure has been designed with multiple orifice openings to detain the full spectrum of storm events.

A geotechnical analysis will be performed to confirm the structural stability of the existing pond embankment, and any applicable geotechnical recommendations will be implemented in conjunction with upgrade of the existing pond. According to DCM Section 6.6, a jurisdictional dam is defined as a dam which "exceeds 10 feet in height measured vertically from the elevation of the lowest point of the natural surface of the ground where that point occurs along the longitudinal centerline of the dam up to the flowline crest of the emergency spillway of the dam."

ABERT RANCH SUBDIVISION
COMPOSITE IMPERVIOUS AREAS

IMPERVIOUS AREAS

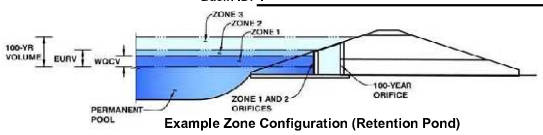
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
C	1.28	1.28	2.5-AC LOTS	11.0							11.000
E	3.12	3.12	2.5-AC LOTS	11.0							11.000
C,E	4.40										11.000
B	2.93	2.93	2.5-AC LOTS	11.0							11.000
F	3.78	3.78	2.5-AC LOTS	11.0							11.000
C,E,B,F	11.11										11.000
G	2.27	2.27	2.5-AC LOTS	11.0							11.000
D11	15.60	15.60	5-AC LOTS	7.0							7.000
H	5.69	5.69	2.5-AC LOTS	11.0							11.000
DPF,G,D11,H	34.67										9.200
A	10.74	10.74	2.5-AC LOTS	11.0							11.000
D12	11.00	11.00	5-AC LOTS	7.0							7.000
OI1	13.12	13.12	5-AC LOTS	7.0							7.000
I	25.60	16.60	5-AC LOTS	7.0	9.00	2.5-AC LOTS	11.0				8.406
DPH,D12,OI1,I	95.13										8.632

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: ABERT RANCH

Basin ID: I



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB		
Watershed Area =	95.10	acres	
Watershed Length =	2,800	ft	
Watershed Slope =	0.041	ft/ft	
Watershed Imperviousness =	8.60%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	100.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Desired WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.466	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	0.759	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	0.514	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.810	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.991	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	5.595	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	7.841	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	10.774	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.07 in.) =	16.086	acre-feet	3.07 inches
Approximate 2-yr Detention Volume =	0.477	acre-feet	
Approximate 5-yr Detention Volume =	0.758	acre-feet	
Approximate 10-yr Detention Volume =	1.686	acre-feet	
Approximate 25-yr Detention Volume =	2.410	acre-feet	
Approximate 50-yr Detention Volume =	2.510	acre-feet	
Approximate 100-yr Detention Volume =	3.272	acre-feet	

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.466	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.293	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.512	acre-feet
Total Detention Basin Volume =	3.272	acre-feet

Depth Increment = 2 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	–	0.00	–	–	–	10	0.000		
Bot EL=7543.0	–	1.00	–	–	–	3,154	0.072	1,551	0.036
	–	2.00	--	–	–	4,061	0.093	5,149	0.118
	–	4.00	--	–	–	9,656	0.222	18,906	0.434
	–	6.00	–	–	–	16,274	0.374	44,836	1.029
	–	8.00	–	–	–	25,480	0.585	86,590	1.988
	–	10.00	–	–	–	39,095	0.897	151,165	3.470
Spillway=7552.9	–	11.00	–	–	–	46,559	1.069	193,992	4.453
	–	12.00	--	–	–	54,023	1.240	244,283	5.608
Top EL=7555.0	–	13.00	–	–	–	61,500	1.412	302,045	6.934
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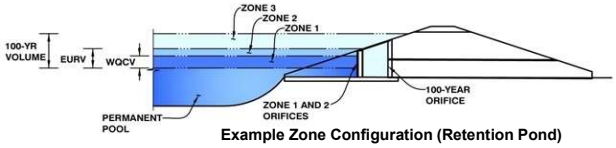
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: ABERT RANCH

Basin ID: I



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.37	0.520	Orifice Plate
Zone 2 (EURV)	5.56	0.350	Orifice Plate
Zone 3 (100-year)	10.00	2.598	Weir&Pipe (Restrict)
		3.467	Total

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.403E-02	ft^2
Depth at top of Zone using Orifice Plate =	5.22	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	14.30	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.02	sq. inches (diameter = 1-9/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.74	3.48					
Orifice Area (sq. inches)	2.02	2.02	2.02					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	8.90	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	10.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	10.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	8.90	N/A	feet
Over Flow Weir Slope Length =	10.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	10.27	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	70.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	35.00	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	42.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	28.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	6.81	N/A	ft^2
Outlet Orifice Centroid =	1.31	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	10.90	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	65.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.95	feet
Stage at Top of Freeboard =	12.85	feet
Basin Area at Top of Freeboard =	1.39	acres

Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.07
Calculated Runoff Volume (acre-ft) =	0.520	0.870	0.596	0.930	2.146	5.733	7.974	10.901	16.207
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.519	0.868	0.595	0.929	2.145	5.728	7.963	10.885	16.192
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.24	0.77	1.06	1.42	2.04
Predevelopment Peak Q (cfs) =	0.0	0.0	1.3	2.3	22.6	72.9	100.7	134.7	194.1
Peak Inflow Q (cfs) =	9.7	16.2	11.2	17.3	39.6	104.0	143.4	194.1	285.1
Peak Outflow Q (cfs) =	0.3	0.4	0.3	0.4	0.5	59.6	101.1	114.7	236.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.0	0.8	1.0	0.9	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.8	1.4	1.6	1.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	49	41	50	76	77	72	67	60
Time to Drain 99% of Inflow Volume (hours) =	**41**	52	44	54	83	89	86	82	78
Maximum Ponding Depth (ft) =	4.21	5.40	4.50	5.57	8.14	9.68	10.01	10.92	11.60
Area at Maximum Ponding Depth (acres) =	0.24	0.33	0.26	0.34	0.61	0.85	0.90	1.06	1.17
Maximum Volume Stored (acre-ft) =	0.480	0.816	0.554	0.876	2.065	3.183	3.470	4.368	5.126

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
A1	7.6	31.2
D11	6.0	28.8
D12	4.6	21.9
S1	2.3	9.3
S2	12.7	52.5
S3	19.0	78.1
S4	2.8	13.7
S	22.0	90.6
E	2.5	10.2
F	5.9	24.5
H	14.6	64.4
I (DEVELOPED)	32.8	147.9
1 (DETAINED)	0.4	113.9

EXISTING GRANDVIEW SUBDIVISION

SILVER NELL DRIVE

OI1 13.12 AC.

EXISTING STOCK POND; UPGRADE TO DETENTION POND 1 (VOL=3.3 AF)

EXISTING WALDEN PRESERVE FILING NO. 1

RUSHING LEAVES LANE

EXISTING GRANDVIEW SUBDIVISION

PROPOSED SETTLERS VIEW

PROPOSED CHANNEL A

A 10.74 AC. — A1

I 25.60 AC. — I

EXISTING 48" RCP CULVERT I

PROPOSED CULVERT H

CHANNEL I

PROPOSED ABERT RANCH

PARCEL #61000-00-268 MOREHEAD LIVING TRUST 40.0 AC.

OS1 4.01 AC.

PROPOSED CULVERT F

F — H 5.69 AC. — D11 — CHANNEL H — D12

PROPOSED SETTLERS RANCH FILING NO. 2

B 2.93 AC.

F 3.78 AC.

D11b 9.9 AC.

D12 11.0 AC.

S4 2.46 AC. — S4

PROPOSED CULVERT S1 — S1 — S1 4.30 AC.

S3 12.67 AC. — S3

PROPOSED CULVERT E

C 1.28 AC.

E 3.12 AC.

G 2.27 AC.

PROPOSED CULVERT D11a (18" RCP)

POND VIEW PLACE

EXISTING CHANNEL

PROPOSED DETENTION POND S3 — S3

DITCH S3

S2 9.04 AC. — S2

CHANNEL S2

EXISTING STOCK POND

CHANNEL S3.1

PROPOSED CULVERT S2

D9

EXISTING 21" RCP CULVERT

D11a 5.7 AC.

D14 12.2 AC.

NOTE: THIS SEGMENT OF SETTLERS RANCH ROAD TO BE GRADED BY ABERT RANCH FOR SECONDARY ACCESS

EXISTING STABLE CHANNEL

D9a 9.8 AC.

D9b 3.4 AC.

PROPOSED SETTLERS RANCH FILING NO. 2

PROPOSED SETTLERS VIEW

EXISTING 36" RCP CULVERT

PROPOSED CULVERT D9b (18" RCP)

D9c 1.1 AC.

FUTURE SETTLERS RANCH DETENTION POND NO. 5

D6a 11.4 AC.

D8d 4.1 AC.

D8b 10.2 AC.

PROPOSED SETTLERS RANCH FILING NO. 2

SETTLERS RANCH RD.

SETTLERS RANCH DETENTION POND NO. 4

D6b 2.0 AC.

D8c 0.9 AC.

D8a 7.8 AC.

DETENTION POND SUMMARY TABLE
(PER "UD-DETENTION")

POND	PRE-DEVELOPMENT PEAK FLOW (Q100-CFS)	PEAK INFLOW (Q100-CFS)	PEAK OUTFLOW (Q100-CFS)
S3	45.4	68.2	39.0
I	134.7	191.9	113.9

200' 0 200' 400' N

ORIGINAL SCALE: 1"=200'
(24"x36" SHEET)
CONTOUR INTERVAL=2'

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SETTLERS VIEW & ABERT RANCH

DEVELOPED DRAINAGE PLAN

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

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

No.	REVISION	BY	DATE

HORZ. SCALE: 1"=200'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: HANNIGAN	CHECKED: JPS
CREATED: 12/26/16	LAST MODIFIED: 2/25/20
PROJECT NO: 111603	MODIFIED BY: BJJ
SHEET: D1	

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
F	5.9	24.5
H	14.6	64.4
I (DEVELOPED)	32.8	147.9
I (DETAINED)	0.4	113.9

DATUM IS NAVD '88. BENCHMARK IS THE MONUMENT AT THE SOUTHWEST PROPERTY CORNER, HAVING AN ELEVATION OF 7650.0

ORIGINAL SCALE: 1"=100' (24"x36" SHEET)
CONTOUR INTERVAL=2'

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

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

ABERT RANCH

DEVELOPED DRAINAGE PLAN

No.	REVISION	BY	DATE

HORZ. SCALE: 1"=100'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: HANNIGAN	CHECKED: JPS
CREATED: 12/27/16	LAST MODIFIED: 4/15/20
PROJECT NO: 111604	MODIFIED BY: MSP
SHEET: D1.1	

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APPENDIX B

HYDROLOGIC CALCULATIONS

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

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

3.2 Time of Concentration

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

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

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

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

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

3.2.1 Overland (Initial) Flow Time

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

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

Where:

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

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

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

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

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

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

3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

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

L = waterway length (ft)

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

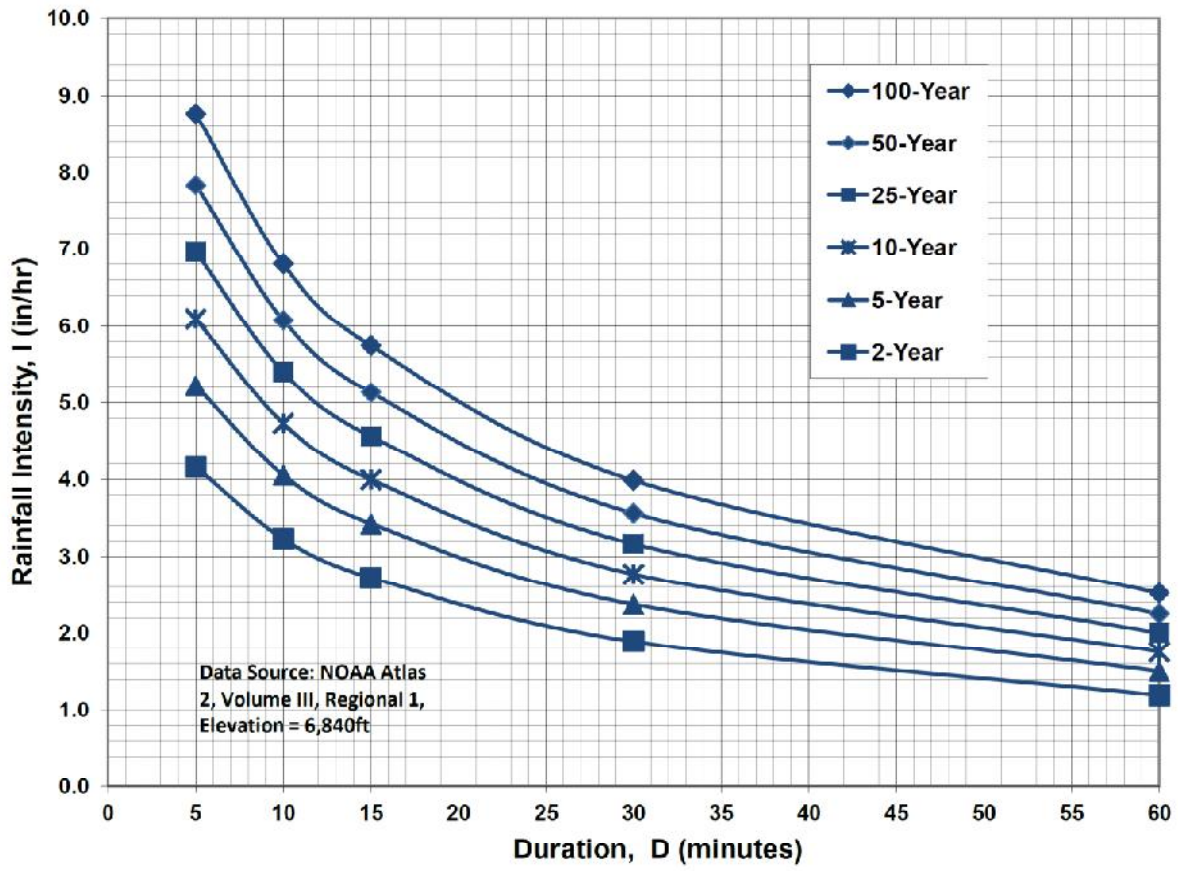
3.2.4 Minimum Time of Concentration

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

3.2.5 Post-Development Time of Concentration

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

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

SETTLERS RANCH
RATIONAL METHOD

HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR[7]	C 100-YEAR[7]	OVERLAND LENGTH (FT)	SLOPE (%)	Tco[1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS[2] VELOCITY (FT/S)	Tt[3] (MIN)	TOTAL Tc[4] (MIN)	INTENSITY[5] 5-YR (IN/HR)	INTENSITY[5] 100-YR (IN/HR)	PEAK FLOW Q5[6] (CFS)	PEAK FLOW Q100[6] (CFS)
E3	1	15.90	0.270	0.370									16.7	3.24	5.54	13.91	32.59
OS1a		32.50	0.280	0.370									25.1	2.61	4.48	23.75	53.87
OS1b		4.80	0.280	0.370									18.6	3.07	5.24	4.13	9.31
E4		46.00	0.260	0.360									24.4	2.66	4.55	31.81	75.35
E2		57.50	0.250	0.350									27.9	2.46	4.23	35.36	85.13
E1		18.80	0.250	0.350									36.1	2.12	3.66	9.96	24.08
OS1a,b,E4,E2,E1	2	159.60	0.260	0.370									31.8	2.20	4.00	91.29	236.21
E7		11.10	0.250	0.350	400	7.5	15.6	350	1.50	2.9	2.55	2.3	17.9	3.10	5.25	8.60	20.40
E5		67.20	0.250	0.350			0.0	2150	1.50	3.7	2.89	12.4	12.4				
E6		15.80	0.250	0.350			0.0	220	1.50	4.6	3.20	1.1	1.1				
E7,E5,E6	E6	94.10	0.250	0.350									31.5	2.30	4.00	54.11	131.74
E8	E8	23.10	0.250	0.350	300	9.3	12.6	1350	1.50	5.2	3.42	6.6	19.2	3.00	5.20	17.33	42.04
E9	E9	13.10	0.250	0.350	400	8.3	15.1	550	1.50	5.6	3.55	2.6	17.7	3.10	5.25	10.15	24.07
E9-E5	3	130.30	0.250	0.350									31.5	2.30	4.00	74.92	182.42
E11	E11	16.50	0.250	0.350	600	5.8	20.9	700	1.50	7.4	4.08	2.9	23.7	2.69	4.61	11.10	26.62
E12	E12	10.90	0.250	0.350	600	6.7	19.9	140	1.50	7.1	4.00	0.6	20.5	2.90	5.00	7.90	19.08
E11,E12	4	27.40	0.250	0.350									23.7	2.69	4.61	18.43	44.21
E10	E10	6.70	0.250	0.350	1000	4.6	29.1	900	1.50	5.6	3.55	4.2	33.3	2.20	3.85	3.69	9.03
E14		12.20	0.250	0.350	300	4.0	16.7	1050	1.50	5.9	3.64	4.8	21.5	2.85	5.00	8.69	21.35
E10,E14	5	18.90	0.250	0.350									33.3	2.20	3.85	10.40	25.47
E13	E13	5.80	0.250	0.350	300	6.7	14.1	380	1.50	5.8	3.61	1.8	15.8	3.35	5.70	4.86	11.57

1) OVERLAND FLOW Tco = (1.87*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = K * ((SLOPE(%))^0.5)
K = 0.25 FOR MEADOW
K = 1.0 FOR BARE SOIL
K = 1.5 FOR GRASS CHANNEL
K = 2.0 FOR PAVEMENT
3) GUTTER/SWALE FLOW, Tt = (GUTTER LENGTH/ SCS VELOCITY) / 60 SEC
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F CURVE IN EL PASO COUNTY DRAINAGE CRITERIA MANUAL
6) Q = CiA
7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

SETTLERS RANCH FILING NO. 3
COMPOSITE RUNOFF COEFFICIENTS - TYPICAL RURAL RESIDENTIAL LOTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	UILDING / PAVEME	0.90	89.00	LANDSCAPED	0.08				0.170

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	UILDING / PAVEME	0.96	89.00	LANDSCAPED	0.35				0.417

IMPERVIOUS AREAS

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT MPERVIOU	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT MPERVIOU	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT MPERVIOU	WEIGHTED % IMP
2.5-ACRE LOTS	2.50	11.00	UILDING / PAVEME	100	89.00	LANDSCAPED	0				11.000

SETTLERS RANCH FILING NO. 3
RATIONAL METHOD

DEVELOPED FLOWS

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR[7]	C 100-YEAR[7]	LENGTH (FT)	SLOPE (FT/FT)	Tco[1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS[2] VELOCITY (FT/S)	Tt[3] (MIN)	TOTAL Tc[4] (MIN)	TOTAL Tc[4] (MIN)	INTENSITY[5] 5-YR (IN/HR)	INTENSITY[5] 100-YR (IN/HR)	PEAK FLOW Q5[6] (CFS)	PEAK FLOW Q100[6] (CFS)
D5b		1.8	0.170	0.417	100	0.087	8.3	300	15	0.071	4.00	1.3	9.5	9.5	4.20	7.05	1.29	5.29
D7b		2.5	0.170	0.417	100	0.047	10.2	350	15	0.044	3.15	1.9	12.0	12.0	3.85	6.47	1.64	6.74
D5b,D7b	D7b	4.3	0.170	0.417									12.0	12.0	3.85	6.47	2.82	11.60
D5a		15.0	0.170	0.417			0.0	600	15	0.050	3.35	3.0	3.0	5.0	5.17	8.68	13.18	54.29
D7a		5.7	0.170	0.417	100	0.750	4.0	650	15	0.050	3.35	3.2	7.3	7.3	4.61	7.73	4.46	18.39
D5a-D5b,D7a-D7b	D5a	25.0	0.170	0.417									15.0	15.0	3.52	5.91	14.96	61.61
D5c	D5c	17.6	0.170	0.417	100	0.083	8.4	1130	15	0.063	3.76	5.0	13.4	13.4	3.69	6.19	11.04	45.44
D9b		3.4	0.170	0.417	100	0.080	8.5	150	15	0.080	4.24	0.6	9.1	9.1	4.27	7.17	2.47	10.16
D9c		1.1	0.170	0.417	100	0.107	7.7	50	15	0.107	4.91	0.2	7.9	7.9	4.48	7.53	0.84	3.45
D9b,D9c		4.5	0.170	0.417									9.1	9.1	4.27	7.17	3.27	13.45
D9a		9.8	0.170	0.417			0.0	700	15	0.074	4.08	2.9	2.9	5.0	5.17	8.68	8.61	35.47
D9a-D9c	D9	14.3	0.170	0.417									12.0	12.0	3.86	6.48	9.38	38.64
D11a		5.7	0.170	0.417	100	0.037	11.0	550	15	0.077	4.16	2.2	13.2	13.2	3.71	6.23	3.60	14.81
D11b		9.9	0.170	0.417			0.0	750	15	0.059	3.64	3.4	3.4	5.0	5.17	8.68	8.70	35.83
D11a,D11b	D11	15.6	0.170	0.417									16.6	16.6	3.36	5.65	8.92	36.74
D12		11.0	0.170	0.417	100	0.067	9.0	640	15	0.068	3.91	2.7	11.8	11.8	3.89	6.52	7.27	29.92
D11,D12	4	26.6	0.170	0.417									16.6	16.6	3.36	5.65	15.22	62.65
D10		6.7	0.170	0.417	100	0.046	10.2	1800	15	0.051	3.39	8.9	19.1	19.1	3.16	5.30	3.60	14.81
D14		12.2	0.170	0.417	100	0.040	10.7	1250	15	0.056	3.55	5.9	16.6	16.6	3.37	5.66	6.99	28.77
D10,D14	5	18.9	0.170	0.417									19.1	19.1	3.16	5.30	10.15	41.79
D13	D13	5.7	0.170	0.417	100	0.067	9.0	580	15	0.061	3.70	2.6	11.6	11.6	3.90	6.55	3.78	15.57

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES
3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
I_5 = -1.5 * ln(Tc) + 7.583
I_{100} = -2.52 * ln(Tc) + 12.735
6) Q = CiA
7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

APPENDIX C1

HYDRAULIC CALCULATIONS – ROADSIDE DITCHES

TABLE 10-4

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

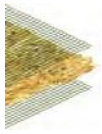
Channel Slope	Lining	Permissible Mean Channel Velocity * (ft/sec)
0 - 5%	Sodded grass	7
	Bermudagrass	6
	Reed canarygrass	5
	Tall fescue	5
	Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10%	Sodded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

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

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

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

RollMax Product Selection Chart

	TEMPORARY						
	ERONET						BIONET
							
	DS75	**DS150**	**S75**	**S150**	**SC150**	**C125**	**S75BN**
Longevity	45 days	60 days	12 mo.	12 mo.	24 mo.	36 mo.	12 mo.
Applications	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Medium Flow Channels 2:1-1:1 Slopes	High-Flow Channels 1:1 and Greater Slopes	Low Flow Channels 4:1-3:1 Slopes
Design Permissible Shear Stress lbs/ft² (Pa)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 2.00 (96)	Unvegetated 2.25 (108)	Unvegetated 1.60 (76)
Design Permissible Velocity ft/s (m/s)	Unvegetated 5.00 (1.52)	Unvegetated 6.00 (1.52)	Unvegetated 5.00 (1.2)	Unvegetated 6.00 (1.83)	Unvegetated 8.00 (2.44)	Unvegetated 10.00 (3.05)	Unvegetated 5.00 (1.52)
Top Net	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft² (1.47 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft² (1.47 kg/100 m²) approx wt	Leno woven. 100% biodegradable jute fiber 9.30 lbs/1000 ft² (4.53 kg/100 m²) approx wt
Center Net	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fiber Matrix	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw/coconut matrix 70% Straw 0.35 lbs/yd² (0.19 kg/m²) 30% Coconut 0.15 lbs/yd² (0.08 kg/m²)	Coconut fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)
Bottom Net	N/A	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	N/A	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft² (1.47 kg/100 m²) approx wt	N/A
Thread	Accelerated degradable	Accelerated degradable	Degradable	Degradable	Degradable	UV-stabilized polypropylene	Biodegradable

SETTLERS RANCH - FILING NO. 3
DITCH CALCULATION SUMMARY

PROPOSED ROADSIDE DITCHES

ROADWAY	FROM STA	TO STA	SIDE	PROPOSED SLOPE (%)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	ROW WIDTH (ft)	BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING
SETTLERS RANCH RD	50+06	52+62	E	4.0	4:1/3:1	2.5	0.030	60	D9b	9.3	60	5.6	0.6	4.4	GRASS
SETTLERS RANCH RD	50+06	52+62	W	4.0	4:1/3:1	2.5	0.030	60	D9a	35.3	10	3.5	0.5	3.9	GRASS
SETTLERS RANCH RD	52+62	55+20	E	7.9	4:1/3:1	2.5	0.030	60	D11a	12.5	40	5.0	0.5	5.5	**GRASS / TRM**
SETTLERS RANCH RD	52+62	55+20	W	7.9	4:1/3:1	2.5	0.030	60	D11b	35.6	10	3.6	0.5	5.0	**GRASS / TRM**
SETTLERS RANCH RD	55+20	59+20	S	4.0	4:1/3:1	2.5	0.030	60	D11a	12.5	70	8.8	0.7	4.9	GRASS
SETTLERS RANCH RD	55+20	59+20	N	4.0	4:1/3:1	2.5	0.030	60	D11b	35.6	10	3.6	0.5	3.9	GRASS
SETTLERS RANCH RD	59+20	62+02	S	2.5	4:1/3:1	2.5	0.030	60	D11a	12.5	30	3.8	0.6	3.3	GRASS
SETTLERS RANCH RD	59+20	62+02	N	2.5	4:1/3:1	2.5	0.030	60	D11b	35.6	10	3.6	0.6	3.3	GRASS
SETTLERS RANCH RD	62+02	65+25	S	2.0	4:1/3:1	2.5	0.030	60	D14	24.4	10	2.4	0.5	2.7	GRASS
SETTLERS RANCH RD	62+02	65+25	N	2.0	4:1/3:1	2.5	0.030	60	D12	22.7	10	2.3	0.5	2.7	GRASS
SETTLERS RANCH RD	65+25	68+75	S	6.0	4:1/3:1	2.5	0.030	60	D13	13.5	10	1.4	0.3	3.6	GRASS
SETTLERS RANCH RD	65+25	68+75	N	6.0	4:1/3:1	2.5	0.030	60	D12	22.7	10	2.3	0.4	4.1	GRASS
SETTLERS RANCH RD	68+75	70+85	S	1.5	4:1/3:1	2.5	0.030	60	D13	13.5	10	1.4	0.4	2.1	GRASS
SETTLERS RANCH RD	68+75	70+85	N	1.5	4:1/3:1	2.5	0.030	60	D12	22.7	10	2.3	0.5	2.4	GRASS
SETTLERS RANCH RD	70+85	71+93	S	6.0	4:1/3:1	2.5	0.030	60	D13	13.5	20	2.7	0.4	4.2	GRASS
SETTLERS RANCH RD	70+85	71+93	N	6.0	4:1/3:1	2.5	0.030	60	D12	22.7	20	4.5	0.5	4.8	GRASS
SETTLERS RANCH RD	71+93	72+91	S	4.0	4:1/3:1	2.5	0.030	60	D13	13.5	20	2.7	0.5	36.0	GRASS
SETTLERS RANCH RD	71+93	72+91	N	4.0	4:1/3:1	2.5	0.030	60	D12	22.7	20	4.5	0.6	4.1	GRASS

ROADWAY	FROM STA	TO STA	SIDE	PROPOSED SLOPE (%)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	ROW WIDTH (ft)	BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING
BOUNDARY BASIN CT	10+16	11+16	E	4.0	4:1/3:1	2.5	0.030	60	D5c	38.7	20	7.7	0.7	4.7	GRASS
BOUNDARY BASIN CT	10+16	11+16	W	4.0	4:1/3:1	2.5	0.030	60	D5a	**51.5**	15	7.7	0.7	4.7	GRASS
BOUNDARY BASIN CT	11+16	13+20	E	5.5	4:1/3:1	2.5	0.030	60	D5c	38.7	20	7.7	0.6	5.3	**GRASS / TRM**
BOUNDARY BASIN CT	11+16	13+20	W	5.5	4:1/3:1	2.5	0.030	60	D5a	**51.5**	15	7.7	0.6	5.3	**GRASS / TRM**
BOUNDARY BASIN CT	13+20	15+69	E	8.0	4:1/3:1	2.5	0.030	60	D5c	38.7	15	5.8	0.5	5.7	**GRASS / TRM**
BOUNDARY BASIN CT	13+20	15+69	W	8.0	4:1/3:1	2.5	0.030	60	D5a	**51.5**	10	5.2	0.5	5.5	**GRASS / TRM**
BOUNDARY BASIN CT	15+69	18+25	E	3.0	4:1/3:1	2.5	0.030	60	D5b	4.7	100	4.7	0.6	3.7	GRASS
BOUNDARY BASIN CT	15+69	18+25	W	3.0	4:1/3:1	2.5	0.030	60	D5a	**51.5**	10	5.2	0.6	3.9	GRASS
BOUNDARY BASIN CT	18+25	21+07	E	1.0	4:1/3:1	2.5	0.030	60	D7b	5.8	30	1.7	0.5	1.9	GRASS
BOUNDARY BASIN CT	18+25	21+07	W	1.0	4:1/3:1	2.5	0.030	60	D7a	12.5	10	1.3	0.5	1.8	GRASS
STEPPLER ROAD-POND DVWY				4.7	4:1/3:1	2.0	0.030	60	5d	18.6	100	18.6	0.9	6.2	GRASS

1) Channel flow calculations based on Manning's Equation
2) Channel depth includes 1' minimum freeboard
3) n = 0.03 for grass-lined non-irrigated channels (minimum)
4) n = 0.045 for riprap-lined channels
5) Vmax = 5.0 fps per El Paso County criteria (p. 10-13) for fescue (dry land grass) for 100-year flows
6) Vmax = 8.0 fps with Turf Reinforcement Mat (TRM) Lining (Tensar Eronet SC150 or equal)

Hydraulic Analysis Report

Project Data

Project Title: Project - Settlers Ranch F3 - Roadside Ditches
Designer: JPS
Project Date: Monday, March 11, 2024
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Channel Analysis-SR-Rd-Ditch-50+06 to 52+62,E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0400 ft/ft
Manning's n: 0.0300
Flow: 6.1000 cfs

Result Parameters

Depth: 0.6260 ft
Area of Flow: 1.3717 ft^2
Wetted Perimeter: 4.5609 ft
Hydraulic Radius: 0.3008 ft
Average Velocity: 4.4470 ft/s
Top Width: 4.3822 ft
Froude Number: 1.4007
Critical Depth: 0.7193 ft
Critical Velocity: 3.3682 ft/s
Critical Slope: 0.0191 ft/ft
Critical Top Width: 5.14 ft
Calculated Max Shear Stress: 1.5626 lb/ft^2
Calculated Avg Shear Stress: 0.7507 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-50+06 to 52+62,W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0400 ft/ft
Manning's n: 0.0300
Flow: 3.6000 cfs

Result Parameters

Depth: 0.5137 ft
Area of Flow: 0.9236 ft^2
Wetted Perimeter: 3.7425 ft
Hydraulic Radius: 0.2468 ft
Average Velocity: 3.8977 ft/s
Top Width: 3.5959 ft
Froude Number: 1.3553
Critical Depth: 0.5825 ft
Critical Velocity: 3.0311 ft/s
Critical Slope: 0.0205 ft/ft
Critical Top Width: 4.16 ft
Calculated Max Shear Stress: 1.2822 lb/ft^2
Calculated Avg Shear Stress: 0.6160 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-52+62 to 55+20,E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0787 ft/ft
Manning's n: 0.0300
Flow: 5.9000 cfs

Result Parameters

Depth: 0.5446 ft
Area of Flow: 1.0380 ft^2
Wetted Perimeter: 3.9674 ft
Hydraulic Radius: 0.2616 ft
Average Velocity: 5.6842 ft/s **>5 fps….Use TRM Lining**
Top Width: 3.8120 ft
Froude Number: 1.9197
Critical Depth: 0.7098 ft
Critical Velocity: 3.3458 ft/s
Critical Slope: 0.0192 ft/ft
Critical Top Width: 5.07 ft
Calculated Max Shear Stress: 2.6743 lb/ft^2
Calculated Avg Shear Stress: 1.2848 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-52+62 to 55+20,W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0787 ft/ft
Manning's n: 0.0300
Flow: 3.6000 cfs

Result Parameters

Depth: 0.4525 ft
Area of Flow: 0.7166 ft^2
Wetted Perimeter: 3.2965 ft
Hydraulic Radius: 0.2174 ft
Average Velocity: 5.0238 ft/s **>5 fps….Use TRM Lining**
Top Width: 3.1674 ft
Froude Number: 1.8613
Critical Depth: 0.5825 ft
Critical Velocity: 3.0311 ft/s
Critical Slope: 0.0205 ft/ft
Critical Top Width: 4.16 ft
Calculated Max Shear Stress: 2.2221 lb/ft^2
Calculated Avg Shear Stress: 1.0675 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-55+20 to 59+20,S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0400 ft/ft
Manning's n: 0.0300
Flow: 10.4000 cfs

Result Parameters

Depth: 0.7647 ft
Area of Flow: 2.0466 ft^2
Wetted Perimeter: 5.5711 ft
Hydraulic Radius: 0.3674 ft
Average Velocity: 5.0815 ft/s **>5 fps….Use TRM Lining**
Top Width: 5.3528 ft
Froude Number: 1.4482
Critical Depth: 0.8905 ft
Critical Velocity: 3.7475 ft/s
Critical Slope: 0.0178 ft/ft
Critical Top Width: 6.36 ft
Calculated Max Shear Stress: 1.9087 lb/ft^2
Calculated Avg Shear Stress: 0.9169 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-55+20 to 59+20,N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0400 ft/ft
Manning's n: 0.0300
Flow: 3.6000 cfs

Result Parameters

Depth: 0.5137 ft
Area of Flow: 0.9236 ft^2
Wetted Perimeter: 3.7425 ft
Hydraulic Radius: 0.2468 ft
Average Velocity: 3.8977 ft/s
Top Width: 3.5959 ft
Froude Number: 1.3553
Critical Depth: 0.5825 ft
Critical Velocity: 3.0311 ft/s
Critical Slope: 0.0205 ft/ft
Critical Top Width: 4.16 ft
Calculated Max Shear Stress: 1.2822 lb/ft^2
Calculated Avg Shear Stress: 0.6160 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-59+20 to 62+02,S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0250 ft/ft
Manning's n: 0.0300
Flow: 4.4000 cfs

Result Parameters

Depth: 0.6049 ft
Area of Flow: 1.2806 ft^2
Wetted Perimeter: 4.4067 ft
Hydraulic Radius: 0.2906 ft
Average Velocity: 3.4360 ft/s
Top Width: 4.2341 ft
Froude Number: 1.1011
Critical Depth: 0.6312 ft
Critical Velocity: 3.1552 ft/s
Critical Slope: 0.0199 ft/ft
Critical Top Width: 4.51 ft
Calculated Max Shear Stress: 0.9436 lb/ft^2
Calculated Avg Shear Stress: 0.4533 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-59+20 to 62+02,N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0250 ft/ft
Manning's n: 0.0300
Flow: 3.6000 cfs

Result Parameters

Depth: 0.5610 ft
Area of Flow: 1.1016 ft^2
Wetted Perimeter: 4.0873 ft
Hydraulic Radius: 0.2695 ft
Average Velocity: 3.2679 ft/s
Top Width: 3.9272 ft
Froude Number: 1.0873
Critical Depth: 0.5825 ft
Critical Velocity: 3.0311 ft/s
Critical Slope: 0.0205 ft/ft
Critical Top Width: 4.16 ft
Calculated Max Shear Stress: 0.8752 lb/ft^2
Calculated Avg Shear Stress: 0.4205 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-62+02 to 65+25,S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0300
Flow: 2.9000 cfs

Result Parameters

Depth: 0.5394 ft
Area of Flow: 1.0185 ft^2
Wetted Perimeter: 3.9300 ft
Hydraulic Radius: 0.2592 ft
Average Velocity: 2.8474 ft/s
Top Width: 3.7761 ft
Froude Number: 0.9662
Critical Depth: 0.5343 ft
Critical Velocity: 2.9028 ft/s
Critical Slope: 0.0211 ft/ft
Critical Top Width: 3.82 ft
Calculated Max Shear Stress: 0.6732 lb/ft^2
Calculated Avg Shear Stress: 0.3234 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-62+02 to 65+25,N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0300
Flow: 3.0000 cfs

Result Parameters

Depth: 0.5463 ft
Area of Flow: 1.0447 ft^2
Wetted Perimeter: 3.9803 ft
Hydraulic Radius: 0.2625 ft
Average Velocity: 2.8716 ft/s
Top Width: 3.8244 ft
Froude Number: 0.9682
Critical Depth: 0.5416 ft
Critical Velocity: 2.9225 ft/s
Critical Slope: 0.0210 ft/ft
Critical Top Width: 3.87 ft
Calculated Max Shear Stress: 0.6818 lb/ft^2
Calculated Avg Shear Stress: 0.3276 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-65+25 to 68+75,S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0600 ft/ft
Manning's n: 0.0300
Flow: 1.6000 cfs

Result Parameters

Depth: 0.3513 ft
Area of Flow: 0.4318 ft^2
Wetted Perimeter: 2.5590 ft
Hydraulic Radius: 0.1687 ft
Average Velocity: 3.7051 ft/s
Top Width: 2.4588 ft
Froude Number: 1.5580
Critical Depth: 0.4212 ft
Critical Velocity: 2.5773 ft/s
Critical Slope: 0.0228 ft/ft
Critical Top Width: 3.01 ft
Calculated Max Shear Stress: 1.3151 lb/ft^2
Calculated Avg Shear Stress: 0.6318 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-65+25 to 68+75,N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0600 ft/ft
Manning's n: 0.0300
Flow: 3.0000 cfs

Result Parameters

Depth: 0.4446 ft
Area of Flow: 0.6919 ft^2
Wetted Perimeter: 3.2393 ft
Hydraulic Radius: 0.2136 ft
Average Velocity: 4.3356 ft/s
Top Width: 3.1124 ft
Froude Number: 1.6205
Critical Depth: 0.5416 ft
Critical Velocity: 2.9225 ft/s
Critical Slope: 0.0210 ft/ft
Critical Top Width: 3.87 ft
Calculated Max Shear Stress: 1.6647 lb/ft^2
Calculated Avg Shear Stress: 0.7997 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-68+75 to 70+85,S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0150 ft/ft
Manning's n: 0.0300
Flow: 1.6000 cfs

Result Parameters

Depth: 0.4555 ft
Area of Flow: 0.7263 ft^2
Wetted Perimeter: 3.3187 ft
Hydraulic Radius: 0.2188 ft
Average Velocity: 2.2031 ft/s
Top Width: 3.1887 ft
Froude Number: 0.8135
Critical Depth: 0.4212 ft
Critical Velocity: 2.5773 ft/s
Critical Slope: 0.0228 ft/ft
Critical Top Width: 3.01 ft
Calculated Max Shear Stress: 0.4264 lb/ft^2
Calculated Avg Shear Stress: 0.2048 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-68+75 to 70+85,N

Notes:

Input Parameters

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

Result Parameters

Depth: 0.5766 ft
Area of Flow: 1.1637 ft^2
Wetted Perimeter: 4.2009 ft
Hydraulic Radius: 0.2770 ft
Average Velocity: 2.5780 ft/s
Top Width: 4.0363 ft
Froude Number: 0.8461
Critical Depth: 0.5416 ft
Critical Velocity: 2.9225 ft/s
Critical Slope: 0.0210 ft/ft
Critical Top Width: 3.87 ft
Calculated Max Shear Stress: 0.5397 lb/ft^2
Calculated Avg Shear Stress: 0.2593 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-70+85 to 71+93,S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0600 ft/ft
Manning's n: 0.0300
Flow: 3.1000 cfs

Result Parameters

Depth: 0.4501 ft
Area of Flow: 0.7092 ft^2
Wetted Perimeter: 3.2794 ft
Hydraulic Radius: 0.2163 ft
Average Velocity: 4.3713 ft/s
Top Width: 3.1509 ft
Froude Number: 1.6238
Critical Depth: 0.5487 ft
Critical Velocity: 2.9418 ft/s
Critical Slope: 0.0209 ft/ft
Critical Top Width: 3.92 ft
Calculated Max Shear Stress: 1.6853 lb/ft^2
Calculated Avg Shear Stress: 0.8096 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-70+85 to 71+93,N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0600 ft/ft
Manning's n: 0.0300
Flow: 6.0000 cfs

Result Parameters

Depth: 0.5766 ft
Area of Flow: 1.1637 ft^2
Wetted Perimeter: 4.2009 ft
Hydraulic Radius: 0.2770 ft
Average Velocity: 5.1559 ft/s **>5 fps….Use TRM Lining**
Top Width: 4.0363 ft
Froude Number: 1.6922
Critical Depth: 0.7146 ft
Critical Velocity: 3.3571 ft/s
Critical Slope: 0.0191 ft/ft
Critical Top Width: 5.11 ft
Calculated Max Shear Stress: 2.1589 lb/ft^2
Calculated Avg Shear Stress: 1.0371 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-71+93 to 72+91,S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0400 ft/ft
Manning's n: 0.0300
Flow: 3.1000 cfs

Result Parameters

Depth: 0.4857 ft
Area of Flow: 0.8256 ft^2
Wetted Perimeter: 3.5384 ft
Hydraulic Radius: 0.2333 ft
Average Velocity: 3.7547 ft/s
Top Width: 3.3998 ft
Froude Number: 1.3427
Critical Depth: 0.5487 ft
Critical Velocity: 2.9418 ft/s
Critical Slope: 0.0209 ft/ft
Critical Top Width: 3.92 ft
Calculated Max Shear Stress: 1.2123 lb/ft^2
Calculated Avg Shear Stress: 0.5824 lb/ft^2

Channel Analysis: Channel Analysis-SR-Rd-Ditch-71+93 to 72+91,N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0400 ft/ft
Manning's n: 0.0300
Flow: 6.0000 cfs

Result Parameters

Depth: 0.6222 ft
Area of Flow: 1.3548 ft^2
Wetted Perimeter: 4.5327 ft
Hydraulic Radius: 0.2989 ft
Average Velocity: 4.4287 ft/s
Top Width: 4.3551 ft
Froude Number: 1.3993
Critical Depth: 0.7146 ft
Critical Velocity: 3.3571 ft/s
Critical Slope: 0.0191 ft/ft
Critical Top Width: 5.11 ft
Calculated Max Shear Stress: 1.5529 lb/ft^2
Calculated Avg Shear Stress: 0.7460 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-10+16 to 11+16,E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0400 ft/ft
Manning's n: 0.0300
Flow: 9.1000 cfs

Result Parameters

Depth: 0.7273 ft
Area of Flow: 1.8516 ft^2
Wetted Perimeter: 5.2990 ft
Hydraulic Radius: 0.3494 ft
Average Velocity: 4.9147 ft/s
Top Width: 5.0914 ft
Froude Number: 1.4362
Critical Depth: 0.8441 ft
Critical Velocity: 3.6487 ft/s
Critical Slope: 0.0181 ft/ft
Critical Top Width: 6.03 ft
Calculated Max Shear Stress: 1.8154 lb/ft^2
Calculated Avg Shear Stress: 0.8722 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-10+16 to 11+16,W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0400 ft/ft
Manning's n: 0.0300
Flow: 8.1000 cfs

Result Parameters

Depth: 0.6963 ft
Area of Flow: 1.6968 ft^2
Wetted Perimeter: 5.0726 ft
Hydraulic Radius: 0.3345 ft
Average Velocity: 4.7737 ft/s
Top Width: 4.8739 ft
Froude Number: 1.4258
Critical Depth: 0.8057 ft
Critical Velocity: 3.5648 ft/s
Critical Slope: 0.0184 ft/ft
Critical Top Width: 5.76 ft
Calculated Max Shear Stress: 1.7379 lb/ft^2
Calculated Avg Shear Stress: 0.8349 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-11+16 to 13+20,E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0550 ft/ft
Manning's n: 0.0300
Flow: 9.1000 cfs

Result Parameters

Depth: 0.6852 ft
Area of Flow: 1.6432 ft^2
Wetted Perimeter: 4.9918 ft
Hydraulic Radius: 0.3292 ft
Average Velocity: 5.5381 ft/s **>5 fps….Use TRM Lining**
Top Width: 4.7963 ft
Froude Number: 1.6674
Critical Depth: 0.8441 ft
Critical Velocity: 3.6487 ft/s
Critical Slope: 0.0181 ft/ft
Critical Top Width: 6.03 ft
Calculated Max Shear Stress: 2.3515 lb/ft^2
Calculated Avg Shear Stress: 1.1297 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-11+16 to 13+20,W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0550 ft/ft
Manning's n: 0.0300
Flow: 8.1000 cfs

Result Parameters

Depth: 0.6559 ft
Area of Flow: 1.5058 ft^2
Wetted Perimeter: 4.7786 ft
Hydraulic Radius: 0.3151 ft
Average Velocity: 5.3792 ft/s **>5 fps….Use TRM Lining**
Top Width: 4.5914 ft
Froude Number: 1.6553
Critical Depth: 0.8057 ft
Critical Velocity: 3.5648 ft/s
Critical Slope: 0.0184 ft/ft
Critical Top Width: 5.76 ft
Calculated Max Shear Stress: 2.2511 lb/ft^2
Calculated Avg Shear Stress: 1.0815 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-13+20 to 15+69,E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0800 ft/ft
Manning's n: 0.0300
Flow: 6.8000 cfs

Result Parameters

Depth: 0.5726 ft
Area of Flow: 1.1475 ft^2
Wetted Perimeter: 4.1716 ft
Hydraulic Radius: 0.2751 ft
Average Velocity: 5.9258 ft/s **>5 fps….Use TRM Lining**
Top Width: 4.0081 ft
Froude Number: 1.9517
Critical Depth: 0.7513 ft
Critical Velocity: 3.4422 ft/s
Critical Slope: 0.0188 ft/ft
Critical Top Width: 5.37 ft
Calculated Max Shear Stress: 2.8584 lb/ft^2
Calculated Avg Shear Stress: 1.3732 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-13+20 to 15+69,W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0800 ft/ft
Manning's n: 0.0300
Flow: 5.4000 cfs

Result Parameters

Depth: 0.5252 ft
Area of Flow: 0.9653 ft^2
Wetted Perimeter: 3.8261 ft
Hydraulic Radius: 0.2523 ft
Average Velocity: 5.5940 ft/s **>5 fps….Use TRM Lining**
Top Width: 3.6762 ft
Froude Number: 1.9238
Critical Depth: 0.6851 ft
Critical Velocity: 3.2871 ft/s
Critical Slope: 0.0194 ft/ft
Critical Top Width: 4.90 ft
Calculated Max Shear Stress: 2.6217 lb/ft^2
Calculated Avg Shear Stress: 1.2595 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-15+69 to 18+25,E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0300 ft/ft
Manning's n: 0.0300
Flow: 5.3000 cfs

Result Parameters

Depth: 0.6268 ft
Area of Flow: 1.3751 ft^2
Wetted Perimeter: 4.5665 ft
Hydraulic Radius: 0.3011 ft
Average Velocity: 3.8544 ft/s
Top Width: 4.3876 ft
Froude Number: 1.2133
Critical Depth: 0.6800 ft
Critical Velocity: 3.2748 ft/s
Critical Slope: 0.0194 ft/ft
Critical Top Width: 4.86 ft
Calculated Max Shear Stress: 1.1734 lb/ft^2
Calculated Avg Shear Stress: 0.5637 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-15+69 to 18+25,W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0300 ft/ft
Manning's n: 0.0300
Flow: 5.4000 cfs

Result Parameters

Depth: 0.6312 ft
Area of Flow: 1.3945 ft^2
Wetted Perimeter: 4.5986 ft
Hydraulic Radius: 0.3032 ft
Average Velocity: 3.8724 ft/s
Top Width: 4.4184 ft
Froude Number: 1.2147
Critical Depth: 0.6851 ft
Critical Velocity: 3.2871 ft/s
Critical Slope: 0.0194 ft/ft
Critical Top Width: 4.90 ft
Calculated Max Shear Stress: 1.1816 lb/ft^2
Calculated Avg Shear Stress: 0.5677 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-18+25 to 21+07,E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0100 ft/ft
Manning's n: 0.0300
Flow: 2.0000 cfs

Result Parameters

Depth: 0.5344 ft
Area of Flow: 0.9996 ft^2
Wetted Perimeter: 3.8933 ft
Hydraulic Radius: 0.2567 ft
Average Velocity: 2.0009 ft/s
Top Width: 3.7408 ft
Froude Number: 0.6821
Critical Depth: 0.4605 ft
Critical Velocity: 2.6949 ft/s
Critical Slope: 0.0221 ft/ft
Critical Top Width: 3.29 ft
Calculated Max Shear Stress: 0.3335 lb/ft^2
Calculated Avg Shear Stress: 0.1602 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-18+25 to 21+07,W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0100 ft/ft
Manning's n: 0.0300
Flow: 1.8000 cfs

Result Parameters

Depth: 0.5137 ft
Area of Flow: 0.9236 ft^2
Wetted Perimeter: 3.7425 ft
Hydraulic Radius: 0.2468 ft
Average Velocity: 1.9489 ft/s
Top Width: 3.5959 ft
Froude Number: 0.6777
Critical Depth: 0.4415 ft
Critical Velocity: 2.6387 ft/s
Critical Slope: 0.0224 ft/ft
Critical Top Width: 3.15 ft
Calculated Max Shear Stress: 0.3205 lb/ft^2
Calculated Avg Shear Stress: 0.1540 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-21+07 to 22+61,E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0300
Flow: 4.7000 cfs

Result Parameters

Depth: 0.6465 ft
Area of Flow: 1.4629 ft^2
Wetted Perimeter: 4.7101 ft
Hydraulic Radius: 0.3106 ft
Average Velocity: 3.2127 ft/s
Top Width: 4.5256 ft
Froude Number: 0.9958
Critical Depth: 0.6481 ft
Critical Velocity: 3.1971 ft/s
Critical Slope: 0.0197 ft/ft
Critical Top Width: 4.63 ft
Calculated Max Shear Stress: 0.8068 lb/ft^2
Calculated Avg Shear Stress: 0.3876 lb/ft^2

Channel Analysis: Channel Analysis-BB-Ct-Ditch-21+07 to 22+61,W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0300
Flow: 5.5000 cfs

Result Parameters

Depth: 0.6858 ft
Area of Flow: 1.6460 ft^2
Wetted Perimeter: 4.9961 ft
Hydraulic Radius: 0.3295 ft
Average Velocity: 3.3415 ft/s
Top Width: 4.8004 ft
Froude Number: 1.0056
Critical Depth: 0.6902 ft
Critical Velocity: 3.2992 ft/s
Critical Slope: 0.0193 ft/ft
Critical Top Width: 4.93 ft
Calculated Max Shear Stress: 0.8558 lb/ft^2
Calculated Avg Shear Stress: 0.4112 lb/ft^2

Channel Analysis: Channel Analysis-Steppler-Rd-W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0470 ft/ft
Manning's n: 0.0300
Flow: 18.6000 cfs

Result Parameters

Depth: 0.9226 ft
Area of Flow: 2.9794 ft^2
Wetted Perimeter: 6.7218 ft
Hydraulic Radius: 0.4432 ft
Average Velocity: 6.2428 ft/s
Top Width: 6.4585 ft
Froude Number: 1.6198
Critical Depth: 1.1236 ft
Critical Velocity: 4.2096 ft/s
Critical Slope: 0.0164 ft/ft
Critical Top Width: 8.03 ft
Calculated Max Shear Stress: 2.7059 lb/ft^2
Calculated Avg Shear Stress: 1.3000 lb/ft^2

Use TRM Lining

SETTLERS RANCH - FILING NO. 3
CHANNEL CALCULATION SUMMARY

PROPOSED CHANNELS

ROADWAY	PROPOSED SLOPE (FT/FT)	BOTTOM WIDTH (FT)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING
POND #5 NW ENTRY SWALE D14	0.12	0	4:1	2.0	0.030	D14	28.8	70	20.2	0.8	8.8	**GRASS / TRM**
POND #5 SW ENTRY SWALE D10a	0.058	0	4:1	2.0	0.030	D10	14.8	100	14.8	0.8	6.2	**GRASS / TRM**
POND #5 SW ENTRY SWALE D10b	0.200	0	4:1	2.0	0.030	D10	14.8	100	14.8	0.6	9.9	**GRASS / TRM**
POND #5 ENTRY RUNDOWN	0.054	4	3:1	2.0	0.045	DP5	41.8	100	41.8	1.0	5.9	**RIPRAP**

1) Channel flow calculations based on Manning's Equation
2) Channel depth includes 1' minimum freeboard
3) n = 0.03 for grass-lined non-irrigated channels (minimum)
4) n = 0.045 for riprap-lined channels
5) Vmax = 5.0 fps per El Paso County criteria (p. 10-13) for fescue (dry land grass) for 100-year flows
6) Vmax = 8.0 fps with Turf Reinforcement Mat (TRM) Lining (Tensar Eronet SC150 or equal)
6) Vmax = 10.0 fps with Turf Reinforcement Mat (TRM) Lining (Tensar Eronet C125 or equal)

Hydraulic Analysis Report

Project Data

Project Title: Project - Settlers Ranch Flg. 3 - Channels
Designer: JPS
Project Date: Saturday, July 20, 2024
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Channel Analysis - D14

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Longitudinal Slope: 0.1200 ft/ft
Manning's n: 0.0300
Flow: 20.2000 cfs

Result Parameters

Depth: 0.7574 ft
Area of Flow: 2.2949 ft^2
Wetted Perimeter: 6.2460 ft
Hydraulic Radius: 0.3674 ft
Average Velocity: 8.8022 ft/s **> 5 fps…..Use TRM Lining**
Top Width: 6.0595 ft
Froude Number: 2.5206
Critical Depth: 1.0964 ft
Critical Velocity: 4.2013 ft/s
Critical Slope: 0.0167 ft/ft
Critical Top Width: 8.77 ft
Calculated Max Shear Stress: 5.6717 lb/ft^2
Calculated Avg Shear Stress: 2.7512 lb/ft^2

Channel Analysis: Channel Analysis- D10a

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0580 ft/ft

Manning's n: 0.0300

Flow: 14.8000 cfs

Result Parameters

Depth: 0.7725 ft

Area of Flow: 2.3870 ft^2

Wetted Perimeter: 6.3701 ft

Hydraulic Radius: 0.3747 ft

Average Velocity: 6.2003 ft/s **> 5 fps…..Use TRM Lining**

Top Width: 6.1799 ft

Froude Number: 1.7581

Critical Depth: 0.9681 ft

Critical Velocity: 3.9479 ft/s

Critical Slope: 0.0174 ft/ft

Critical Top Width: 7.74 ft

Calculated Max Shear Stress: 2.7958 lb/ft^2

Calculated Avg Shear Stress: 1.3562 lb/ft^2

Channel Analysis: Channel Analysis- D10b

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.2000 ft/ft

Manning's n: 0.0300

Flow: 14.8000 cfs

Result Parameters

Depth: 0.6125 ft

Area of Flow: 1.5005 ft^2

Wetted Perimeter: 5.0507 ft

Hydraulic Radius: 0.2971 ft

Average Velocity: 9.8631 ft/s **> 5 fps…..Use TRM Lining**

Top Width: 4.8999 ft

Froude Number: 3.1409

Critical Depth: 0.9681 ft

Critical Velocity: 3.9479 ft/s

Critical Slope: 0.0174 ft/ft

Critical Top Width: 7.74 ft

Calculated Max Shear Stress: 7.6438 lb/ft^2

Calculated Avg Shear Stress: 3.7078 lb/ft^2

Channel Analysis: Channel Analysis- DP5 – Riprap Apron / Rundown

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 3.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0520 ft/ft
Manning's n: 0.0450
Flow: 41.8000 cfs

Result Parameters

Depth: 1.0139 ft
Area of Flow: 7.1393 ft^2
Wetted Perimeter: 10.4123 ft
Hydraulic Radius: 0.6857 ft
Average Velocity: 5.8549 ft/s **> 5 fps…..Use RR Lining**
Top Width: 10.0832 ft
Froude Number: 1.2262
Critical Depth: 1.1314 ft
Critical Velocity: 4.9967 ft/s
Critical Slope: 0.0336 ft/ft
Critical Top Width: 10.79 ft
Calculated Max Shear Stress: 3.2898 lb/ft^2
Calculated Avg Shear Stress: 2.2248 lb/ft^2

APPENDIX C2

HYDRAULIC CALCULATIONS - CULVERT

SETTLERS RANCH FILING NO. 3
CULVERT DESIGN SUMMARY

BASIN	DESIGN POINT	RD CL ELEV	INV IN ELEV	INV OUT ELEV	PIPE LENGTH (FT)	N0. OF PIPES	PIPE DIA (FT)	TOTAL Q_5 (CFS)	PER PIPE Q_5 (CFS)	Q_5 MAX ALLOWABLE HEADWATER [1]	CALC Q_5 HW ELEV	TOTAL Q_{100} (CFS)	PER PIPE Q_{100} (CFS)	Q_{100} MAX ALLOWABLE HEADWATER [2]	CALC Q_{100} HW ELEV
SILVERADO HILL VIEW:															
D7b	D7b	7650.20	7647.80	7642.07	74.0	1	**1.5**	2.8	2.8	7649.3	7648.7	11.6	11.6	7650.38	7650.22

[1] Q_5 MAX. ALLOWABLE HEADWATER, HW/D = 1.0

[2] Q_{100} MAX. ALLOWABLE HEADWATER = 6" DEPTH AT SHOULDER (PER DCM TABLE 6-1)

HY-8 Culvert Analysis Report

Crossing Discharge Data – Culvert D7b

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1 cfs

Design Flow: 2.8 cfs

Maximum Flow: 11.6 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing D7b

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert D7b Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7648.28	1.00	1.00	0.00	1
7648.50	2.06	2.06	0.00	1
7648.65	2.80	2.80	0.00	1
7648.91	4.18	4.18	0.00	1
7649.08	5.24	5.24	0.00	1
7649.26	6.30	6.30	0.00	1
7649.45	7.36	7.36	0.00	1
7649.65	8.42	8.42	0.00	1
7649.89	9.48	9.48	0.00	1
7650.15	10.54	10.54	0.00	1
7650.22	11.60	10.79	0.72	9
7650.20	10.73	10.73	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing D7b

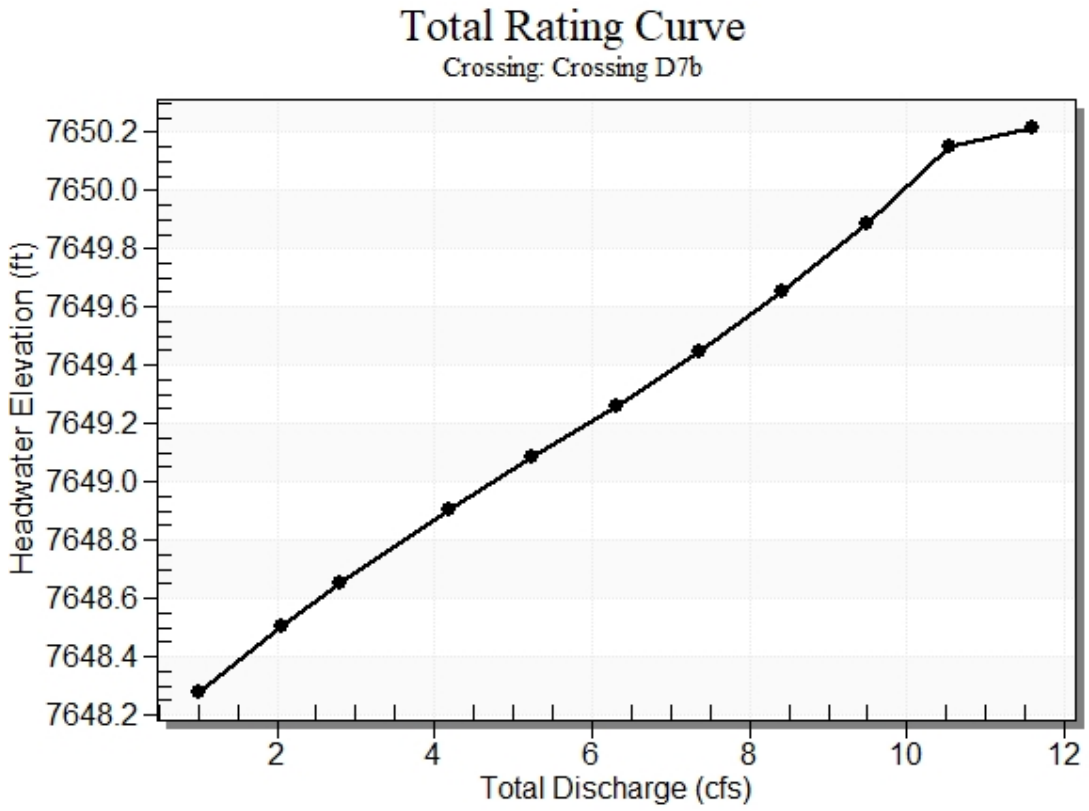


Table 2 - Culvert Summary Table: Culvert D7b

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	7648.28	0.481	0.0*	1-S2n	0.184	0.369	0.184	0.343	7.927	2.121
2.06	2.06	7648.50	0.705	0.0*	1-S2n	0.262	0.539	0.262	0.450	9.677	2.540
2.80	2.80	7648.65	0.853	0.0*	1-S2n	0.305	0.634	0.305	0.505	10.557	2.743
4.18	4.18	7648.91	1.106	0.0*	1-S2n	0.373	0.782	0.373	0.587	11.806	3.032
5.24	5.24	7649.08	1.282	0.0*	1-S2n	0.418	0.879	0.418	0.639	12.586	3.208
6.30	6.30	7649.26	1.458	0.0*	1-S2n	0.460	0.965	0.488	0.685	12.216	3.360
7.36	7.36	7649.45	1.646	0.0*	5-S2n	0.499	1.048	0.538	0.726	12.475	3.493
8.42	8.42	7649.65	1.854	0.0*	5-S2n	0.536	1.120	0.536	0.763	14.345	3.612
9.48	9.48	7649.89	2.087	0.0*	5-S2n	0.572	1.188	0.609	0.798	13.601	3.721
10.54	10.54	7650.15	2.351	0.0*	5-S2n	0.606	1.246	0.606	0.830	15.233	3.821
11.60	10.79	7650.22	2.418	0.0*	5-S2n	0.614	1.259	0.659	0.861	13.973	3.913

* Full Flow Headwater elevation is below inlet invert.

****

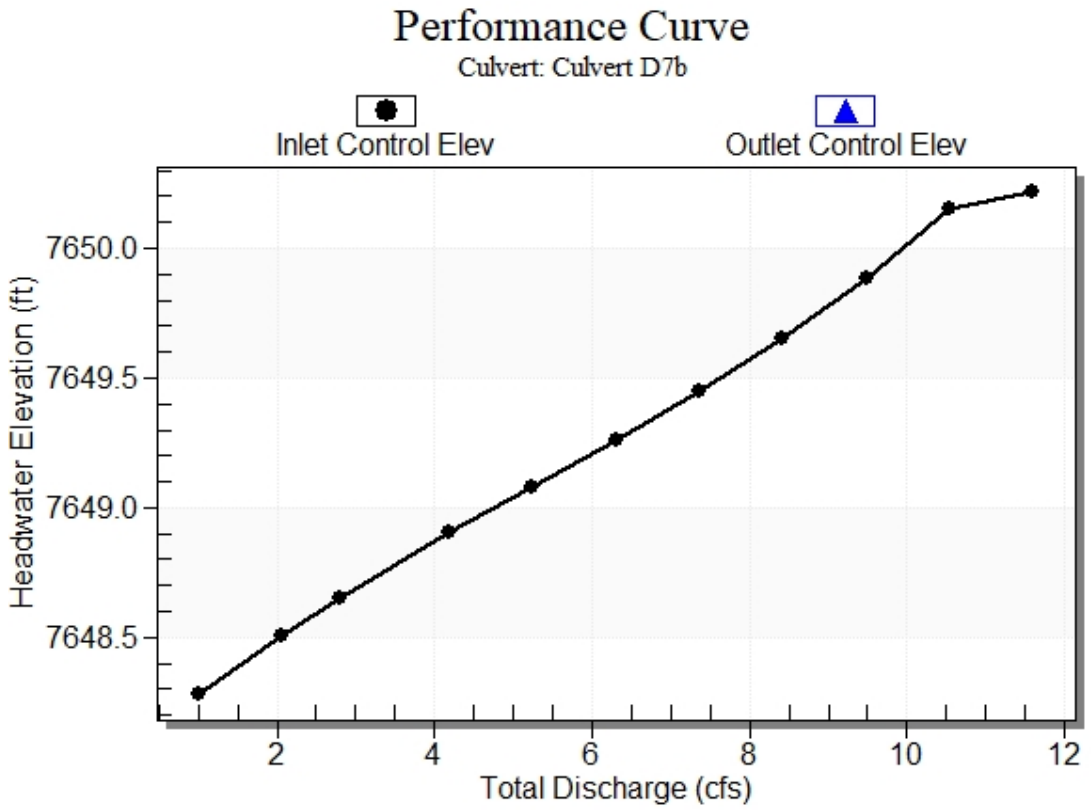
Straight Culvert

Inlet Elevation (invert): 7647.80 ft, Outlet Elevation (invert): 7642.07 ft

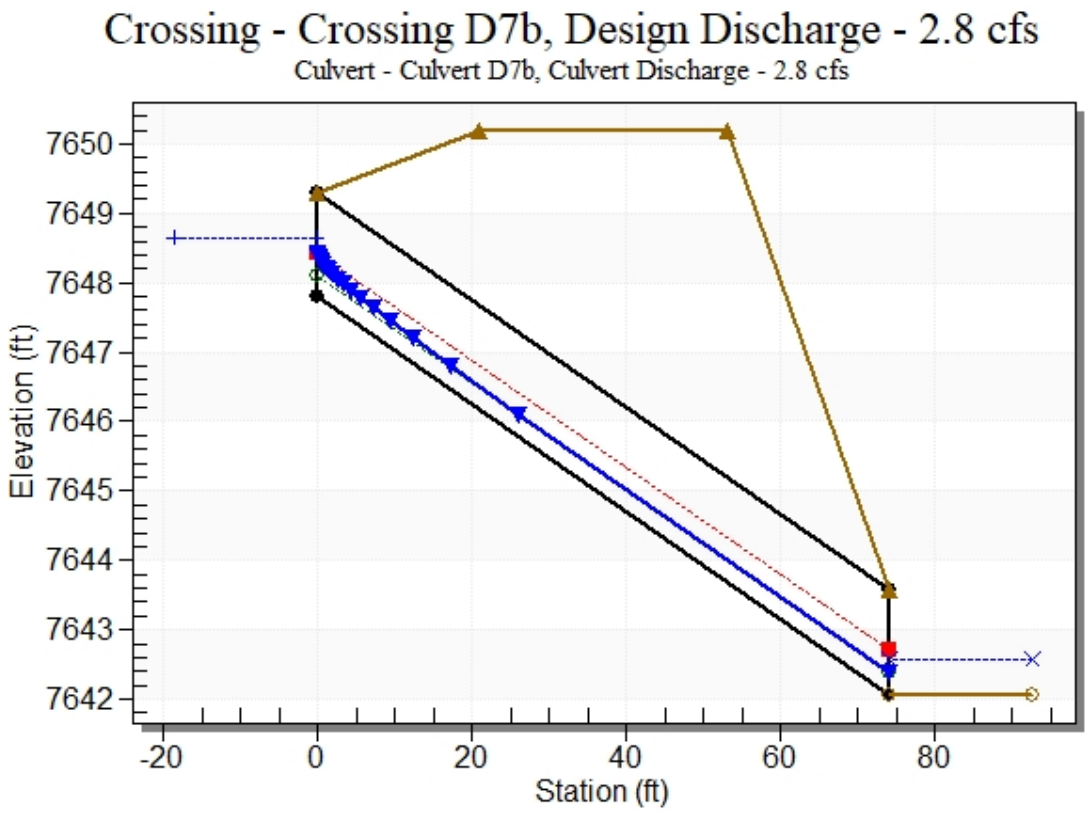
Culvert Length: 74.22 ft, Culvert Slope: 0.0774

****

Culvert Performance Curve Plot: Culvert D7b



Water Surface Profile Plot for Culvert: Culvert D7b



Site Data - Culvert D7b

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7647.80 ft

Outlet Station: 74.00 ft

Outlet Elevation: 7642.07 ft

Number of Barrels: 1

Culvert Data Summary - Culvert D7b

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing D7b)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.00	7642.41	0.34	2.12	0.43	0.90
2.06	7642.52	0.45	2.54	0.56	0.94
2.80	7642.58	0.51	2.74	0.63	0.96
4.18	7642.66	0.59	3.03	0.73	0.99
5.24	7642.71	0.64	3.21	0.80	1.00
6.30	7642.75	0.68	3.36	0.85	1.01
7.36	7642.80	0.73	3.49	0.91	1.02
8.42	7642.83	0.76	3.61	0.95	1.03
9.48	7642.87	0.80	3.72	1.00	1.04
10.54	7642.90	0.83	3.82	1.04	1.04
11.60	7642.93	0.86	3.91	1.07	1.05

Tailwater Channel Data - Crossing D7b

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 7642.07 ft

Roadway Data for Crossing: Crossing D7b

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7650.20 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Q100 (DP-D7b) = 11.6 cfs; D = 1.5 ft
Q / D^1.5 = 11.6 / (1.5^1.5) = 6.3

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

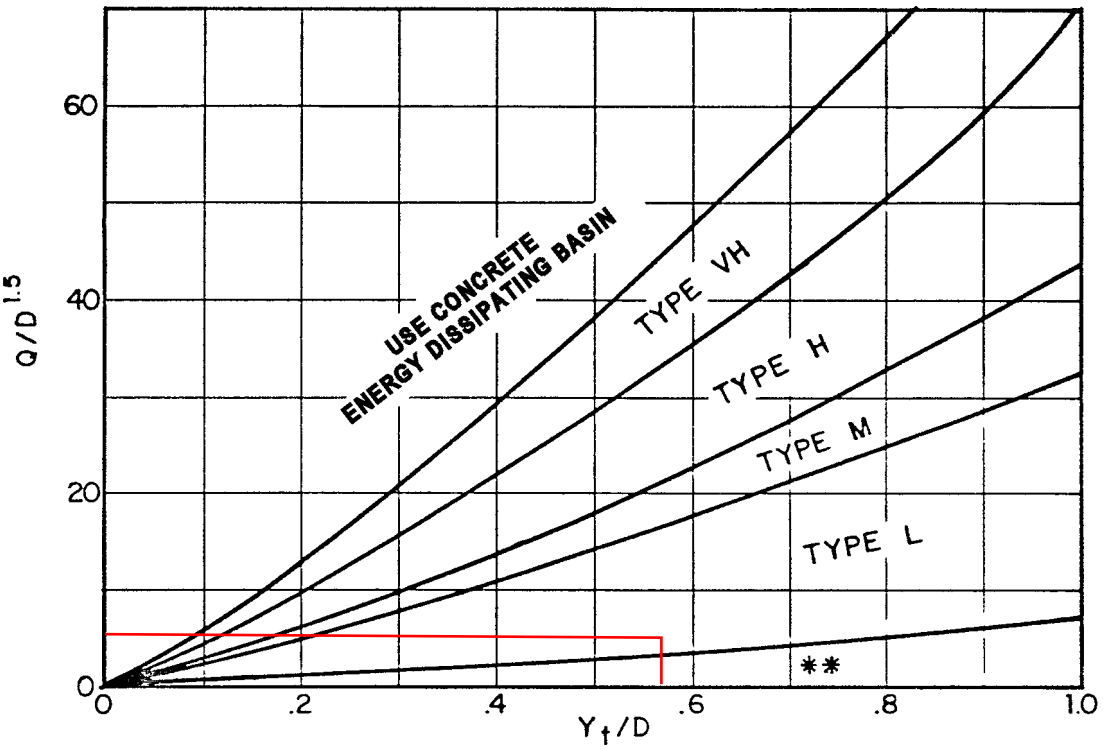
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)



Yt = 0.86 ft; Yt / D = (0.86 / 1.5) = 0.57

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

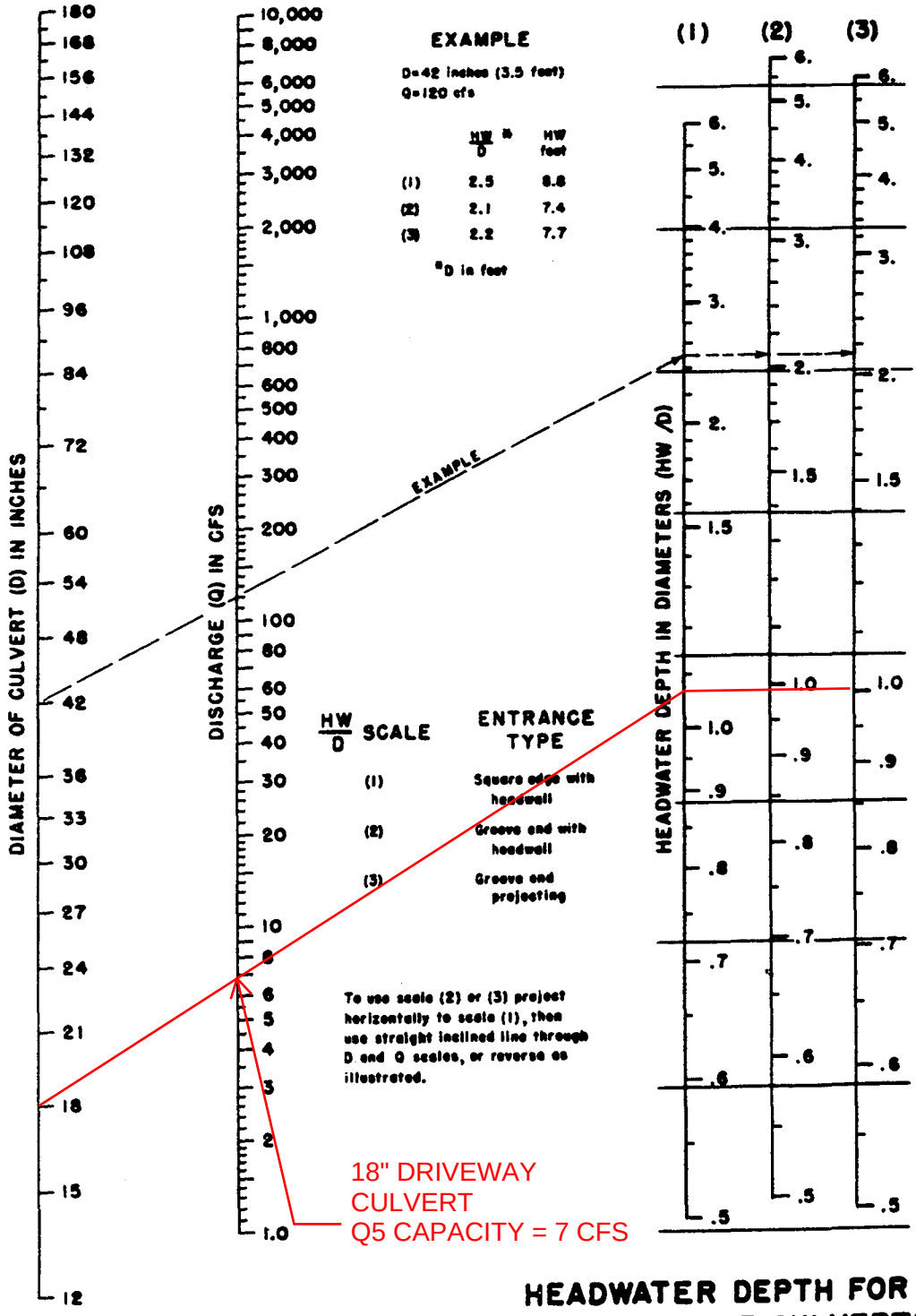
Use Type M (Conservative)

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

SETTLERS RANCH FILING NO. 3
DRIVEWAY CULVERT SIZING SUMMARY

PRIVATE CULVERT LOT #	BASIN/ DP	Q5 FLOW (CFS)	FLOW % AT DVWY CULVERT	CULVERT FLOW (Q5, CFS)		CULVERT SIZE (IN)
1	D9a	8.6	10	0.9		18
2	D9b	2.5	20	0.5		18
3	D9b	2.5	20	0.5		18
4	D11a	3.6	30	1.1		18
5	D11a	3.6	70	2.5		18
6	D11a	3.6	100	3.6		18
7	D14	7.0	10	0.7		18
8	D14	7.0	10	0.7		18
9	D13	3.8	10	0.4		18
10	D13	3.8	10	0.4		18
11	D13	3.8	10	0.4		18
12	D12	7.3	10	0.7		18
13	D12	7.3	10	0.7		18
14	D12	7.3	10	0.7		18
15	D11b	8.7	10	0.9		18
16	D11b	8.7	10	0.9		18
17	D5c	11.0	20	2.2		18
18	D5c	11.0	30	3.3		18
19	D5c	11.0	15	1.7		18
20	D5b	1.3	100	1.3		18
21	D7b	1.6	100	1.6		18
22	D7a	4.5	50	2.3		18
23	D7a	4.5	80	3.6		18
24	D5a	13.2	10	1.3		18

* CULVERT SIZING BASED ON EPC DCM, FIGURE 9-34; ASSUMING MAX. HW/D = 1.0 FOR Q5



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

APPENDIX D1

DETENTION POND CALCULATIONS
ABERT RANCH POND #I CAPACITY ANALYSIS

ABERT RANCH SUBDIVISION
COMPOSITE IMPERVIOUS AREAS

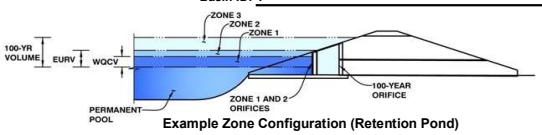
IMPERVIOUS AREAS - PER 2020 ABERT RANCH FDR

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
C	1.28	1.28	2.5-AC LOTS	11.0							11.000
E	3.12	3.12	2.5-AC LOTS	11.0							11.000
C,E	4.40										11.000
B	2.93	2.93	2.5-AC LOTS	11.0							11.000
F	3.78	3.78	2.5-AC LOTS	11.0							11.000
C,E,B,F	11.11										11.000
G	2.27	2.27	2.5-AC LOTS	11.0							11.000
D11	**15.60**	**15.60**	**5-AC LOTS**	**7.0**							**7.000**
H	5.69	5.69	2.5-AC LOTS	11.0							11.000
DPF,G,D11,H	34.67										9.200
A	10.74	10.74	2.5-AC LOTS	11.0							11.000
D12	**11.00**	**11.00**	**5-AC LOTS**	**7.0**							**7.000**
OI1	13.12	13.12	5-AC LOTS	7.0							7.000
I	25.60	16.60	5-AC LOTS	7.0	9.00	2.5-AC LOTS	11.0				8.406
DPH,D12,OI1,I	**95.13**										**8.632**

ABERT RANCH SUBDIVISION
COMPOSITE IMPERVIOUS AREAS

IMPERVIOUS AREAS - PER 2024 SETTLERS RANCH FILING NO. 3 FDR

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
C	1.28	1.28	2.5-AC LOTS	11.0							11.000
E	3.12	3.12	2.5-AC LOTS	11.0							11.000
C,E	4.40										11.000
B	2.93	2.93	2.5-AC LOTS	11.0							11.000
F	3.78	3.78	2.5-AC LOTS	11.0							11.000
C,E,B,F	11.11										11.000
G	2.27	2.27	2.5-AC LOTS	11.0							11.000
D11	**15.60**	**15.60**	**2.5-AC LOTS**	**11.0**							**11.000**
H	5.69	5.69	2.5-AC LOTS	11.0							11.000
DPF,G,D11,H	34.67										11.000
A	10.74	10.74	2.5-AC LOTS	11.0							11.000
D12	**11.00**	**11.00**	**2.5-AC LOTS**	**11.0**							**11.000**
OI1	13.12	13.12	5-AC LOTS	7.0							7.000
I	25.60	16.60	5-AC LOTS	7.0	9.00	2.5-AC LOTS	11.0				8.406
DPH,D12,OI1,I	**95.13**										**9.750**



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: ABERT RANCH

Basin ID: I

Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**				
Watershed Area =	95.10	acres			
Watershed Length =	2,800	ft			
Watershed Slope =	0.041	ft/ft			
Watershed Imperviousness =	9.75%	percent			
Percentage Hydrologic Soil Group A =	0.0%	percent			
Percentage Hydrologic Soil Group B =	100.0%	percent			
Percentage Hydrologic Soil Groups C/D =	0.0%	percent			
Desired WQCV Drain Time =	40.0	hours			
Location for 1-hr Rainfall Depths =	User Input				
Water Quality Capture Volume (WQCV) =	0.520	acre-feet	Optional User Override 1-hr Precipitation		
Excess Urban Runoff Volume (EURV) =	0.870	acre-feet			
2-yr Runoff Volume (P1 = 1.19 in.) =	0.596	acre-feet		1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.930	acre-feet		1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.146	acre-feet		1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	5.733	acre-feet		2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	7.974	acre-feet		2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	10.901	acre-feet		2.52	inches
500-yr Runoff Volume (P1 = 3.07 in.) =	16.207	acre-feet		3.07	inches
Approximate 2-yr Detention Volume =	0.554	acre-feet			
Approximate 5-yr Detention Volume =	0.871	acre-feet			
Approximate 10-yr Detention Volume =	1.827	acre-feet			
Approximate 25-yr Detention Volume =	2.562	acre-feet			
Approximate 50-yr Detention Volume =	2.678	acre-feet			
Approximate 100-yr Detention Volume =	3.467	acre-feet			

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.520	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.350	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.598	acre-feet
Total Detention Basin Volume =	3.467	acre-feet

Depth Increment = 2 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Bot EL=7543.0	--	1.00	--	--	--	3,154	0.072	1,551	0.036
	--	2.00	--	--	--	4,061	0.093	5,149	0.118
	--	4.00	--	--	--	9,656	0.222	18,906	0.434
	--	6.00	--	--	--	16,274	0.374	44,836	1.029
	--	8.00	--	--	--	25,480	0.585	86,590	1.988
	--	10.00	--	--	--	39,095	0.897	151,165	3.470
Spillway=7552.9	--	11.00	--	--	--	46,559	1.069	193,992	4.453
	--	12.00	--	--	--	54,023	1.240	244,283	5.608
Top EL=7555.0	--	13.00	--	--	--	61,500	1.412	302,045	6.934
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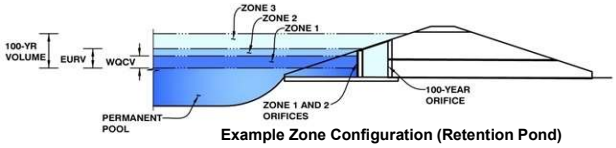
EXISTING DESIGN VOLUME IS ADEQUATE FOR INCREASED TOTAL IMPERVIOUS AREA OF 9.8%

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: ABERT RANCH

Basin ID: I



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.37	0.520	Orifice Plate
Zone 2 (EURV)	5.56	0.350	Orifice Plate
Zone 3 (100-year)	10.00	2.598	Weir&Pipe (Restrict)
		3.467	Total

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.403E-02	ft^2
Depth at top of Zone using Orifice Plate =	5.22	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	14.30	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.02	sq. inches (diameter = 1-9/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.74	3.48					
Orifice Area (sq. inches)	2.02	2.02	2.02					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	8.90	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	10.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	10.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	8.90	N/A	feet
Over Flow Weir Slope Length =	10.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	10.27	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	70.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	35.00	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	42.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	28.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	6.81	N/A	ft^2
Outlet Orifice Centroid =	1.31	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	10.90	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	65.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.95	feet
Stage at Top of Freeboard =	12.85	feet
Basin Area at Top of Freeboard =	1.39	acres

Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.07
Calculated Runoff Volume (acre-ft) =	0.520	0.870	0.596	0.930	2.146	5.733	7.974	10.901	16.207
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.519	0.868	0.595	0.929	2.145	5.728	7.963	10.885	16.192
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.24	0.77	1.06	1.42	2.04
Predevelopment Peak Q (cfs) =	0.0	0.0	1.3	2.3	22.6	72.9	100.7	134.7	194.1
Peak Inflow Q (cfs) =	9.7	16.2	11.2	17.3	39.6	104.0	143.4	194.1	285.1
Peak Outflow Q (cfs) =	0.3	0.4	0.3	0.4	0.5	59.6	101.1	114.7	236.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.0	0.8	1.0	0.9	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.8	1.4	1.6	1.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	49	41	50	76	77	72	67	60
Time to Drain 99% of Inflow Volume (hours) =	**41**	52	44	54	83	89	86	82	78
Maximum Ponding Depth (ft) =	4.21	5.40	4.50	5.57	8.14	9.68	10.01	10.92	11.60
Area at Maximum Ponding Depth (acres) =	0.24	0.33	0.26	0.34	0.61	0.85	0.90	1.06	1.17
Maximum Volume Stored (acre-ft) =	0.480	0.816	0.554	0.876	2.065	3.183	3.470	4.368	5.126

APPENDIX D2

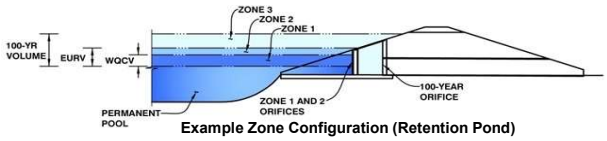
DETENTION POND CALCULATIONS
SETTLERS RANCH POND #5

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Settlers Ranch Filing No. 3**

Basin ID: **Detention Pond #5**



Example Zone Configuration (Retention Pond)

Watershed Information

			Optional User Overrides	
Selected BMP Type =	**EDB**			
Watershed Area =	18.90	acres		
Watershed Length =	1,950	ft		
Watershed Length to Centroid =	975	ft		
Watershed Slope =	0.049	ft/ft		
Watershed Imperviousness =	11.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.114	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.197	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.268	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.576	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.882	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.422	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.793	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	2.324	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	3.295	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.127	acre-feet		
Approximate 5-yr Detention Volume =	0.198	acre-feet		
Approximate 10-yr Detention Volume =	0.394	acre-feet		
Approximate 25-yr Detention Volume =	0.541	acre-feet		
Approximate 50-yr Detention Volume =	0.568	acre-feet		
Approximate 100-yr Detention Volume =	0.730	acre-feet		

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.114	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.083	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.533	acre-feet
Total Detention Basin Volume =	0.730	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Bot EL=7562.0	--	1.00	--	--	--	5,230	0.120	2,620	0.060
	--	3.00	--	--	--	8,045	0.185	15,895	0.365
Spillway=7566.0	--	5.00	--	--	--	11,447	0.263	35,387	0.812
Top EL=7568.0	--	7.00	--	--	--	15,165	0.348	61,999	1.423
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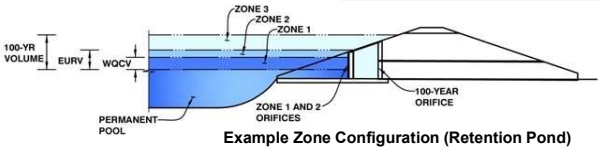
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Settlers Ranch Filing No. 3**

Basin ID: **Detention Pond #5**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.43	0.114	Orifice Plate
Zone 2 (EURV)	2.01	0.083	Orifice Plate
Zone 3 (100-year)	4.68	0.533	Weir&Pipe (Restrict)
Total (all zones)		0.730	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.903E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.01	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.85	sq. inches (diameter = 1 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.67	1.34					
Orifice Area (sq. inches)	0.85	0.85	0.85					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.01	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.01	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	5.19	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	2.15	N/A	ft^2
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	0.73	N/A	feet
Restrictor Plate Height Above Pipe Invert =	15.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.87	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.80	feet
Spillway Crest Length =	8.00	feet	Stage at Top of Freeboard =	6.80	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.34	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.35	acre-ft

Calculated Parameters for Spillway

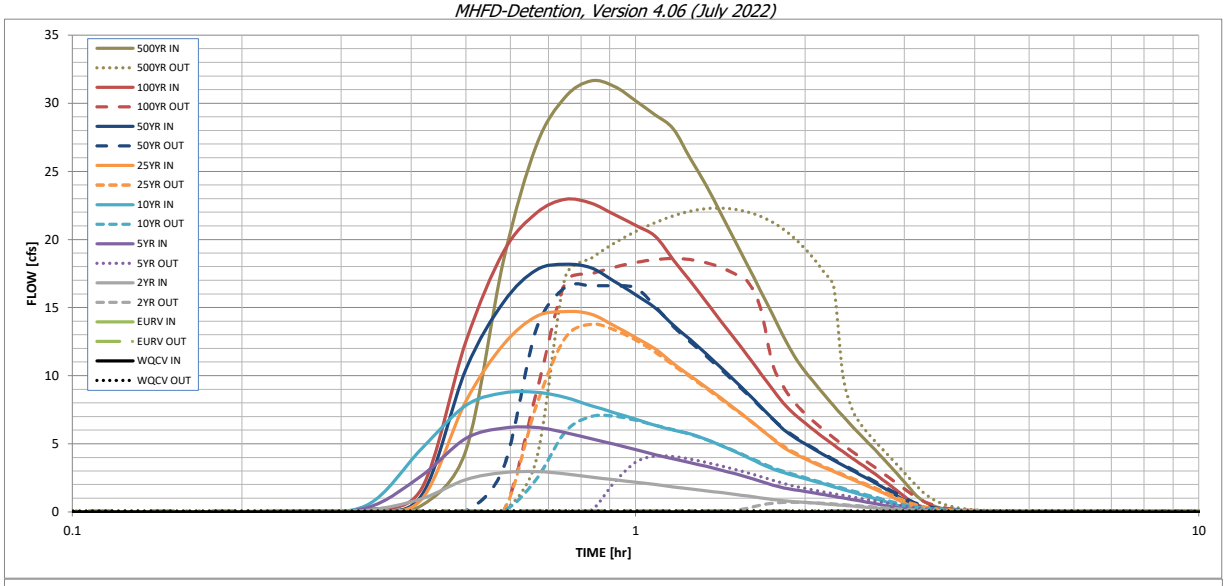
Routed Hydrograph Results

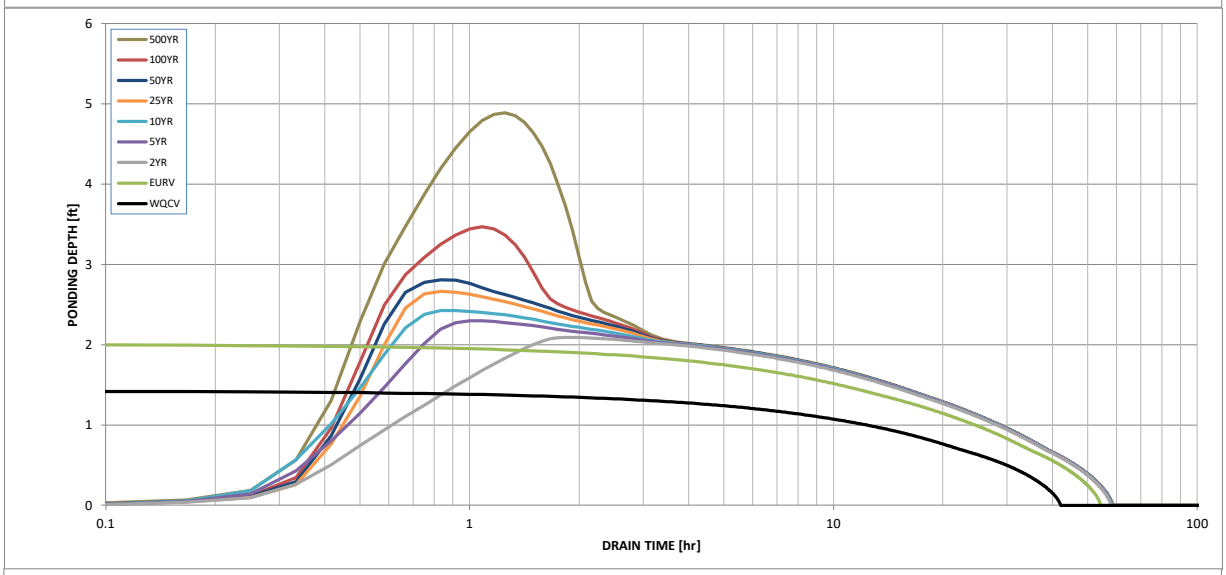
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

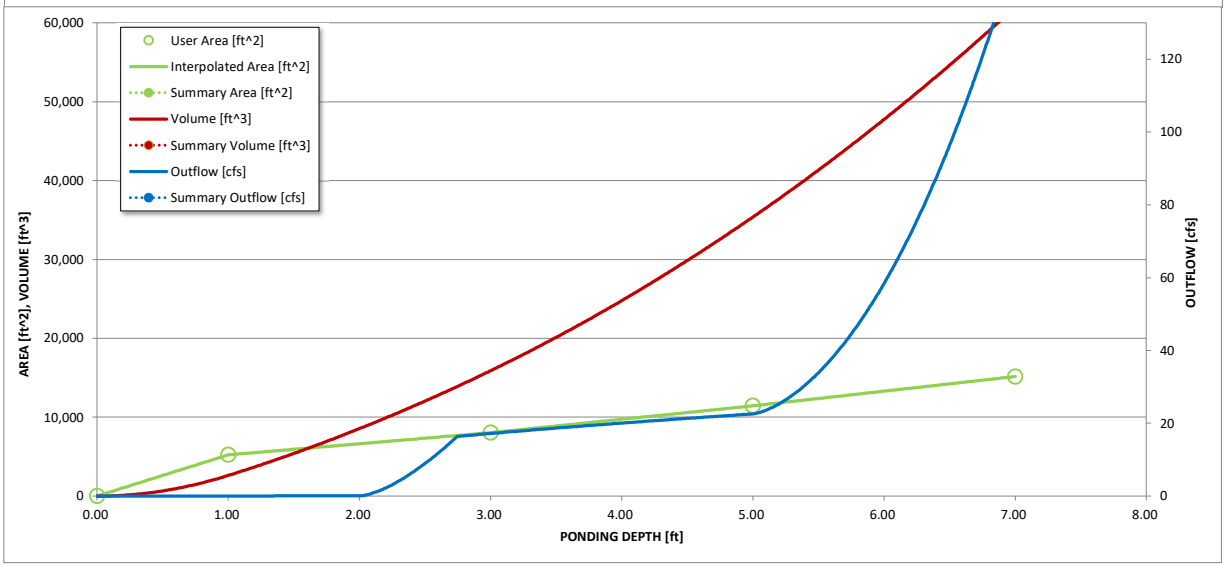
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.114	0.197	0.268	0.576	0.882	1.422	1.793	2.324	3.295
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.268	0.576	0.882	1.422	1.793	2.324	3.295
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.7	4.9	7.4	13.3	16.8	21.4	30.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.09	0.26	0.39	0.71	0.89	1.13	1.59
Peak Inflow Q (cfs) =	N/A	N/A	3.0	6.2	8.8	14.7	18.2	23.0	31.6
Peak Outflow Q (cfs) =	0.1	0.1	0.7	4.1	7.0	13.8	16.6	18.6	22.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.9	1.0	1.0	0.9	0.7
Structure Controlling Flow =	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.05	0.4	0.6	1.2	1.5	1.7	2.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	48	50	45	40	34	30	26	20
Time to Drain 99% of Inflow Volume (hours) =	**40**	52	55	52	50	47	45	42	37
Maximum Ponding Depth (ft) =	1.43	2.01	2.09	2.30	2.43	2.66	2.81	3.47	4.89
Area at Maximum Ponding Depth (acres) =	0.13	0.15	0.16	0.16	0.17	0.17	0.18	0.20	0.26
Maximum Volume Stored (acre-ft) =	0.115	0.198	0.210	0.242	0.263	0.304	0.329	0.454	0.781

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.03	0.05	0.06	0.04	0.05	0.05	0.07
	0:20:00	0.00	0.00	0.11	0.29	0.49	0.11	0.14	0.16	0.47
	0:25:00	0.00	0.00	0.96	2.64	4.62	0.91	1.19	1.70	4.51
	0:30:00	0.00	0.00	2.37	5.38	7.82	8.13	10.47	12.51	18.51
	0:35:00	0.00	0.00	2.87	6.15	8.73	12.31	15.41	19.12	26.89
	0:40:00	0.00	0.00	2.96	6.19	8.78	14.35	17.77	21.93	30.43
	0:45:00	0.00	0.00	2.79	5.81	8.40	14.71	18.18	22.95	31.64
	0:50:00	0.00	0.00	2.56	5.38	7.80	14.52	17.92	22.67	31.25
	0:55:00	0.00	0.00	2.35	4.96	7.29	13.66	16.93	21.83	30.19
	1:00:00	0.00	0.00	2.18	4.58	6.81	12.80	15.95	21.04	29.16
	1:05:00	0.00	0.00	2.01	4.20	6.35	11.97	14.99	20.24	28.12
	1:10:00	0.00	0.00	1.83	3.89	6.00	10.89	13.71	18.52	25.96
	1:15:00	0.00	0.00	1.68	3.61	5.73	10.00	12.66	16.95	24.01
	1:20:00	0.00	0.00	1.55	3.34	5.33	9.16	11.61	15.45	21.94
	1:25:00	0.00	0.00	1.41	3.07	4.89	8.37	10.62	14.03	19.93
	1:30:00	0.00	0.00	1.28	2.80	4.43	7.59	9.64	12.70	18.05
	1:35:00	0.00	0.00	1.16	2.53	3.99	6.84	8.69	11.43	16.25
	1:40:00	0.00	0.00	1.03	2.24	3.55	6.10	7.76	10.20	14.50
	1:45:00	0.00	0.00	0.91	1.97	3.16	5.37	6.85	9.01	12.84
	1:50:00	0.00	0.00	0.82	1.77	2.87	4.72	6.04	7.95	11.40
	1:55:00	0.00	0.00	0.75	1.62	2.65	4.26	5.46	7.17	10.32
	2:00:00	0.00	0.00	0.70	1.50	2.44	3.88	5.00	6.53	9.42
	2:05:00	0.00	0.00	0.64	1.38	2.23	3.55	4.56	5.94	8.56
	2:10:00	0.00	0.00	0.58	1.25	2.03	3.23	4.15	5.40	7.77
	2:15:00	0.00	0.00	0.53	1.14	1.83	2.95	3.78	4.89	7.04
	2:20:00	0.00	0.00	0.48	1.02	1.65	2.67	3.42	4.42	6.36
	2:25:00	0.00	0.00	0.43	0.91	1.47	2.40	3.08	3.99	5.72
	2:30:00	0.00	0.00	0.38	0.80	1.29	2.15	2.75	3.57	5.11
	2:35:00	0.00	0.00	0.33	0.70	1.13	1.90	2.43	3.16	4.52
	2:40:00	0.00	0.00	0.28	0.59	0.97	1.64	2.11	2.76	3.94
	2:45:00	0.00	0.00	0.23	0.49	0.81	1.40	1.79	2.35	3.36
	2:50:00	0.00	0.00	0.19	0.39	0.65	1.15	1.48	1.94	2.78
	2:55:00	0.00	0.00	0.14	0.29	0.49	0.90	1.17	1.54	2.20
	3:00:00	0.00	0.00	0.09	0.19	0.35	0.66	0.86	1.14	1.63
	3:05:00	0.00	0.00	0.06	0.12	0.24	0.42	0.56	0.76	1.11
	3:10:00	0.00	0.00	0.04	0.08	0.18	0.27	0.37	0.50	0.77
	3:15:00	0.00	0.00	0.03	0.07	0.14	0.17	0.25	0.34	0.54
	3:20:00	0.00	0.00	0.02	0.05	0.12	0.12	0.17	0.23	0.38
	3:25:00	0.00	0.00	0.02	0.04	0.09	0.08	0.12	0.15	0.26
	3:30:00	0.00	0.00	0.01	0.03	0.07	0.05	0.09	0.10	0.17
	3:35:00	0.00	0.00	0.01	0.03	0.06	0.04	0.06	0.06	0.11
	3:40:00	0.00	0.00	0.01	0.02	0.04	0.03	0.04	0.03	0.07
	3:45:00	0.00	0.00	0.01	0.01	0.03	0.02	0.03	0.02	0.05
	3:50:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.04
	3:55:00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.01	0.03
	4:00:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
	4:05:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	4:10:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: JPS
Company: JPS
Date: April 18, 2024
Project: Settlers Ranch - Detention Pond #5
Location: SW Corner of Steppler Road & Settlers Ranch Road, Monument, CO (El Paso County)

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 11.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.110

C) Contributing Watershed Area — Area = 18.900 ac

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

E) Design Concept (Select EURV when also designing for flood control)
Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN} = 0.114 ac-ft

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

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

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = 0.197 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$ = ac-f t

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

3. Basin Side Slopes

A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

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

5. Forebay

A) Minimum Forebay Volume
(V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.002 ac-ft

B) Actual Forebay Volume — V_F = 0.003 ac-ft

C) Forebay Depth
(D_F = 18 inch maximum) — D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 21.40 cfs

ii) Forebay Discharge Design Flow
($Q_F = 0.02 * Q_{100}$) — Q_F = 0.43 cfs

E) Forebay Discharge Design
Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 4.4 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: April 18, 2024
Project: Settlers Ranch - Detention Pond #5
Location: SW Corner of Steppler Road & Settlers Ranch Road, Monument, CO (El Paso County)

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (●) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One: (●) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.00 inches
E) Total Outlet Area	A_{ot} = 2.55 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s = 5.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 89 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*S.S. Well Screen with 60% Open Area*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 149 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 2.01 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 52.12 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches **VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: April 18, 2024
Project: Settlers Ranch - Detention Pond #5
Location: SW Corner of Steppler Road & Settlers Ranch Road, Monument, CO (El Paso County)

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Buried Soil Riprap Spillway
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One: ○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Periodic inspection and removal as needed; Access ramp provided to pond bottom

Notes:

Hydraulic Analysis Report

Project Data

Project Title: Project - Settlers Ranch Flg. 3 - Det. Pond #5 Trickle Channel
Designer: JPS
Project Date: Saturday, July 20, 2024
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Channel Analysis - Trickle Channel

Notes:

Input Parameters

Channel Type: Rectangular
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0050 ft/ft
Manning's n: 0.0130
Flow: 0.8600 cfs **(Design Flow = 2 * Forebay Discharge Capacity = 2 * 0.43 cfs = 0.86 cfs)**

Result Parameters

Depth: 0.1161 ft **< 0.5 ft Trickle Channel Depth…..OK**
Area of Flow: 0.4644 ft^2
Wetted Perimeter: 4.2322 ft
Hydraulic Radius: 0.1097 ft
Average Velocity: 1.8517 ft/s
Top Width: 4.0000 ft
Froude Number: 0.9577
Critical Depth: 0.1128 ft
Critical Velocity: 1.9059 ft/s
Critical Slope: 0.0055 ft/ft
Critical Top Width: 4.00 ft
Calculated Max Shear Stress: 0.0362 lb/ft^2
Calculated Avg Shear Stress: 0.0342 lb/ft^2

Settlers Ranch Filing No. 3
Detention Pond #5 Spillway

Figure 13-12c. Emergency Spillway Protection

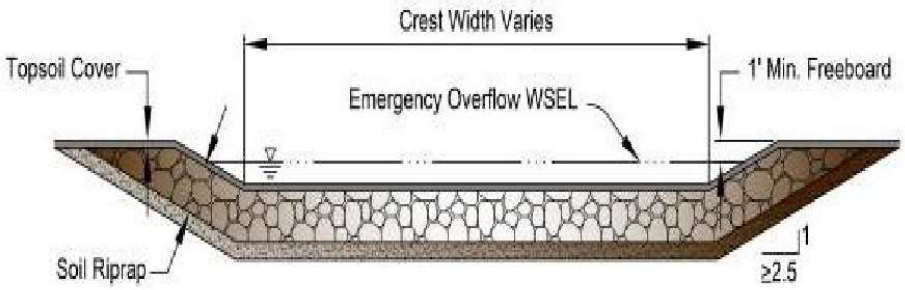
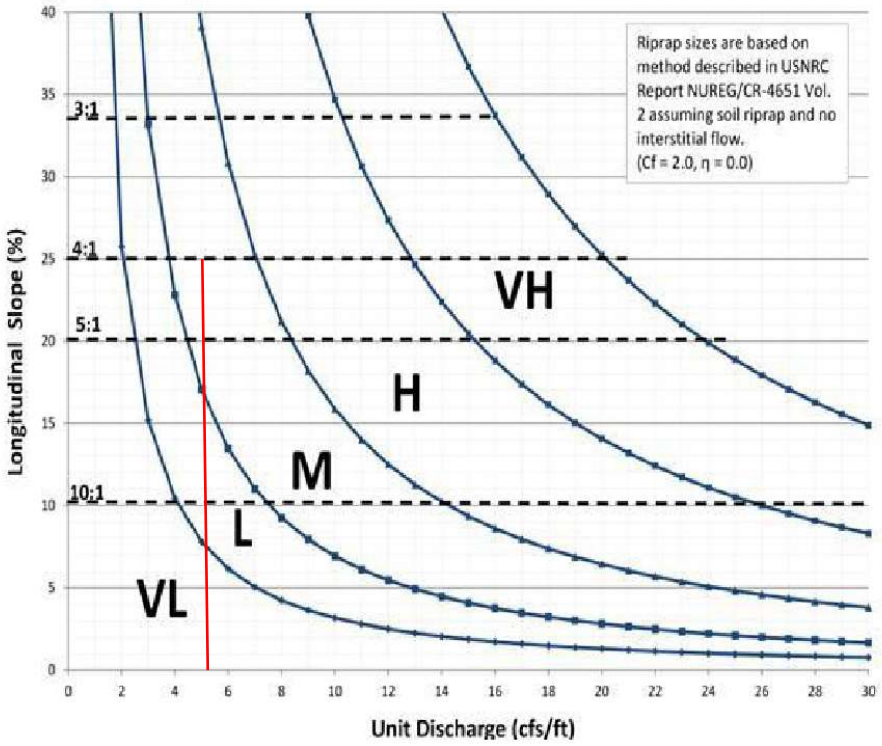


Figure 13-12d. Riprap Types for Emergency Spillway Protection



Spillway Q100 = 41.8 cfs (Undetained DP-5)
Unit Discharge = (41.8 cfs / 8 ft) = 5.2

Q100 (Pond Discharge) = 18.6 cfs; D = 2.0 ft
Q / D^1.5 = 18.6 / (2.0^1.5) = 6.6

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

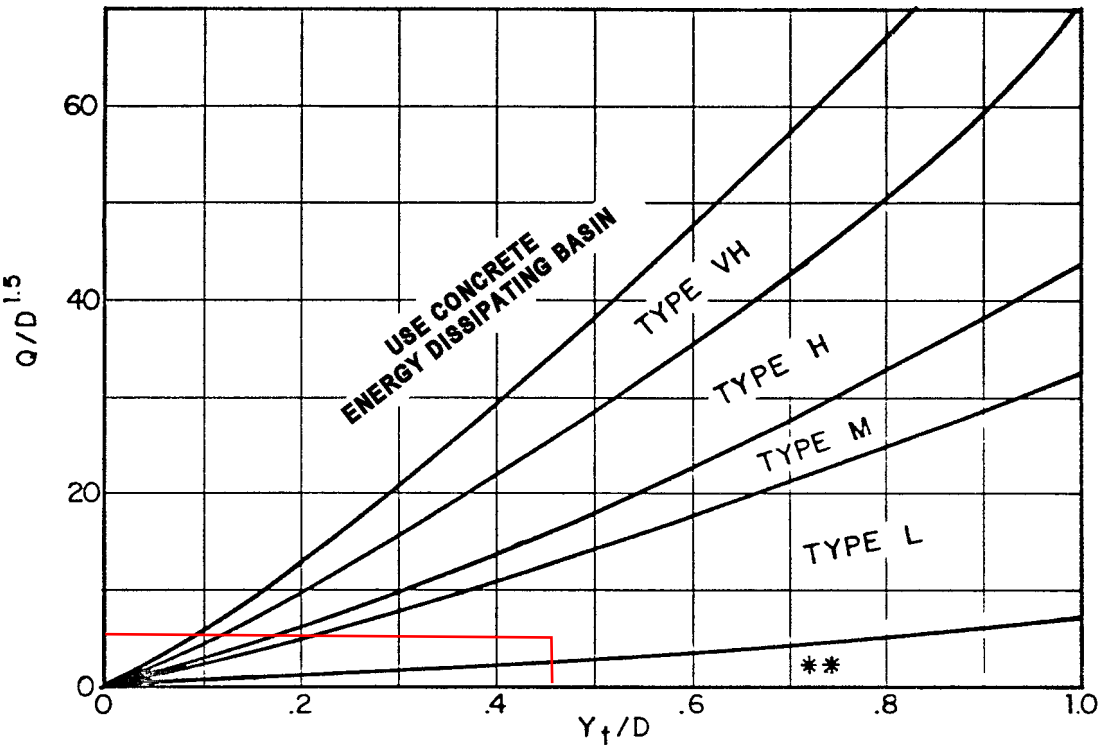
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)



Yt = 0.9 ft; Yt / D = (0.9 / 2.0) = 0.45

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

Use Type M (Conservative)

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

APPENDIX E

COST ESTIMATES

SETTLERS RANCH - FILING NO. 3
DRAINAGE IMPROVEMENTS COST ESTIMATE

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	DRAINAGE IMPROVEMENTS				
506	Riprap Culvert Aprons (d_{50} = 12")	8	TN	$104	$832
603	18" RCP Culvert	74	LF	$82	$6,068
603	18" RCP FES	2	EA	$492	$984
	SUBTOTAL				**$7,884**
	Contingency @ 15%				**$1,183**
	TOTAL				**$9,067**

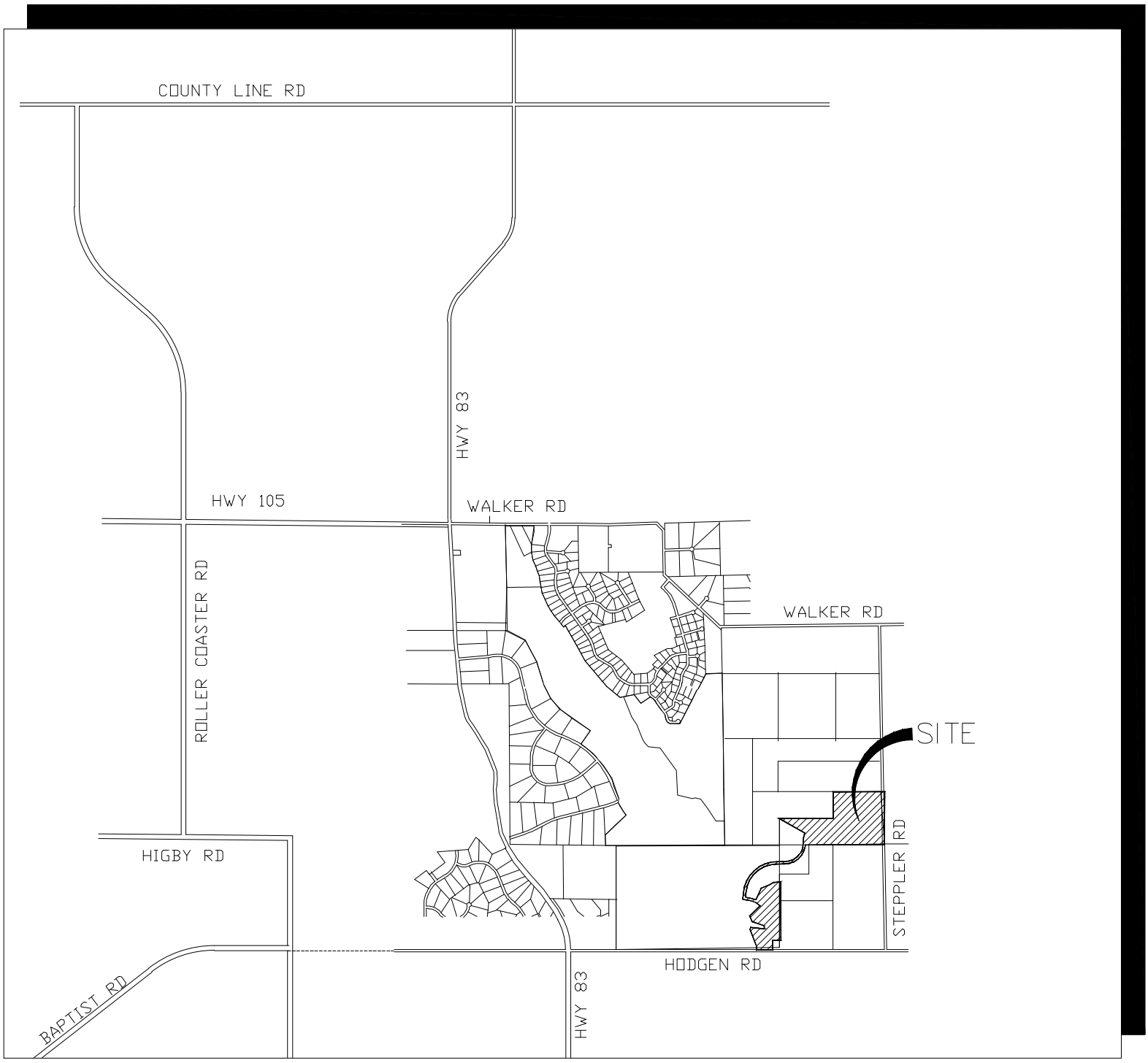
SETTLERS RANCH FILING NO. 3 - DETENTION POND NO. 5
ENGINEER'S COST ESTIMATE
DRAINAGE IMPROVEMENTS - FULL-SPECTRUM DETENTION FACILITY (PRIVATE)

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	PRIVATE DRAINAGE FACILITIES (NON-REIMBURSABLE)				
	Aggregate Base Course (Access Drive / Ramp)	126	CY	$66	$8,316
	Riprap Aprons (12" Riprap)	30	TN	$104	$3,120
	Concrete Forebay	1	LS	$2,500	$2,500
	Concrete Trickle Channel	37	SY	$40	$1,480
	18" RCP Driveway Culvert	42	LF	$82	$3,444
	24" RCP Pond Discharge Line	130	LF	$98	$12,740
	Detention Basin Outlet Structure	1	LS	$8,000	$8,000
	Buried Soil Riprap Spillway	85	TN	$104	$8,840
	SUBTOTAL				**$48,440**
	Contingency @ 10%				$4,844
	TOTAL				**$53,284**

The cost estimate submitted herein is based on time-honored practices within the construction industry. As such the engineer does not control the cost of labor, materials, equipment or a contractor's method of determining prices and competitive bidding practices or market conditions. The estimate represents our best judgement as design professionals using current information available at the time of the preparation. The engineer cannot guarantee that proposals, bids and/or construction costs will not vary from this cost estimate.

APPENDIX F

FIGURES



VICINITY MAP

NOT TO SCALE

National Flood Hazard Layer FIRMette

FEMA

104°44'33"W 39°4'58"N

104°43'55"W 39°4'30"N

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/20/2024 at 6:53 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

PBMP LEGEND

- TRIBUTARY TO SETTLERS RANCH POND NO. 4
- TRIBUTARY TO SETTLERS VIEW POND NO. S3
- TRIBUTARY TO ABERT RANCH POND NO. I
- TRIBUTARY TO SETTLERS RANCH POND NO. 5
- EXCLUDED FROM PBMP REQUIREMENTS PER ECM

PBMP SUMMARY TABLE

FLG. NO. 3 BASINS	PBMP TRIBUTARY AREA (AC)	PBMP
D5–D7	42.6	SETTLERS RANCH POND #4
D9	14.3	SETTLERS VIEW POND #S3
D11–D12	26.6	ABERT RANCH POND # I
D10, D14	18.9	SETTLERS RANCH POND #5
D13.1 (LOT AREA)	5.1	EXCLUDED **
D13.2 (ROAD AREA)	0.6	EXCLUDED *
D8a.1	0.3	EXCLUDED **

N

300' 0 300' 600'

ORIGINAL SCALE: 1"=300' (24"x36" SHEET)
CONTOUR INTERVAL=2'

* EXCLUDED BASED ON LESS THAN 1-ACRE OF DEVELOPED AREA PER ECM APP. I.7.1.C.1.

** EXCLUDED BASED ON LARGE LOT EXEMPTION PER ECM APP. I.7.1.B.5.

SETTLERS RANCH - FILING NO. 3

PBMP APPLICABILITY EXHIBIT

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

REVISION	BY	DATE
No.		

HORZ. SCALE: 1"=300'	DRAWN: RMD
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RAMPART	CHECKED: JPS
CREATED: 5/2/06	LAST MODIFIED: 8/23/24
PROJECT NO: 030501	MODIFIED BY: MSP

SHEET: PBMP

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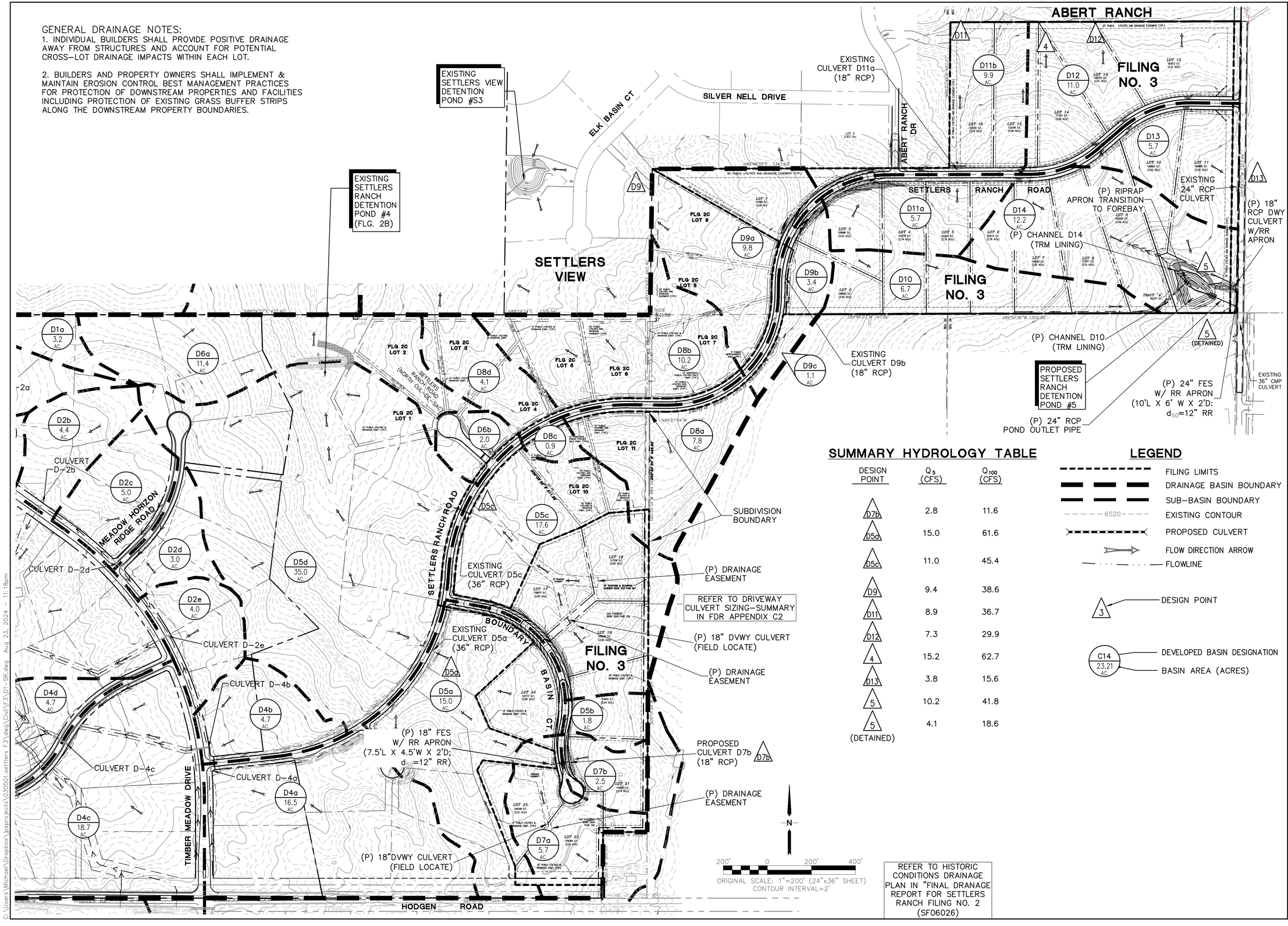
GENERAL DRAINAGE NOTES:
1. INDIVIDUAL BUILDERS SHALL PROVIDE POSITIVE DRAINAGE AWAY FROM STRUCTURES AND ACCOUNT FOR POTENTIAL CROSS-LOT DRAINAGE IMPACTS WITHIN EACH LOT.

2. BUILDERS AND PROPERTY OWNERS SHALL IMPLEMENT & MAINTAIN EROSION CONTROL BEST MANAGEMENT PRACTICES FOR PROTECTION OF DOWNSTREAM PROPERTIES AND FACILITIES INCLUDING PROTECTION OF EXISTING GRASS BUFFER STRIPS ALONG THE DOWNSTREAM PROPERTY BOUNDARIES.



SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
D7b	2.8	11.6
D5a	15.0	61.6
D5c	11.0	45.4
D9	9.4	38.6
D11	8.9	36.7
D12	7.3	29.9
4	15.2	62.7
D13	3.8	15.6
5	10.2	41.8
5 (DETAINED)	4.1	18.6

LEGEND

- FILING LIMITS
- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- PROPOSED CULVERT
- FLOW DIRECTION ARROW
- FLOWLINE
- 3 DESIGN POINT
- C14 23.21 AC. DEVELOPED BASIN DESIGNATION / BASIN AREA (ACRES)

REFER TO HISTORIC CONDITIONS DRAINAGE PLAN IN "FINAL DRANAGE REPORT FOR SETTLERS RANCH FILING NO. 2 (SF06026)

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SETTLERS RANCH - FILING NO. 3

DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO
80903
PH: 719-477-9429
FAX: 719-471-0766
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CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

HORZ. SCALE: 1"=200'	DRAWN: RMD
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RAMPART	CHECKED: JPS
CREATED: 5/2/06	LAST MODIFIED: 8/23/24
PROJECT NO: 030501	MODIFIED BY: MSP

SHEET: D1-SR