

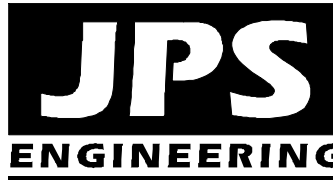
**FINAL DRAINAGE REPORT**  
**for**  
**SETTLERS RANCH SUBDIVISION**  
**FILING NO. 3**

**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:**



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

**SETTLERS RANCH SUBDIVISION – FILING NO. 3**  
**FINAL DRAINAGE REPORT**  
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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.

\_\_\_\_\_  
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

\_\_\_\_\_  
Date

Printed Name: Mark Davis, Manager  
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.

10/15/2024

\_\_\_\_\_  
Joshua Palmer, P.E.  
County Engineer / ECM Administrator

\_\_\_\_\_  
Date

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 Stepler 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-foot 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                          |             |
|                                      | <u>C5</u>                  | <u>C100</u> |
| • 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 Stepler 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)

The 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 Point #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 D12 is 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 Stepler 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:

<b>Detention Basin</b>	<b>Tributary Drainage Basins</b>	<b>Total Tributary Area (ac)</b>	<b>Flg. 3 Tributary Area <sup>2</sup> (ac)</b>	<b>Impervious Percentage</b>	<b>Min. 100-Yr FSD Vol. (af)</b>	<b>Design Volume (af)</b>
<b>Existing Detention Ponds: <sup>1</sup></b>						
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 <sup>3</sup>	D11,D12	26.6	26.6	9.8	3.5	4.4
<b>Proposed Detention Pond:</b>						
SR #5	D10,D14	18.9	18.9	11.0	0.7	0.8

<sup>1</sup> Existing Detention Ponds will not be altered and have adequate capacity for Flg. 3 developed flows

<sup>2</sup> Includes Sub-Basin areas extending into adjoining filings

<sup>3</sup> 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**

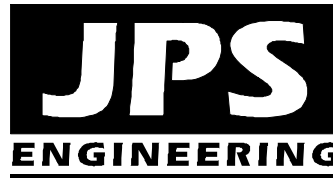
**DRAINAGE LETTER REPORT**  
**for**  
**SETTLERS RANCH FILING NO. 2C**

**Prepared for:**

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

March 22, 2019

**Prepared by:**



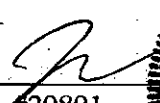
**19 E. Willamette Avenue**  
**Colorado Springs, CO 80903**  
**(719)-477-9429**  
**[www.jpsengr.com](http://www.jpsengr.com)**

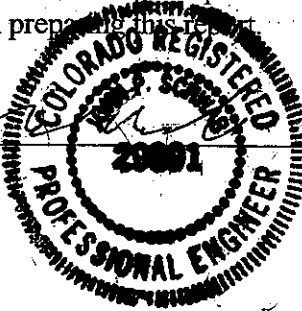
**JPS Project No. 111603**  
**PCD File No.: SF-18-018**

## 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 the report.

  
John P. Schwab, P.E. #29891



5/20/19

### 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

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

3/25/19  
Date

### 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.  
County Engineer / ECM Administrator

Approved

By: Elizabeth NijKamp

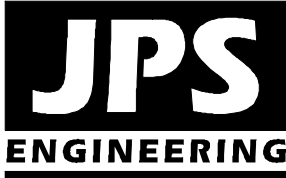
Date: 06/18/2019

El Paso County Planning & Community Development



Date

Conditions:



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

**WALDEN PRESERVE**

**UNPLATTED ZONED RR3**

**DETENTION POND #4 (FLG. 2B)**

**FLG 2C**

**FLG 2B**

**FLG 2A**

**DETENTION POND #5 (PHASE 4)**

**EXISTING 36\"/>

**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

**HYDROLOGY SUMMARY TABLE**

DESIGN POINT	Q <sub>5</sub> (CFS)	Q <sub>100</sub> (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

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

## DEVELOPED DRAINAGE PLAN

**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

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

D1

**DRAINAGE LETTER REPORT**

**for**

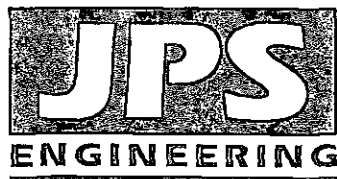
**SETTLERS RANCH SUBDIVISION  
FILING NO. 2B**

**Prepared for:**

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

December 30, 2015  
Revised February 18, 2016

**Prepared by:**



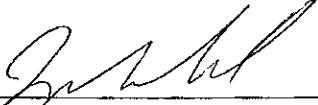
19 E. Willamette Avenue  
Colorado Springs, CO 80903  
(719)-477-9429  
(719)-471-0766 fax  
[www.jpsengr.com](http://www.jpsengr.com)

**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.

  
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: 

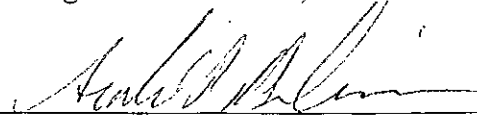
Printed Name: Mark Davis, Manager

  
Date

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

### El Paso County's Statement

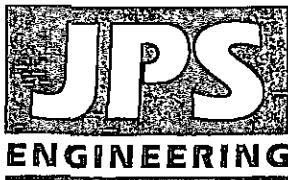
Filed in accordance with the requirements of the El Paso County Land Development Code, Drainage Criteria Manual, Volumes 1 and 2, and Engineering Criteria Manual as amended.

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

4-12-16

Date

Conditions:



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.

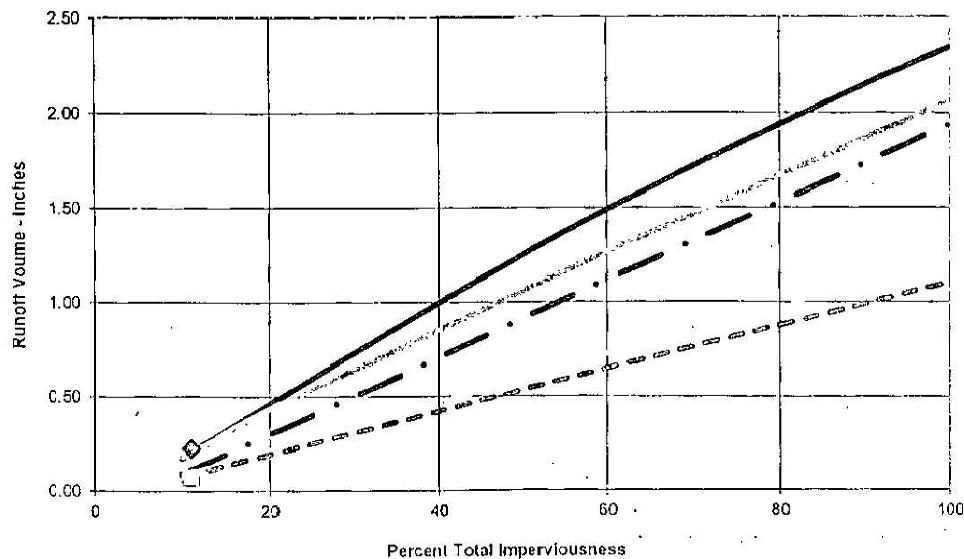
Area of Watershed (acres)	86.30	
Subwatershed Imperviousness	11.0%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	1	
Effective Imperviousness <sup>1</sup>	8.6%	
Hydrologic Soil Type	Percentage of Area	Area (acres)
Type A		0.0
Type B	100.0%	86.3
Type C or D		0.0

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		Decay Coefficient-- <i>D</i>
Initial-- <i>f<sub>i</sub></i>	Final-- <i>f<sub>o</sub></i>	
4.5	0.6	0.0018

Detention Volumes <sup>2,5</sup>		Maximum Allowable Release Rate, cfs <sup>3</sup>
(watershed inches)	(acre-feet)	
0.07	0.50	Design Outlet to Empty EURV in 72 Hours
0.23	1.62	73.36

Excess Urban Runoff Volume<sup>4</sup>

100-year Detention Volume plus 1/2 WQCV<sup>5</sup>



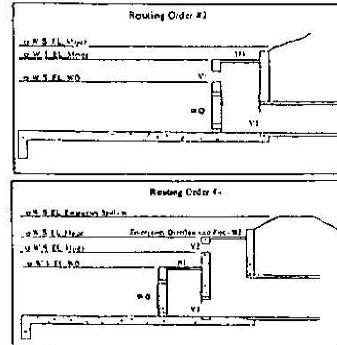
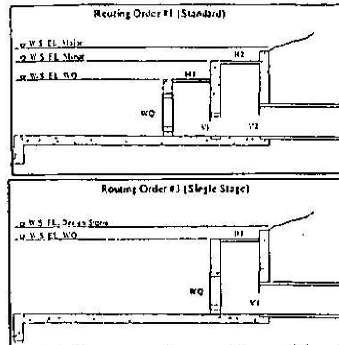
### Notes:

- 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-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):

Circular Opening: Diameter in Inches  
 OR  
 Rectangular Opening: Width in Feet  
 Length (Height for Vertical)

Percentage of Open Area After Trash Rack Reduction  
 Orifice Coefficient  
 Weir Coefficient  
 Orifice Elevation (Bottom for Vertical)

## Calculation of Collection Capacity:

Net Opening Area (after Trash Rack Reduction)  
 OPTIONAL: User-Override Net Opening Area  
 Perimeter as Weir Length  
 OPTIONAL: User-Override Weir Length

	#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Dia. =					inches
W =	5.67		1.99		ft.
L or H =	2.82		2.45		ft.
% open =	63		100		%
C <sub>o</sub> =	0.60		0.60		
C <sub>w</sub> =	3.00				
E <sub>o</sub> =	7560.00		7558.00		ft.
A <sub>o</sub> =	10.43		4.88		sq. ft.
A <sub>w</sub> =					sq. ft.
L <sub>w</sub> =	12.98				ft.
L <sub>w</sub> =					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).**

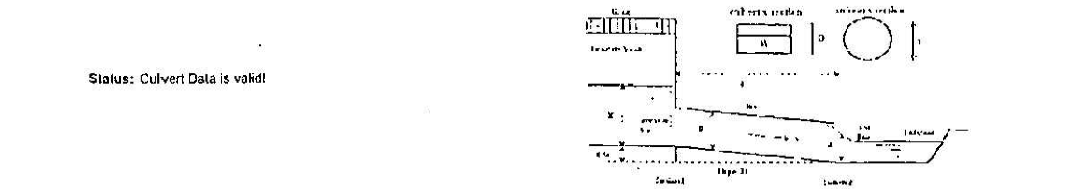
Labels for WQCV, Minor, & Major Storage W.S. Elevations (input)	Water Surface Elevation ft (linked)	WQCV Plate/Riser Flow cfs (User-linked)	Horizontal Orifices				Vertical Orifices		Total Collection Capacity cfs (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (link for anal seek)
			#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)		
	7558.30	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	31.30	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**  
BasinID: **POND #4**

Status: Culvert Data is valid!



**Design Information (Input):**

Circular Culvert: Barrel Diameter in inches D =  in.  
 Circular Culvert: Inlet Edge Type (choose from pull-down list)   
 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)

Circular Culvert: Barrel Diameter in inches	D = <input type="text" value="30"/>	in.
Circular Culvert: Inlet Edge Type (choose from pull-down list)	<input type="text" value="Groover End with Headwall"/>	
OR:		
Box Culvert: Barrel Height (Rise) in Feet	Height (Rise) = <input type="text"/>	ft.
Box Culvert: Barrel Width (Span) in Feet	Width (Span) = <input type="text"/>	ft.
Box Culvert: Inlet Edge Type (choose from pull-down list)	<input type="text" value="Square Edge w/ 80-15 deg. Flared Wingwall"/>	
Number of Barrels	No. = <input type="text" value="1"/>	
Inlet Elevation at Culvert Invert	$I_{oc}$ = <input type="text" value="7555.00"/>	ft. elev.
Outlet Elevation at Culvert Invert	$O_{oc}$ = <input type="text" value="7555.00"/>	ft. elev.
Culvert Length in Feet	L = <input type="text" value="66.0"/>	ft.
Manning's Roughness	n = <input type="text" value="0.0130"/>	
Bend Loss Coefficient	$K_b$ = <input type="text" value="0.00"/>	
Exit Loss Coefficient	$K_e$ = <input type="text" value="1.00"/>	

Number of Barrels	Nb =	1	
Inlet Elevation at Culvert Invert	I <sub>ce</sub> =	7556.00	ft. elev.
Outlet Elevation at Culvert Invert	O <sub>ce</sub> =	7555.00	ft. elev.
Culvert Length in Feet	L =	66.0	ft.
Manning's Roughness	n =	0.0130	
Bend Loss Coefficient	K <sub>b</sub> =	0.00	
Exit Loss Coefficient	K <sub>e</sub> =	1.00	

**Design Information (calculated):**

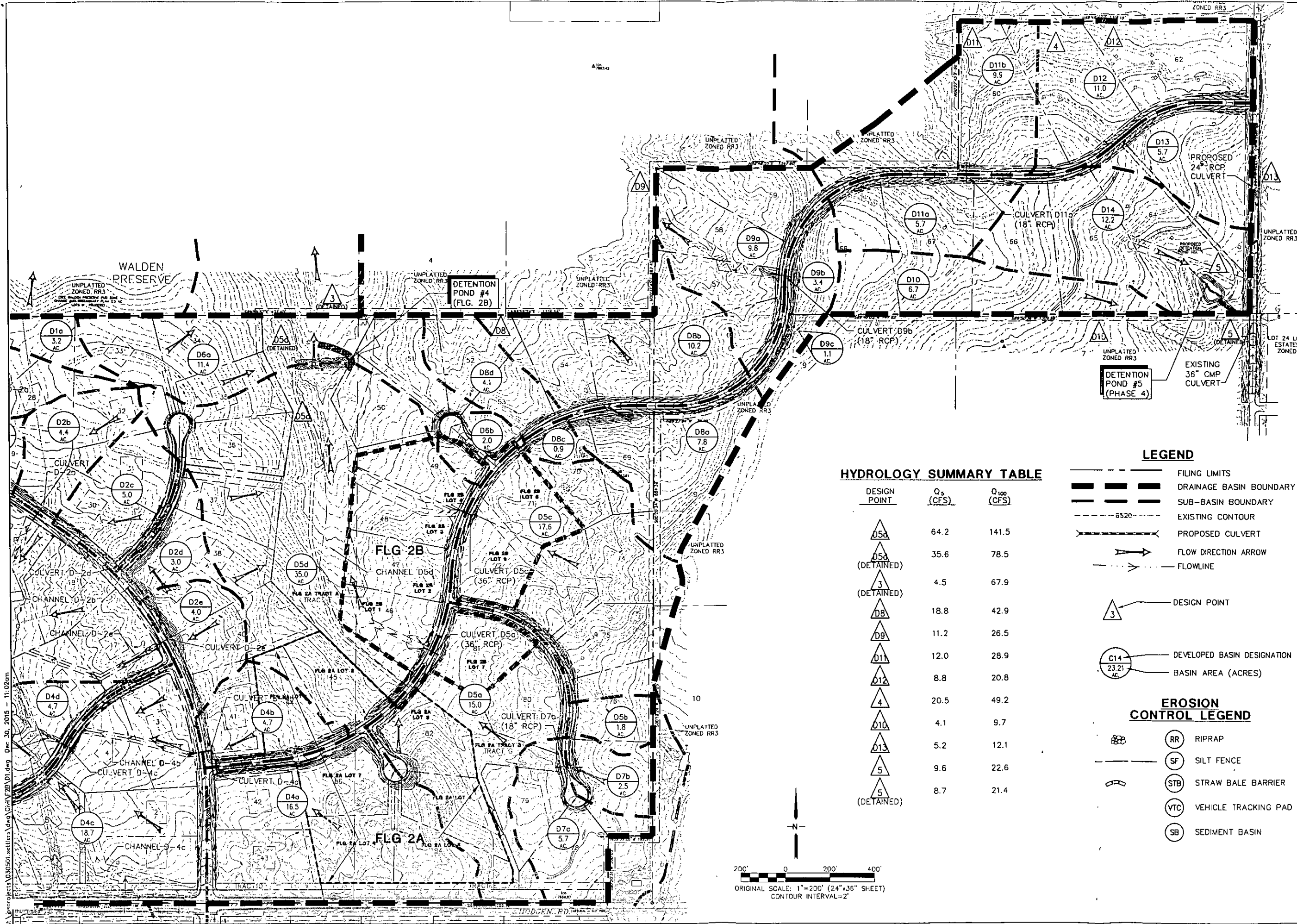
Entrance Loss Coefficient	$K_e =$	0.29
Friction Loss Coefficient:	$K_f =$	0.61
Sum of All Loss Coefficients	$K_L =$	1.81
Orifice Inlet Condition Coefficient	$C_d =$	0.99
Minimum Energy Condition Coefficient:	$KE_{min} =$	-0.04

Entrance Loss Coefficient	$K_e =$	0.29
Friction Loss Coefficient:	$K_f =$	0.61
Sum of All Loss Coefficients	$K_L =$	1.81
Orifice Inlet Condition Coefficient	$C_d =$	0.99
Minimum Energy Condition Coefficient:	$KE_{min} =$	-0.04

Calculations of Culvert Capacity (output):

[illegible]





HYDROLOGY SUMMARY TABLE

DESIGN POINT	Q <sub>5</sub> (CFS)	Q <sub>100</sub> (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

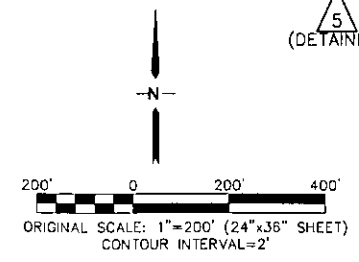
LEGEND

- FILING LIMITS
- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- EXISTING CONTOUR
- PROPOSED CULVERT
- FLOW DIRECTION ARROW
- FLOWLINE

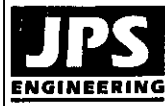
- DESIGN POINT
- DEVELOPED BASIN DESIGNATION
- BASIN AREA (ACRES)

EROSION CONTROL LEGEND

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



SETTLERS RANCH - FILING NO. 2



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NO.	REVISION	BY	DATE

DEVELOPED DRAINAGE PLAN

HORIZ. 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

**FINAL DRAINAGE REPORT**  
**for**  
**SETTLERS RANCH SUBDIVISION**  
**FILING NO. 2**

**Prepared for:**

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

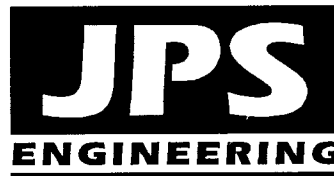
August 31, 2006  
Revised December 29, 2006  
Revised December 21, 2007  
Revised May 30, 2008

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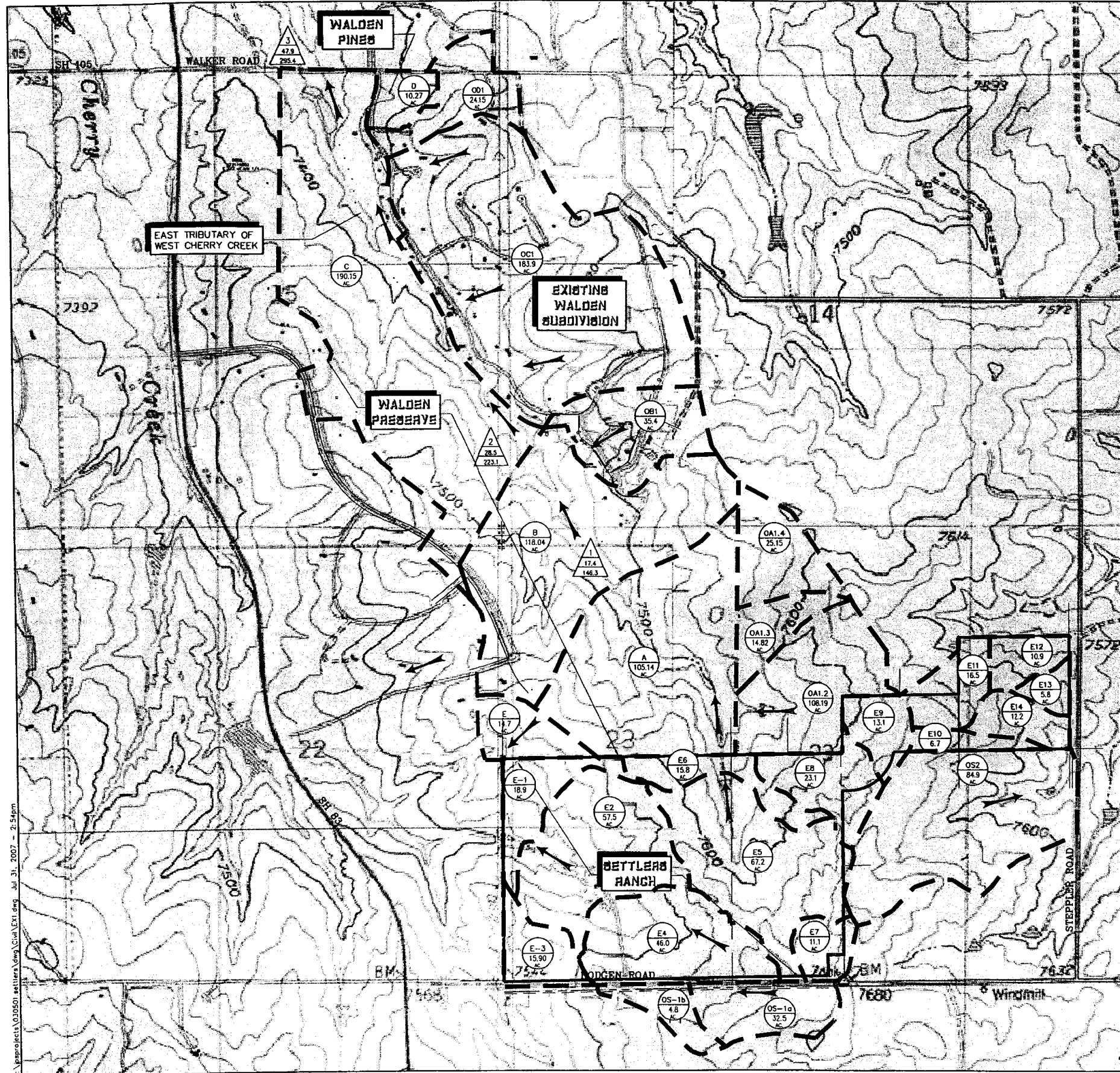
**EPC DEVELOPMENT SERVICES**

**Prepared by:**

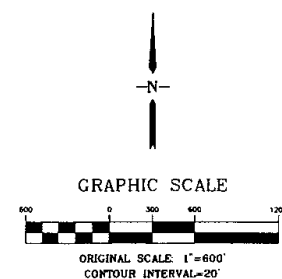


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**JPS Project No. 030501**



- LEGEND**
- FILING LIMITS
  - MAJOR BASIN BOUNDARY
  - EXISTING CONTOUR
  - FLOWLINE
  - PROPOSED FLOW DIRECTION ARROW
  - △ DESIGN POINT
  - △ Q<sub>a</sub> (cfs)
  - △ Q<sub>100</sub> (cfs)
  - BASIN DESIGNATION
  - BASIN AREA (ACRES)



# SETTLERS RANCH SUBDIVISION

## MAJOR BASIN / HISTORIC DRAINAGE PLAN

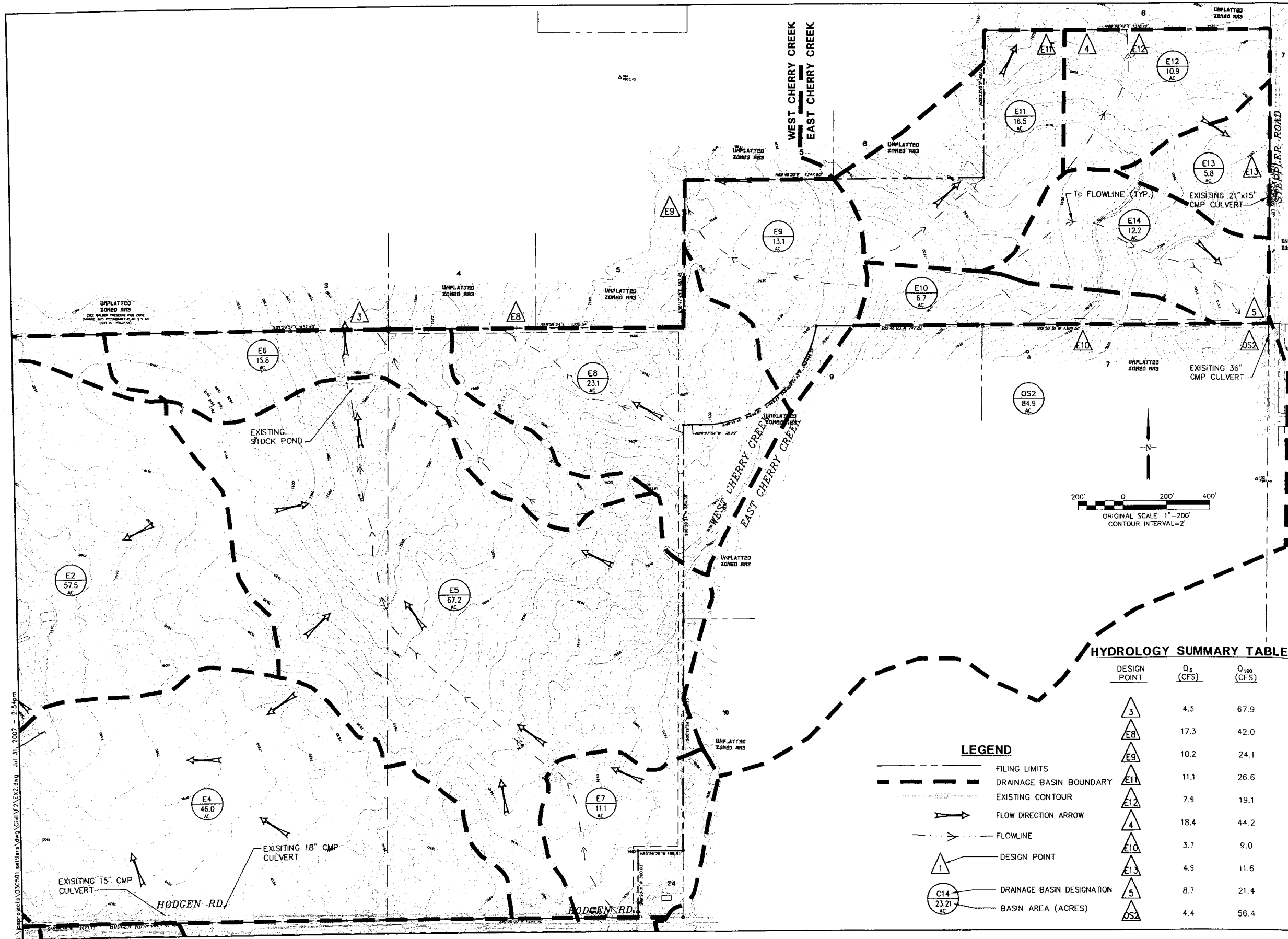


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80903  
Ph: 719-477-9429  
Fax: 719-471-0766

NO.	REVISION	BY	DATE

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





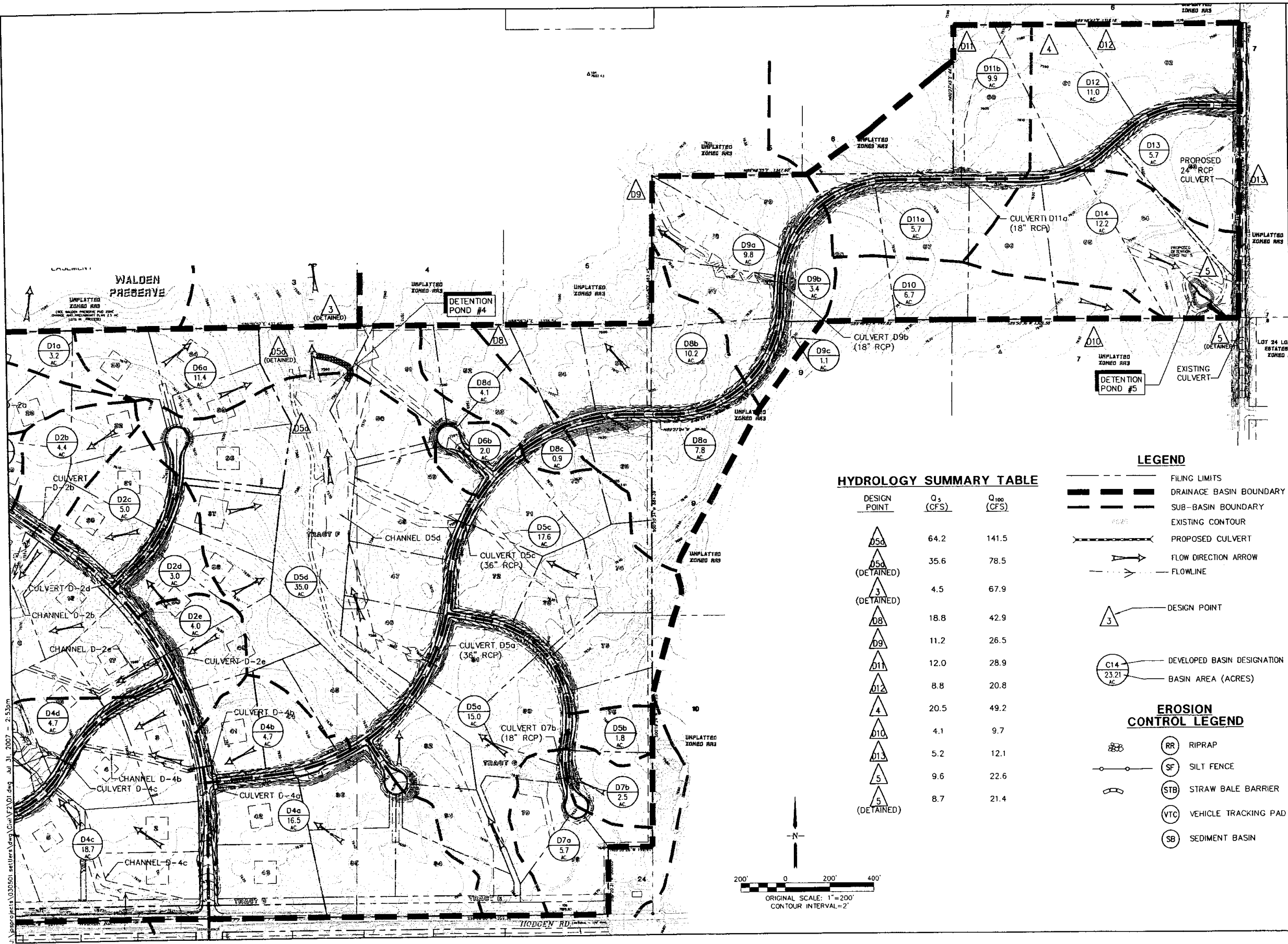
# SETTLERS RANCH - FILING NO. 2

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Colorado Springs, CO  
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PH: 719-477-9429  
FAX: 719-471-0766

NO.	REVISION	BY	DATE

## HISTORIC DRAINAGE PLAN

HORIZ. SCALE: 1"=200'	DRAWN: M.P.
VERT. SCALE: N/A	DESIGNED: J.P.S.
SURVEYED: RAMPART	CHECKED: J.P.S.
CREATED: 5/2/06	LAST MODIFIED: 12/28/06
PROJECT NO: 030501	MODIFIED BY: M.P.
SHEET:	EX2



HYDROLOGY SUMMARY TABLE

DESIGN POINT	Q <sub>s</sub> (CFS)	Q <sub>100</sub> (CFS)
D5a	64.2	141.5
D5a (DETAINED)	35.6	78.5
D3 (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
D4	20.5	49.2
D10	4.1	9.7
D13	5.2	12.1
D5	9.6	22.6
D5 (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

SETTLERS RANCH - FILING NO. 2

DEVELOPED DRAINAGE PLAN

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

NO.	REVISION	BY	DATE

HORIZ. 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

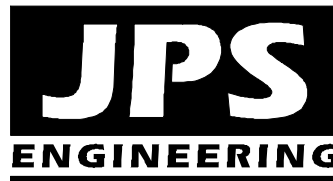
**FINAL DRAINAGE REPORT**  
**for**  
**SETTLERS VIEW SUBDIVISION**

**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  
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(719)-471-0766 fax  
[www.jpsengr.com](http://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

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL Tc <sup>(4)</sup> (MIN)	TOTAL Tc <sup>(4)</sup> (MIN)	INTENSITY <sup>(5)</sup>		PEAK FLOW	
			5-YEAR <sup>(7)</sup>	100-YEAR <sup>(7)</sup>	LENGTH (FT)	SLOPE (FT/FT)	Tco <sup>(1)</sup> (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS <sup>(2)</sup> VELOCITY (FT/S)	Tt <sup>(3)</sup> (MIN)			5-YR (IN/HR)	100-YR (IN/HR)	Q5 <sup>(6)</sup> (CFS)	Q100 <sup>(6)</sup> (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

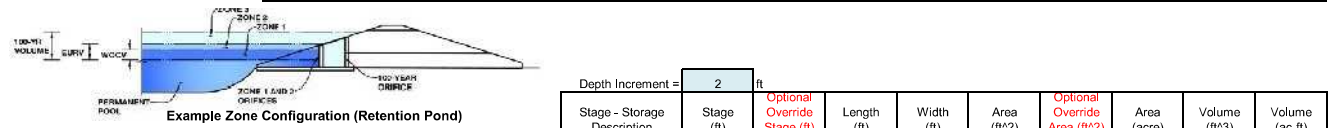
- 1) OVERLAND FLOW Tco = (0.395\*(1.1-RUNOFF COEFFICIENT))\*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
- 2) SCS VELOCITY = C \* ((SLOPE(FT/FT)^0.5)
  - C = 2.5 FOR HEAVY MEADOW
  - C = 5 FOR TILLAGE/FIELD
  - C = 7 FOR SHORT PASTURE AND LAWNS
  - C = 10 FOR NEARLY BARE GROUND
  - C = 15 FOR GRASSED 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<sub>5</sub> = -1.5 \* ln(Tc) + 7.583
  - I<sub>100</sub> = -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



### Required Volume Calculation

Selected BMP Type =	<b>EDB</b>	
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
5-yr Runoff Volume (P1 = 1.5 in.) =	0.318	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.694	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	1.763	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	2.433	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	3.308	acre-feet
500-yr Runoff Volume (P1 = 3.14 in.) =	5.008	acre-feet
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) =	0.833	acre-feet
Total Detention Basin Volume =	1.100	acre-feet
Initial Surgecharge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surgecharge Depth (ISD) =	user	ft
Total Available Detention Depth ( $H_{\text{total}}$ ) =	user	ft
Depth of Trickle Channel ( $H_{TC}$ ) =	user	ft
Slope of Trickle Channel ( $S_{TC}$ ) =	user	ft/ft
Slopes of Main Basin Sides ( $S_{\text{main}}$ ) =	user	H:V
Basin Length-to-Width Ratio ( $R_{L/W}$ ) =	user	

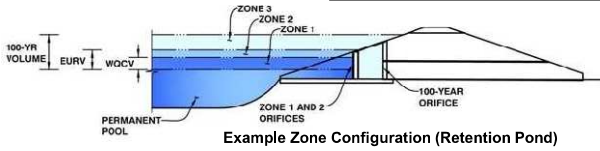
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## Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: **SETTLERS VIEW**

Basin ID: **S3**



	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 =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  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 =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 1-3/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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 =	<input type="text" value="N/A"/>	<input type="text" value="N/A"/>	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	<input type="text" value="N/A"/>	<input type="text" value="N/A"/>	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	<input type="text" value="N/A"/>	<input type="text" value="N/A"/>	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	<input type="text" value="N/A"/>	<input type="text" value="N/A"/>	ft <sup>2</sup>
Vertical Orifice Centroid =	<input type="text" value="N/A"/>	<input type="text" value="N/A"/>	feet

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

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

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H <sub>t</sub> =	<input type="text" value="3.00"/>	<input type="text" value="N/A"/>	feet
Over Flow Weir Slope Length =	<input type="text" value="2.50"/>	<input type="text" value="N/A"/>	feet
Grate Open Area / 100-yr Orifice Area =	<input type="text" value="1.89"/>	<input type="text" value="N/A"/>	should be ≥ 4
Overflow Grate Open Area w/o Debris =	<input type="text" value="7.00"/>	<input type="text" value="N/A"/>	ft <sup>2</sup>
Overflow Grate Open Area w/ Debris =	<input type="text" value="3.50"/>	<input type="text" value="N/A"/>	ft <sup>2</sup>

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 =	<input type="text" value="0.00"/>	<input type="text" value="N/A"/>	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	<input type="text" value="30.00"/>	<input type="text" value="N/A"/>	inches
Restrictor Plate Height Above Pipe Invert =	<input type="text" value="21.20"/>	<input type="text" value="N/A"/>	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	<input type="text" value="3.71"/>	<input type="text" value="N/A"/>	ft <sup>2</sup>
Outlet Orifice Centroid =	<input type="text" value="0.98"/>	<input type="text" value="N/A"/>	feet
Half-Central Angle of Restrictor Plate on Pipe =	<input type="text" value="2.00"/>	<input type="text" value="N/A"/>	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

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

### Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in) =	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**

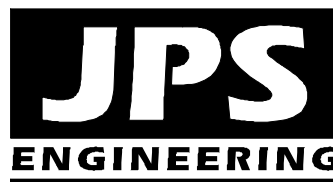
## **ABERT RANCH SUBDIVISION**

**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](http://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.

  
\_\_\_\_\_  
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: 

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

5/14/20  
\_\_\_\_\_  
Date

### 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.  
County Engineer / ECM Administrator

\_\_\_\_\_  
Date

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 Stepler 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 Point #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, O11, 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.”

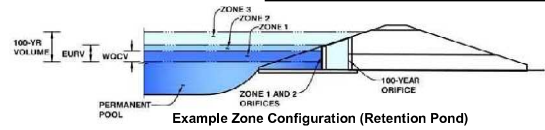
ABERT RANCH SUBDIVISION COMPOSITE IMPERVIOUS AREAS											
IMPERVIOUS AREAS											
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
C	1.28	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



### Required Volume Calculation

Selected BMP Type =	<b>EDB</b>	
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
Excess Urban Runoff Volume (EURV) =	0.759	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.514	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.810	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	1.991	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	5.595	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	7.841	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	10.774	acre-feet
500-yr Runoff Volume (P1 = 3.07 in.) =	16.086	acre-feet
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

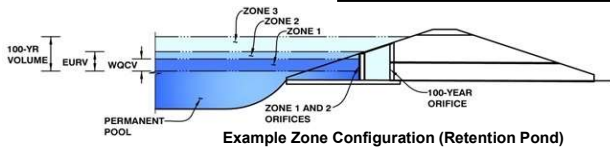
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## Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: **ABERT RANCH**

Basin ID: **I**



	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 =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  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 =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 1-9/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice

Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Slope =  H:V (enter zero for flat grate)  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %, grate open area/total area  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir

Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Over Flow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =  should be ≥ 4  
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

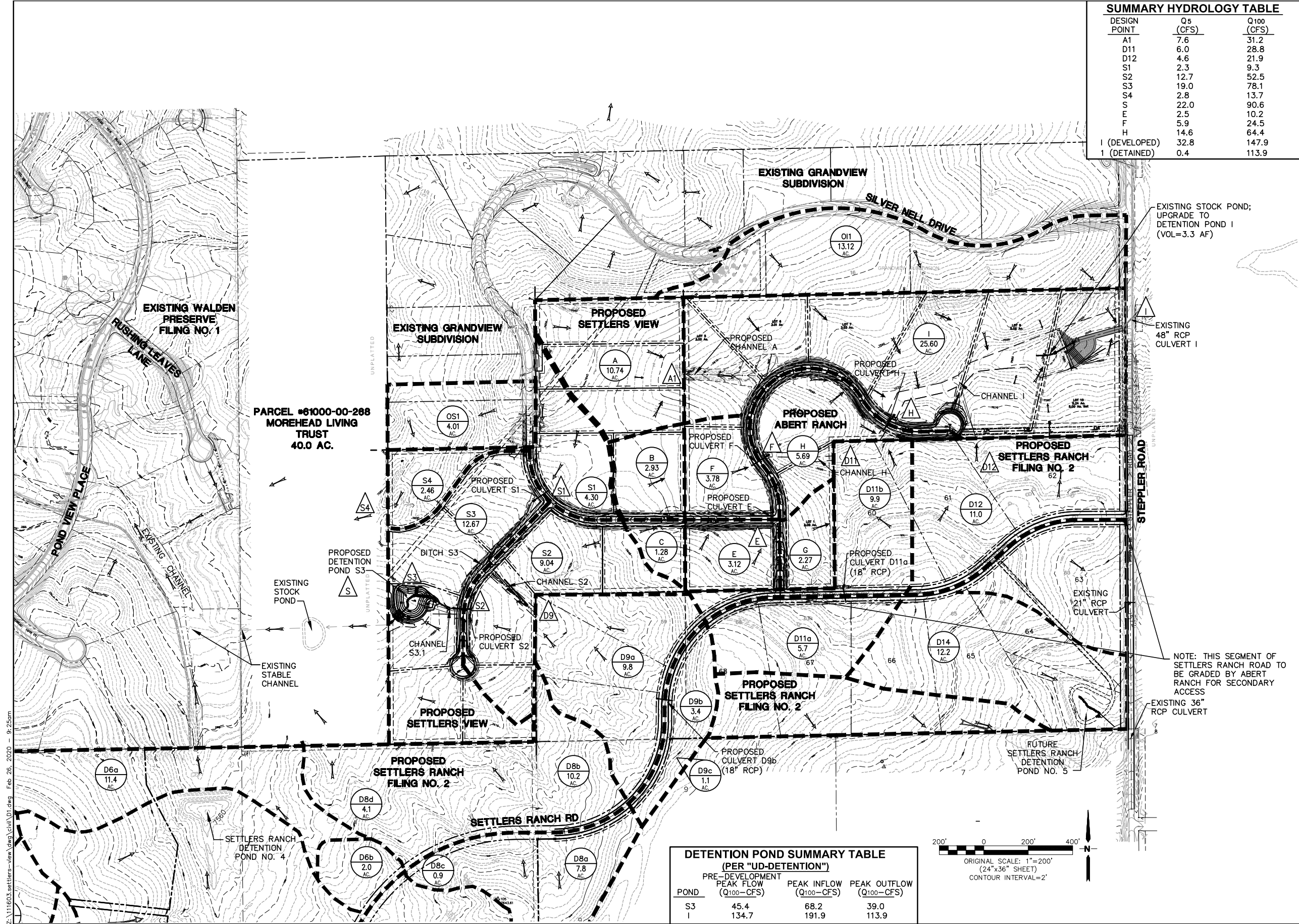
Spillway Invert Stage =  ft (relative to basin bottom at Stage = 0 ft)  
Spillway Crest Length =  feet  
Spillway End Slopes =  H:V  
Freeboard above Max Water Surface =  feet

Calculated Parameters for Spillway

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

### Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.07
One-Hour Rainfall Depth (in) =	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
I (DETAINED)	0.4	113.9

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

JPS

ENGINEERING

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UTILITIES.

BY

DATE

REVISION

NO.

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=200'

VERT. SCALE: N/A

SURVEYED: HANNIGAN

CREATED: 12/26/16

PROJECT NO: 111603

SHEET: D1

DRAWN: BJJ

DESIGNED: JPS

CHECKED: JPS

LAST MODIFIED: 2/25/20

MODIFIED BY: BJJ





**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 ( $t_r$ ) 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 ( $t_r$ ) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

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

Where:

$t_c$  = time of concentration (min)

$t_i$  = overland (initial) flow time (min)

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

### 3.2.1 Overland (Initial) Flow Time

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

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

Where:

$t_i$  = overland (initial) flow time (min)

$C_5$  = runoff coefficient for 5-year frequency (see Table 6-6)

$L$  = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)

$S$  = average basin slope (ft/ft)

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

### 3.2.2 Travel Time

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

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

Where:

$V$  = velocity (ft/s)

$C_v$  = conveyance coefficient (from Table 6-7)

$S_w$  = watercourse slope (ft/ft)

**Table 6-7. Conveyance Coefficient,  $C_v$** 

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

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

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

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

### 3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

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

$L$  = waterway length (ft)

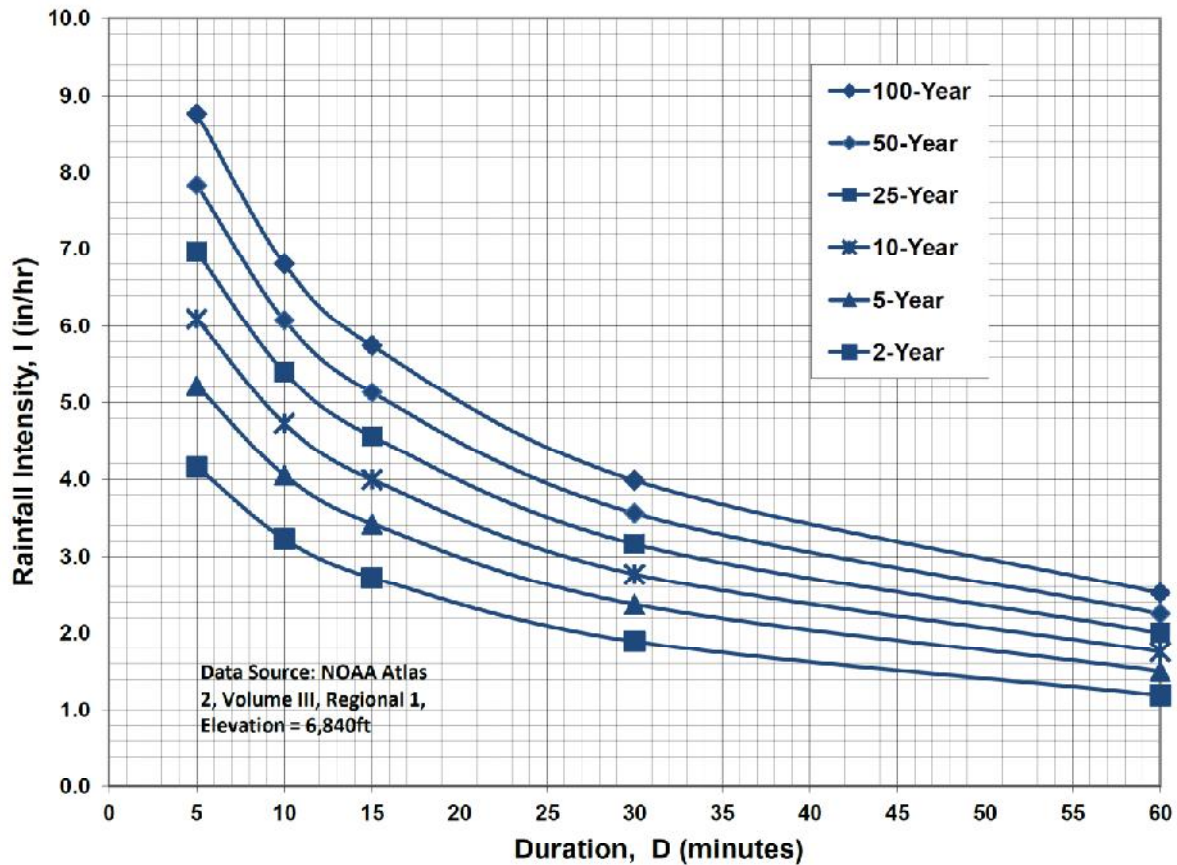
Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed.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

### 3.2.4 Minimum Time of Concentration

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

### 3.2.5 Post-Development Time of Concentration

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

**Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency****IDF Equations**

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

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

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

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

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

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

**SETTLERS RANCH  
RATIONAL METHOD**

**HISTORIC FLOWS**

BASIN	DESIGN POINT	AREA (AC)	C		OVERLAND LENGTH (FT)	SLOPE (%)	T <sub>co</sub> <sup>(1)</sup> (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS <sup>(2)</sup> VELOCITY (FT/S)	T <sub>t</sub> <sup>(3)</sup> (MIN)	TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN)	INTENSITY <sup>(5)</sup>		PEAK FLOW	
			5-YEAR <sup>(7)</sup>	100-YEAR <sup>(7)</sup>										5-YR (IN/HR)	100-YR (IN/HR)	Q5 <sup>(6)</sup> (CFS)	Q100 <sup>(6)</sup> (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  $T_{co} = (1.87 * (1.1 - \text{RUNOFF COEFFICIENT}) * (\text{OVERLAND FLOW LENGTH}^{0.5}) / (\text{SLOPE}^{0.333}))$

2) SCS VELOCITY =  $K * ((\text{SLOPE}(\%))^0.5)$

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,  $T_t = (\text{GUTTER LENGTH} / \text{SCS VELOCITY}) / 60 \text{ SEC}$

4)  $T_c = T_{co} + T_t$

\*\*\* 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)  $Q = C_i A$

7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

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

<b>DEVELOPED CONDITIONS</b>											
<b>5-YEAR C VALUES</b>											
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
<b>100-YEAR C VALUES</b>											
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
<b>IMPERVIOUS AREAS</b>											
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

**SETTLERS RANCH FILING NO. 3**  
**RATIONAL METHOD**

**DEVELOPED FLOWS**

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL Tc <sup>(4)</sup> (MIN)	TOTAL Tc <sup>(4)</sup> (MIN)	INTENSITY <sup>(5)</sup>		PEAK FLOW	
			5-YEAR <sup>(7)</sup>	100-YEAR <sup>(7)</sup>	LENGTH (FT)	SLOPE (FT/FT)	Tco <sup>(1)</sup> (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS <sup>(2)</sup> VELOCITY (FT/S)	Tt <sup>(3)</sup> (MIN)			5-YR (IN/HR)	100-YR (IN/HR)	Q5 <sup>(6)</sup> (CFS)	Q100 <sup>(6)</sup> (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**

<u>Channel Slope</u>	<u>Lining</u>	<u>Permissible Mean Channel Velocity *</u> (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
<b>Longevity</b>	45 days	60 days	12 mo.	12 mo.	24 mo.	36 mo.	12 mo.
<b>Applications</b>	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
<b>Design Permissible Shear Stress</b> lbs/ft <sup>2</sup> (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)
<b>Design Permissible Velocity</b> 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)
<b>Top Net</b>	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft <sup>2</sup> (0.73 kg/100 m <sup>2</sup> ) approx wt	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft <sup>2</sup> (0.73 kg/100 m <sup>2</sup> ) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft <sup>2</sup> (0.73 kg/100 m <sup>2</sup> ) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft <sup>2</sup> (0.73 kg/100 m <sup>2</sup> ) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft <sup>2</sup> (1.47 kg/100 m <sup>2</sup> ) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft <sup>2</sup> (1.47 kg/100 m <sup>2</sup> ) approx wt	Leno woven, 100% biodegradable jute fiber 9.30 lbs/1000 ft <sup>2</sup> (4.53 kg/100 m <sup>2</sup> ) approx wt
<b>Center Net</b>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Fiber Matrix</b>	Straw fiber 0.50 lbs/yd <sup>2</sup> (0.27 kg/m <sup>2</sup> )	Straw fiber 0.50 lbs/yd <sup>2</sup> (0.27 kg/m <sup>2</sup> )	Straw fiber 0.50 lbs/yd <sup>2</sup> (0.27 kg/m <sup>2</sup> )	Straw fiber 0.50 lbs/yd <sup>2</sup> (0.27 kg/m <sup>2</sup> )	Straw/coconut matrix 70% Straw 0.35 lbs/yd <sup>2</sup> (0.19 kg/m <sup>2</sup> ) 30% Coconut 0.15 lbs/yd <sup>2</sup> (0.08 kg/m <sup>2</sup> )	Coconut fiber 0.50 lbs/yd <sup>2</sup> (0.27 kg/m <sup>2</sup> )	Straw fiber 0.50 lbs/yd <sup>2</sup> (0.27 kg/m <sup>2</sup> )
<b>Bottom Net</b>	N/A	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft <sup>2</sup> (0.73 kg/100 m <sup>2</sup> ) approx wt	N/A	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft <sup>2</sup> (0.73 kg/100 m <sup>2</sup> ) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft <sup>2</sup> (0.73 kg/100 m <sup>2</sup> ) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft <sup>2</sup> (1.47 kg/100 m <sup>2</sup> ) approx wt	N/A
<b>Thread</b>	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	<b>51.5</b>	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	<b>GRASS / TRM</b>
BOUNDARY BASIN CT	11+16	13+20	W	5.5	4:1/3:1	2.5	0.030	60	D5a	<b>51.5</b>	15	7.7	0.6	5.3	<b>GRASS / TRM</b>
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	<b>GRASS / TRM</b>
BOUNDARY BASIN CT	13+20	15+69	W	8.0	4:1/3:1	2.5	0.030	60	D5a	<b>51.5</b>	10	5.2	0.5	5.5	<b>GRASS / TRM</b>
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	<b>51.5</b>	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
STEPLER 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.7507 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.6160 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.2848 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.0675 lb/ft<sup>2</sup>



## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.9169 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.6160 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.4533 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.4205 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.3234 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.3276 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.6318 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.7997 lb/ft<sup>2</sup>



## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.2048 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.2593 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.8096 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.0371 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.5824 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.7460 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.8722 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.8349 lb/ft<sup>2</sup>



## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.1297 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.0815 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.3732 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.2595 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.5637 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.5677 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.1602 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.1540 lb/ft<sup>2</sup>



## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.3876 lb/ft<sup>2</sup>

## **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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.4112 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
Wetted Perimeter: 6.7218 ft  
Hydraulic Radius: 0.4432 ft  
Average Velocity: 6.2428 ft/s      **Use TRM Lining**  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.3000 lb/ft<sup>2</sup>

**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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 2.7512 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 1.3562 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 3.7078 lb/ft<sup>2</sup>

## 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 2.2248 lb/ft<sup>2</sup>



## **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 <sub>5</sub> (CFS)	PER PIPE Q <sub>5</sub> (CFS)	Q <sub>5</sub> MAX ALLOWABLE HEADWATER <sup>1</sup>	CALC Q <sub>5</sub> HW ELEV	TOTAL Q <sub>100</sub> (CFS)	PER PIPE Q <sub>100</sub> (CFS)	Q <sub>100</sub> MAX ALLOWABLE HEADWATER <sup>2</sup>	CALC Q <sub>100</sub> HW ELEV
<b>SILVERADO HILL VIEW:</b>															
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

<sup>1</sup> Q<sub>5</sub> MAX. ALLOWABLE HEADWATER, HW/D = 1.0

<sup>2</sup> Q<sub>100</sub> 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

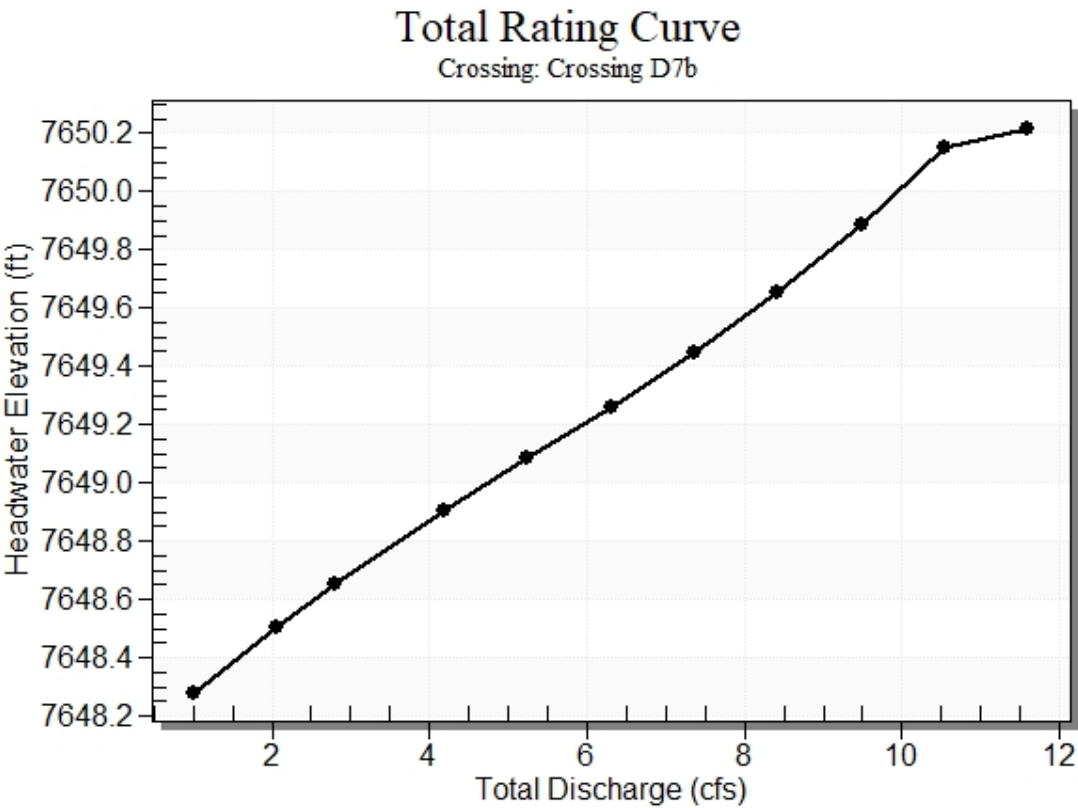


Table 2 - Culvert Summary Table: Culvert D7b

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.

\*\*\*\*\*

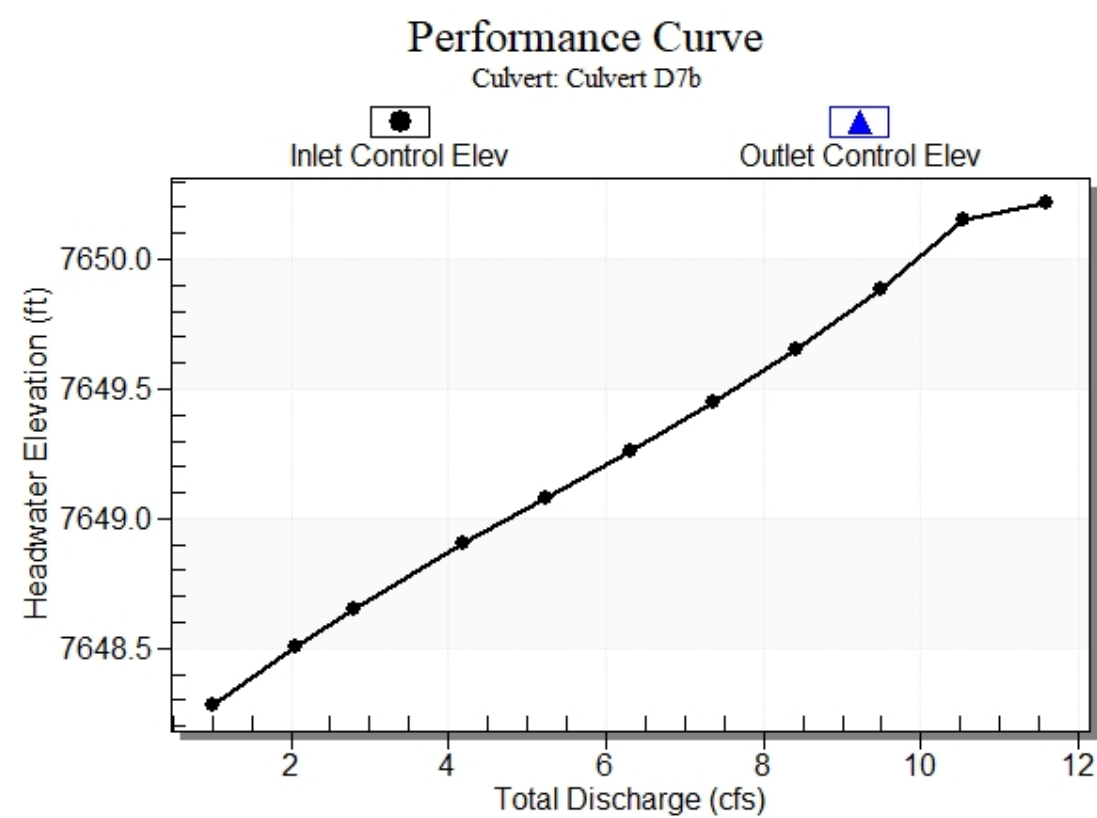
Straight Culvert

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

Culvert Length: 74.22 ft,      Culvert Slope: 0.0774

\*\*\*\*\*

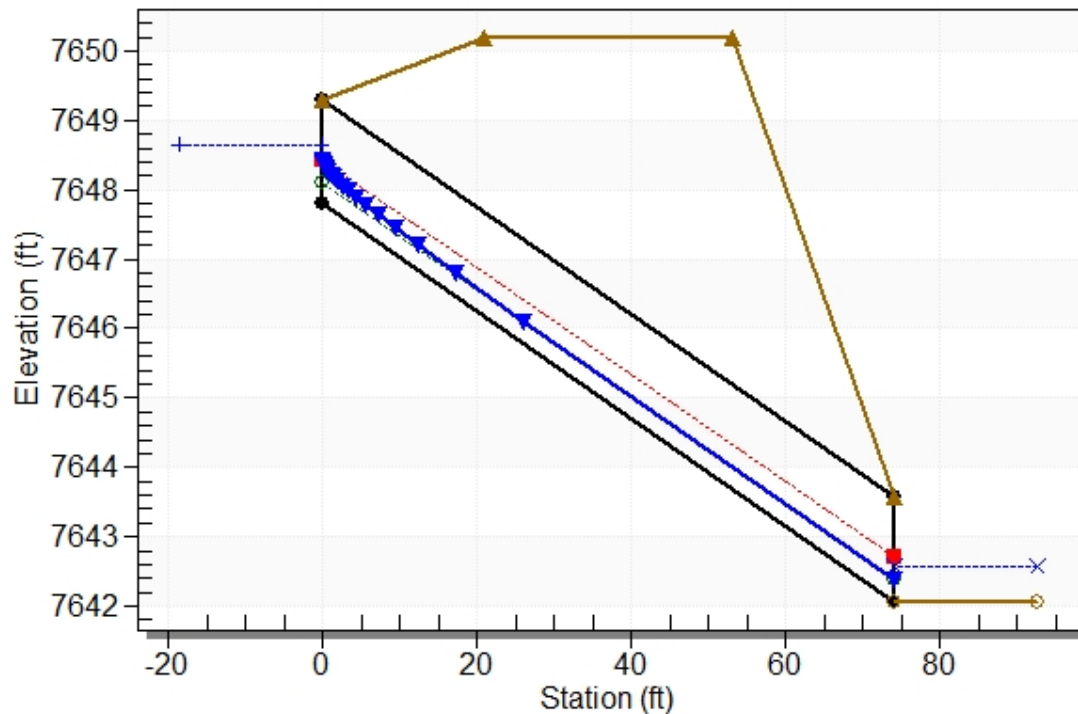
Culvert Performance Curve Plot: Culvert D7b



## Water Surface Profile Plot for Culvert: Culvert D7b

Crossing - Crossing D7b, Design Discharge - 2.8 cfs

Culvert - Culvert D7b, Culvert Discharge - 2.8 cfs



## 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

$$Q_{100} \text{ (DP-D7b)} = 11.6 \text{ cfs; } D = 1.5 \text{ ft}$$

$$Q / D^{1.5} = 11.6 / (1.5^{1.5}) = 6.3$$

$$H_a = \frac{(H + Y_n)}{2}$$

Equation 9-19

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

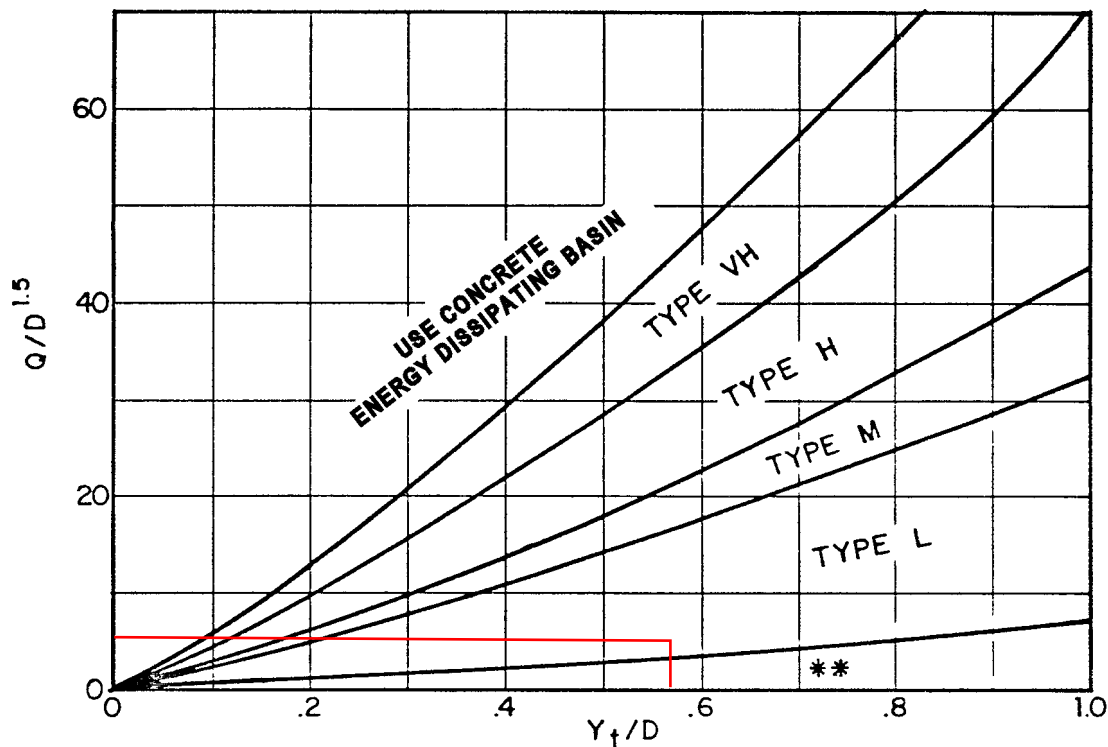
$D_a$  = parameter to use in place of  $D$  in Figure 9-38 when flow is supercritical (ft)

$D_c$  = 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)



$$Y_t = 0.86 \text{ ft; } Y_t / D = (0.86 / 1.5) = 0.57$$

Use  $D_a$  instead of  $D$  whenever flow is supercritical in the barrel.

\*\* Use Type L for a distance of  $3D$  downstream.

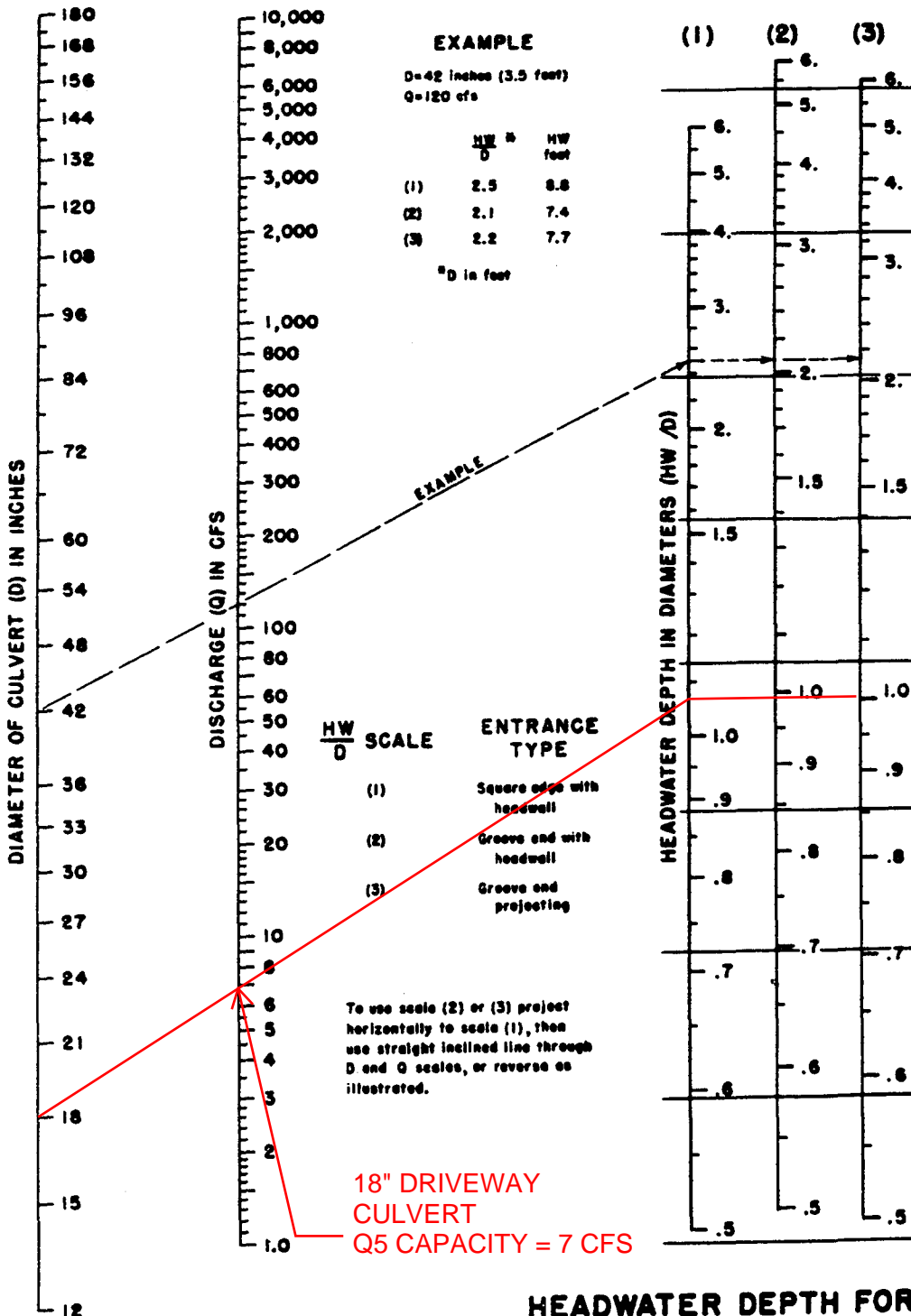
Use Type M (Conservative)

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for  $Q/D^{2.5} \leq 6.0$ )

**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



BUREAU OF PUBLIC ROADS JAN. 1963



HDR Infrastructure, Inc.  
 A Centerra Company

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

Date

OCT. 1987

Figure

9-34

## **APPENDIX D1**

### **DETENTION POND CALCULATIONS ABERT RANCH POND #1 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

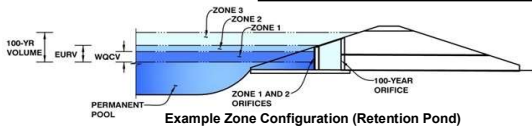
ABERT RANCH SUBDIVISION COMPOSITE IMPERVIOUS AREAS											
IMPERVIOUS AREAS - PER 2024 SETTLERS RANCH FILING NO. 3 FDR											
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	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: 1



### Required Volume Calculation

Selected BMP Type =	<b>EDB</b>	
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 Group 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
Excess Urban Runoff Volume (EURV) =	0.870	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.596	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.930	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	2.146	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	5.733	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	7.974	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	10.901	acre-feet
500-yr Runoff Volume (P1 = 3.07 in.) =	16.207	acre-feet
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

Optional User Override  
1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.07	inches

### 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

[illegible]

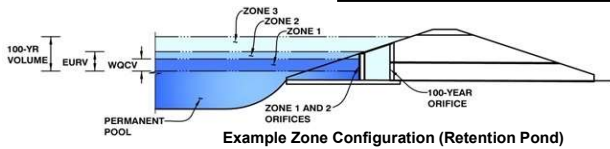
EXISTING DESIGN VOLUME  
IS ADEQUATE FOR  
INCREASED TOTAL  
IMPERVIOUS AREA OF 9.8%

## 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 =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

**Calculated Parameters for Underdrain**

Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  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 =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 1-9/16 inches)

**Calculated Parameters for Plate**

WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

**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)**

Invert of Vertical Orifice =   ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =   ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =   inches

**Calculated Parameters for Vertical Orifice**

Vertical Orifice Area =   ft<sup>2</sup>  
Vertical Orifice Centroid =   feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =   ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =   feet  
Overflow Weir Slope =   H:V (enter zero for flat grate)  
Horiz. Length of Weir Sides =   feet  
Overflow Grate Open Area % =   %, grate open area/total area  
Debris Clogging % =   %

**Calculated Parameters for Overflow Weir**

Height of Grate Upper Edge, H<sub>u</sub> =   feet  
Over Flow Weir Slope Length =   feet  
Grate Open Area / 100-yr Orifice Area =   should be ≥ 4  
Overflow Grate Open Area w/o Debris =   ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =   ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =   ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =   inches  
Restrictor Plate Height Above Pipe Invert =   inches

**Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate**

Outlet Orifice Area =   ft<sup>2</sup>  
Outlet Orifice Centroid =   feet  
Half-Central Angle of Restrictor Plate on Pipe =   radians

**User Input: Emergency Spillway (Rectangular or Trapezoidal)**

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

**Calculated Parameters for Spillway**

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

### Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.07
One-Hour Rainfall Depth (in) =	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

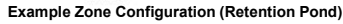


## **APPENDIX D2**

### **DETENTION POND CALCULATIONS SETTLERS RANCH POND #5**

*MHFD-Detention, Version 4.06 (July 2022)*

**Basin ID:** Detention Pond #5

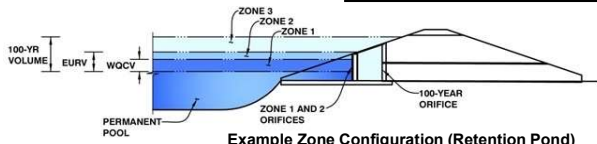
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# DETENTION BASIN OUTLET STRUCTURE DESIGN

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 Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft <sup>2</sup>
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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.01	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	8.00	inches
Orifice Plate: Orifice Area per Row =	0.85	sq. inches (diameter = 1 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	5.903E-03	ft <sup>2</sup>
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft <sup>2</sup>

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	
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 <sup>2</sup>
Vertical Orifice Centroid =	N/A	N/A	feet

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	
Overflow Weir Front Edge Height, H <sub>o</sub> =	2.01	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H <sub>u</sub> =	2.01	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.19	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft <sup>2</sup>
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft <sup>2</sup>

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	15.50		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.15	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	0.73	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.87	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	5.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	8.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.80	feet
Stage at Top of Freeboard =	6.80	feet
Basin Area at Top of Freeboard =	0.34	acres
Basin Volume at Top of Freeboard =	1.35	acre-ft

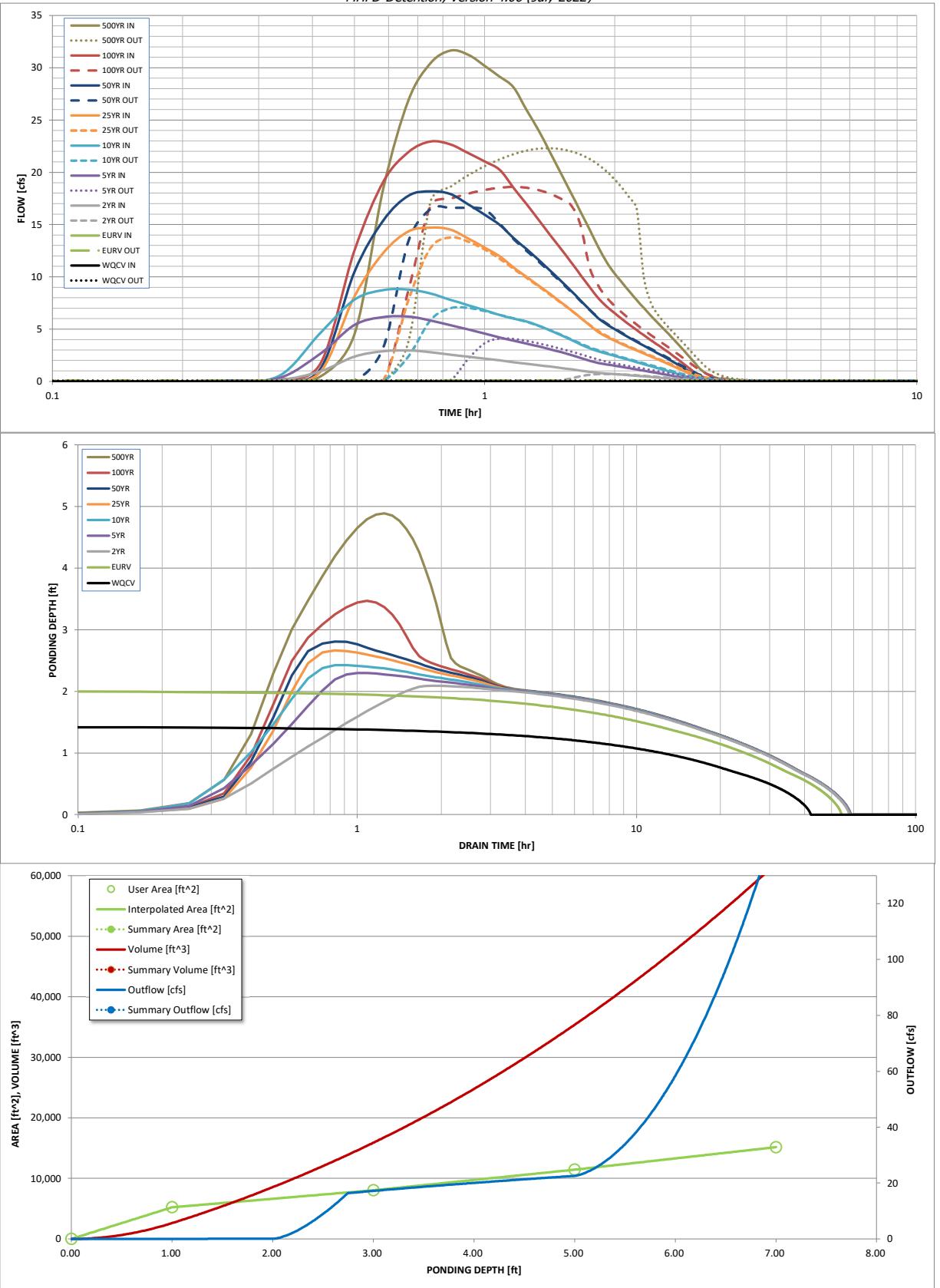
## Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
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)

Sheet 1 of 3

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

## 1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area,  $I_a$
- B) Tributary Area's Imperviousness Ratio ( $i = I_a / 100$ )
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept  
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time  
( $V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * \text{Area})$ )
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume  
( $V_{WQCV\ OTHER} = (d_s * (V_{DESIGN} / 0.43))$ )
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume  
(Only if a different WQCV Design Volume is desired)
- I) NRCS Hydrologic Soil Groups of Tributary Watershed  
 i) Percentage of Watershed consisting of Type A Soils  
 ii) Percentage of Watershed consisting of Type B Soils  
 iii) Percentage of Watershed consisting of Type C/D Soils
- 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:  $EURV_{C/D} = 1.20 * i^{1.08}$
- K) User Input of Excess Urban Runoff Volume (EURV) Design Volume  
(Only if a different EURV Design Volume is desired)

$I_a = 11.0$  %

$i = 0.110$

Area = 18.900 ac

$d_s =$  in

Choose One

- ☐ Water Quality Capture Volume (WQCV)  
☒ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 0.114$  ac-ft

$V_{DESIGN\ OTHER} =$  ac-ft

$V_{DESIGN\ USER} =$  ac-ft

HSG A = 0 %

HSG B = 100 %

HSG C/D = 0 %

$EURV_{DESIGN} = 0.197$  ac-ft

$EURV_{DESIGN\ USER} =$  ac-ft

## 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  
( $V_{MIN} = 2\%$  of the WQCV)

$V_{MIN} = 0.002$  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)

Sheet 2 of 3

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

## 6. Trickle Channel

A) Type of Trickle Channel

F) Slope of Trickle Channel

Choose One  
☒ Concrete  
☐ Soft Bottom

S = 0.0050 ft / ft

## 7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-foot minimum)

B) Surface Area of Micropool (10 ft<sup>2</sup> minimum)

C) Outlet Type

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)

E) Total Outlet Area

D<sub>M</sub> = 2.5 ft

A<sub>M</sub> = 10 sq ft

Choose One  
☒ Orifice Plate  
☐ Other (Describe):

D<sub>orifice</sub> = 1.00 inches

A<sub>orifice</sub> = 2.55 square inches

## 8. Initial Surge Volume

A) Depth of Initial Surge Volume (Minimum recommended depth is 4 inches)

B) Minimum Initial Surge Volume (Minimum volume of 0.3% of the WQCV)

C) Initial Surge Provided Above Micropool

D<sub>IS</sub> = 6 in

V<sub>IS</sub> = cu ft

V<sub>s</sub> = 5.0 cu ft

## 9. Trash Rack

A) Water Quality Screen Open Area: A<sub>t</sub> = A<sub>or</sub> \* 38.5\*(e<sup>-0.095D</sup>)

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 area to the total screen area for the material specified.)

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other')

D) Total Water Quality Screen Area (based on screen type)

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)

F) Height of Water Quality Screen (H<sub>TR</sub>)

G) Width of Water Quality Screen Opening (W<sub>opening</sub>) (Minimum of 12 inches is recommended)

A<sub>t</sub> = 89 square inches

S.S. Well Screen with 60% Open Area

User Ratio =

A<sub>total</sub> = 149 sq. in.

H = 2.01 feet

H<sub>TR</sub> = 52.12 inches

W<sub>opening</sub> = 12.0 inches

VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.

# Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 3

**Designer:** JPS  
**Company:** JPS  
**Date:** April 18, 2024  
**Project:** Settlers Ranch - Detention Pond #5  
**Location:** SW Corner of Stepler 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<sup>2</sup>  
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<sup>2</sup>  
Calculated Avg Shear Stress: 0.0342 lb/ft<sup>2</sup>

Settlers Ranch Filing No. 3  
Detention Pond #5 Spillway

Figure 13-12c. Emergency Spillway Protection

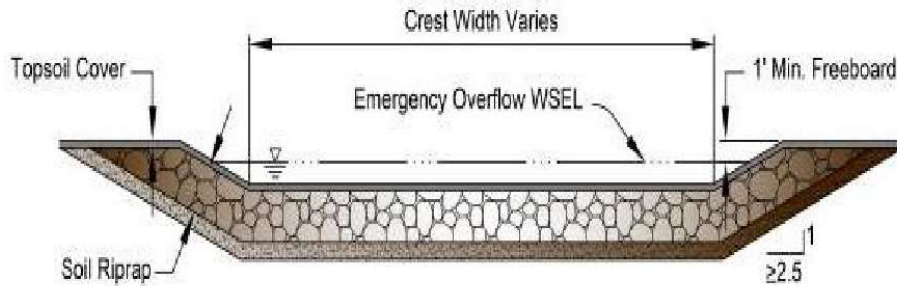
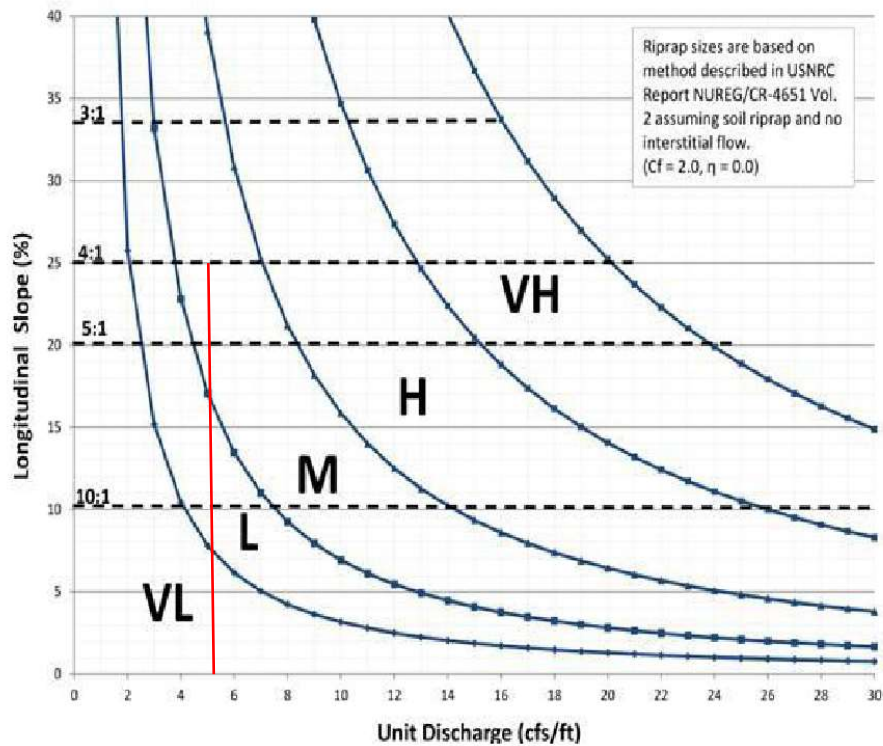


Figure 13-12d. Riprap Types for Emergency Spillway Protection



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

$Q_{100}$  (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:

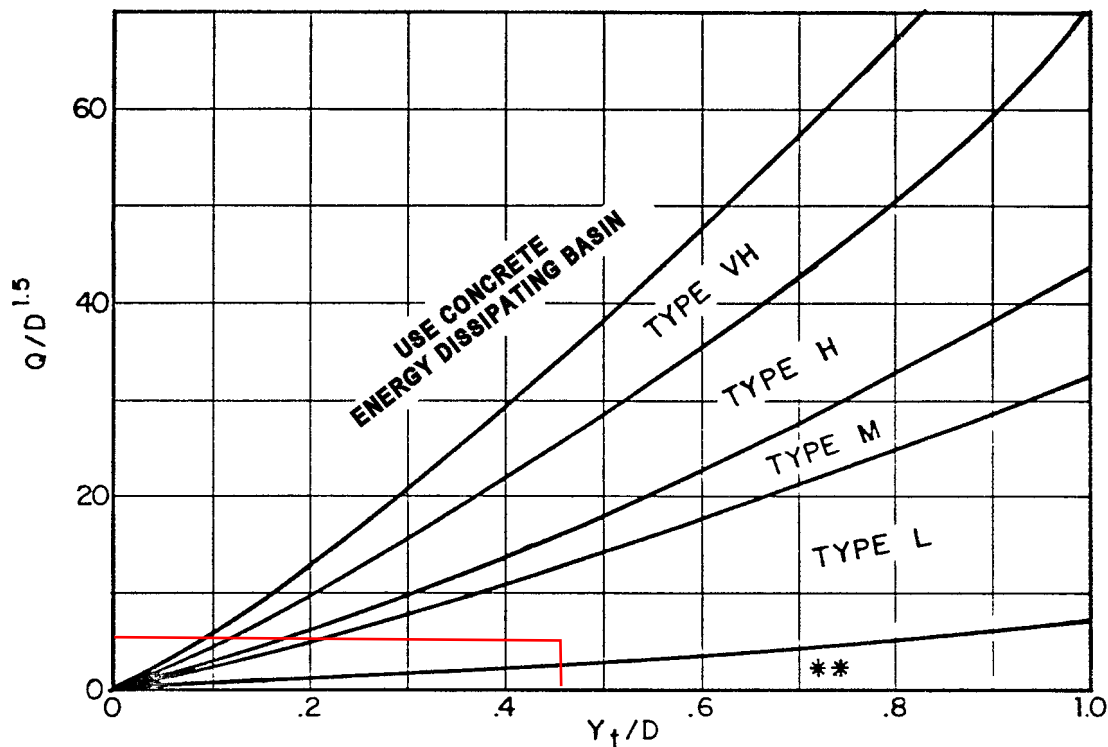
$D_a$  = parameter to use in place of  $D$  in Figure 9-38 when flow is supercritical (ft)

$D_c$  = 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)



$Y_t = 0.9$  ft;  $Y_t / D = (0.9 / 2.0) = 0.45$

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  $Q/D^{2.5} \leq 6.0$ )

**APPENDIX E**  
**COST ESTIMATES**

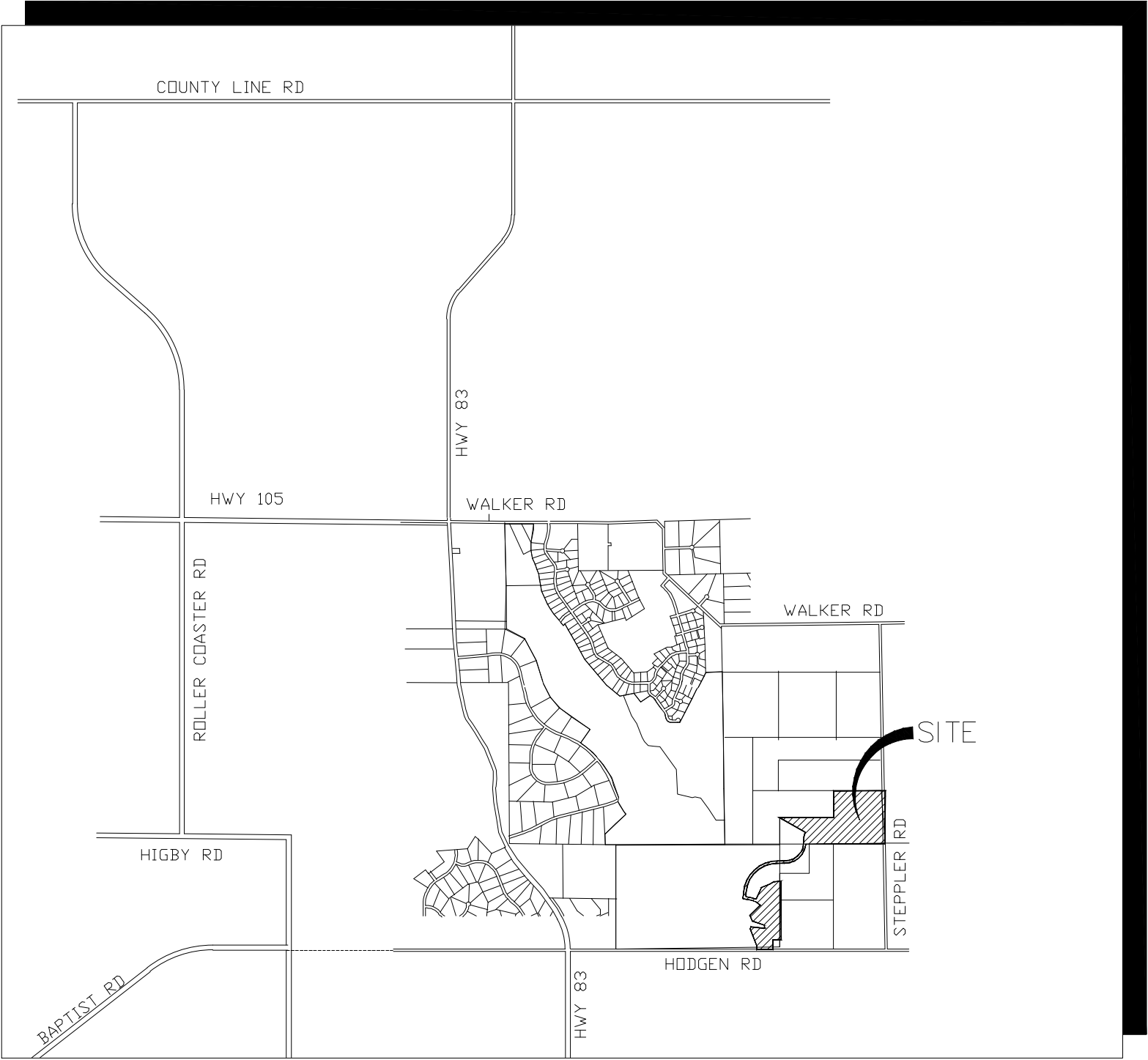
**SETTLERS RANCH - FILING NO. 3**  
**DRAINAGE IMPROVEMENTS COST ESTIMATE**

Item No.	Description	Quantity	Unit	Unit Cost (\$\$)	Total Cost (\$\$)
	<b>DRAINAGE IMPROVEMENTS</b>				
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
	<b>SUBTOTAL</b>				<b>\$7,884</b>
	Contingency @ 15%				<b>\$1,183</b>
	<b>TOTAL</b>				<b>\$9,067</b>

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 (\$\$)
	<b>PRIVATE DRAINAGE FACILITIES (NON-REIMBURSABLE)</b>				
	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
	<b>SUBTOTAL</b>				<b>\$48,440</b>
	Contingency @ 10%				\$4,844
	<b>TOTAL</b>				<b>\$53,284</b>
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**

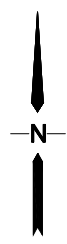
### **FIGURES**



VICINITY MAP

---

NOT TO SCALE





# National Flood Hazard Layer FIRMette



104°44'33"W 39°4'58"N



1:6,000

104°43'55"W 39°4'30"N

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 Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



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

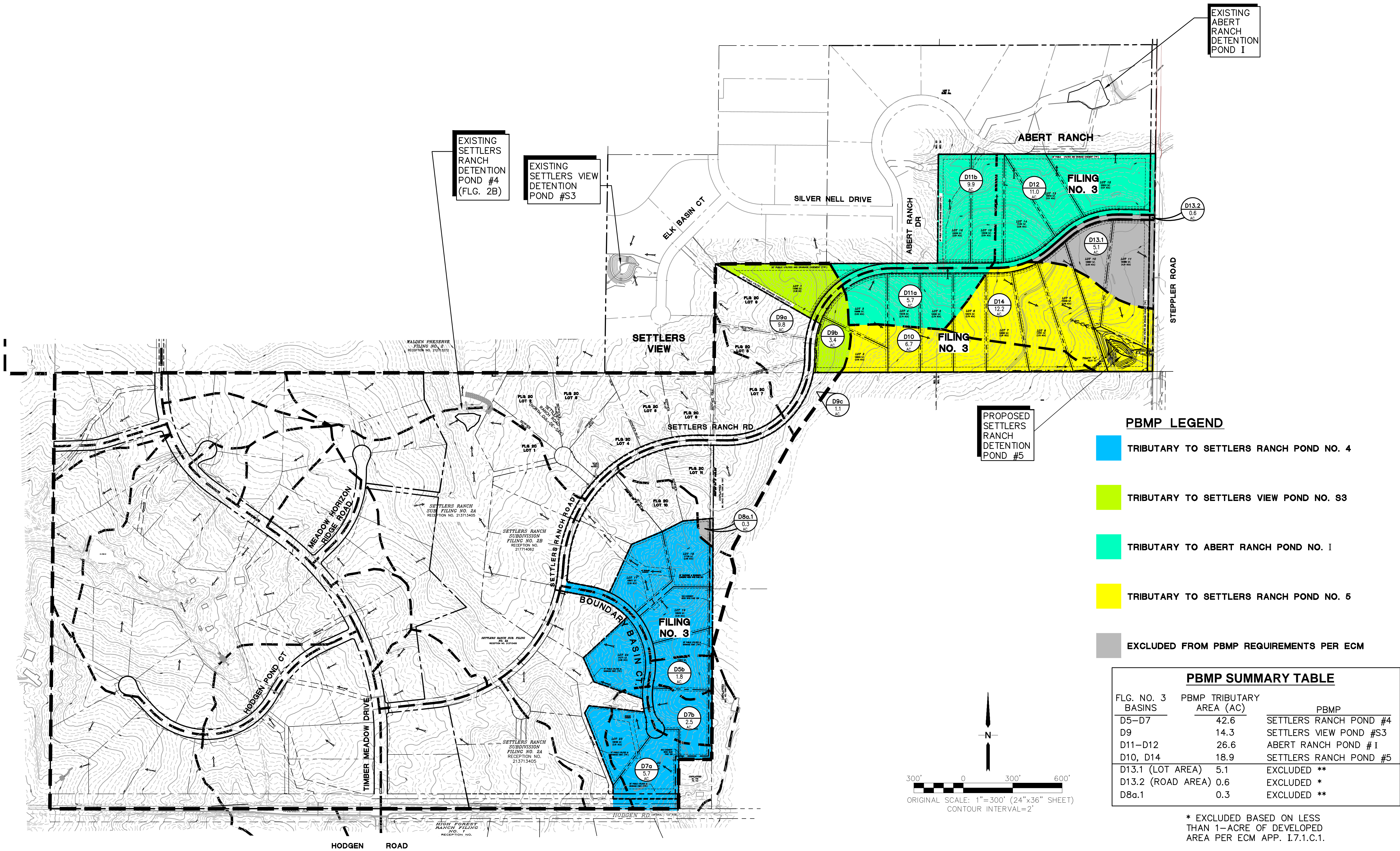
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

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.



C:\Users\Michael\Dropbox\jpsprojects\030501.settlers\F3.dwg\Civil\F3\FBMP.dwg Aug 23, 2024 -- 9:48pm



PBMP LEGEND		
<div></div>	TRIBUTARY TO SETTLERS RANCH POND NO. 4	
<div></div>	TRIBUTARY TO SETTLERS VIEW POND NO. S3	
<div></div>	TRIBUTARY TO ABERT RANCH POND NO. 1	
<div></div>	TRIBUTARY TO SETTLERS RANCH POND NO. 5	
<div></div>	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 #1
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 **

\* 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.7.1.8.5.

SETTLERS RANCH - FILING NO. 3

PBMP  
APPLICABILITY EXHIBIT

JPSENGINEERING

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.

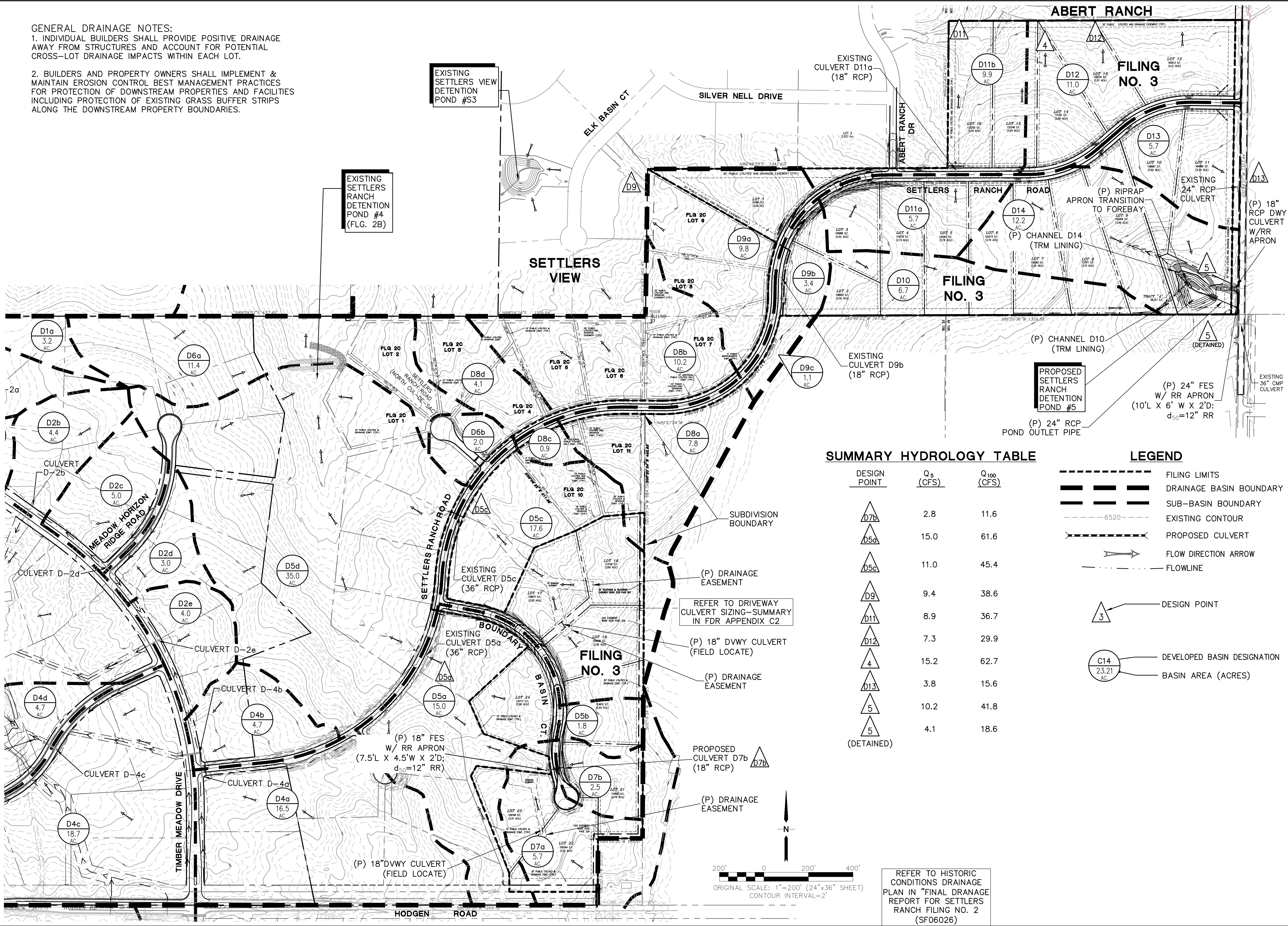
No.	REVISION	BY	DATE

HORIZ. 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



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.



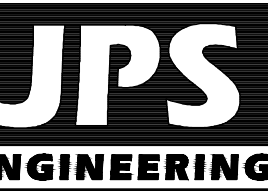
SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q <sub>5</sub> (CFS)	Q <sub>100</sub> (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
- EXISTING CONTOUR
- PROPOSED CULVERT
- FLOW DIRECTION ARROW
- FLOWLINE
- DESIGN POINT
- DEVELOPED BASIN DESIGNATION
- BASIN AREA (ACRES)

SETTLERS RANCH - FILING NO. 3



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FOR THE MARKING OF UNDERGROUND  
MEMBER UTILITIES.

REVISION	BY	DATE
No.		

DEVELOPED DRAINAGE PLAN

HORIZ. 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