FINAL DRAINAGE REPORT

for

WALDEN PRESERVE 2 – FILING NO. 5

Prepared for:

Walden Holdings I, LLC
1230 Scarsbrook Court
Monument, CO 80132

January 10, 2022

Prepared by:

JPS ENGINEERING

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JPS Project No. 040201
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WALDEN PRESERVE 2 – FILING NO. 5
FINAL DRAINAGE REPORT
TABLE OF CONTENTS

PAGE

APPENDICES

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WALDEN PRESERVE 2 – FILING NO. 5
FINAL DRAINAGE REPORT - EXECUTIVE SUMMARY

A. Background

- Walden Preserve is a residential subdivision of a 345-acre parcel located in northeastern El Paso County. Walden Preserve 2 Filing No. 5 consists of 50 residential lots in the northwest area of the Walden Preserve development.
- The proposed Filing No. 5 conforms to the previously approved Walden Preserve 2 PUD.
- Walden Preserve is located within the Cherry Creek Drainage Basin, which comprises a total drainage area in excess of 30 square miles. The Walden Preserve property represents less than 2 percent of the total basin area.

B. General Drainage Concept

- Developed drainage within the site will be conveyed through paved streets with roadside ditches and culverts, as well as grass-lined channels through open space areas.
- Developed flows from Walden Preserve will be detained to historic levels through on-site stormwater detention ponds.
- The existing tributary channel of West Cherry Creek running through the site will be preserved as a greenway and trail corridor. Main channel improvements have previously been completed with development of Walden Preserve Filing No. 1, including upgrade of two existing stock ponds.

C. Drainage Impacts

- The Walden Preserve detention ponds will release historic flows at the downstream property boundary, ensuring no significant adverse impact from developed drainage flows.
- Drainage facilities within public road rights-of-way and open space areas will be designed and constructed to El Paso County standards, and dedicated to the County for maintenance. The private stormwater detention ponds will be owned and maintained by the HOA or Metropolitan District.

DRAINAGE STATEMENTS

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: Date

Title:

Walden Holdings I, LLC
1230 Scarsbrook Court
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.

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Jennifer Irvine, P.E. Date

County Engineer / ECM Administrator

Conditions:

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Walden Preserve is a residential subdivision located in the Walden community of northeastern El Paso County, Colorado. The Walden Preserve 2 PUD area is located south and west of Woodhaven Drive, north of Pond View Place, and east of Walden Way, as shown in Figure A1 (Appendix F). The originally approved 2004 Walden Preserve PUD consisted of a combination of medium-density residential lots (0.5-acre average size) and low-density residential lots (2.5-acre minimum size) on a 345-acre property. The currently approved 2014 Walden Preserve 2 PUD includes phased development of 116 new residential lots (1-acre typical lot size), resulting in a total of 211 lots in the Walden Preserve development (including both previously platted lots and proposed lots). All of the lots in the amended PUD area will be served by the existing central water and sewer system.

Walden Preserve 2 Filings No. 1-4 have been completed. These filings comprise 66 lots on the south side of the Walden Preserve 2 PUD area.

The proposed Walden Preserve 2 Filing No. 5 consists of 50 residential lots on 91.9 acres within the previously approved Walden Preserve 2 PUD (part of El Paso County Assessor's Parcel Number 61230-01-023), consisting of the existing meadow area located along the extension of Pinehurst Circle on the east side of Walden Way.

B. Scope

This report is intended to fulfill the El Paso County requirements for a Final Drainage Report (FDR) in support of the final plat application for the proposed Walden Preserve 2 Filing No. 5. The report will provide a summary of site drainage issues impacting the proposed development, including analysis of impacts from upstream drainage areas, site-specific developed drainage patterns, and impacts on downstream facilities. This Final Drainage Report was prepared based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual.

C. Site Location and Description

The Walden Preserve parcel is located in parts of Sections 14, 15, 22, and 23, Township 11 South, Range 66 West of the 6th Principal Meridian. The site has historically been a vacant forest and meadow tract, with the exception of existing utility facilities (i.e. wastewater lagoon and well sites) serving the Walden Subdivision. The Walden Preserve property was re-zoned to PUD in 2005, with an approved development plan including a band of low-density lots along the south and west sides of the parcel, transitioning to medium-density lots adjacent to the existing platted areas of the Walden Subdivision, which is zoned RR1 for ½-acre lots.

Access to the areas on the west side of the Walden Preserve will be provided by extension of several existing local roads from Walden Way, including Needles Drive and Pinehurst Circle. Associated site improvements will include paving of new public roadways through the site, as well as grading, drainage, and utility service improvements for the proposed residential lots. Interior roads will all be classified as rural local roads, with 60-feet rights-of-way and paved widths of 28-feet.

The Walden Preserve parcel is bordered by Walker Road to the north, developed areas of the Walden III Subdivision (Zoned RR1) to the east, the Settlers Ranch Subdivision to the south, and developed areas of the Walden Subdivision (Zoned RR5) to the west. Ground elevations within the parcel range from a low point of approximately 7,350 feet above mean sea level at the north boundary of the parcel, to a high point of 7,600 feet at the south boundary.

Surface drainage from this area flows northerly towards a tributary of West Cherry Creek on the west side of Woodhaven Drive. The terrain is rolling with south to north slopes ranging from 1% to 10%. Existing vegetation is typical eastern Colorado prairie grass in the meadow areas and evergreen pines in the forest areas towards the easterly property boundary.

D. General Soil Conditions

According to the Soil Survey of El Paso County prepared by the Soil Conservation Service, the majority of the parcel is classified as "Tomah" series loamy sand, and characterized as hydrologic soils group B. On-site soils are comprised primarily of the following soil types (see Appendix A):

- Type 92 - "Tomah-Crawfoot loamy sands": slow surface runoff, slight to moderate erosion hazard (Hydrologic Group B)
- Type 71 – "Pring sandy loam": medium surface runoff, moderate erosion hazard (Hydrologic Group B)
- Type 25 – "Elbeth sandy loam": slow to medium surface runoff, moderate erosion hazard (Hydrologic group B)

E. References

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

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

CDOT, "CDOT Drainage Design Manual," July, 1995.

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

ERO Resources Corporation, "Wetland Delineation Report for Walden Village," March 4, 2003.

Guenther Polok, "Drainage Report, Walden III, Filings 5, 6, and 7," July, 1983.

JPS Engineering, Inc., "Drainage Letter Report for Walden Preserve 2 – Filing No. 3," November 16, 2015 (approved May 31, 2016).

JPS Engineering, Inc., "Final Drainage Report for Settlers Ranch Subdivision Filing No. 1," October 18, 2005 (approved October 19, 2005).

JPS Engineering, Inc., "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2," May 30, 2008 (approved March 31, 2009).

JPS Engineering, Inc., "Final Drainage Report for Walden Preserve 2 - Filings No. 1 & No. 2," revised November 13, 2014.

JPS Engineering, Inc., "Final Drainage Report for Walden Preserve 2 - Filing No. 4," revised September 30, 2019 (approved October 30, 2019).

JPS Engineering, Inc., "Final Drainage Report for Walden Preserve Subdivision Filing No. 1," May 11, 2005.

JPS Engineering, Inc., "Master Development Drainage Plan (MDDP) and Final Drainage Report for Monument Academy," revised April 9, 2020 (approved April 28, 2020).

JPS Engineering, Inc., "Master Development Drainage Plan (MDDP) and Preliminary Drainage Report for Walden Preserve Subdivision," December 10, 2004.

JPS Engineering, Inc., "Master Development Drainage Plan (MDDP) and Preliminary Drainage Report Addendum No. 1 for Walden Preserve 2 PUD," revised September 30, 2019.

JPS Engineering, Inc., "Master Development Drainage Plan (MDDP) and Preliminary Drainage Report for Walden Preserve 2 PUD," September 17, 2014 (approved November 6, 2014).

JPS Engineering, Inc., "Preliminary Drainage Report for Walden Pines Subdivision," December 29, 2003.

JPS Engineering, Inc., "Final Drainage Report for Walden Pines Subdivision," March 24, 2004.

Kiowa Engineering Corporation, "Final Drainage Plan and Erosion Control Plan, Walden III Filing 6 Phase 1, Filing 6 Phase 2 and Filing 7," February 19, 2002.

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

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

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The proposed development lies within the West Cherry Creek Drainage Basin (CYCY 0400) as classified by El Paso County. Drainage from this site 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.

The major drainage basins lying in and around the proposed development are depicted in Figure EX1. The Walden Preserve parcel is located near the southerly limits of the West Cherry Creek Basin, which comprises a total drainage area in excess of 30 square miles. As such, the proposed 349-acre Walden Preserve subdivision represents less than 2 percent of the total basin area, which is primarily agricultural land.

B. Floodplain Impacts

The proposed development area 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) Numbers 08041C0285G dated December 7, 2018, as shown in the attached Firmette exhibit (Appendix F). The nearest FEMA 100-year floodplain limits (beyond the boundary of Filing No. 5) extend slightly south of Walker Road in the vicinity of the existing culvert crossing.

No impacts to the existing drainage channel are proposed as part of this subdivision filing.

C. Sub-Basin Description

three

The existing drainage basins lying in and around the proposed development are depicted in Figure EX1 (Appendix F). The site is impacted by off-site drainage basins of approximately 515 acres to the south and east, which flow to the existing natural drainage channel that bisects the property. The existing on-site topography has been delineated as five drainage basins. Basins A, B, and C drain into the main tributary channel flowing northerly to the existing culvert crossing Walker Road.

The developed drainage basins lying within the proposed development are depicted in Figures D1 and D1.03 (Appendix F). The interior site layout has been divided into drainage basins based on the road layout and topography within the site. The natural drainage patterns will be impacted through development by site grading and concentration of runoff in subdivision roadside ditches and channels. The majority of sub-basins drain to the north, collecting in the interior roads and drainage channels. On-site flows will be diverted to natural swales draining towards the main tributary channel 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 the West Cherry Creek Drainage Basin. JPS Engineering, Inc. prepared the "Master Development Drainage Plan (MDDP) and Preliminary Drainage Report for Walden Preserve 2 PUD" dated September 17, 2014, which was approved by El Paso County on November 6, 2014 in support of the Walden Preserve 2 PUD and Preliminary Plan. JPS Engineering prepared the "Master Development Drainage Plan (MDDP) and Preliminary Drainage Report Addendum No. 1 for Walden Preserve 2 PUD," dated September 30, 2019 in support of the previously approved Filing No. 4. The proposed drainage plan for Walden Preserve 2 Filing No. 5 is in full conformance with the previously approved MDDP and related subdivision drainage reports.

B. Hydrologic Criteria

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

• Design storm (minor)	5-year
• Design storm (major)	100-year
• Storm distribution	SCS Type II
• 100-year, 24-hour rainfall	4.4 inches (NOAA isopluvial map)
• 5-year, 24-hour rainfall	2.6 inches (NOAA isopluvial map)
• Hydrologic soil type	B
• SCS curve number - undeveloped conditions	61 (pasture / range)
• SCS curve number – 1-ac to 2.5-ac lots	68
• SCS curve number – 0.5-acre lots	70

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

• Design storm (minor)	5-year	
• Design storm (major)	100-year	
• Rainfall Intensities	El Paso County I-D-F Curve	
• Hydrologic soil type	B	
	C5	C100
• Runoff Coefficients - undeveloped:		
Existing pasture/range areas	0.25	0.35
Existing forest areas	0.1	0.15
Existing 5-acre lot areas	0.137	0.392
• Runoff Coefficients - developed:		
Proposed lot areas (1-2.5-acre lots)	0.30	0.40
Proposed lot areas (1/2-acre lots)	0.35	0.45

To provide for conservative drainage design, the developed flow hydrologic calculations were performed using conservative assumptions for runoff curve numbers and coefficients associated with the 1-acre lots proposed throughout the Walden Preserve 2 PUD. For example, the SCS curve number of 68 for 1-acre lots has been applied without reduction to the majority of developed areas throughout the Walden Preserve 2 PUD, while in fact there are significant open space areas in the subdivision layout. As noted in Table 5-5 of Appendix B, the SCS curve number of 68 is recommended for densities of 1 acre per dwelling unit. The Walden Preserve 2 PUD has an actual gross density of approximately 1.8 acres per dwelling unit, providing for a significant factor of safety in the subdivision drainage design.

Hydrologic calculations are detailed in Appendix B, and peak design flows are identified on the drainage plan drawings in Appendix F.

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. 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:

<u>Step 1: Employ Runoff Reduction Practices</u>

- 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.

<u>Step 2: Stabilize Drainageways</u>

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

<u>Step 3: Provide Water Quality Capture Volume (WQCV)</u>

- Detention Ponds and Rain Gardens: The developed site will drain through stormwater detention ponds and rain gardens which will capture and slowly release the WQCV over an extended release period.

<u>Step 4: Consider Need for Industrial and Commercial BMPs</u>

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

- On-site drainage will be routed through private detention ponds and rain gardens to minimize introduction of contaminants to the County's public drainage system.

V. GENERAL DRAINAGE RECOMMENDATIONS

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

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

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

VI. DRAINAGE FACILITY DESIGN

A. General Concept

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

The stormwater management concept for the Walden Preserve development will be to provide roadside ditches and grass-lined 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.

One of the existing stock ponds along the main channel within the site ("Pond B") has previously been upgraded to serve as a stormwater retention pond to mitigate the impact of developed flows and ensure that historic flows are maintained downstream of the proposed subdivision. Development of the balance of the western part of the Walden Preserve property (Filing No. 5) will include construction of one additional detention pond ("Pond C8"), along with other permanent water quality control measures to further mitigate developed flow impacts.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions within the site are depicted in Figure EX2. The existing tributary channel of West Cherry Creek runs northerly through the site, collecting drainage from numerous natural swales on each side of the main channel.

Off-site flows from Basin OA1 combine with Basin A at the south end of the site, flowing into an existing stock pond ("Pond A") at Design Point #1, with historic peak flows of Q_5 = 39.4 cfs and Q_{100} = 240.8 cfs (SCS Method).

Off-site flows from Basin OB1 combine with flows from Basin B near the center of the existing parcel, adding to the flow in the main tributary channel at the second existing stock pond ("Pond B") located at Design Point #2. Historic peak flows at this location are calculated as Q_5 = 73.4 cfs and Q_{100} = 321.3 cfs (SCS Method).

Off-site flows from Basins OC1 and OD1 combine with flows from Basins C and D, joining with flows in the main tributary channel at the existing culvert crossing Walker Road at the northerly property boundary of the Walden Wastewater Treatment Plant property. Historic peak flows at Design Point #4 are calculated as Q_5 = 234.8 cfs and Q_{100} = 620.0 cfs (SCS Method).

2. Developed Drainage Conditions

Master Development Drainage Plan

The developed drainage basins and projected flows are shown in Figures D1 and D1.01-D1.03 (Appendix F). As discussed in the approved MDDP, developed Sub-basins A1-A6 are located in the south and southeasterly areas previously developed as Walden Preserve Filings No. 1 and No. 2. Walden Preserve 2 Filings No. 1-3 included development of the areas within Sub-Basins A7-A9 on the north side of Pond View Place between the main drainage channel and Walden Way. Walden Preserve 2 Filing No. 4 included development of the areas within Sub-Basins B8-B10 and C1-C2 along the northerly extension of Pinehurst Circle.

Sub-basins A1-A9 will continue to flow northerly towards the main tributary channel, combining at the existing southerly stock pond (Pond A) with developed peak flows calculated as Q_5 = 99.6 cfs and Q_{100} = 285.5 cfs (SCS Method) at Design Point #1 (see Appendix B1). While the existing Stock Pond A is not planned for use as a drainage detention pond, the pond will be maintained as an aesthetic feature within the subdivision. The pond was previously upgraded with an engineered overflow spillway during development of Walden Preserve Filing No. 1.

Walden Preserve Filing No. 1 included development of the areas within Sub-basins B1-B4 on the east side of the main drainage channel. Sub-basins B5-B10 include the remaining areas developed as 1-acre lots along the west side of the drainage channel. Developed Sub-basins B1-B10 will continue to flow northerly towards the main tributary channel, combining at the existing northerly stock pond (Pond B) with developed peak flows of Q_5 = 189.1 cfs and Q_{100} = 508.9 cfs (SCS Method) at Design Point #2 (see Appendix B1). The existing stock pond (Pond B) has been upgraded to serve as a sub-regional stormwater detention and water quality pond for the remaining phases of the Walden Preserve Subdivision. Subdivision infrastructure for Walden Preserve 2 Filing No. 4 included improvements to the Pond B outlet structure to meet current full-spectrum detention design standards.

The pond has been designed to “over-detain” to allow for discharges of developed flows from downstream sub-basins, while ensuring that discharges downstream of Walker Road (Design Point #4) remain below historic levels. An energy dissipation structure has been constructed at the discharge point from Pond B to reduce erosion concerns in the downstream channel.

Sub-basins C1-C4 include areas north of Pond B which will be developed as 1-acre lots. Runoff from these basins will flow northeasterly to the main drainage channel. Water Quality Rain Gardens C2 and C4 will be constructed on the downstream side of the extension of Pinehurst Circle through the Walden Preserve 2 PUD area. While Water Quality Rain Gardens C2 and C4 are not needed for stormwater detention in the overall drainage analysis, these small water quality basins will encourage infiltration of developed drainage and provide water quality mitigation of developed drainage impacts, consistent with an overall low-impact development approach.

Sub-basins C5-C8 include additional areas to be developed as 1-acre lots. These basins will flow northeasterly to the proposed Detention Pond C8, which will mitigate developed flow impacts prior to discharging through Basin C9 into the main channel upstream of the proposed emergency access and trail crossing at Highview Drive. Total undetained developed peak flows at Design Point #3 are calculated as Q_5 = 295.8 cfs and Q_{100} = 764.9 cfs (SCS Method; per Appendix B1).

Sub-basins C10-C12 include additional 1-acre lot areas to be developed in the northwest part of Walden Preserve, and Sub-basin C13 covers the existing Walden Wastewater Treatment

Facility at the northwest corner of the Walden property. Water Quality Rain Garden C12 will be constructed in the northeast corner of the residential development area to mitigate developed flow impacts from Sub-Basins C10-C12.

Developed flows from Sub-basins C10-C13 will flow northeasterly, combining with flows in the main tributary channel, and ultimately reaching the existing culvert crossing Walker Road.

Flows from Basins OC1-OC2 on the east side of the channel, along with flows from Basins OD1 and D in vicinity of the Walden Pines Subdivision drain northwesterly across Woodhaven Drive, contributing to the total flow in the main channel. Flows from Basins OA1-OD1 and A1-D1 combine at Design Point #4, with total undetained developed flows calculated as Q_5 = 324.4 cfs and Q_{100} = 845.4 cfs (SCS Method; per Appendix B1).

As detailed in the previously approved "Final Drainage Report for Walden Preserve 2 Filing No. 4," SCS hydrologic models have been analyzed using the HEC-HMS software package to evaluate the comparison of historic and developed flow conditions, and confirm sizing of the existing and proposed stormwater detention ponds. The detained flow analysis shows that the combination of Pond B and Pond C8 results in detained flows at Design Point #4 calculated as Q_5 = 226.7 cfs and Q_{100} = 601.4 cfs, which achieves the goal of remaining below historic flows at the downstream boundary of the subdivision.

<u>WP2 Filing No. 5 Drainage Plan</u>

Walden Preserve 2 Filing No. 5 is located in Basins C1-C12 as depicted in the enclosed drainage plans (Sh. D1 and D1.01-D1.03, Appendix F).

Developed Sub-basin C1 comprises the area along the west side of the extension of Pinehurst Circle at the south end of Filing No. 5. Sub-basin C1 will generally flow southeasterly along the roadside ditch to Culvert C1 (Filing No. 4) at the low point in the road profile. Developed peak flows at Design Point #C1 are calculated as Q_5 = 9.7 cfs and Q_{100} = 23.0 cfs (Rational Method). Culvert C1 (24" RCP) will convey the flow from this basin easterly across Pinehurst Circle, draining through Channel C1 into Water Quality Rain Garden C2 (Filing No. 4).

C2.1? Per map D1.03

Developed Sub-basin C2 comprises the area on the easterly downstream side of the extension of Pinehurst Circle at the south end of Filing No. 4, sheet flowing easterly to Water Quality Pond C2. Developed flows from Sub-basins C1-C2 combine at Design Point #C2, with peak flows calculated as Q_5 = 18.3 cfs and Q_{100} = 43.5 cfs (Rational Method). Water Quality Pond C2 (constructed with Filing No. 4) provides water quality enhancement for combined Basins C1 and C2.

Developed Sub-basin C3 comprises a small area along the west side of Pinehurst Circle, north of Emerson Cliff Court. Sub-basin C3 will flow northeasterly along the roadside ditch to Culvert C3. Developed peak flows at Design Point #C3 are calculated as Q_5 =

2.2 cfs and Q_{100} = 5.1 cfs (Rational Method). Culvert C3 (18" RCP) will convey the flow from this basin easterly across Pinehurst Circle, draining to Water Quality Rain Garden C4.

show location on map D1.02

Developed Sub-basin C4 comprises the area on the easterly downstream side of Pinehurst Circle, north of Emerson Cliff Court, which sheet flows easterly to Water Quality Rain Garden C4. Developed flows from Sub-basins C3-C4 combine at Design Point #C4.1, with peak flows calculated as Q_5 = 18.2 cfs and Q_{100} = 43.2 cfs (Rational Method). Water Quality Pond C4 will provide water quality enhancement for combined Basins C3 and C4.

Developed Sub-basin C5 comprises a large tributary area along the west side of Pinehurst Circle, extending north from Emerson Cliff Court towards Cul-de-Sac C. Sub-basin C5 will flow northeasterly along existing and proposed grass-lined drainage swales to Culvert C5. Developed peak flows at Design Point #C5 are calculated as Q_5 = 18.1 cfs and Q_{100} = 50.2 cfs (Rational Method). Culvert C5 (30" RCP) will convey the flow from this basin easterly across Pinehurst Circle, draining to Detention Pond C8.

Developed Sub-basin C6 comprises the small area on the east side of Pinehurst Circle, south of Cul-de-Sac B, which flows northwesterly to Culvert C6. Developed peak flows at Design Point #C6 are calculated as Q_5 = 1.3 cfs and Q_{100} = 3.0 cfs (Rational Method). Culvert C6 (18" RCP) will convey the flow from this basin northerly across Cul-de-Sac B, continuing northerly along the roadside ditch on the east side of Pinehurst Circle, and draining to Detention Pond C8.

Developed Sub-basin C8 comprises the area on the easterly downstream side of Pinehurst Circle, north of Cul-de-Sac B, which flows northeasterly to Detention Pond C8. Developed flows from Sub-basins C5, C6, and C8 combine at Design Point #C8.1, with peak flows calculated as Q_5 = 18.2 cfs and Q_{100} = 43.2 cfs (Rational Method). Full-Spectrum Extended Detention Basin C8 will provide stormwater detention and water quality enhancement for combined Basins C5, C6, and C8.

Developed Sub-basin C9 comprises the undeveloped area along the east edge of Filing No. 5 adjoining the existing drainage channel. Developed peak flows at Design Point #C9 are calculated as Q_5 = 6.9 cfs and Q_{100} = 16.4 cfs (Rational Method).

Developed Sub-basin C10 comprises the small area on the west side of Pinehurst Circle, south of Cul-de-Sac C, which flows northeasterly to Culvert C10. Developed peak flows at Design Point #C10 are calculated as Q_5 = 3.4 cfs and Q_{100} = 8.0 cfs (Rational Method). Culvert C10 (18" RCP) will convey the flow from this basin northerly across Cul-de-Sac C, continuing northwesterly along the roadside ditch on the west side of Pinehurst Circle, and draining to Culvert C11.

Developed Sub-basin C11 comprises the tributary area on the west side of Pinehurst Circle, north of Cul-de-Sac C, which flows northeasterly to Culvert C11. Developed

No detention needed for these basins? Discuss. Also provide a table that shows existing vs proposed flows for these basins. We need to see the difference in flowrates from existing to proposed conditions at the discharge points of proposed Pond C8 --- similar to the tables shown below. We know from the UD-Detention worksheet on pdf pg 100 below that the proposed flows are less than the existing for Pond C8.

Per ECM Chap 3.2.8.B, “The proposed project or developed land use shall not change historical runoff values, cause downstream damage, or adversely impact adjacent properties.” Increases from the historical flowrates are allowable (with or without full spectrum detention) if it is shown (via text and/or calcs) that the flow increase can be accommodated downstream (ie: show that there is a suitable outfall, per ECM, Chap 3.2.4). If applicable, reference the downstream facilities in a DBPS or MDDP.

drainage from Sub-basins C10 and C11 combines at Design Point #C11.1, with peak flows calculated as Q_5 = 12.3 cfs and Q_{100} = 29.2 cfs (Rational Method). Culvert C11 (24” RCP) will convey the flow from these basins northeasterly across Pinehurst Circle, flowing through Channels C12.1-C12.2 to Rain Garden C12.

Developed Sub-basin C12 comprises the area at the north end of Filing No. 5, which sheet flows northeasterly to Water Quality Rain Garden C12. Developed flows from Sub-basins C10-C12 combine at Design Point #C12.1, with peak flows calculated as Q_5 = 30.5 cfs and Q_{100} = 72.4 cfs (Rational Method). Water Quality Pond C12 will provide water quality enhancement for the combined Basins C10-C12.

Developed Sub-basin G1 comprises the mostly undeveloped area at the northwest corner of Filing No. 5. Developed peak flows at Design Point #G1 are calculated as Q_5 = 4.2 cfs and Q_{100} = 9.9 cfs (Rational Method).

Describe where/how runoff from this basin will be treated if at all. If no treatment, discuss applicable WQ exclusion(s)

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, and the increase in developed flows will be mitigated through on-site stormwater detention facilities.

The comparison of historic to developed and detained discharges across the full spectrum of storm events at key design points is summarized in the following tables (see detailed calculations in Appendix B):

Specify that the DP's in these tables are shown in Drainage Map EX1

Historic Flows:

Design Point	Peak Flow							
	Area (ac)	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)	
1	337.1	11.2	39.4	78.5	118.0	188.1	240.8	
2	490.5	39.3	73.4	121.5	169.9	256.2	321.3	
4	902.7	145.8	234.8	322.2	400.0	527.9	620.0	

Developed Flows:

Design Point	Peak Flow							Comparison of Developed to Historic Flow (Q_{100}%)
	Area (ac)	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)	
1	342.0	59.8	99.6	139.8	176.3	238.7	285.5	119% (increase)
2	504.7	117.0	189.1	262.6	327.1	432.5	508.9	158% (increase)
4	902.7	204.0	324.4	445.1	552.4	724.7	845.4	136% (increase)

Update to include DP3

As detailed in the "Final Drainage Report for Walden Preserve 2 Filing No. 4," Appendix B includes the HEC-HMS model for detained flows incorporating the calculated outflows from the upgrade of Pond B to full-spectrum detention. The resulting ultimate discharges at downstream Design Point #4 remain at or below historic levels for the full spectrum of design storms:

Detained Flows:

Design Point	Peak Flow Comparison						
	Area (ac)	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)
4 (Historic)	902.7	145.8	234.8	322.2	400.0	527.9	620.0
4 (Detained)	902.7	139.0	226.7	314.1	391.5	515.3	601.4
Comparison [a]		95%	97%	97%	98%	98%	97%

[a] Comparison of Detained Flow / Historic Flow

D. Detention Ponds

The total developed storm runoff downstream of the proposed subdivision will be maintained at historic levels by routing flows through an existing detention pond (Pond B) located along the main tributary channel running through the property, along with ultimate construction of four additional ponds (Rain Gardens C2, C4, and C12, and Detention Pond C8) serving the northern parts of the Walden 2 PUD area. Rain Gardens C4 and C12 have been designed as a stormwater quality facility in accordance with County and UDFCD criteria, and Detention Pond C8 has been designed as a "full-spectrum" detention pond.

Development of Walden Preserve 2 Filing No. 5 will include construction of Full-Spectrum Extended Detention Basin (EDB) C8. Final pond design calculations utilizing the Mile High Flood District (MHFD) "MH-Detention_v4.04" software package are enclosed in Appendix D1. Design parameters for Detention Pond C8 are summarized as follows:

Pond	**Tributary Area (ac)**	**Percent Impervious (%)**	**Required 100-Yr FSD Volume (ac-ft)**	**Design Volume (ac-ft)**
C8	40.6	17.7%	2.0	2.9

Walden Preserve 2 Filing No. 5 will also include construction of Water Quality Rain Gardens C4 and C12. Design calculations utilizing the MHFD "UD-BMP_v3.07" software package are enclosed in Appendix D2.

Design parameters for WQ Rain Gardens C4 and C12 are summarized as follows:

Pond	Tributary Area (ac)	Percent Impervious (%)	Required WQCV (ac-ft)	Design Volume (ac-ft)
C4	17.6	20.0%	0.14	0.14
C12	29.3	18.1%	0.21	0.22

The existing and proposed detention ponds will be owned and maintained by the Walden Property Owners Association or metropolitan district.

E. On-Site Drainage Facility Design

Developed sub-basins and proposed drainage improvements are depicted in the enclosed Drainage Plans (Sheets D1 and D1.01-D1.03). In accordance with El Paso County standards, new roadways will be graded with a minimum longitudinal slope of 1.0 percent. The typical local road section will consist of a 28-foot paved width with 2-foot gravel shoulders and 4:1 slopes to 2.5-foot deep ditches. On-site drainage facilities will consist of roadside ditches, grass-lined channels, and culverts. Hydraulic calculations for preliminary sizing of major on-site drainage facilities are enclosed in Appendix C, and design criteria are summarized as follows:

1. Culverts

The internal road system will be graded to drain roadside ditches to low points along the road profile, where cross-culverts will convey developed flows into grass-lined channels following historic drainage paths. Culvert pipes have been specified as reinforced concrete pipe (RCP) with a minimum diameter of 18-inches. Final culvert design calculations were performed utilizing the FHWA HY-8 software package to perform a detailed analysis of inlet and outlet control conditions, meeting El Paso County criteria for allowable headwater depths and overtopping. Riprap outlet protection will be provided at all culverts.

2. Open Channels

Drainage easements will be dedicated along major drainage channels following historic drainage paths through the subdivision. These channels have generally been designed as grass-lined channels designed to convey 100-year flows, with a trapezoidal cross-section, variable bottom width and depth, 4:1 maximum side-slopes, 1-foot freeboard, and a minimum slope of 0.5 percent.

The proposed drainage channels have been sized utilizing Manning's equation for open channel flow, assuming a friction factor ("n") of 0.030 for dry-land grass channels. Maximum allowable velocities will be evaluated based on El Paso County drainage criteria, typically allowing for a maximum 100-year velocity of 4-5 feet per second. Erosion control mats have been specified for channel segments with maximum 100-year velocities up to 8 feet per second. The proposed channels will generally be seeded with native grasses for erosion control. Erosion control mats, ditch checks, and/or riprap channel lining will be provided where required based on erosive velocities. Ditch flows will be diverted to drainage channels at the nearest practical location to minimize excessive roadside ditch sizes. Primary drainage swales crossing proposed lots have been placed in drainage easements, with variable widths based on the required channel sections.

The proposed development plan for Walden Preserve provides a substantial open space buffer along the existing Tributary Channel of West Cherry Creek running through the site, with the intention of protecting this existing greenway and providing an active trail connection along the drainage corridor. The existing main channel upstream of Pond B is a grass-lined channel in stable condition, and the major channel will generally be protected from development. The existing stock ponds have previously been upgraded with engineered outlet structures and spillways.

F. Analysis of Existing and Proposed Downstream Facilities

The general concept of the proposed drainage plan is to mitigate developed flow impacts and attenuate peak flows in the main channel by routing developed flows through on-site detention ponds. Detention Pond B has been designed to "over-detain" to account for release of developed flows from some downstream parts of the Walden Preserve Subdivision.

Downstream of Pond B, the existing channel flows through the back yards of a block of existing developed lots platted in the 1970's along Woodhaven Drive (Walden III Subdivision). While Pond B provides significant stormwater detention, the historic drainage basin contributing to this channel comprises over 500 acres so this channel will periodically be expected to experience high flows. The channel downstream of Pond B is an existing deficient condition from a drainage design standpoint. No structural improvements (i.e. riprap lining, drop structures) were constructed to stabilize this segment of channel when the original Walden Subdivision was developed, and as a result this segment of channel does not meet County standards for public drainage facilities. The channel downstream of Pond B flows through a row of existing private backyards, and a number of existing private structures are located along the drainage channel. The channel has historically shown signs of erosion in several areas, and limited maintenance access is available along this private reach of channel. We are aware of one existing downstream property that has experienced periodic flooding as a result of the basement level being below the existing channel elevation.

Recognizes the existing deficiencies in the channel downstream of Pond B, Filing No. 4 improvements included upgrading Pond B to full-spectrum detention standards to provide a substantial decrease in peak outflows compared to predevelopment peak flows across the full spectrum of design storms (see UD-Detention modeling in Appendix D1). An engineered energy dissipation structure was previously constructed at the Pond B discharge point to further mitigate the impact of flows from the Walden Preserve Subdivision.

The existing 43"x27" elliptical CMP culvert at Walker Road has an estimated capacity of 55 cfs. The existing culvert is undersized based on the calculated historic flows from the basin. While the existing roadway would be expected to overtop during major storm events, we are not aware of any reported drainage problems at this crossing and we are not aware of any County plans for replacement of the existing culvert. The existing stock ponds upstream in the main channel provide a significant level of stormwater detention/retention in their current condition, which likely has minimized historic concerns with flows overtopping the roadway at this crossing.

Combined flows in the East Tributary of West Cherry Creek continue flowing northerly through a grass-lined channel following a 100-foot wide drainage easement through the Shamrock Hills Subdivision north of Walker Road, ultimately reaching a confluence with West Cherry Creek. The existing channel downstream of the culvert crossing Walker Road consists of a broad grass-lined swale with no signs of active erosion. On-site detention ponds mitigate the developed drainage impacts from the Walden Preserve Subdivision, so there is no need for this development to upgrade existing downstream facilities.

G. Anticipated Drainage Problems and Solutions

Stormwater detention ponds have been designed to mitigate the impacts of developed drainage from the overall Walden Preserve 2 PUD project. The previously completed construction and upgrades to Pond B are sufficient to provide stormwater detention for WP2 Filings No. 1-4. Stormwater Detention Basin C8 and Water Quality Rain Gardens C4 and C12 will provide stormwater detention and water quality mitigation for Filing No. 5.

The overall drainage plan for the subdivision includes a system of roadside ditches, channels, and culverts to convey developed flows through the site. The primary drainage problems anticipated within this development will consist of maintenance of these drainage channels, culverts, and detention pond facilities. Care will need to be taken to implement proper erosion control measures in the proposed roadside ditches, channels, and swales.

Ditches have been designed to meet allowable velocity criteria. Erosion control mats will be installed where necessary to minimize erosion concerns. Proper construction and maintenance of the proposed detention facility will minimize downstream drainage impacts.

VII. EROSION / SEDIMENT CONTROL

The Contractor will be required to implement Best Management Practices (BMP's) for erosion control through the course of construction. Sediment control measures will include installation of silt fence at the toe of disturbed slopes and hay bales protecting drainage ditches. Cut slopes will be stabilized during excavation as necessary and vegetation will be established for stabilization of disturbed areas as soon as possible. All ditches will be designed to meet El Paso County criteria for slope and velocity.

VIII. COST ESTIMATE AND DRAINAGE FEES

A cost estimate for proposed drainage improvements is enclosed in Appendix E.

The developer will finance all construction costs for proposed roadway and drainage improvements, and public facilities will be owned and maintained by El Paso County upon final acceptance. The existing and proposed detention pond and water quality facilities will ultimately be owned and maintained by the Walden Metropolitan District.

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

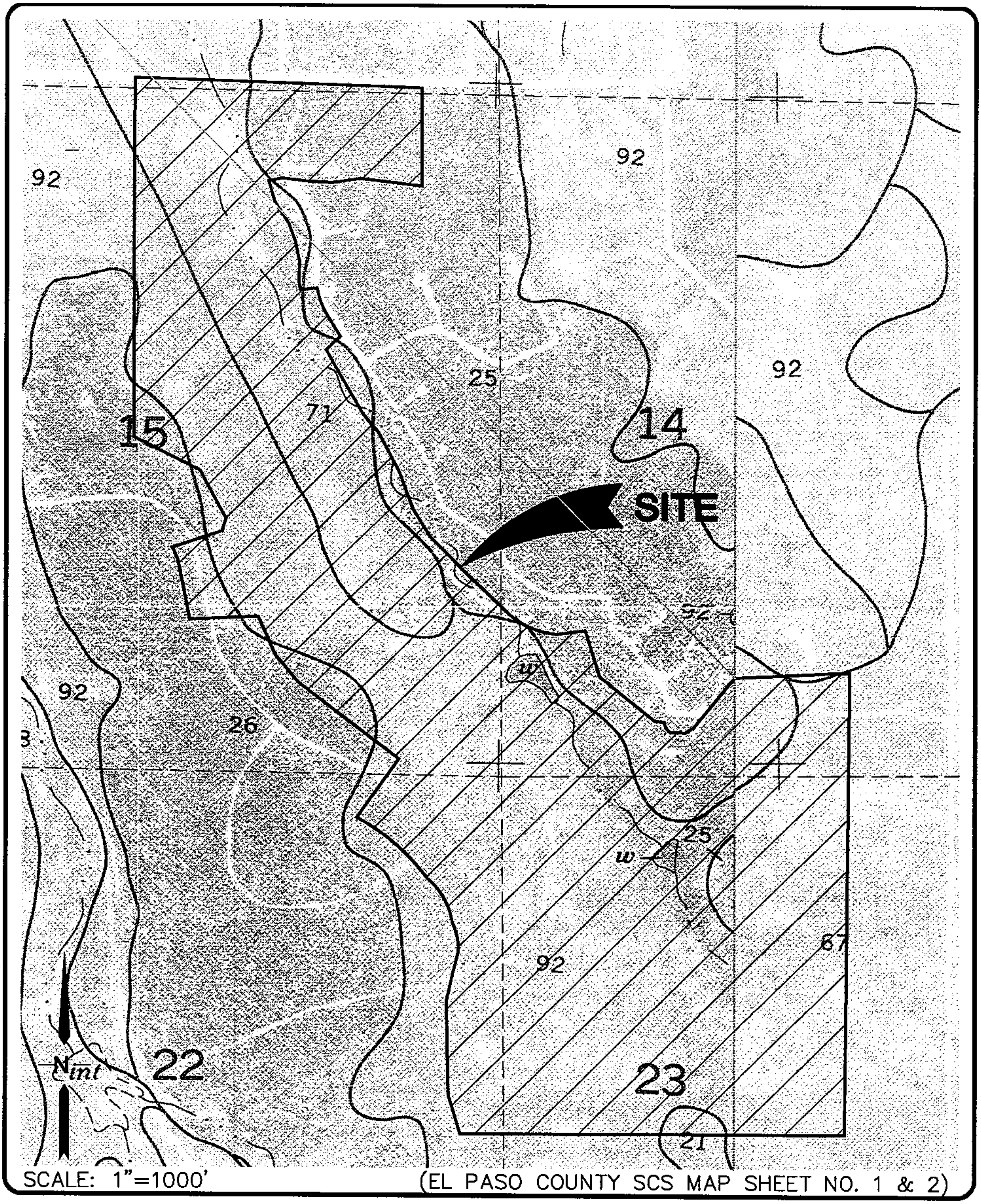
IX. SUMMARY

Walden Preserve 2 Filing No. 5 consists of 50 proposed lots along the extension of Pinehurst Circle east of Walden Way. Developed drainage impacts from the Walden Preserve 2 PUD will be mitigated through existing and proposed on-site stormwater detention and water quality 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. Based on the on-site stormwater detention facilities, no downstream drainage improvements are proposed.

The existing and proposed detention ponds have been designed to maintain historic peak flows downstream of the Walden Preserve Subdivision. Proper construction and maintenance of the proposed drainage and erosion control facilities will ensure that this subdivision has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A

SOILS INFORMATION



J:\jpsprojects\040201.walden\WALDEN PRESERVE 2\DWG\CIVIL\SCS-1.dwg Sep 17, 2014 - 9:42am

SCS SOILS MAP

JPS ENGINEERING

WALDEN PRESERVE

FIGURE SCS-1

JPS PROJ NO. 040201

The presence of princesplume, two-groove milkvetch, and Fremont goldenweed indicates that selenium-bearing plants are in the stand.

Good grazing management is essential to maintain desirable grasses on the Kutch soil. Deferment of grazing early in spring helps to maintain the health and vigor of cool-season grasses. Proper location of livestock watering facilities helps to control grazing.

If the range has deteriorated, blue grama, junegrass, and native bluegrasses increase. Sleepygrass and annuals replace these grasses if the range has seriously deteriorated. Proper range management and proper location of livestock watering facilities are essential to maintain the potential vegetation on these soils. Seeding is advisable if the range is in poor condition. Seeding of the native vegetation is desirable, but the range can also be seeded with tame species of grasses such as Nordan crested wheatgrass, Russian wildrye, pubescent wheatgrass, or intermediate wheatgrass.

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

The main limitations of these soils for homesites are depth to sandstone and shale, permeability, and the shrink-swell potential of the subsoil. Dwellings and roads need to be designed to offset these limitations. Septic tank absorption fields do not function properly because of the depth to shale and permeability. Capability subclass VIe.

25—Elbeth sandy loam, 3 to 8 percent slopes. This deep, well drained soil formed in material transported from arkose deposits on uplands. Elevation ranges from 1,800 to 7,600 feet. The average annual precipitation is about 18 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically the surface layer is very dark grayish brown sandy loam about 3 inches thick. The subsurface layer is light gray loamy sand about 20 inches thick. The subsoil is brown sandy clay loam about 45 inches thick. The substratum is light brown sandy clay loam.

Included with this soil in mapping are small areas of Tomah-Crowfoot loamy sands, 3 to 8 percent slopes; Kettle gravelly loamy sand, 3 to 8 percent slopes; and Peyton-Pring complex, 3 to 8 percent slopes.

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

This soil is used for woodland, limited livestock grazing, recreation, wildlife habitat, and homesites.

This soil is suited to the production of ponderosa pine. It is capable of producing about 2,240 cubic feet, or 4,900 board feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. Conventional methods can be used for harvesting, but operations may be restricted during wet periods. Reforestation, after harvesting, must be carefully managed to reduce competition of undesirable understory plants.

Woodland wildlife, such as mule deer and wild turkey, is attracted to this soil because of its potential to produce ponderosa pine, Gambel oak, and various grasses and shrubs. Water developments, such as guzzlers, would enhance populations of wild turkey as well as other kinds of wildlife. Where wildlife and livestock share the same range, proper grazing management is needed to prevent overuse and to reduce competition. Livestock watering facilities would also benefit wildlife on this soil.

This soil has good potential for homesites. The main limitation is the moderate shrink-swell potential in the subsoil. Special road design is necessary on this soil to overcome the limitations of shrink-swell potential and frost action. Special planning is needed on this soil to minimize site disturbance and tree and seedling damage. During seasons of low precipitation, fire may become a hazard to homesites on this soil. The hazard can be minimized by installing firebreaks and reducing the amount of potential fuel on the forest floor. Capability subclass VIe.

26—Elbeth sandy loam, 8 to 15 percent slopes. This deep, well drained soil formed in material transported from arkose deposits on uplands. Elevation ranges from 7,300 to 7,600 feet. The average annual precipitation is about 18 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is about 120 days.

Typically, the surface layer is very dark grayish brown sandy loam about 3 inches thick. The subsurface layer is light gray loamy sand about 20 inches thick. The subsoil is brown sandy clay loam about 45 inches thick. The substratum is light brown.

Included with this soil in mapping are small areas of Tomah-Crowfoot loamy sand, 8 to 15 percent slopes; Peyton-Pring complex, 8 to 15 percent slopes; Kettle gravelly loamy sand, 8 to 40 percent slopes; and Kettle-Rock outcrop complex.

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

This soil is used for woodland, limited livestock grazing, recreation, wildlife habitat, and homesites.

This soil is suited to the production of ponderosa pine. It is capable of producing about 2,240 cubic feet, or 4,900 board feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. Conventional methods can be used for harvesting, but operations may be restricted during wet periods. Reforestation, after harvesting, must be carefully managed to reduce competition of undesirable understory plants.

survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

These soils have a good potential for homesites. The main limitations, especially on the Peyton soil, are low bearing strength and frost-action potential. Buildings and roads can be designed to overcome these limitations. Access roads should have adequate cut-slope grade and be provided with drains to control surface runoff and keep soil losses to a minimum. Capability subclass VIe.

69—Peyton-Pring complex, 8 to 15 percent slopes. These gently to moderately sloping soils are on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

The Peyton soil makes up about 40 percent of the complex, the Pring soil about 30 percent, and other soils about 30 percent.

Included with these soils in mapping are areas of Holderness loam, 8 to 15 percent slopes; Tomah-Crowfoot loamy sands, 8 to 15 percent slopes; Kettle gravelly loamy sand, 8 to 40 percent slopes; and a few areas of Rock outcrop.

The Peyton soil is commonly on the less sloping part of the landscape. It is deep, noncalcareous, and well drained. It formed in alluvium and residuum derived from weathered, arkosic, sedimentary rock. Typically, the surface layer is grayish brown sandy loam about 12 inches thick. The subsoil, about 23 inches thick, is pale brown sandy clay loam in the upper 13 inches and pale brown sandy loam in the lower 10 inches. The substratum is pale brown sandy loam to a depth of 60 inches or more.

Permeability of the Peyton soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Some gullies have developed along drainageways and livestock trails.

The Pring soil is deep, noncalcareous, and well drained. It formed in sandy sediment derived from weathered, arkosic, sedimentary rock. Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Permeability of the Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Some gullies have developed along drainageways and livestock trails.

The soils in this complex are used as rangeland, for wildlife habitat, and for homesites.

These soils are well suited to the production of native vegetation suitable for grazing. The dominant native species are mountain muhly, bluestem grasses, needleandthread, and blue grama. These soils are subject to invasion of Kentucky bluegrass and Gambel oak. Common forbs are hairy goldenrod, geranium, milkvetch, low larkspur, fringed sage, and buckwheat.

Properly locating livestock watering facilities helps to control grazing. Timely deferment of grazing is needed to protect the plant cover.

Windbreaks and environmental plantings generally are suited to these soils. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are well suited to wildlife habitat. They are best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

These soils have good potential for use as homesites. The main limitations are steepness of slope, limited ability to support a load, and frost-action potential. Buildings and roads can be designed to overcome these limitations. These soils also require special site or building designs because of the slope. Access roads should have adequate cut-slope grade and drains should be provided to control surface runoff and keep soil losses to a minimum. Capability subclass VIe.

70—Pits, gravel. Gravel pits are in nearly level to rolling areas. They are open excavations several feet deep and commonly 5 acres or less in size.

Gravel pits are very low in natural fertility and are highly susceptible to soil blowing. A cover of weeds or straw helps to control erosion.

Windbreaks and environmental plantings generally are not suited to these areas. Onsite investigation is needed to determine if plantings are feasible. Capability subclass VIIIs.

71—Pring coarse sandy loam, 3 to 8 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Alamosa loam, 1 to 3 percent slopes, along drainageways; Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 1 to 5 percent slopes; Peyton sandy loam, 5 to 9 percent slopes; and Tomah-Crowfoot loamy sands, 3 to 8 percent slopes. In some places arkose beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate.

Almost all areas of this soil are used as rangeland. Some areas previously cultivated have been reseeded to grass. This soil is also used for wildlife habitat and homesites.

This soil is well suited to the production of native vegetation suitable for grazing by cattle and sheep. Rangeland vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferment of grazing in spring helps to maintain vigor and production of the cool-season bunchgrasses. Fencing and properly locating livestock watering facilities help to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

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

This soil is well suited for use as homesites. Erosion control practices are needed to control soil blowing and water erosion on construction sites where the ground cover has been removed. Capability subclass IVe.

72—Pring coarse sandy loam, 8 to 15 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 5 to 9 percent slopes; and Tomah-Crowfoot loamy sands, 8 to 15 percent slopes. Arkose beds of sandstone and shale are at a depth of 0 to 40 inches in some places.

Permeability of this Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate. Some gullies have developed along drainageways.

Almost all areas of this soil are used as rangeland. Some areas previously cultivated have been reseeded to grass. This soil is also used for wildlife habitat and as homesites.

This soil is well suited to the production of native vegetation suitable for grazing by cattle and sheep. The native vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferment of grazing in spring helps to maintain the vigor and production of the cool-season bunchgrasses. Fencing and properly locating livestock watering facilities help to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

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

This soil has good potential for urban uses. The main limitation is slope. Special site or building designs are needed because of the slope. Access roads must have adequate cut-slope grade and be provided with drains to control surface runoff. Capability subclass VIe.

73—Razor clay loam, 3 to 9 percent slopes. This moderately deep, well drained, clayey soil formed in residuum derived from calcareous shale on uplands. Elevation ranges from 5,300 to 6,100 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is light brownish gray clay loam about 3 inches thick. The subsoil is grayish brown heavy clay loam or clay about 15 inches thick. The substratum is grayish brown clay that grades to calcareous shale at a depth of about 31 inches. Visible lime is in the lower part of the subsoil and in the substratum.

Included with this soil in mapping are small areas of Midway clay loam, 3 to 25 percent slopes; Heldt clay loam, 0 to 3 percent slopes; and Stoneham sandy loam, 3 to 8 percent slopes.

strength. Special designs for buildings and roads are required to offset these limitations. Methods of sewage disposal other than septic tank absorption fields are needed because of the limited depth to bedrock. Capability subclass VIe.

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes. These gently sloping to moderately sloping soils are on alluvial fans, hills, and ridges in the uplands. Elevation ranges from about 7,300 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 120 days.

The Tomah soil makes up about 50 percent of the complex, the Crowfoot soil about 30 percent, and other soils about 20 percent.

Included with these soils in mapping are areas of Elbeth sandy loam, 3 to 8 percent slopes; Kettle gravelly loamy sand, 3 to 8 percent slopes; and Pring coarse sandy loam, 3 to 8 percent slopes.

The Tomah soil is deep and well drained. It formed in alluvium or residuum derived from arkose beds. Typically, the surface layer is dark grayish brown loamy sand about 10 inches thick. The subsurface layer is very pale brown coarse sand about 12 inches thick. The subsoil, about 26 inches thick, is a matrix of very pale brown coarse sand in which are embedded many thin bands and lamellae of pale brown coarse sandy clay loam. The substratum is very pale brown coarse sand to a depth of 60 inches or more.

Permeability of the Tomah soil is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the hazard of erosion is slight to moderate.

The Crowfoot soil is deep and well drained. It formed in sediment weathered from arkosic sandstone. Typically, the surface layer is grayish brown loamy sand about 12 inches thick. The subsurface layer is very pale brown sand about 11 inches thick. The subsoil is light yellowish brown sandy clay loam about 13 inches thick. The substratum is very pale brown coarse sand to a depth of about 68 inches.

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

This complex is used as rangeland, for wildlife habitat, and as homesites.

Native vegetation is mainly mountain muhly, bluestem, mountain brome, needleandthread, and blue grama. These soils are subject to invasion by Kentucky bluegrass and Gambel oak. Noticeable forbs are hairy goldenrod, geranium, milkvetch, low larkspur, fringed sage, and buckwheat.

Properly locating livestock watering facilities helps to control grazing. Timely deferment of grazing is needed to protect the plant cover.

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

These soils are best suited to habitat for openland wildlife such as pronghorn antelope and sharp-tailed grouse. Although sharp-tailed grouse are not plentiful, they could be encouraged on these soils, especially where brush species are interspersed with grasses and forbs. If these soils are used as rangeland, wildlife production can be increased by managing livestock grazing to preclude overuse of the more desirable grass species and depletion of the various brush species.

These soils have good potential for use as homesites. The main limitation of the Crowfoot soil is frost-action potential. Roads and streets need to be designed to minimize frost-heave damage. Maintaining the existing vegetation on building sites during construction helps to control erosion. Capability subclass IVe.

93—Tomah-Crowfoot loamy sands, 8 to 15 percent slopes. These moderately sloping to strongly sloping soils are on alluvial fans, hills, and ridges in the uplands. Elevation ranges from about 7,300 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 120 days.

The Tomah soil makes up about 50 percent of the complex, the Crowfoot soil about 30 percent, and other soils about 20 percent.

Included with these soils in mapping are areas of Elbeth sandy loam, 8 to 15 percent slopes; Peyton-Pring complex, 8 to 15 percent slopes; and Kettle gravelly loamy sand, 8 to 40 percent slopes.

The Tomah soil is deep and well drained. It formed in alluvium or residuum derived from arkose beds. Typically, the surface layer is dark grayish brown loamy sand about 10 inches thick. The subsurface layer is very pale brown coarse sand about 12 inches thick. The subsoil, about 26 inches thick, consists of a matrix of very pale brown coarse sandy clay loam. The substratum is very pale brown coarse sand to a depth of 60 inches or more.

Permeability of the Tomah soil is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate. Some gullies are present in some drainageways and along stock trails.

The Crowfoot soil is deep and well drained. It formed in sediment weathered from arkosic sandstone. Typically, the surface layer is grayish brown loamy sand about 12 inches thick. The subsurface layer is very pale brown sand about 11 inches thick. The subsoil is light yellowish brown sandy clay loam about 13 inches thick. The substratum is very pale brown coarse sand to a depth of about 68 inches.

TABLE 16.--SOIL AND WATER FEATURES

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

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

See footnote at end of table.

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

Soil name and map symbol	Hydro-logic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Manvel:							
50	C	None	---	---	>60	---	High.
Manzanola:							
51, 52, 53	C	None to rare	---	---	>60	---	Moderate.
Midway:							
54	D	None	---	---	10-20	Rippable	Moderate.
Nederland:							
55	B	None	---	---	>60	---	Moderate.
Nelson:							
†56:							
Nelson part	B	None	---	---	20-40	Rippable	Low.
Tassel part	D	None	---	---	10-20	Rippable	Low.
Neville:							
57	B	None	---	---	>60	---	High.
†58:							
Neville part	B	None	---	---	>60	---	High.
Rednun part	C	None	---	---	>60	---	Moderate.
Nunn:							
59	C	None	---	---	>60	---	Moderate.
Olney:							
60, 61	B	None	---	---	>60	---	Moderate.
†62:							
Olney part	B	None	---	---	>60	---	Moderate.
Vona part	B	None	---	---	>60	---	Moderate.
Paunsaugunt:							
†63:							
Paunsaugunt part	D	None	---	---	10-20	Hard	Moderate.
Rock outcrop part	D	---	---	---	---	---	---
Penrose:							
†64:							
Penrose part	D	None	---	---	10-20	Rippable	Low.
Manvel part	C	None	---	---	>60	---	High.
Perrypark:							
65	B	None	---	---	>60	---	Moderate.
Peyton:							
66, 67	B	None	---	---	>60	---	Moderate.
†68, †69:							
Peyton part	B	None	---	---	>60	---	Moderate.
Pring part	B	None	---	---	>60	---	Moderate.
Pits, gravel:							
70	A	---	---	---	---	---	---
Pring:							
71, 72	B	None	---	---	>60	---	Moderate.
Razor:							
73, 74	C	None	---	---	20-40	Rippable	Moderate.

† See footnote at end of table.

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

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

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

APPENDIX B

HYDROLOGIC CALCULATIONS

SCS CALCULATIONS FROM "FINAL DRAINAGE REPORT FOR WALDEN PRESERVE 2 - FILING NO. 4"

WALDEN PRESERVE SUBDIVISION
SCS HYDROLOGIC CALCULATIONS (HEC-HMS)

HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	CURVE No. (CN)	S	Ia	PERCENT IMPERVIOUS (%)	Time of Concentration Tc (1) (MIN)	Total Lag Time Tl (2) (MIN)	Q2 (3) (CFS)	Q5 (3) (CFS)	Q10 (3) (CFS)	Q25 (3) (CFS)	Q50 (3) (CFS)	Q100 (3) (CFS)
OA1		232.0	0.3625	61	6.39	1.28	2	34.80	20.88						
A		105.1	0.1642	61	6.39	1.28	2	18.80	11.28						
OA1,A	1	337.1	0.5267	61	6.39	1.28	2	53.60	32.16	11.2	39.4	78.5	118.0	188.1	240.8
OB1		35.4	0.0553	70	4.29	0.86	25	8.20	4.92						
B		118.0	0.1844	61	6.39	1.28	2	13.70	8.22						
OA1-OAB,A-B	2	490.5	0.7664	61	6.39	1.28	2	67.30	40.38	39.3	73.4	121.5	169.9	256.2	321.3
OC1		187.6	0.2931	70	4.29	0.86	25	14.40	8.64						
C		190.2	0.2972	61	6.39	1.28	2	47.10	28.26						
OD1		24.1	0.0377	61	6.39	1.28	2	30.30	18.18						
D		10.27	0.0160	61	6.39	1.28	2	4.50	2.70						
OA1-OC1,A-D	4	902.7	1.4104	61	6.39	1.28	2	114.40	68.64	145.8	234.8	322.2	400.0	527.9	620.0

1) Tc = Tco + Tt (from Rational Method Calculation Spreadsheet)
2) SCS LAG TIME, Tl = 0.6 * Tt
3) PEAK FLOWS CALCULATED BY HEC-HMS 4.3
 2-YR; 24-HR RAINFALL DEPTH = 2.1 IN
 5-YR; 24-HR RAINFALL DEPTH = 2.7 IN
 10-YR; 24-HR RAINFALL DEPTH = 3.2 IN
 25-YR; 24-HR RAINFALL DEPTH = 3.6 IN
 50-YR; 24-HR RAINFALL DEPTH = 4.2 IN
 100-YR; 24-HR RAINFALL DEPTH = 4.6 IN

SCS CALCULATIONS FROM "FINAL DRAINAGE REPORT FOR WALDEN PRESERVE 2 - FILING NO. 4"

WALDEN PRESERVE SUBDIVISION
SCS HYDROLOGIC CALCULATIONS (HEC-HMS)

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	CURVE No. (CN)	S	Ia	PERCENT IMPERVIOUS (%)	Time of Concentration Tc (1) (HR)	Total Lag Time Tl (2) (HR)	Q2 (3) (CFS)	Q5 (3) (CFS)	Q10 (3) (CFS)	Q25 (3) (CFS)	Q50 (3) (CFS)	Q100 (3) (CFS)
OA1		232.0	0.3625	61	6.39	1.28	2	36.80	22.08						
A9 (A1-A9)		110.0	0.1719	68	4.71	0.94	20	19.00	11.40						
OA1,A1-A9	1	342.0	0.5344					55.80	33.48	59.8	99.6	139.8	176.3	238.7	285.5
OB1		35.4	0.0553	70	4.29	0.86	25	20.60	12.36						
B4 (B1-B4)		55.5	0.0867	70	4.29	0.86	25	21.10	12.66						
B10 (B5-B10)		71.8	0.1122	68	4.71	0.94	20	28.70	17.22						
Tt DP1 to DP2								13.70	8.22						
OA1-OB1,A-B	2	504.7	0.7886					69.50	41.70	117.0	189.1	262.6	327.1	432.5	508.9
OC1		129	0.2016	69.5	4.39	0.88	23.6	14.40	8.64						
C4 (C1-C4)		40.3	0.0630	68	4.71	0.94	20	21.70	13.02						
C8 (C5-C8)		59.3	0.0927	68	4.71	0.94	20	35.00	21.00						
C9		4.5	0.0070	61	6.39	1.28	2	2.10	1.26						
Tt DP2 to DP3								22.10	13.26						
OA1-OC1,A,B,C1-C8	3	737.8	1.1528					91.60	54.96	187.7	295.8	404.7	501.4	656.3	764.9
OC2		81.7	0.1277	67.9	4.73	0.95	19.1	14.40	8.64						
C12 (C10-C12)		26.4	0.0413	68	4.71	0.94	20	19.10	11.46						
C13		22.4	0.0350	61	6.39	1.28	2	15.30	9.18						
OD1		24.1	0.0377	61	6.39	1.28	2	30.30	18.18						
D		10.3	0.0160	70	4.29	0.86	25	4.50	2.70						
Tt DP3 to DP4								25.40	15.24						
OA1-OC2,A-D	4	902.7	1.4104					117.00	70.20	204.0	324.4	445.1	552.4	724.7	845.4

1) Tc = Tco + Tt (from Rational Method Calculation Spreadsheet)
2) SCS LAG TIME, Tl = 0.6 * Tt
3) PEAK FLOWS CALCULATED BY HEC-HMS 4.3
2-YR; 24-HR RAINFALL DEPTH = 2.1 IN
5-YR; 24-HR RAINFALL DEPTH = 2.7 IN
10-YR; 24-HR RAINFALL DEPTH = 3.2 IN
25-YR; 24-HR RAINFALL DEPTH = 3.6 IN
50-YR; 24-HR RAINFALL DEPTH = 4.2 IN
100-YR; 24-HR RAINFALL DEPTH = 4.6 IN

SCS CALCULATIONS FROM "FINAL DRAINAGE REPORT FOR WALDEN PRESERVE 2 - FILING NO. 4"

WALDEN PRESERVE SUBDIVISION
SCS HYDROLOGIC CALCULATIONS (HEC-HMS)

DETAINED FLOWS

BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	CURVE No. (CN)	S	Ia	PERCENT IMPERVIOUS (%)	Time of Concentration Tc (1) (HR)	Total Lag Time Tl (2) (HR)	Q2 (3) (CFS)	Q5 (3) (CFS)	Q10 (3) (CFS)	Q25 (3) (CFS)	Q50 (3) (CFS)	Q100 (3) (CFS)
OA1		232.0	0.3625	61	6.39	1.28	2	36.80	22.08						
A9 (A1-A9)		110.0	0.1719	68	4.71	0.94	20	19.00	11.40						
OA1,A1-A9	1	342.0	0.5344					55.80	33.48	59.8	99.6	139.8	176.3	238.7	285.5
OB1		35.4	0.0553	70	4.29	0.86	25	20.60	12.36						
B4 (B1-B4)		55.5	0.0867	70	4.29	0.86	25	21.10	12.66						
B10 (B5-B10)		71.8	0.1122	68	4.71	0.94	20	28.70	17.22						
Tt DP1 to DP2								13.70	8.22						
OA1-OB1,A-B	2	504.7	0.7886					69.50	41.70	33.1	74.0	115.8	170.0	277.0	363.8
OC1		129	0.2016	69.5	4.39	0.88	23.6	14.40	8.64						
C4 (C1-C4)		40.3	0.0630	68	4.71	0.94	20	21.70	13.02						
C8 (C5-C8)		59.3	0.0927	68	4.71	0.94	20	35.00	21.00						
C9		4.5	0.0070	61	6.39	1.28	2	2.10	1.26						
Tt DP2 to DP3								22.10	13.26						
OA1-OC1,A,B,C1-C8	3	737.8	1.1528					91.60	54.96	116.3	186.8	257.5	319.1	417.2	483.9
OC2		81.7	0.1277	67.9	4.73	0.95	19.1	14.40	8.64						
C12 (C10-C12)		26.4	0.0413	68	4.71	0.94	20	19.10	11.46						
C13		22.4	0.0350	61	6.39	1.28	2	15.30	9.18						
OD1		24.1	0.0377	61	6.39	1.28	2	30.30	18.18						
D		10.3	0.0160	70	4.29	0.86	25	4.50	2.70						
Tt DP3 to DP4								25.40	15.24						
OA1-OC2,A-D	4	902.7	1.4104					117.00	70.20	139.0	226.7	314.1	391.5	515.3	601.4

1) Tc = Tco + Tt (from Rational Method Calculation Spreadsheet)
2) SCS LAG TIME, Tl = 0.6 * Tt
3) PEAK FLOWS CALCULATED BY HEC-HMS 4.3
   2-YR; 24-HR RAINFALL DEPTH = 2.1 IN
   5-YR; 24-HR RAINFALL DEPTH = 2.7 IN
   10-YR; 24-HR RAINFALL DEPTH = 3.2 IN
   25-YR; 24-HR RAINFALL DEPTH = 3.6 IN
   50-YR; 24-HR RAINFALL DEPTH = 4.2 IN
   100-YR; 24-HR RAINFALL DEPTH = 4.6 IN

(CU-Denver)

Determination of Time of Concentration

The time of concentration is the period of time required for stormwater to travel from the most remote point in the basin to the design point. In general, drainageways in an urban area may be composed of overland flow, gully (swale) flow, and channel (gutter) flow. There are many empirical formulas developed for estimating the time of concentration such as Kirpich, Kinematic Wave, Kerby etc.. They indicate that the time of concentration is a function of basin slope, length of waterway, roughness of waterway and rainfall amount. For an urban area, the airport empirical formula is recommended for estimating overland flow time:

* "Airport"

$$T_o = \frac{1.8\,(1.1 - C)\,L_o^{0.5}}{S_o^{0.33}} = \frac{1.8\,(1.1-C)\sqrt{L_o}}{\sqrt[3]{S_o}} \qquad (4)$$

in which To = overland flow time in minutes, C5 = runoff coefficient for a 5-year storm, Lo = overland flow length in feet, So = overland flow slope in percent.

The U.S. Soil Conservation Service (SCS) upland method is recommended for estimating gully (swale) flow time and channel (gutter) flow time. The SCS upland method classifies the linings of drainageways into six categories. They are: (1) meadow, (2) tillage, (3) lawn, (4) bare soil, (5) grass, and (6) pavement. Flow velocity is approximated by

* "SCS Upland"

$$V = K\,S^{0.5} \quad \longrightarrow \quad T_F = \frac{L_F}{K\sqrt{S_F}\,(60\ s/m)} \qquad (5)$$

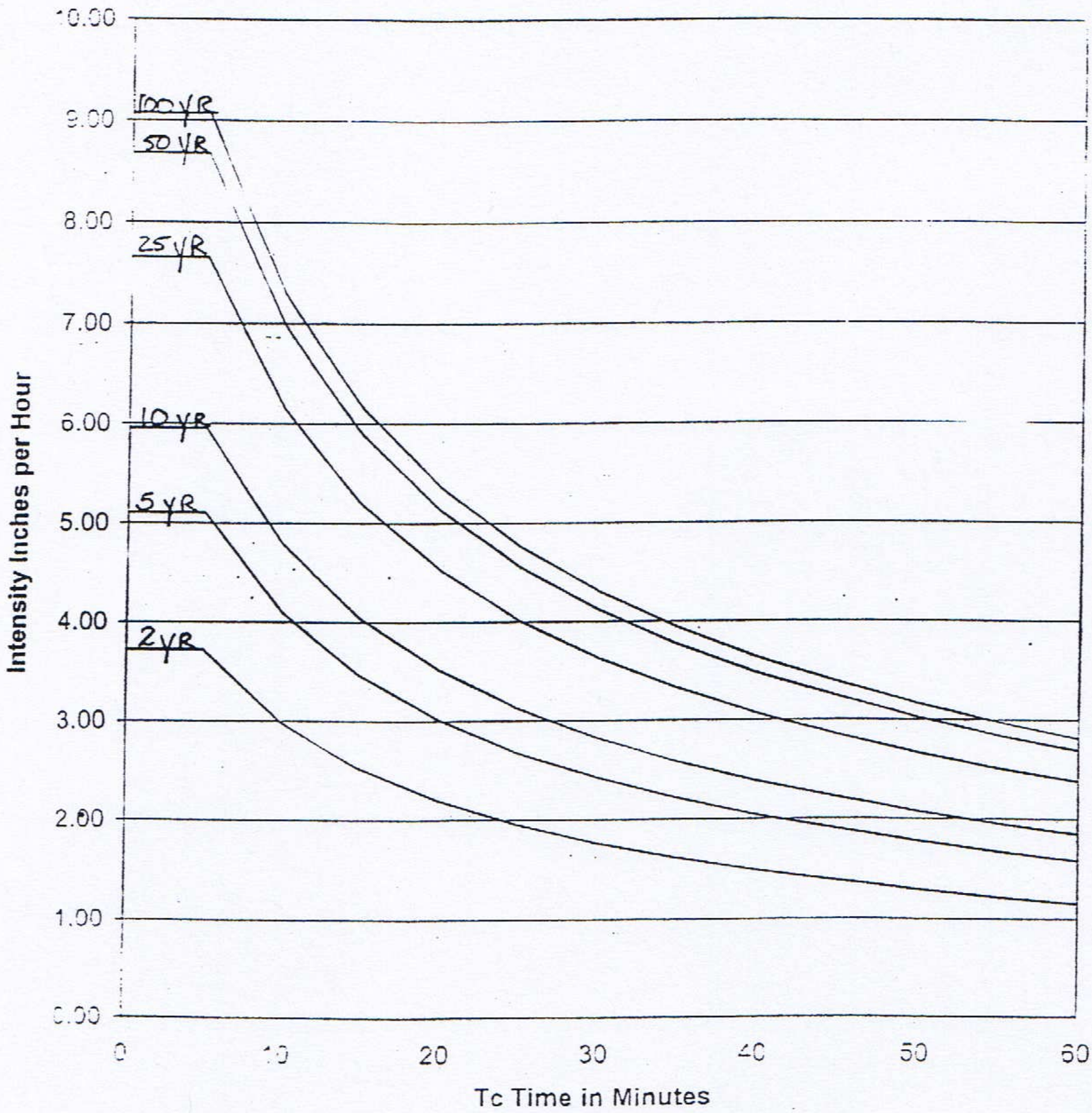
in which V = flow velocity in fps, S = drainageway slope in percent, and K = conveyance coefficient. The values of K for various lining materials are listed as follows: (2 impervious factor)

Linings	meadow	tillage	lawn	bare soil	grass	pavement
Value of K	.25	.45	.70	1.0	1.5	2.0

Applying the SCS upland method to swale and channel flows, we have

Ls

Storm Rainfall Time Intensity-Frequency Curves



Rainfall Depth - Duration - Frequency Table derived from Rainfall Atlas III for Colorado
Resource: Guo, James C.Y., (200[illegible]) "Urban Storm Water Modeling", Chapter 5: Runoff Prediction for Small Catchment, published by Auraria Campus Book Company, University of Colorado at Denver, Denver, Colorado.

TABLE 5-1

RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

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

* Hydrologic Soil Group

WALDEN PRESERVE
COMPOSITE RUNOFF COEFFICIENTS

HISTORIC CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	232	B	232	PASTURE	0.25							0.250
A	105.1	B	31.5	FOREST	0.1	73.6	PASTURE	0.25				0.205
OA1,A	337.1											0.236
OB1	35.4	B	35.4	1/2-AC. LOTS	0.35							0.350
B	118.0	B	23.6	FOREST	0.1	94.4	PASTURE	0.25				0.220
OB1,B	153.4											0.250
OA1,OB1,A,B	490.5											0.240
OC1	122.5		122.5	1/2-AC. LOTS	0.35							0.350
OC2	61.4		61.4	1/2-AC. LOTS	0.35							0.350
C	190.2		190.2	FOREST	0.1							0.100
OC1,OC2,C	374.1											0.223
OA1-OC1,A-C	864.6											0.233
OD1	3.30	B	3.30	1-AC LOTS	0.3							0.300
OD2	4.50	B	4.50	FOREST	0.1							0.100
OD3	10.30	B	10.30	FOREST	0.1							0.100
OD4	6.00	B	6.00	FOREST	0.1							0.100
D	10.27	B	10.27	FOREST	0.1							0.100
OD1-OD4, D	34.37	B										0.119
OA1-OD1,A-D	898.9											0.228
E	14.7		14.74	PASTURE	0.25							0.250
F	7.7		7.71	PASTURE	0.25							0.250

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	232	B	232	PASTURE	0.35							0.350
A	105.1	B	31.5	FOREST	0.15	73.6	PASTURE	0.35				0.290
OA1,A	337.1											0.331
OB1	35.4	B	35.4	1/2-AC. LOTS	0.45							0.450
B	118.0	B	23.6	FOREST	0.15	94.4	PASTURE	0.35				0.310
OB1,B	153.4											0.342
OA1,OB1,A,B	490.5											0.335
OC1	122.5		122.5	1/2-AC. LOTS	0.45							0.450
OC2	61.4		61.4	1/2-AC. LOTS	0.45							0.450
C	190.2		190.2	FOREST	0.15							0.150
OC1,OC2,C	374.1											0.297
OA1-OC1,A-C	864.6											0.319
OD1	3.30	B	3.30	1-AC LOTS	0.4							0.400
OD2	4.50	B	4.50	FOREST	0.15							0.150
OD3	10.30	B	10.30	FOREST	0.15							0.150
OD4	6.00	B	6.00	FOREST	0.15							0.150
D	10.27	B	10.27	FOREST	0.15							0.150
OD1-OD4, D	34.37	B										0.174
OA1-OD1,A-D	898.9											0.313
E	14.7		14.74	PASTURE	0.35							0.350
F	7.7		7.71	PASTURE	0.35							0.350

WALDEN PRESERVE
RATIONAL METHOD

HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR[7]	C 100-YEAR [7]	OVERLAND LENGTH (FT)	SLOPE (%)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
OA1		232.0	0.250	0.350	500	6.0	18.8	2900	1.50	4.1	3.04	15.9	34.8	2.22	3.96	129.00	321.47
A		105.1	0.205	0.290			0.0	2650	1.50	2.45	2.35	18.8	18.8	3.11	5.53	66.97	168.63
OA1,A	1	337.1	0.236	0.331									53.6	1.70	3.03	135.53	338.34
OB1		35.4	0.350	0.450			0.0	1600	1.50	4.7	3.25	8.2	8.2	4.41	7.84	54.60	124.96
B		118.0	0.220	0.310			0.0	1900	1.50	2.37	2.31	13.7	13.7	3.60	6.42	93.56	234.67
OB1,B		153.4	0.250	0.342									13.7	3.60	6.42	138.22	336.56
OA1,OB1,A,B	2	490.5	0.240	0.335									67.3	1.47	2.61	172.87	429.51
OC1		122.5	0.350	0.450			0.0	2800	1.50	4.64	3.23	14.4	14.4	3.52	6.27	151.01	345.59
OC2		61.4	0.350	0.450			0.0	2800	1.50	4.64	3.23	14.4	14.4	3.52	6.27	75.69	173.22
C		190.2	0.100	0.150			0.0	5450	1.50	1.65	1.93	47.1	47.1	1.85	3.29	35.12	93.78
OC1,OC2,C		374.1	0.223	0.297									47.1	1.85	3.29	154.08	365.26
OA1-OC2,A-C		864.6	0.233	0.319									114.4	1.02	1.82	205.98	501.97
OD1		3.30	0.30	0.40	370	5.4	15.8	450	1.50	4.4	3.15	2.4	18.2	3.16	5.63	3.13	7.43
OD2		4.50	0.10	0.15	525	8.2	20.5	0				0.0	20.5	2.98	5.30	1.34	3.58
OD3		10.30	0.10	0.15	700	5.7	26.7	580	1.50	3.1	2.64	3.7	30.3	2.41	4.28	2.48	6.62
OD4		6.00	0.10	0.15	630	5.6	25.5	340	1.50	0.9	1.42	4.0	29.4	2.45	4.36	1.47	3.92
D		10.27	0.10	0.15			0.0	750	1.50	3.5	2.81	4.5	5.0	5.10	9.09	5.24	14.00
OD1-OD4, D	4	34.37	0.12	0.17									34.8	2.22	3.96	9.17	23.12
OA1-OD1,A-D	3	898.9	0.228	0.313									114.4	1.02	1.82	209.57	512.11
E	5	14.7	0.250	0.350	800	4.4	26.4	0				0.0	26.4	2.60	4.63	9.58	23.89
F	6	7.7	0.250	0.350	1000	7.0	25.3	0				0.0	25.3	2.66	4.74	5.13	12.79

1) OVERLAND FLOW Tco = (1.87*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = K * ((SLOPE(%))^0.5)
K = 0.25 FOR MEADOW
K = 1.5 FOR GRASS CHANNEL
K = 2.0 FOR PAVEMENT
3) GUTTER/SWALE FLOW, Tcg = (GUTTER LENGTH/ SCS VELOCITY) / 60 SEC
4) Tc = Tco + Tcg
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F CURVE IN EL PASO COUNTY DRAINAGE CRITERIA MANUAL, REVISED BY CITY OF COLORADO SPRINGS 1/1/03
I = (A * P) / B + Td)^C
5-YEAR VALUES: A = 26.65; P1 = 1.5 IN (1-HOUR DEPTH); B = 10.0; C = 0.76
100-YEAR VALUES: A = 26.65; P = 2.67 IN (1-HOUR DEPTH); B = 10.0; C = 0.76
6) Q = CiA
7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

WALDEN PRESERVE
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1,A1-A9	341.96	B										0.266
OB1,B1-B4	90.90	B										0.350
B5	4.78	B	4.78	2.5-AC. LOTS	0.3							0.300
B6	7.91	B	7.91	5-AC. LOTS	0.137							0.137
B5,B6	12.69	B										0.198
B7	3.24	B	3.24	1-AC LOTS	0.3							0.300
B8	28.74	B	28.74	1-AC LOTS	0.3							0.300
B5-B8	44.67	B										0.271
B9	10.23	B	10.23	1-AC LOTS	0.3							0.300
B10	16.90	B	71.17	1-AC LOTS	0.3							0.300
B5-B10	71.80	B										0.282
OB1,B1-B10	162.70	B										0.320
OA1,OB1,A,B	504.66	B										0.283
OC1	128.95	B	128.95	1/2-AC. LOTS	0.35							0.350
C1-C4	38.79	B	38.79	1-AC LOTS	0.3							0.300
C5	26.83	B	19.5	1-AC. LOTS	0.3	7.3	5-AC. LOTS	0.137				0.256
C6	0.99	B	0.99	1-AC LOTS	0.3							0.300
C8	12.77	B	12.77	1-AC LOTS	0.3							0.300
C5,C6,C8	40.59	B										0.271
C9	4.50	B	4.5	1-AC LOTS	0.3							0.300
OC1,C1-C9	212.83	B										0.325
OA1-OC1,A1-C9	717.49	B										0.296
OC2	81.72	B	81.72	1/2-AC. LOTS	0.35							0.350
C10	2.86	B	2.86	1-AC LOTS	0.3							0.300
C11	8.63	B	8.63	1-AC LOTS	0.3							0.300
C10-C11	11.49	B										0.300
C12	17.77	B	17.77	1-AC LOTS	0.3							0.300
C10-C12	29.26	B										0.300
C13	22.44	B	22.44	MEADOW	0.25							0.250
OC2,C10-C13	133.42	B										0.322
OD1	3.30	B	3.30	1-AC LOTS	0.3							0.300
OD2	4.50	B	4.50	FOREST	0.1							0.100
OD3	10.30	B	10.30	FOREST	0.1							0.100
OD4	6.00	B	6.00	FOREST	0.1							0.100
D	10.27	B	10.27	1-AC LOTS	0.3							0.300
OD1-OD4, D	34.37	B										0.179
OA1-OD1,A-D	885.28	B										0.295

WALDEN PRESERVE
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1,A1-A9	341.96	B										0.366
OB1,B1-B4	90.90	B										0.450
B5	4.78	B	4.78	2.5-AC. LOTS	0.4							0.400
B6	7.91	B	7.91	5-AC. LOTS	0.392							0.392
B5,B6	12.69	B										0.395
B7	3.24	B	3.24	1-AC LOTS	0.4							0.400
B8	28.74	B	28.74	1-AC LOTS	0.4							0.400
B5-B8	44.67	B										0.399
B9	10.23	B	10.23	1-AC LOTS	0.4							0.400
B10	16.90	B	71.17	1-AC LOTS	0.4							0.400
B5-B10	71.80	B										0.399
OB1,B1-B10	162.70	B										0.428
OA1,OB1,A,B	504.66	B										0.386
OC1	128.95	B	128.95	1/2-AC. LOTS	0.45							0.450
C1-C4	38.79	B	38.79	1-AC LOTS	0.4							0.400
C5	26.83	B	19.5	1-AC. LOTS	0.4	7.3	5-AC. LOTS	0.392				0.398
C6	0.99	B	0.99	1-AC LOTS	0.4							0.400
C8	12.77	B	12.77	1-AC LOTS	0.4							0.400
C5,C6,C8	40.59	B										0.399
C9	4.50	B	4.5	1-AC LOTS	0.4							0.400
OC1,C1-C9	212.83	B										0.430
OA1-OC1,A1-C9	717.49	B										0.399
OC2	81.72	B	81.72	1/2-AC. LOTS	0.45							0.450
C10	2.86	B	2.86	1-AC LOTS	0.4							0.400
C11	8.63	B	8.63	1-AC LOTS	0.4							0.400
C10-C11	11.49	B										0.400
C12	17.77	B	17.77	1-AC LOTS	0.4							0.400
C10-C12	29.26	B										0.400
C13	22.44	B	22.44	MEADOW	0.35							0.350
OC2,C10-C13	133.42	B										0.422
OD1	3.30	B	3.30	1-AC LOTS	0.4							0.400
OD2	4.50	B	4.50	FOREST	0.15							0.150
OD3	10.30	B	10.30	FOREST	0.15							0.150
OD4	6.00	B	6.00	FOREST	0.15							0.150
D	10.27	B	10.27	1-AC LOTS	0.4							0.400
OD1-OD4, D	34.37	B										0.249
OA1-OD1,A-D	885.28	B										0.397

RATIONAL METHOD - DRAINAGE CALCULATIONS
DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR[7]	C 100-YEAR [7]	OVERLAND LENGTH (FT)	SLOPE (%)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
OA1,A1-A9	**1**	**341.96**	**0.266**	**0.366**									**55.8**	**55.8**	1.66	2.95	**150.94**	**369.67**
OB1,B1-B4	B4	90.90	0.350	0.450									21.1	21.1	2.93	5.22	93.31	213.54
B5	B5	4.78	0.300	0.400	300	3.7	16.1	270	1.50	5.6	3.55	1.3	17.4	17.4	3.23	5.75	4.63	10.99
B6		7.91	0.137	0.392			0.0	380	1.50	10.0	4.74	1.3	1.3	5.0	5.10	9.09	5.53	28.17
B5,B6	B6	12.69	0.300	0.400									18.7	18.7	3.11	5.54	11.86	28.14
B7	B7	3.24	0.300	0.400	300	6.7	13.2	150	1.50	8	4.24	0.6	13.8	13.8	3.59	6.39	3.49	8.28
WP2 FILING 4:																		
B8		28.74	0.300	0.400			0.0	1250	1.50	4.8	3.29	6.3	6.3	6.3	4.78	8.51	41.24	97.88
B5-B8	B8	44.67	0.271	0.399									25.1	25.1	2.68	4.76	32.40	84.92
B9	B9	10.23	0.300	0.400	300	4.7	14.9	540	1.50	7.4	4.08	2.2	17.1	17.1	3.26	5.80	9.99	23.72
B10		16.90	0.300	0.400			0.0	600	1.50	3.3	2.72	3.7	3.7	5.0	5.10	9.09	25.88	61.42
B5-B10	B10	71.80	0.300	0.400									28.7	28.7	2.48	4.42	53.46	126.87
Tt from DP1 to DP2								1900	1.50	2.4	2.31	13.7	13.7					
OB1,B1-B10		162.70	0.328	0.428									25.1	25.1	2.68	4.76	142.84	331.77
OA1,OB1,A,B	**2**	**504.66**	**0.286**	**0.386**									**69.5**	**69.5**	1.50	2.65	**216.50**	**516.22**
OC1.1		121.57	0.350	0.450			0.0	2800	1.50	4.64	3.23	14.4	14.4	14.4	3.52	6.27	149.86	342.97
OC1.2		7.38	0.350	0.450			0.0	2800	1.50	4.64	3.23	14.4	14.4	14.4	3.52	6.27	9.10	20.82
OC1.1,OC1.2	OC1	**128.95**	0.350	0.450			0.0	2800	1.50	4.64	3.23	14.4	14.4	14.4	3.52	6.27	158.96	363.79
WP2 FILING 5:																		
C1	C1	10.14	0.300	0.400	300	4.0	15.7	550	1.50	8.2	4.30	2.1	17.9	17.9	3.19	5.68	9.70	23.02
C2	C2	11.02	0.300	0.400			0.0	820	1.50	5.5	3.52	3.9	3.9	5.0	5.10	9.09	16.88	40.05
C1,C2	**C2.1**	**21.16**	**0.300**	**0.400**									**21.7**	**21.7**	**2.89**	**5.14**	**18.33**	**43.51**
C3	C3	2.04	0.300	0.400	100	2.0	11.4	500	1.50	3.6	2.85	2.9	14.4	14.4	3.53	6.29	2.16	5.13
C4	C4.1	15.59	0.300	0.400	100	2.0	11.4	900	1.50	6.9	3.94	3.8	15.2	15.2	3.44	6.12	16.08	38.15
C3,C4	**C4.1**	**17.63**	**0.300**	**0.400**									**15.2**	**15.2**	**3.44**	**6.12**	**18.18**	**43.15**
C1-C4	C4.2	38.79	0.300	0.400									21.7	21.7	2.89	5.14	33.61	79.76
C5	C5	26.83	0.256	0.398	300	4.0	16.6	1720	1.50	4.4	3.15	9.1	25.7	25.7	2.64	4.70	18.14	50.20
C6	C6	0.99	0.300	0.400	100	6.0	7.9	250	1.50	8	4.24	1.0	8.9	8.9	4.28	7.62	1.27	3.02
C8	C8	12.77	0.300	0.400	100	8.0	7.2	1200	1.50	5.5	3.52	5.7	12.9	12.9	3.70	6.59	14.18	33.66
Tt from C5 to C8								550	1.50	3.6	2.85	3.2	3.2					
C5,C6,C8 (POND C8)	**C8.1**	**40.59**	**0.271**	**0.399**									**28.9**	**28.9**	**2.47**	**4.40**	**27.21**	**71.30**
C9	C9	4.50	0.300	0.400			0.0	360	1.50	3.6	2.85	2.1	2.1	5.0	5.10	9.09	6.89	16.36
Tt from DP2 to DP3								2700	1.50	1.9	2.04	22.1	22.1					
OC1,C1-C9	**3**	**717.49**	**0.297**	**0.399**									**91.6**	**91.6**	1.50	2.65	**319.64**	**758.64**

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR (7)	C 100-YEAR (7)	OVERLAND LENGTH (FT)	SLOPE (%)	Tco (1) (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS (2) VELOCITY (FT/S)	Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
OC2.1		62.48	0.350	0.450			0.0	2800	1.50	4.64	3.23	14.4	14.4	14.4	3.52	6.27	77.02	176.26
OC2.2		19.24	0.350	0.450			0.0	2800	1.50	4.64	3.23	14.4	14.4	14.4	3.52	6.27	23.72	54.28
OC2.1,OC2.2		81.72	0.350	0.450			0.0	2800	1.50	4.64	3.23	14.4	14.4	14.4	3.52	6.27	100.74	230.54
C10	C10	2.86	0.300	0.400	100	6.0	7.9	600	1.50	4.0	3.00	3.3	11.3	11.3	3.92	6.97	3.36	7.97
C11	C11	8.63	0.300	0.400	100	6.0	7.9	600	1.50	6.7	3.88	2.6	10.5	10.5	4.03	7.16	10.42	24.73
Tt from C10 to C11								400	1.50	2.5	2.37	2.8	2.8					
C10-C11	C11.1	11.49	0.300	0.400									14.1	14.1	3.56	6.34	12.28	29.15
C12	C12	17.77	0.300	0.400	100	10.0	6.7	1300	1.50	3.1	2.64	8.2	14.9	14.9	3.47	6.18	18.52	43.95
C10-C12	**C12.1**	**29.26**	**0.300**	**0.400**									**14.9**	**14.9**	**3.47**	**6.18**	**30.49**	**72.36**
C13	C13	22.44	0.250	0.350	300	7.3	13.7	430	1.50	8.6	4.40	1.6	15.3	15.3	3.43	6.11	19.25	47.97
OC1,OC2,C1-C13		850.91	0.323	0.423									106.5	106.5	1.50	2.65	412.27	953.83
OD1		3.30	0.300	0.400	370	5.4	15.8	450	1.50	4.4	3.15	2.4	18.2	18.2	3.16	5.63	3.13	7.43
OD2		4.50	0.100	0.150	525	8.2	20.5	0				0.0	20.5	20.5	2.98	5.30	1.34	3.58
OD3		10.30	0.100	0.150	700	5.7	26.7	580	1.50	3.1	2.64	3.7	30.3	30.3	2.41	4.28	2.48	6.62
OD4		6.00	0.100	0.150	630	5.6	25.5	340	1.50	0.9	1.42	4.0	29.4	29.4	2.45	4.36	1.47	3.92
OD1-OD4		**24.10**											30.3	30.3				
D		**10.27**	0.300	0.400			0.0	750	1.50	3.5	2.81	4.5	5.0	5.0	5.10	9.09	15.73	37.33
OD1-OD4, D	D	**34.37**	0.179	0.249									34.8	34.8	2.22	3.96	13.67	33.86
G1	G1	3.28	0.300	0.400	100	6.0	7.9	300	1.50	6.7	3.88	1.3	9.2	9.2	4.23	7.53	4.16	9.88
Tt from DP3 to DP4								2750	1.50	1.5	1.81	25.4	25.4					
OA1-OD1,A-D	**4**	**885.28**	**0.297**	**0.397**									**116.9**	**116.9**	1.50	2.65	**394.39**	**931.36**

1) OVERLAND FLOW Tco = (1.87*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = K * ((SLOPE(%))^0.5)
K = 0.70 FOR MEADOW / FOREST
K = 1.0 FOR BARE SOIL
K = 1.5 FOR GRASS CHANNEL
K = 2.0 FOR PAVEMENT
3) GUTTER/SWALE FLOW, TRAVEL TIME, Tt = (CHANNEL LENGTH/ SCS VELOCITY) / 60 SEC
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F CURVE IN EL PASO COUNTY DRAINAGE CRITERIA MANUAL, REVISED BY CITY OF COLORADO SPRINGS 1/1/03
I = (A * P) / B + Td)^C
5-YEAR VALUES: A = 26.65; P1 = 1.5 IN (1-HOUR DEPTH); B = 10.0; C = 0.76
100-YEAR VALUES: A = 26.65; P = 2.67 IN (1-HOUR DEPTH); B = 10.0; C = 0.76
6) Q = CiA
7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

APPENDIX C1

HYDRAULIC CALCULATIONS – OPEN CHANNELS

TABLE 10-4

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

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

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

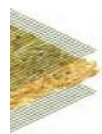
* Grass lined channels are dependent upon assurances of continuous growth and maintenance of grass.

ALLOWABLE VELOCITY AND MAXIMUM SHEAR STRESS
Streambank and Shoreland Protection Code 580

Type of Treatment	Allowable Shear lb/sq ft	Velocity ft/sec
Brush Mattresses[1]		
Staked only w/ rock riprap toe (initial)	0.8 - 4.1	5
Staked only w/ rock riprap toe (grown)	4.0 - 8.0	12
Coir Geotextile Roll[2]		
Roll with coir rope mesh staked only without rock riprap toe	0.2 - 0.8	< 5
Roll with Polypropylene rope mesh staked only without rock riprap toe	0.8 - 3.0	< 8
Roll with Polypropylene rope mesh staked and with rock riprap toe	3.0 - 4.0	< 12
Live Fascine[3]		
LF Bundle w/ rock riprap toe	2.0 - 3.1	8
Soils[4]		
Fine colloidal sand	0.02-0.03	1.5
Sandy loam (noncolloidal)	0.03-0.04	1.75
Alluvial silt (noncolloidal)	0.045-0.05	2
Silty loam (noncolloidal)	0.045-0.05	1.75-2.25
Firm loam	0.075	2.5
Fine gravels	0.075	2.5
Stiff clay	0.26	3-4.5
Alluvial silt (colloidal)	0.26	3.75
Graded loam to cobbles	0.38	3.75
Graded silts to cobbles	0.43	4
Shales and hardpan	0.67	6
Gravel/Cobble[4]		
1-inch	0.33	2.5-5
2-inch	0.67	3-6
6-inch	2	4-7.5
12-inch	4	5.5-12
Vegetation[4]		
Class A turf (ret class)	3.7	6-8
Class B turf (ret class)	2.1	4-7
Class C turf (ret class)	1	3.5
Retardance Class D	0.6	Design of roadside channels HEC-15
Retardance Class E	0.35	
Long native grasses	1.2-1.7	4-6
Short native and bunch grass	0.7-0.95	3-4

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

RollMax Product Selection Chart

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

WALDEN PRESERVE 2 - FILING NO. 5
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
PINEHURST CIRCLE	10+00	10+85	E	1.00	4:1/3:1	2.5	0.030	60	C12	44.0	10	4.4	0.7	2.4	GRASS
PINEHURST CIRCLE	10+00	10+85	W	1.00	4:1/3:1	2.5	0.030	60	C11	24.7	10	2.5	0.6	2.1	GRASS
PINEHURST CIRCLE	10+85	12+49	E	2.65	4:1/3:1	2.5	0.030	60	C12	44.0	10	4.4	0.6	3.5	GRASS
PINEHURST CIRCLE	10+85	12+49	W	2.65	4:1/3:1	2.5	0.030	60	C11	24.7	10	2.5	0.5	3.0	GRASS
PINEHURST CIRCLE	12+49	14+82	E	1.40	4:1/3:1	2.5	0.030	60	C12	44.0	10	4.4	0.7	2.8	GRASS
PINEHURST CIRCLE	12+49	14+82	W	1.40	4:1/3:1	2.5	0.030	60	C11	24.7	10	2.5	0.5	2.4	GRASS
PINEHURST CIRCLE	14+82	17+93	E	1.16	4:1/3:1	2.5	0.030	60	C12	44.0	10	4.4	0.7	2.6	GRASS
PINEHURST CIRCLE	14+82	17+93	W	1.16	4:1/3:1	2.5	0.030	60	C11	24.7	10	2.5	0.6	2.2	GRASS
PINEHURST CIRCLE	17+93	20+75	E	1.80	4:1/3:1	2.5	0.030	60	C12	44.0	10	4.4	0.6	3.0	GRASS
PINEHURST CIRCLE	17+93	20+75	W	1.80	4:1/3:1	2.5	0.030	60	C11	24.7	10	2.5	0.5	2.6	GRASS
PINEHURST CIRCLE	20+75	24+25	E	1.05	4:1/3:1	2.5	0.030	60	C12	44.0	10	4.4	0.7	2.5	GRASS
PINEHURST CIRCLE	21+68	24+25	W	1.05	4:1/3:1	2.5	0.030	60	C10	8.0	50	4.0	0.7	2.4	GRASS
PINEHURST CIRCLE	24+25	27+26	E	1.00	4:1/3:1	2.5	0.030	60	C8	33.7	10	3.4	0.7	2.3	GRASS
PINEHURST CIRCLE	24+25	27+26	W	1.00	4:1/3:1	2.5	0.030	60	C5	50.2	10	5.0	0.8	2.5	GRASS
PINEHURST CIRCLE	27+26	31+84	E	6.18	4:1/3:1	2.5	0.030	60	C6	3.0	100	3.0	0.4	4.4	**GRASS / ECB**
PINEHURST CIRCLE	27+26	31+84	W	6.18	4:1/3:1	2.5	0.030	60	C5	50.2	10	5.0	0.5	5.0	**GRASS / ECB**
PINEHURST CIRCLE	31+84	32+64	E	7.00	4:1/3:1	2.5	0.030	60	C6	3.0	100	3.0	0.4	4.6	**GRASS / ECB**
PINEHURST CIRCLE	31+84	32+64	W	7.00	4:1/3:1	2.5	0.030	60	C5	50.2	10	5.0	0.5	5.2	**GRASS / ECB**
PINEHURST CIRCLE	32+64	33+54	W	4.00	4:1/3:1	2.5	0.030	60	C5	50.2	10	5.0	0.6	4.2	**GRASS / ECB**
PINEHURST CIRCLE	33+54	36+06	E	7.52	4:1/3:1	2.5	0.030	60	C6	3.0	100	3.0	0.6	4.7	**GRASS / ECB**
PINEHURST CIRCLE	33+54	36+06	W	7.52	4:1/3:1	2.5	0.030	60	C5	50.2	10	5.0	0.5	5.4	**GRASS / ECB**
PINEHURST CIRCLE	36+06	39+00	E	2.85	4:1/3:1	2.5	0.030	60	C4	38.2	10	3.8	0.6	3.5	GRASS
PINEHURST CIRCLE	36+06	39+00	W	2.85	4:1/3:1	2.5	0.030	60	C3	5.1	15	0.8	0.3	2.4	GRASS
PINEHURST CIRCLE	39+00	40+44	E	2.85	4:1/3:1	2.5	0.030	60	C4	38.2	10	3.8	0.6	3.5	GRASS
PINEHURST CIRCLE	39+00	40+44	W	2.85	4:1/3:1	2.5	0.030	60	C3	5.1	70	3.6	0.5	3.4	GRASS
PINEHURST CIRCLE	40+44	42+36	E	1.99	4:1/3:1	2.5	0.030	60	C4	38.2	10	3.8	0.6	3.0	GRASS
PINEHURST CIRCLE	40+44	42+36	W	1.99	4:1/3:1	2.5	0.030	60	C3	5.1	35	1.8	0.5	2.5	GRASS
PINEHURST CIRCLE	42+36	44+15	E	4.00	4:1/3:1	2.5	0.030	60	C2	40.1	10	4.0	0.5	4.0	GRASS
PINEHURST CIRCLE	42+36	44+15	W	4.00	4:1/3:1	2.5	0.030	60	C1	23.0	15	3.5	0.5	3.9	GRASS
PINEHURST CIRCLE	44+15	47+30	E	6.83	4:1/3:1	2.5	0.030	60	C2	40.1	15	6.0	0.6	5.4	**GRASS / ECB**
PINEHURST CIRCLE	44+15	47+30	E	6.83	4:1/3:1	2.5	0.030	60	C1	23.0	50	11.5	0.7	6.4	**GRASS / ECB**

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
EMERSON CLIFF CT	10+00	10+65	N	2.00	4:1/3:1	2.5	0.030	60	C4	38.2	10	3.8	0.6	3.0	GRASS
EMERSON CLIFF CT	10+00	10+65	S	2.00	4:1/3:1	2.5	0.030	60	C2	40.1	10	4.0	0.6	3.1	GRASS
EMERSON CLIFF CT	10+65	12+35	N	8.00	4:1/3:1	2.5	0.030	60	C4	38.2	10	3.8	0.5	5.1	**GRASS / ECB**
EMERSON CLIFF CT	10+65	12+35	S	8.00	4:1/3:1	2.5	0.030	60	C2	40.1	10	4.0	0.5	5.2	**GRASS / ECB**
EMERSON CLIFF CT	12+35	13+90	N	2.00	4:1/3:1	2.5	0.030	60	C4	38.2	10	3.8	0.6	3.0	GRASS
EMERSON CLIFF CT	12+35	13+90	S	2.00	4:1/3:1	2.5	0.030	60	C2	40.1	10	4.0	0.6	3.1	GRASS
CUL DE SAC B	10+30	11+46	N	2.00	4:1/3:1	2.5	0.030	60	C8	33.7	10	3.4	0.6	3.0	GRASS
CUL DE SAC B	10+30	11+46	S	2.00	4:1/3:1	2.5	0.030	60	C8	33.7	10	3.4	0.6	3.0	GRASS
CUL DE SAC B	11+46	12+60	N	1.00	4:1/3:1	2.5	0.030	60	C8	33.7	10	3.4	0.7	2.3	GRASS
CUL DE SAC B	11+46	12+60	S	1.00	4:1/3:1	2.5	0.030	60	C8	33.7	10	3.4	0.7	2.3	GRASS
CUL DE SAC C	10+42	11+47	N	7.05	4:1/3:1	2.5	0.030	60	C11	24.7	15	3.7	0.5	4.9	**GRASS / ECB**
CUL DE SAC C	10+42	11+47	S	7.05	4:1/3:1	2.5	0.030	60	C10	8.0	65	5.2	0.5	5.3	**GRASS / ECB**
CUL DE SAC C	11+47	12+37	N	2.00	4:1/3:1	2.5	0.030	60	C11	24.7	10	2.5	0.5	2.7	GRASS
CUL DE SAC C	11+47	12+37	S	2.00	4:1/3:1	2.5	0.030	60	C10	8.0	50	4.0	0.6	3.1	GRASS

1) Channel flow calculations based on Manning's Equation
2) n = 0.03 for grass-lined non-irrigated channels
3) Vmax = 4.0 fps for 100-year flows w/ native grass-lined channels (per ECM Table 10-4 & NRCS Companion Document 580-10)
4) Vmax = 8.0 fps for 100-year flows w/ Erosion Control Blankets (Tensar Eronet SC150 or equal)

Hydraulic Analysis Report

Project Data

Project Title: **Walden WP2 Flg. 5 - Roadside Ditches**

Designer: JPS

Project Date: Thursday, January 6, 2022

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Ditch-STA-1000-1085-E – (Sample Ditch Calculation)

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0300

Flow: 4.4000 cfs **= Q_{100}**

Result Parameters

Depth: 0.7183 ft

Area of Flow: 1.8056 ft^2

Wetted Perimeter: 5.2328 ft

Hydraulic Radius: 0.3451 ft

Average Velocity: 2.4368 ft/s **< 4.0 fps (Grass Lining OK)**

Top Width: 5.0278 ft

Froude Number: 0.7166

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: 0.4482 lb/ft^2

Calculated Avg Shear Stress: 0.2153 lb/ft^2

Channel Analysis: Ditch-STA-2726-3184-W – (Sample Ditch Calculation)

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0618 ft/ft

Manning's n: 0.0300

Flow: 5.0000 cfs **= Q_{100}**

Result Parameters

Depth: 0.5355 ft

Area of Flow: 1.0038 ft^2

Wetted Perimeter: 3.9016 ft

Hydraulic Radius: 0.2573 ft

Average Velocity: 4.9811 ft/s **> 4.0 fps (Provide ECB/TRM Ditch Lining)**

Top Width: 3.7487 ft

Froude Number: 1.6964

Critical Depth: 0.6643 ft

Critical Velocity: 3.2369 ft/s

Critical Slope: 0.0196 ft/ft

Critical Top Width: 4.75 ft

Calculated Max Shear Stress: 2.0652 lb/ft^2

Calculated Avg Shear Stress: 0.9921 lb/ft^2

WALDEN PRESERVE 2 - FILING NO. 5
CHANNEL CALCULATIONS
DEVELOPED FLOWS

PROPOSED CHANNELS

CHANNEL	DESIGN POINT	PROPOSED MAX. SLOPE (%)	BOTTOM WIDTH (B, FT)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	CHANNEL LINING
C5.1	C5	0.5	8	4:1	2.0	0.030	50.2	1.2	3.2	GRASS
C5.2	C5	5.1	8	4:1	2.0	0.030	50.2	0.7	7.2	**GRASS/ECB**
C8.1	C8.1	8.0	0	4:1	2.0	0.030	6.7	0.5	5.7	**GRASS/ECB**
C8.2	C8.2	1.2	0	4:1	2.0	0.030	16.9	1.1	3.6	GRASS
C12.1	C11	6.7	0	4:1	2.0	0.030	29.2	1.0	7.8	**GRASS/ECB**
C12.2	C11	3.9	0	4:1	2.0	0.030	29.2	1.1	6.3	**GRASS/ECB**

* DP-C8.1 CALCULATED AS 20% OF DP-C8
* DP-C8.2 CALCULATED AS 50% OF DP-C8

ASSUMPTIONS:

1) Channel flow calculations based on Manning's Equation
2) Channel depth includes 1' minimum freeboard
3) n = 0.03 for grass-lined non-irrigated channels (minimum)
4) n = 0.035 for riprap-lined channels
5) Vmax = 5.0 fps for 100-year flows w/ grass-lined channels
6) Vmax = 8.0 fps for 100-year flows w/ Erosion Control Blankets (Tensar Eronet SC150 or equal)
7) Vmax = 10.0 fps for 100-year flows w/ Erosion Control Blankets (Tensar Eronet C125 or equal)

Hydraulic Analysis Report

Project Data

Project Title: **Walden WP2 Filing No. 5 - Channels**

Designer: JPS

Project Date: Monday, May 10, 2021

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Channel C5.1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0300

Flow: 50.2000 cfs

Result Parameters

Depth: 1.2201 ft

Area of Flow: 15.7159 ft^2

Wetted Perimeter: 18.0614 ft

Hydraulic Radius: 0.8701 ft

Average Velocity: 3.1942 ft/s

Top Width: 17.7610 ft

Froude Number: 0.5984

Critical Depth: 0.9117 ft

Critical Velocity: 4.7274 ft/s

Critical Slope: 0.0151 ft/ft

Critical Top Width: 15.29 ft

Calculated Max Shear Stress: 0.3807 lb/ft^2

Calculated Avg Shear Stress: 0.2715 lb/ft^2

Channel Analysis: Channel C5.2

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0510 ft/ft

Manning's n: 0.0300

Flow: 50.2000 cfs

Result Parameters

Depth: 0.6543 ft

Area of Flow: 6.9466 ft^2

Wetted Perimeter: 13.3953 ft

Hydraulic Radius: 0.5186 ft

Average Velocity: 7.2266 ft/s

Top Width: 13.2343 ft

Froude Number: 1.7578

Critical Depth: 0.9115 ft

Critical Velocity: 4.7292 ft/s

Critical Slope: 0.0151 ft/ft

Critical Top Width: 15.29 ft

Calculated Max Shear Stress: 2.0822 lb/ft^2

Calculated Avg Shear Stress: 1.6503 lb/ft^2

Channel Analysis: Channel C8.1

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0800 ft/ft

Manning's n: 0.0300

Flow: 6.7000 cfs

Result Parameters

Depth: 0.5403 ft

Area of Flow: 1.1677 ft^2

Wetted Perimeter: 4.4555 ft

Hydraulic Radius: 0.2621 ft

Average Velocity: 5.7377 ft/s

Top Width: 4.3224 ft

Froude Number: 1.9454

Critical Depth: 0.7051 ft

Critical Velocity: 3.3693 ft/s

Critical Slope: 0.0193 ft/ft

Critical Top Width: 5.64 ft

Calculated Max Shear Stress: 2.6972 lb/ft^2

Calculated Avg Shear Stress: 1.3083 lb/ft^2

Channel Analysis: Channel C8.2

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0120 ft/ft

Manning's n: 0.0300

Flow: 16.9000 cfs

Result Parameters

Depth: 1.0909 ft

Area of Flow: 4.7606 ft^2

Wetted Perimeter: 8.9961 ft

Hydraulic Radius: 0.5292 ft

Average Velocity: 3.5500 ft/s

Top Width: 8.7275 ft

Froude Number: 0.8471

Critical Depth: 1.0209 ft

Critical Velocity: 4.0541 ft/s

Critical Slope: 0.0171 ft/ft

Critical Top Width: 8.17 ft

Calculated Max Shear Stress: 0.8169 lb/ft^2

Calculated Avg Shear Stress: 0.3963 lb/ft^2

Channel Analysis: Channel C12.1

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0670 ft/ft

Manning's n: 0.0300

Flow: 29.2000 cfs

Result Parameters

Depth: 0.9701 ft

Area of Flow: 3.7644 ft^2

Wetted Perimeter: 7.9997 ft

Hydraulic Radius: 0.4706 ft

Average Velocity: 7.7568 ft/s

Top Width: 7.7608 ft

Froude Number: 1.9627

Critical Depth: 1.2705 ft

Critical Velocity: 4.5227 ft/s

Critical Slope: 0.0159 ft/ft

Critical Top Width: 10.16 ft

Calculated Max Shear Stress: 4.0558 lb/ft^2

Calculated Avg Shear Stress: 1.9674 lb/ft^2

Channel Analysis: Channel C12.2

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0390 ft/ft

Manning's n: 0.0300

Flow: 29.2000 cfs

Result Parameters

Depth: 1.0737 ft

Area of Flow: 4.6113 ft^2

Wetted Perimeter: 8.8540 ft

Hydraulic Radius: 0.5208 ft

Average Velocity: 6.3322 ft/s

Top Width: 8.5896 ft

Froude Number: 1.5230

Critical Depth: 1.2705 ft

Critical Velocity: 4.5227 ft/s

Critical Slope: 0.0159 ft/ft

Critical Top Width: 10.16 ft

Calculated Max Shear Stress: 2.6130 lb/ft^2

Calculated Avg Shear Stress: 1.2675 lb/ft^2

APPENDIX C2

HYDRAULIC CALCULATIONS – CULVERTS

WALDEN PRESERVE 2 FILING NO. 5
CULVERT DESIGN SUMMARY

BASIN	DESIGN POINT	ROAD STA	RD CL ELEV	INV IN ELEV	INV OUT ELEV	PIPE LENGTH (FT)	# of CULVERTS	PIPE DIA (FT)	TOTAL Q_5 (CFS)	PER PIPE Q_5 (CFS)	Q_5 MAX ALLOWABLE HEADWATER [1]	CALC Q_5 HW ELEV	TOTAL Q_{100} (CFS)	PER PIPE Q_{100} (CFS)	Q_{100} MAX ALLOWABLE HEADWATER [2]	CALC Q_{100} HW ELEV
PINEHURST CIRCLE:																
C3	C3	39+00	7489.99	7487.30	7486.86	44.0	1	**1.5**	2.2	2.2	7488.8	7488.1	5.1	5.1	7490.2	7488.6
C5	C5	26+74	7429.15	7426.64	7423.04	80.6	1	**2.5**	18.1	18.1	7429.1	7428.7	50.2	50.2	7429.3	7429.3
CUL-DE-SAC B:																
C6	C6	10+26	7462.53	7459.37	7458.87	50.0	1	**1.5**	1.3	1.3	7460.9	7460.0	3.0	3.0	7462.7	7460.3
CUL-DE-SAC C:																
C10	C10	10+26	7427.11	7425.14	7424.16	73.0	1	**1.5**	3.4	3.4	7426.6	7426.1	8.0	8.0	7427.3	7426.8
PINEHURST CIRCLE:																
C11	C11.1	17+93	7421.65	7417.44	7413.03	104.0	1	**2.0**	12.3	12.3	7419.4	7419.3	29.2	29.2	7421.8	7421.5

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

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

HY-8 Culvert Analysis Report
Walden Preserve 2 Filing No. 5

Crossing Discharge Data – Culvert C3

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

Minimum Flow: 1 cfs

Design Flow: 2.2 cfs

Maximum Flow: 5.1 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing C3

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C3 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7487.80	1.00	1.00	0.00	1
7487.90	1.41	1.41	0.00	1
7487.99	1.82	1.82	0.00	1
7488.07	2.20	2.20	0.00	1
7488.16	2.64	2.64	0.00	1
7488.23	3.05	3.05	0.00	1
7488.30	3.46	3.46	0.00	1
7488.37	3.87	3.87	0.00	1
7488.43	4.28	4.28	0.00	1
7488.49	4.69	4.69	0.00	1
7488.55	5.10	5.10	0.00	1
7489.99	12.81	12.81	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing C3

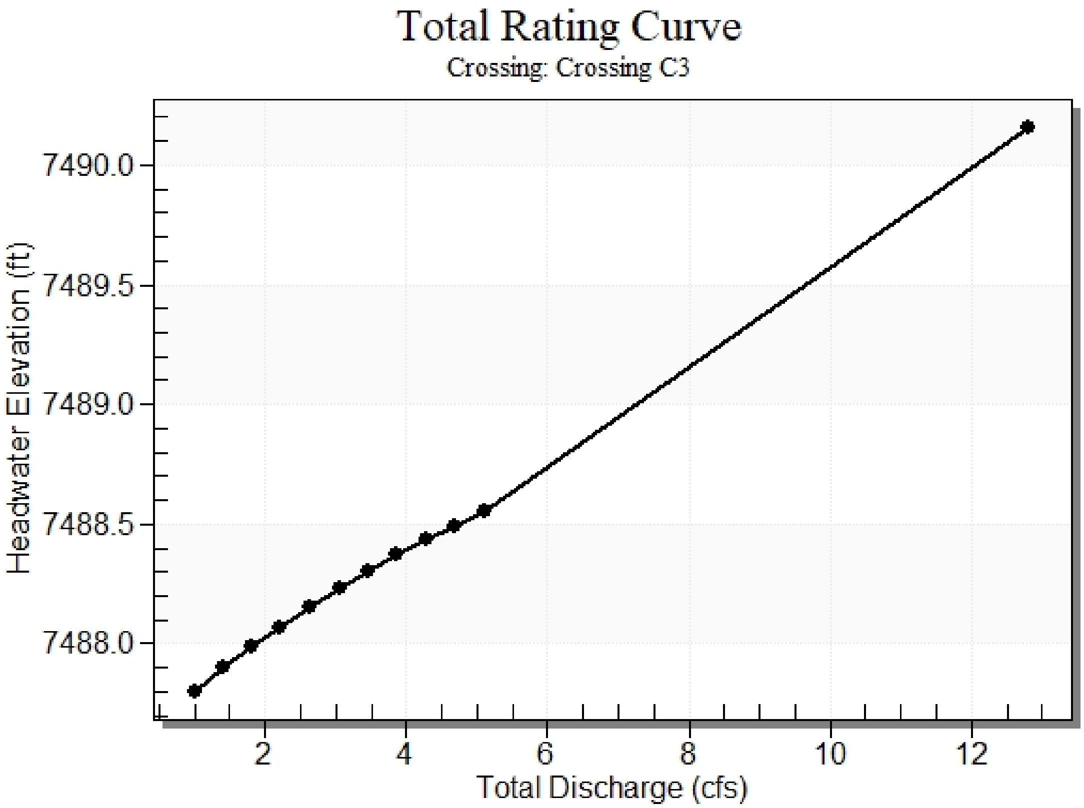


Table 2 - Culvert Summary Table: Culvert C3

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	7487.80	0.503	0.0*	1-S2n	0.304	0.369	0.304	0.133	3.787	1.711
1.41	1.41	7487.90	0.602	0.022	1-S2n	0.361	0.443	0.361	0.162	4.160	1.934
1.82	1.82	7487.99	0.690	0.097	1-S2n	0.411	0.504	0.411	0.189	4.478	2.113
2.20	2.20	7488.07	0.766	0.163	1-S2n	0.453	0.555	0.453	0.210	4.722	2.257
2.64	2.64	7488.16	0.855	0.243	1-S2n	0.499	0.614	0.514	0.234	4.755	2.402
3.05	3.05	7488.23	0.932	0.316	1-S2n	0.539	0.664	0.556	0.254	4.942	2.520
3.46	3.46	7488.30	1.003	0.389	1-S2n	0.577	0.710	0.596	0.273	5.109	2.629
3.87	3.87	7488.37	1.069	0.461	1-S2n	0.613	0.752	0.635	0.291	5.260	2.727
4.28	4.28	7488.43	1.133	0.534	1-S2n	0.649	0.792	0.672	0.308	5.401	2.818
4.69	4.69	7488.49	1.194	0.607	1-S2n	0.683	0.829	0.707	0.325	5.533	2.904
5.10	5.10	7488.55	1.253	0.682	1-S2n	0.717	0.864	0.742	0.341	5.661	2.982

* Full Flow Headwater elevation is below inlet invert.

****

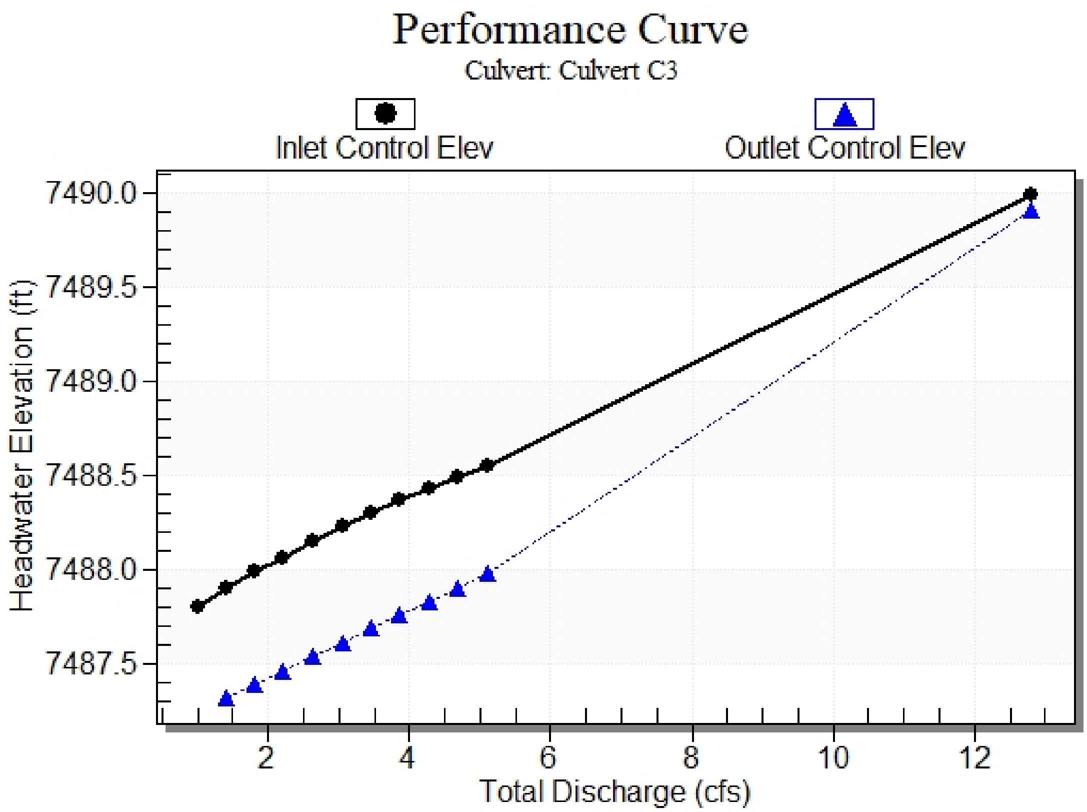
Straight Culvert

Inlet Elevation (invert): 7487.30 ft, Outlet Elevation (invert): 7486.86 ft

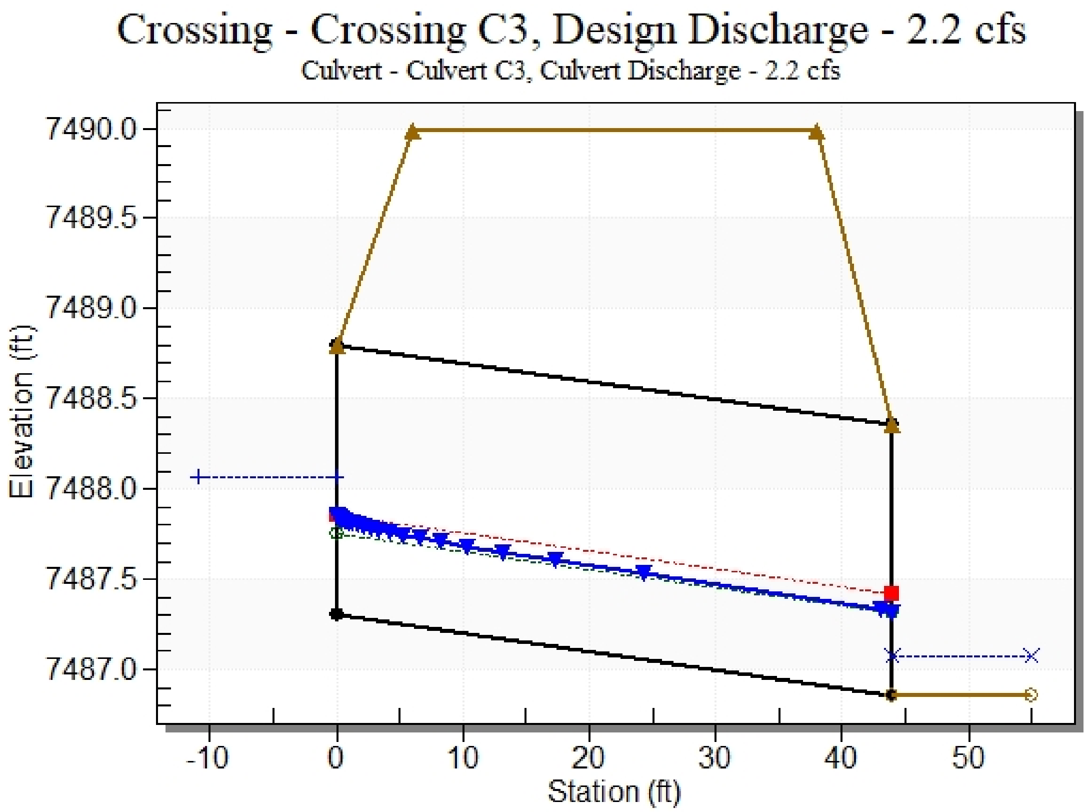
Culvert Length: 44.00 ft, Culvert Slope: 0.0100

****

Culvert Performance Curve Plot: Culvert C3



Water Surface Profile Plot for Culvert: Culvert C3



Site Data - Culvert C3

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7487.30 ft

Outlet Station: 44.00 ft

Outlet Elevation: 7486.86 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C3

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing C3)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.00	7486.99	0.13	1.71	0.17	0.86
1.41	7487.02	0.16	1.93	0.20	0.89
1.82	7487.05	0.19	2.11	0.24	0.91
2.20	7487.07	0.21	2.26	0.26	0.92
2.64	7487.09	0.23	2.40	0.29	0.94
3.05	7487.11	0.25	2.52	0.32	0.95
3.46	7487.13	0.27	2.63	0.34	0.96
3.87	7487.15	0.29	2.73	0.36	0.97
4.28	7487.17	0.31	2.82	0.38	0.97
4.69	7487.18	0.32	2.90	0.41	0.98
5.10	7487.20	0.34	2.98	0.42	0.99

Tailwater Channel Data - Crossing C3

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 7486.86 ft

Roadway Data for Crossing: Crossing C3

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7489.99 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data – Culvert C5

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

Minimum Flow: 10 cfs

Design Flow: 18.1 cfs

Maximum Flow: 50.2 cfs

Table 4 - Summary of Culvert Flows at Crossing: Crossing C5

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7428.07	10.00	10.00	0.00	1
7428.39	14.02	14.02	0.00	1
7428.67	18.04	18.04	0.00	1
7428.67	18.10	18.10	0.00	1
7429.16	26.08	25.45	0.45	24
7429.21	30.10	26.05	3.85	5
7429.24	34.12	26.49	7.46	4
7429.26	38.14	26.86	11.20	4
7429.29	42.16	27.18	14.79	3
7429.31	46.18	27.48	18.55	3
7429.33	50.20	27.76	22.34	3
7429.15	25.25	25.25	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing C5

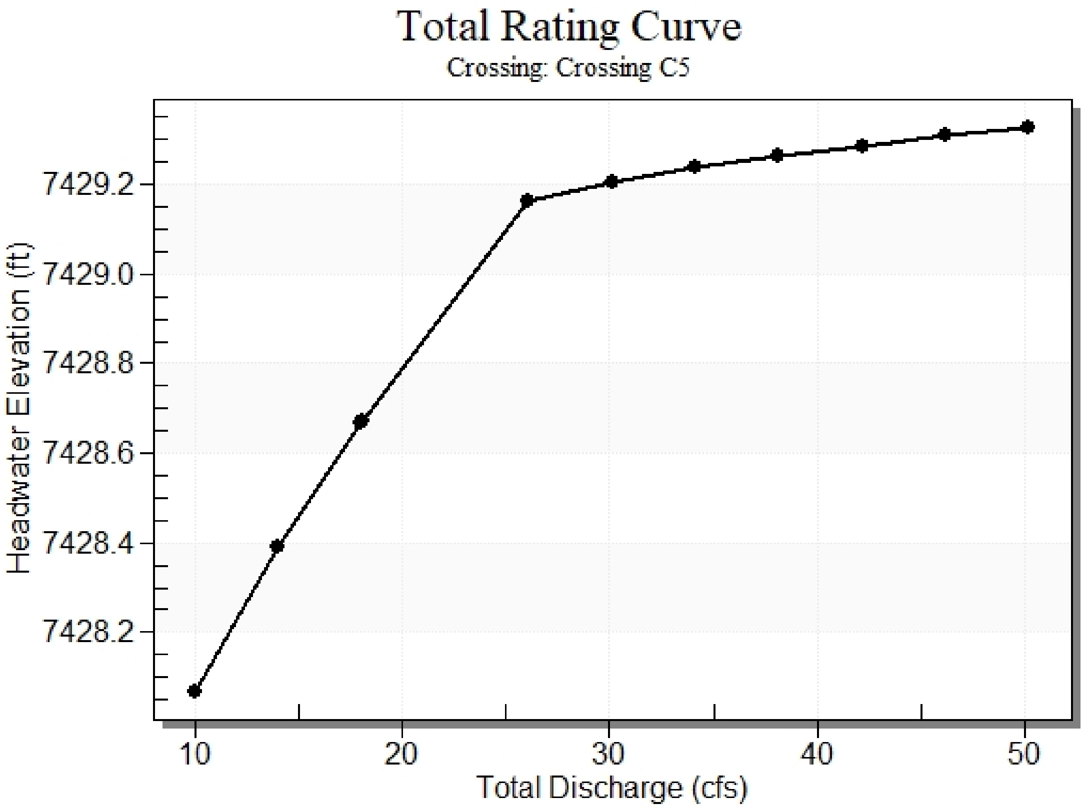


Table 5 - Culvert Summary Table: Culvert C5

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)
10.00	10.00	7428.07	1.429	0.0*	1-S2n	0.557	1.054	0.601	0.398	10.632	3.313
14.02	14.02	7428.39	1.749	0.0*	1-S2n	0.661	1.260	0.709	0.480	11.808	3.687
18.04	18.04	7428.67	2.028	0.0*	1-S2n	0.753	1.435	0.815	0.552	12.550	3.986
18.10	18.10	7428.67	2.032	0.0*	1-S2n	0.754	1.438	0.816	0.553	12.564	3.989
26.08	25.45	7429.16	2.523	0.0*	5-S2n	0.903	1.714	0.991	0.674	13.573	4.453
30.10	26.05	7429.21	2.566	0.0*	5-S2n	0.914	1.735	1.004	0.727	13.662	4.646
34.12	26.49	7429.24	2.597	0.0*	5-S2n	0.923	1.749	1.013	0.777	13.721	4.819
38.14	26.86	7429.26	2.623	0.0*	5-S2n	0.930	1.765	1.019	0.824	13.803	4.977
42.16	27.18	7429.29	2.646	0.0*	5-S2n	0.935	1.775	1.025	0.869	13.854	5.122
46.18	27.48	7429.31	2.668	0.0*	5-S2n	0.941	1.785	1.033	0.911	13.864	5.257
50.20	27.76	7429.33	2.689	0.0*	5-S2n	0.946	1.794	1.040	0.951	13.877	5.383

* Full Flow Headwater elevation is below inlet invert.

****

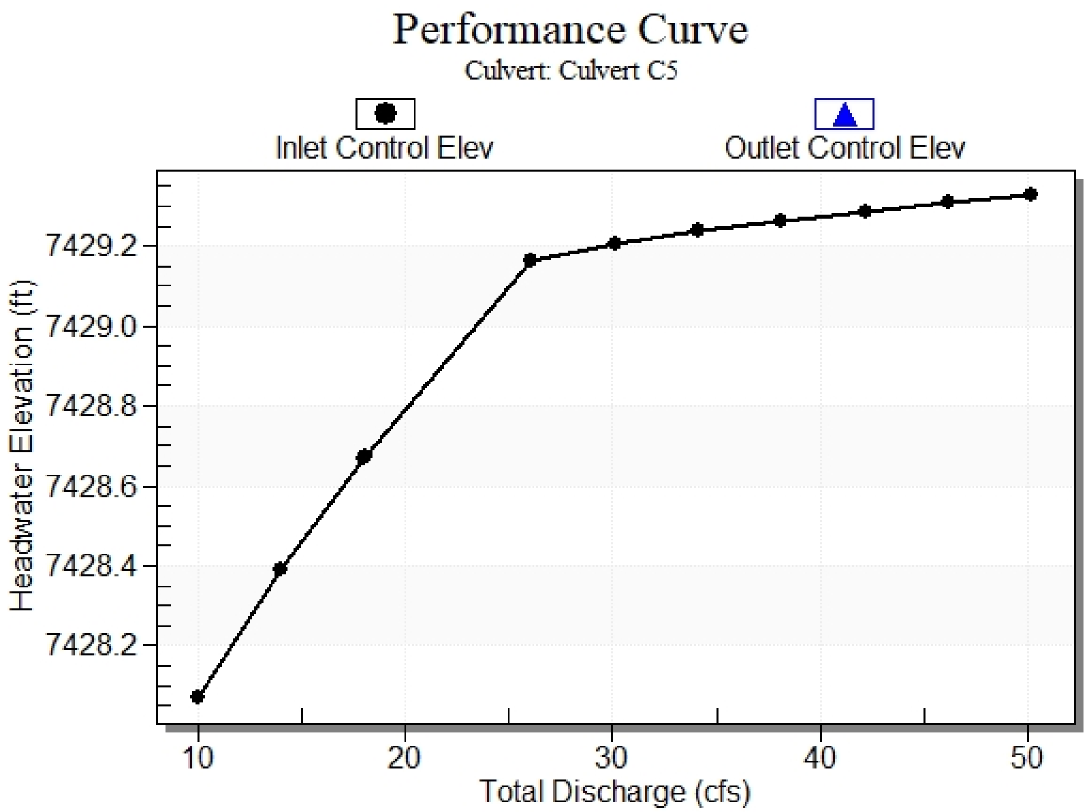
Straight Culvert

Inlet Elevation (invert): 7426.64 ft, Outlet Elevation (invert): 7423.04 ft

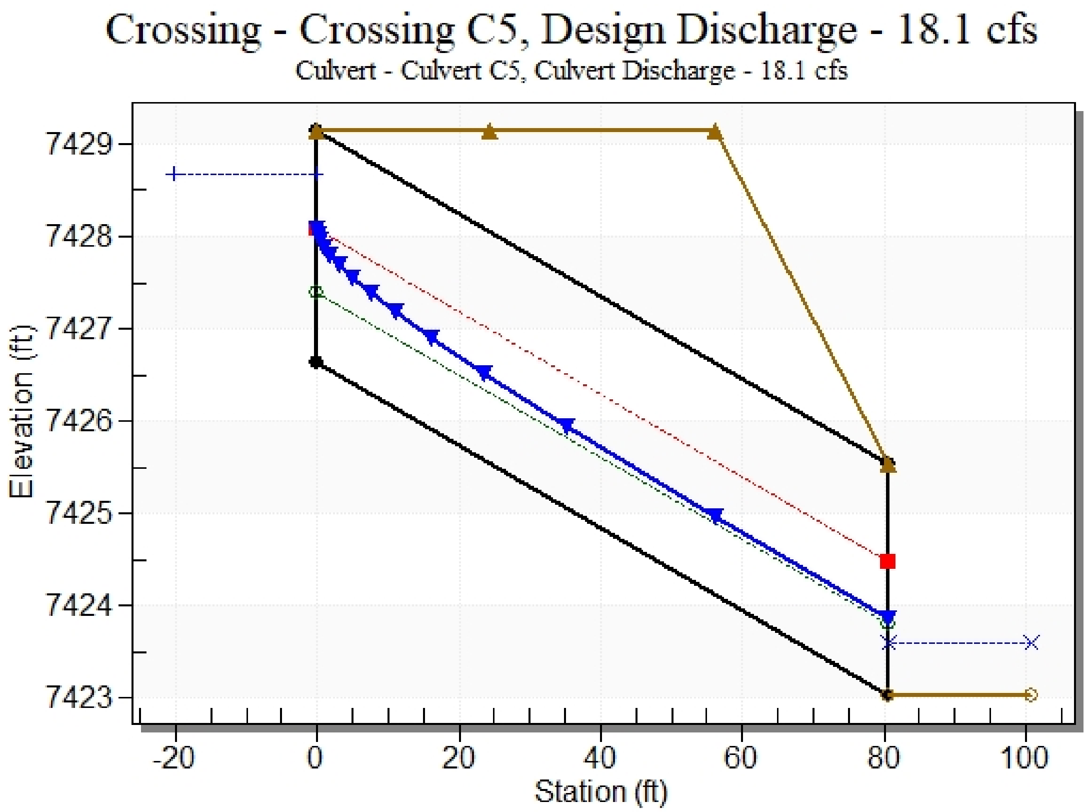
Culvert Length: 80.68 ft, Culvert Slope: 0.0447

****

Culvert Performance Curve Plot: Culvert C5



Water Surface Profile Plot for Culvert: Culvert C5



Site Data - Culvert C5

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7426.64 ft

Outlet Station: 80.60 ft

Outlet Elevation: 7423.04 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C5

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: Crossing C5)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
10.00	7423.44	0.40	3.31	0.50	1.02
14.02	7423.52	0.48	3.69	0.60	1.05
18.04	7423.59	0.55	3.99	0.69	1.07
18.10	7423.59	0.55	3.99	0.69	1.07
26.08	7423.71	0.67	4.45	0.84	1.09
30.10	7423.77	0.73	4.65	0.91	1.11
34.12	7423.82	0.78	4.82	0.97	1.12
38.14	7423.86	0.82	4.98	1.03	1.12
42.16	7423.91	0.87	5.12	1.08	1.13
46.18	7423.95	0.91	5.26	1.14	1.14
50.20	7423.99	0.95	5.38	1.19	1.15

Tailwater Channel Data - Crossing C5

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

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

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 7423.04 ft

Roadway Data for Crossing: Crossing C5

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7429.15 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data – Culvert C6

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

Minimum Flow: 0.5 cfs

Design Flow: 1.3 cfs

Maximum Flow: 3 cfs

Table 7 - Summary of Culvert Flows at Crossing: Crossing C6

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7459.72	0.50	0.50	0.00	1
7459.80	0.75	0.75	0.00	1
7459.87	1.00	1.00	0.00	1
7459.94	1.25	1.25	0.00	1
7459.95	1.30	1.30	0.00	1
7460.05	1.75	1.75	0.00	1
7460.10	2.00	2.00	0.00	1
7460.15	2.25	2.25	0.00	1
7460.20	2.50	2.50	0.00	1
7460.25	2.75	2.75	0.00	1
7460.29	3.00	3.00	0.00	1
7462.53	14.48	14.48	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing C6

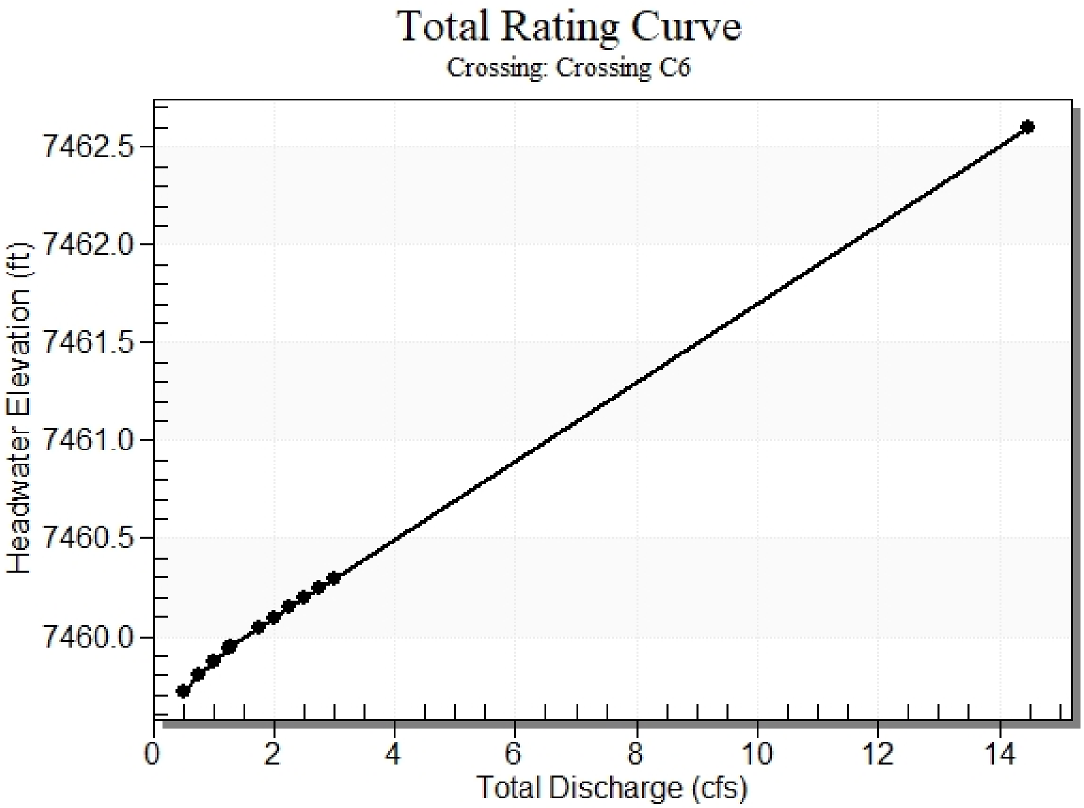


Table 8 - Culvert Summary Table: Culvert C6

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)
0.50	0.50	7459.72	0.352	0.0*	1-S2n	0.216	0.258	0.216	0.265	3.107	1.783
0.75	0.75	7459.80	0.435	0.0*	1-S2n	0.264	0.316	0.272	0.308	3.348	1.973
1.00	1.00	7459.87	0.503	0.0*	1-S2n	0.304	0.369	0.304	0.343	3.787	2.121
1.25	1.25	7459.94	0.565	0.0*	1-S2n	0.340	0.415	0.340	0.373	4.031	2.242
1.30	1.30	7459.95	0.578	0.0*	1-S2n	0.347	0.424	0.347	0.379	4.080	2.264
1.75	1.75	7460.05	0.676	0.026	1-S2n	0.403	0.493	0.414	0.424	4.259	2.439
2.00	2.00	7460.10	0.726	0.072	1-S2n	0.431	0.530	0.431	0.445	4.611	2.522
2.25	2.25	7460.15	0.777	0.115	1-S2n	0.459	0.562	0.472	0.465	4.583	2.597
2.50	2.50	7460.20	0.828	0.161	1-S2n	0.485	0.596	0.499	0.484	4.707	2.666
2.75	2.75	7460.25	0.876	0.207	1-S2n	0.510	0.628	0.525	0.502	4.825	2.731
3.00	3.00	7460.29	0.923	0.252	1-S2n	0.534	0.658	0.550	0.518	4.947	2.791

* Full Flow Headwater elevation is below inlet invert.

****

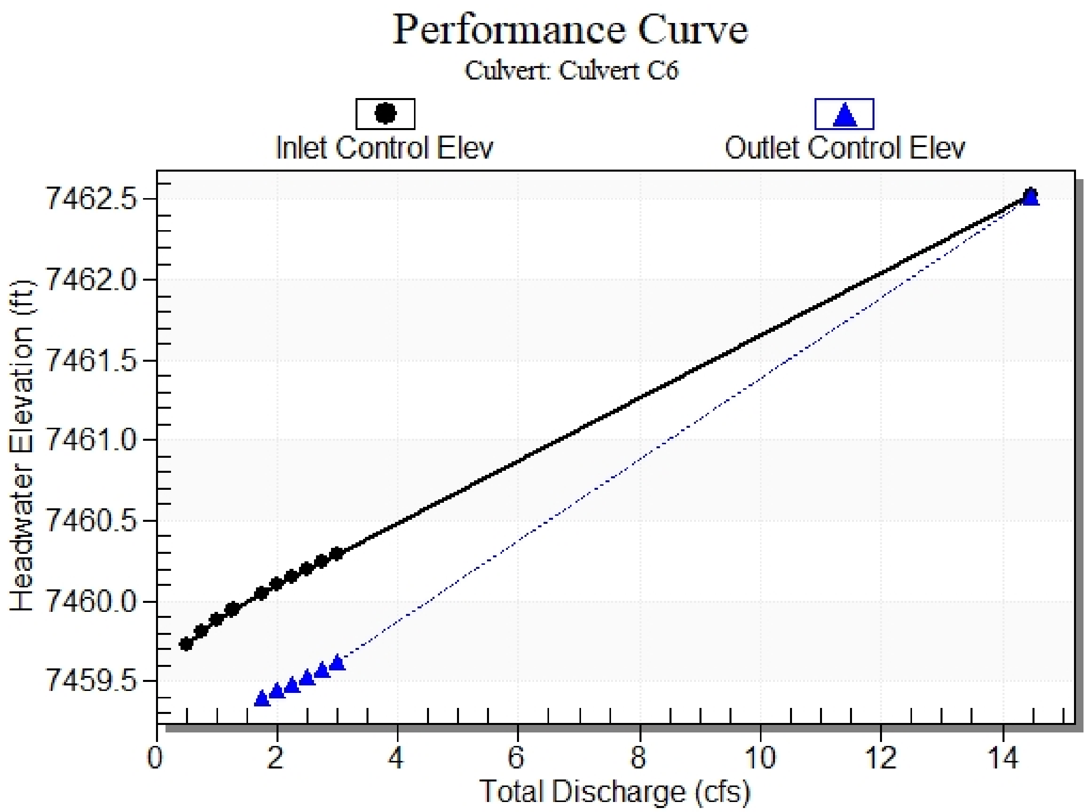
Straight Culvert

Inlet Elevation (invert): 7459.37 ft, Outlet Elevation (invert): 7458.87 ft

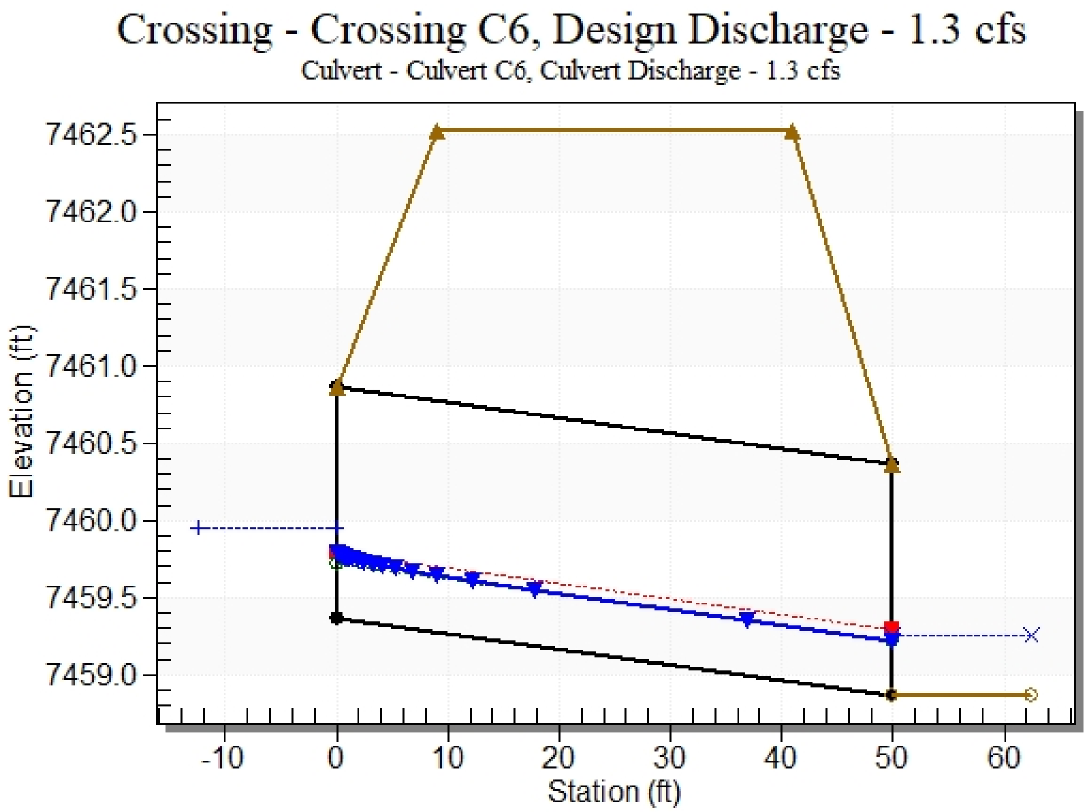
Culvert Length: 50.00 ft, Culvert Slope: 0.0100

****

Culvert Performance Curve Plot: Culvert C6



Water Surface Profile Plot for Culvert: Culvert C6



Site Data - Culvert C6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7459.37 ft

Outlet Station: 50.00 ft

Outlet Elevation: 7458.87 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C6

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: Crossing C6)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.50	7459.13	0.26	1.78	0.33	0.86
0.75	7459.18	0.31	1.97	0.38	0.89
1.00	7459.21	0.34	2.12	0.43	0.90
1.25	7459.24	0.37	2.24	0.47	0.91
1.30	7459.25	0.38	2.26	0.47	0.92
1.75	7459.29	0.42	2.44	0.53	0.93
2.00	7459.32	0.45	2.52	0.56	0.94
2.25	7459.34	0.47	2.60	0.58	0.95
2.50	7459.35	0.48	2.67	0.60	0.96
2.75	7459.37	0.50	2.73	0.63	0.96
3.00	7459.39	0.52	2.79	0.65	0.97

Tailwater Channel Data - Crossing C6

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: 7458.87 ft

Roadway Data for Crossing: Crossing C6

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7462.53 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data – Culvert C10

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

Minimum Flow: 2 cfs

Design Flow: 3.4 cfs

Maximum Flow: 8 cfs

Table 10 - Summary of Culvert Flows at Crossing: Crossing C10

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C10 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7425.86	2.00	2.00	0.00	1
7425.98	2.60	2.60	0.00	1
7426.10	3.20	3.20	0.00	1
7426.13	3.40	3.40	0.00	1
7426.29	4.40	4.40	0.00	1
7426.38	5.00	5.00	0.00	1
7426.46	5.60	5.60	0.00	1
7426.55	6.20	6.20	0.00	1
7426.63	6.80	6.80	0.00	1
7426.72	7.40	7.40	0.00	1
7426.82	8.00	8.00	0.00	1
7427.11	9.66	9.66	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing C10

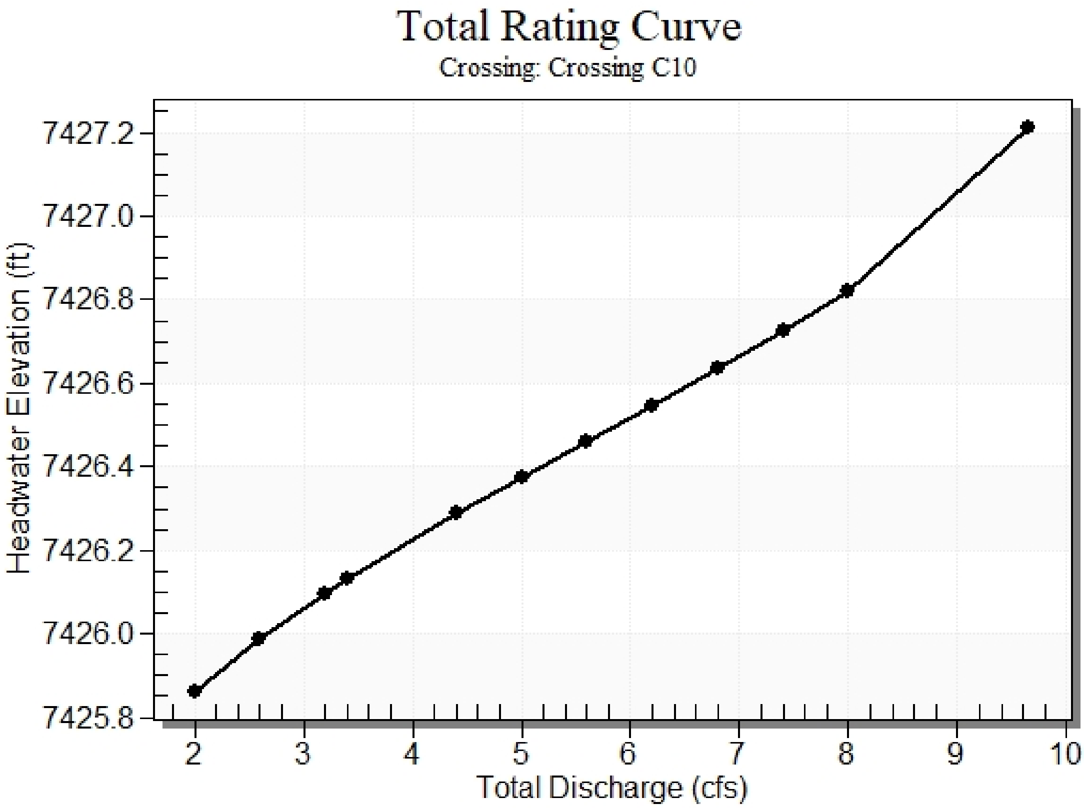


Table 11 - Culvert Summary Table: Culvert C10

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)
2.00	2.00	7425.86	0.723	0.0*	1-S2n	0.400	0.530	0.412	0.445	4.911	2.522
2.60	2.60	7425.98	0.845	0.0*	1-S2n	0.458	0.609	0.474	0.491	5.240	2.693
3.20	3.20	7426.10	0.956	0.0*	1-S2n	0.511	0.681	0.527	0.531	5.582	2.836
3.40	3.40	7426.13	0.990	0.0*	1-S2n	0.528	0.703	0.545	0.543	5.679	2.879
4.40	4.40	7426.29	1.148	0.066	1-S2n	0.607	0.803	0.627	0.598	6.070	3.071
5.00	5.00	7426.38	1.236	0.189	1-S2n	0.652	0.856	0.673	0.628	6.297	3.171
5.60	5.60	7426.46	1.321	0.323	1-S2n	0.695	0.909	0.718	0.655	6.486	3.262
6.20	6.20	7426.55	1.407	0.459	1-S2n	0.738	0.957	0.764	0.681	6.631	3.346
6.80	6.80	7426.63	1.494	0.607	1-S2n	0.780	1.007	0.807	0.705	6.790	3.424
7.40	7.40	7426.72	1.584	0.757	5-S2n	0.822	1.050	0.822	0.727	7.232	3.497
8.00	8.00	7426.82	1.678	0.915	5-S2n	0.863	1.092	0.892	0.749	7.074	3.566

* Full Flow Headwater elevation is below inlet invert.

****

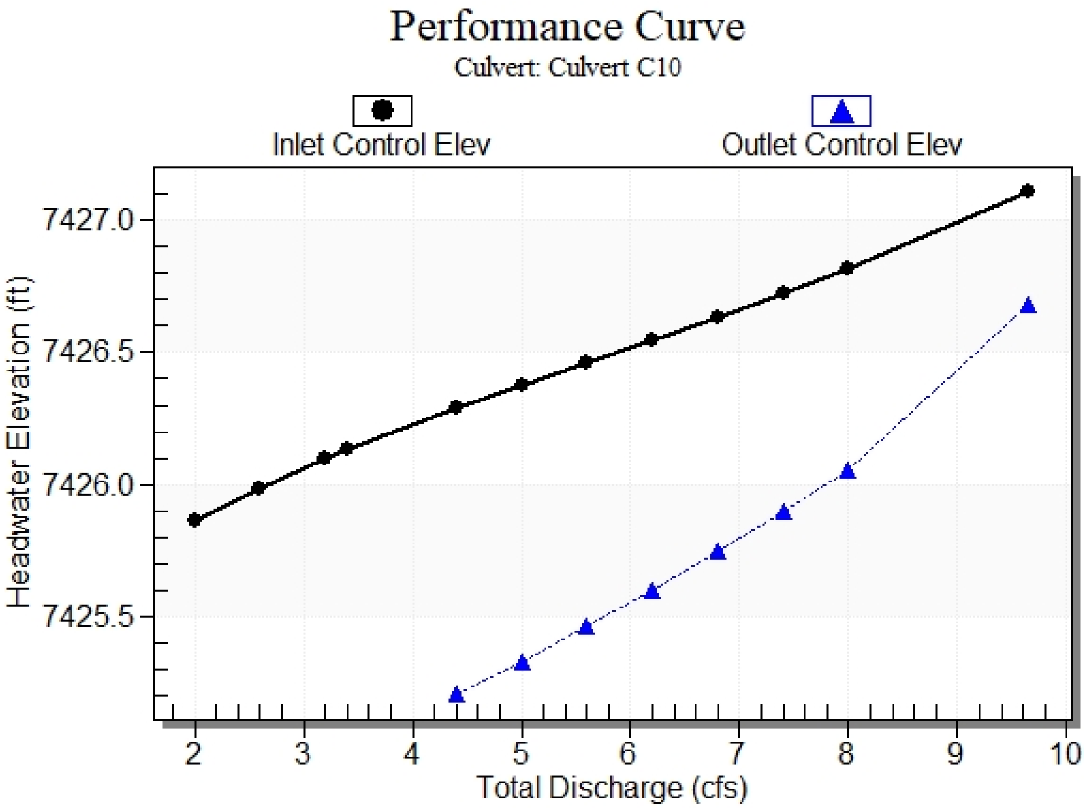
Straight Culvert

Inlet Elevation (invert): 7425.14 ft, Outlet Elevation (invert): 7424.16 ft

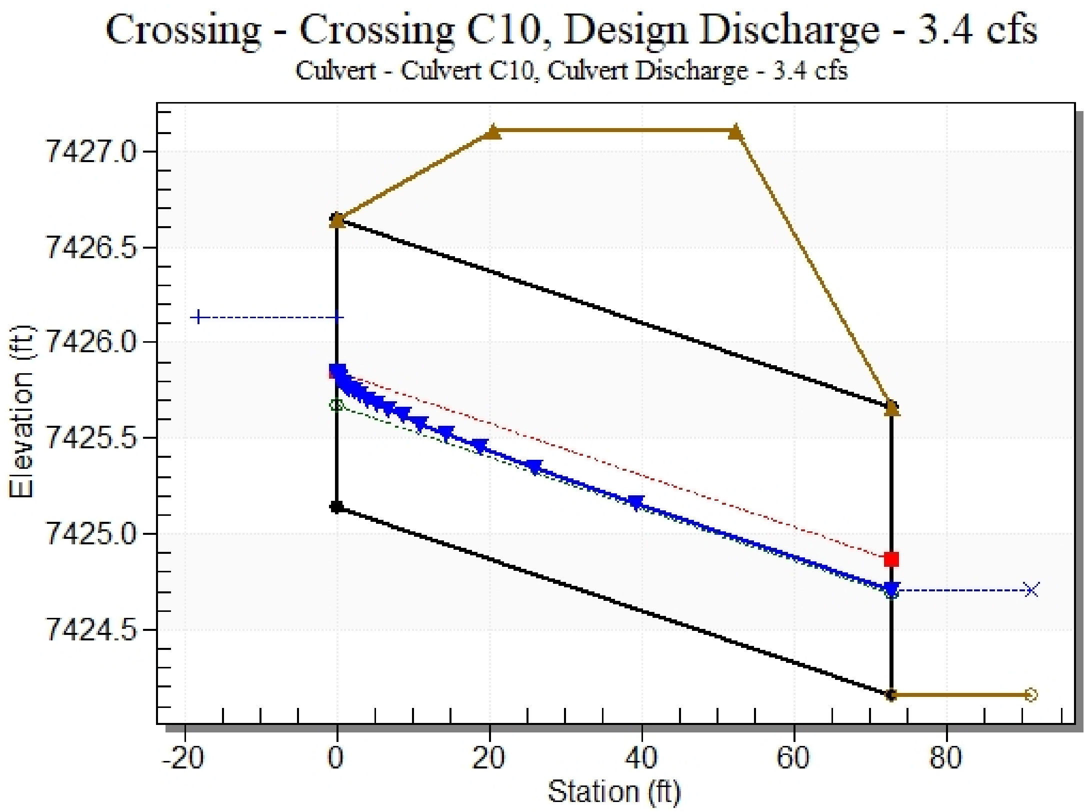
Culvert Length: 73.01 ft, Culvert Slope: 0.0134

****

Culvert Performance Curve Plot: Culvert C10



Water Surface Profile Plot for Culvert: Culvert C10



Site Data - Culvert C10

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7425.14 ft

Outlet Station: 73.00 ft

Outlet Elevation: 7424.16 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C10

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: Grooved End Projecting

Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: Crossing C10)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.00	7424.61	0.45	2.52	0.56	0.94
2.60	7424.65	0.49	2.69	0.61	0.96
3.20	7424.69	0.53	2.84	0.66	0.97
3.40	7424.70	0.54	2.88	0.68	0.97
4.40	7424.76	0.60	3.07	0.75	0.99
5.00	7424.79	0.63	3.17	0.78	1.00
5.60	7424.82	0.66	3.26	0.82	1.00
6.20	7424.84	0.68	3.35	0.85	1.01
6.80	7424.86	0.70	3.42	0.88	1.02
7.40	7424.89	0.73	3.50	0.91	1.02
8.00	7424.91	0.75	3.57	0.93	1.03

Tailwater Channel Data - Crossing C10

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: 7424.16 ft

Roadway Data for Crossing: Crossing C10

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7427.11 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data – Culvert C11

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

Minimum Flow: 5 cfs

Design Flow: 12.3 cfs

Maximum Flow: 29.2 cfs

Table 13 - Summary of Culvert Flows at Crossing: Crossing C11

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C11 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7418.49	5.00	5.00	0.00	1
7418.78	7.42	7.42	0.00	1
7419.02	9.84	9.84	0.00	1
7419.24	12.26	12.26	0.00	1
7419.25	12.30	12.30	0.00	1
7419.72	17.10	17.10	0.00	1
7420.00	19.52	19.52	0.00	1
7420.32	21.94	21.94	0.00	1
7420.68	24.36	24.36	0.00	1
7421.08	26.78	26.78	0.00	1
7421.52	29.20	29.20	0.00	1
7421.65	29.88	29.88	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing C11

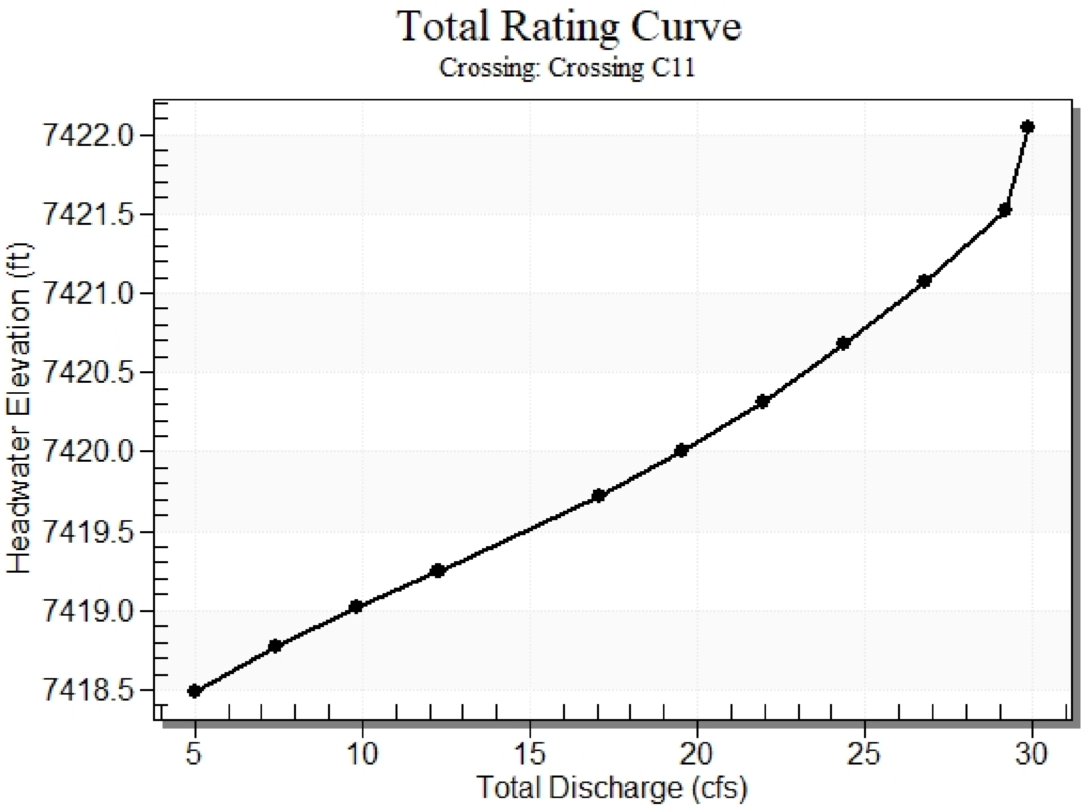


Table 14 - Culvert Summary Table: Culvert C11

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)
5.00	5.00	7418.49	1.054	0.0*	1-S2n	0.430	0.783	0.430	0.501	9.735	4.990
7.42	7.42	7418.78	1.338	0.0*	1-S2n	0.525	0.968	0.567	0.580	9.769	5.507
9.84	9.84	7419.02	1.579	0.0*	1-S2n	0.607	1.117	0.636	0.645	11.053	5.910
12.26	12.26	7419.24	1.803	0.0*	1-S2n	0.681	1.256	0.707	0.701	11.932	6.244
12.30	12.30	7419.25	1.807	0.0*	1-S2n	0.683	1.258	0.683	0.701	12.545	6.249
17.10	17.10	7419.72	2.281	0.0*	5-S2n	0.816	1.489	0.868	0.794	12.654	6.786
19.52	19.52	7420.00	2.560	0.0*	5-S2n	0.879	1.586	0.934	0.834	13.110	7.014
21.94	21.94	7420.32	2.877	0.0*	5-S2n	0.940	1.672	1.005	0.871	13.436	7.222
24.36	24.36	7420.68	3.236	0.0*	5-S2n	0.999	1.745	1.070	0.906	13.790	7.413
26.78	26.78	7421.08	3.636	0.296	5-S2n	1.058	1.804	1.136	0.939	14.088	7.591
29.20	29.20	7421.52	4.079	0.849	5-S2n	1.117	1.849	1.197	0.970	14.434	7.757

* Full Flow Headwater elevation is below inlet invert.

****

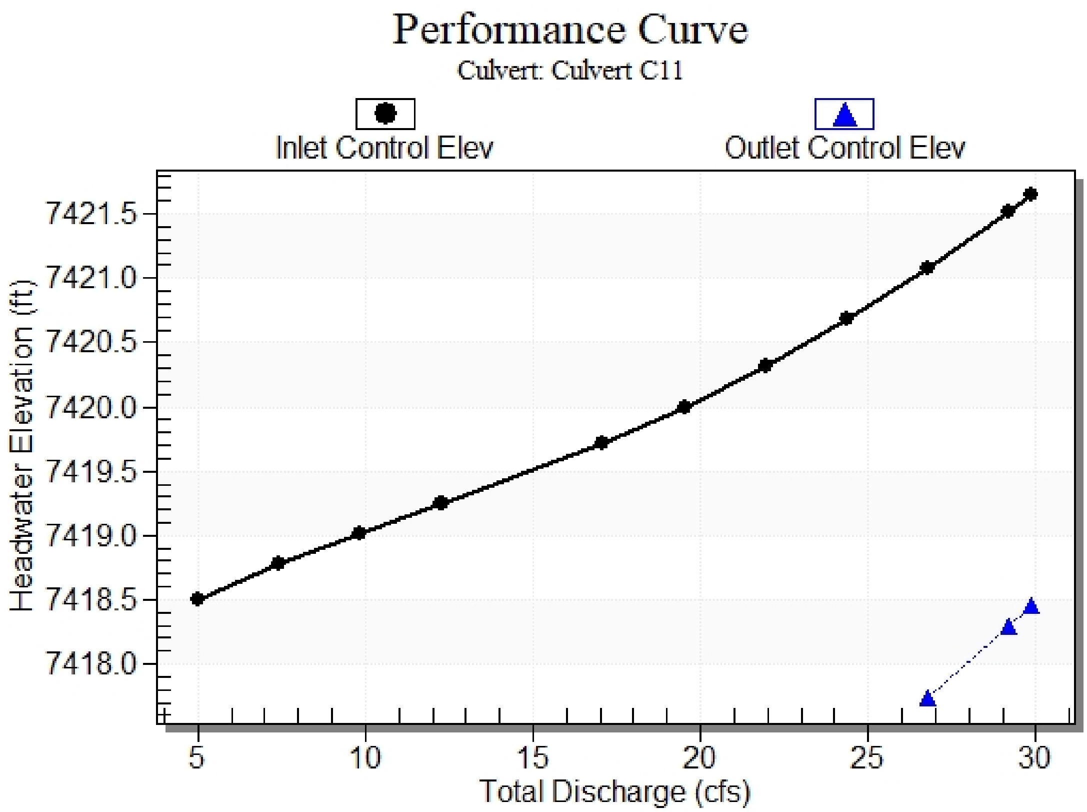
Straight Culvert

Inlet Elevation (invert): 7417.44 ft, Outlet Elevation (invert): 7413.03 ft

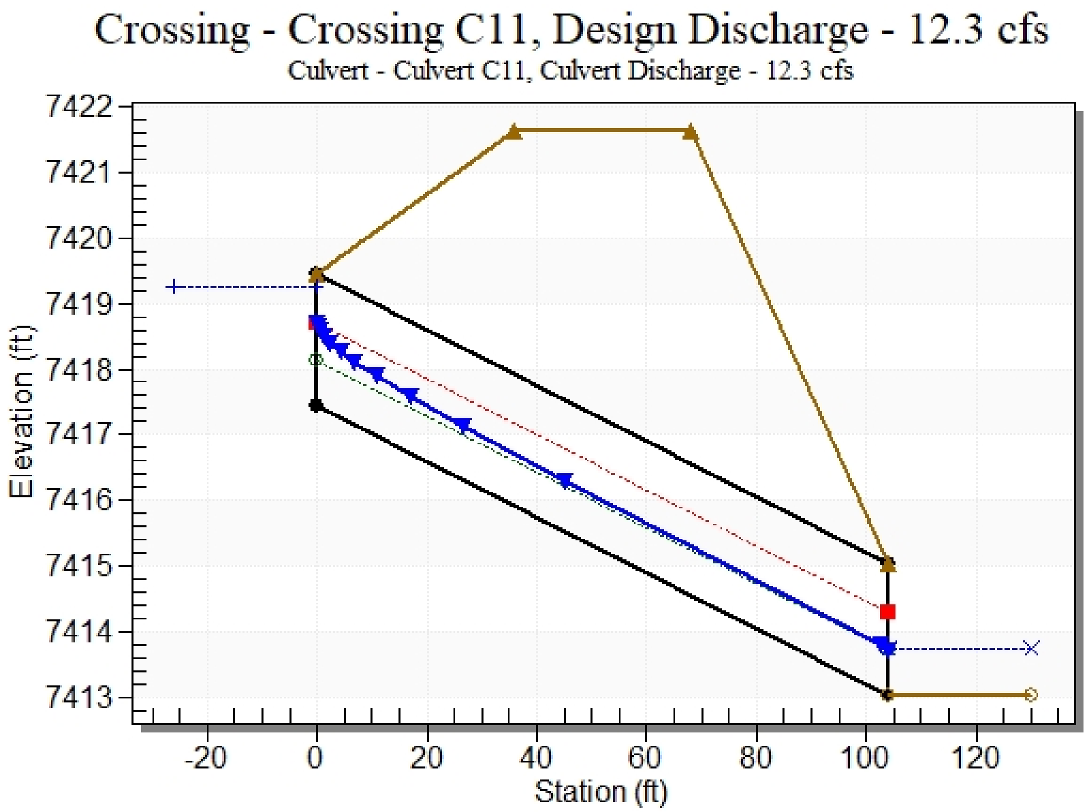
Culvert Length: 104.09 ft, Culvert Slope: 0.0424

****

Culvert Performance Curve Plot: Culvert C11



Water Surface Profile Plot for Culvert: Culvert C11



Site Data - Culvert C11

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7417.44 ft

Outlet Station: 104.00 ft

Outlet Elevation: 7413.03 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C11

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 15 - Downstream Channel Rating Curve (Crossing: Crossing C11)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	7413.53	0.50	4.99	2.09	1.76
7.42	7413.61	0.58	5.51	2.43	1.80
9.84	7413.68	0.65	5.91	2.70	1.83
12.26	7413.73	0.70	6.24	2.93	1.86
12.30	7413.73	0.70	6.25	2.93	1.86
17.10	7413.82	0.79	6.79	3.32	1.90
19.52	7413.86	0.83	7.01	3.49	1.91
21.94	7413.90	0.87	7.22	3.64	1.93
24.36	7413.94	0.91	7.41	3.79	1.94
26.78	7413.97	0.94	7.59	3.93	1.95
29.20	7414.00	0.97	7.76	4.06	1.96

Tailwater Channel Data - Crossing C11

Tailwater Channel Option: Triangular Channel

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

Channel Slope: 0.0670

Channel Manning's n: 0.0300

Channel Invert Elevation: 7413.03 ft

Roadway Data for Crossing: Crossing C11

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7421.65 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

APPENDIX D1

DETENTION POND CALCULATIONS – POND C8

WALDEN PRESERVE

IMPERVIOUS AREA CALCULATIONS

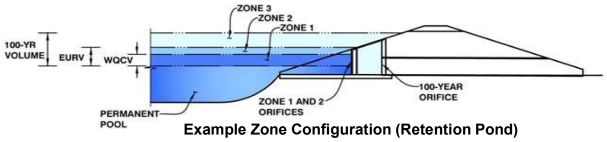
BASIN	TOTAL AREA (AC)	SOIL TYPE	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	% IMP.	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	% IMP.	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	% IMP.	WEIGHTED PERCENT IMPERVIOUS
OA1,A1-A9	341.96	B										6.20
OB1,B1-B4	90.90	B										25.00
B5	4.78	B	4.78	2.5-AC. LOTS	11.0							11.00
B6	7.91	B	7.91	5-AC. LOTS	7.0							7.00
B5,B6	12.69	B										8.51
B7	3.24	B	3.24	1-AC LOTS	20.0							20.00
B8	28.74	B	28.74	1-AC LOTS	20.0							20.00
B5-B8	44.67	B										16.73
B9	10.23	B	10.23	1-AC LOTS	20.0							20.00
B10	16.90	B	71.17	1-AC LOTS	20.0							20.00
B5-B10	71.80	B										17.97
OB1,B1-B10	162.70	B										21.90
OA1,OB1,A,B	504.66	B										11.26
OC1	128.95	B	128.95	1/2-AC. LOTS	25.0							25.00
C1	10.14	B	5.0	1-AC. LOTS	20.0	5.1	5-AC. LOTS	7.0				13.41
C2	11.02	B	11.02	1-AC LOTS	20.0							20.00
C1-C2	**21.16**	**B**										**16.84**
C3	2.04	B	2.04	1-AC LOTS	20.0							20.00
C4	15.59	B	15.59	1-AC LOTS	20.0							20.00
C3-C4	**17.63**	**B**										**20.00**
C1-C4	38.79	B										18.28
C5	26.83	B	19.5	1-AC. LOTS	20.0	7.3	5-AC. LOTS	7.0				16.46
C6	0.99	B	0.99	1-AC LOTS	20.0							20.00
C8	12.77	B	12.77	1-AC LOTS	20.0							20.00
C5,C6,C8	**40.59**	**B**										**17.66**
C9	4.50	B	4.5	1-AC LOTS	20.0							20.00
OC1,C1-C9	212.83	B										22.27
OA1-OC1,A1-C9	717.49	B										14.53
OC2	81.72	B	81.72	1/2-AC. LOTS	25.0							25.00
C10	2.86	B	2.86	1-AC LOTS	20.0							20.00
C11	8.63	B	8.63	1-AC LOTS	20.0							20.00
C12	17.77	B	17.77	1-AC LOTS	20.0							20.00
C10-C12	**29.26**	**B**										**18.05**
C13	22.44	B	22.44	MEADOW	0.0							0.00
OC2,C11-C13	133.42	B										19.27
OD1	3.30	B	3.30	1-AC LOTS	20.0							20.00
OD2	4.50	B	4.50	FOREST	0.0							0.00
OD3	10.30	B	10.30	FOREST	0.0							0.00
OD4	6.00	B	6.00	FOREST	0.0							0.00
D	10.27	B	10.27	1-AC LOTS	20.0							20.00
OD1-OD4, D	34.37	B										7.90
OA1-OD1,A-D	885.28	B										14.98

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WALDEN WP2 FILING NO. 5

Basin ID: DETENTION BASIN C8



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	40.59	acres
Watershed Length =	2,570	ft
Watershed Length to Centroid =	1,285	ft
Watershed Slope =	0.042	ft/ft
Watershed Imperviousness =	17.66%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.357	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.705	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.805	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.518	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.205	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	3.344	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	4.152	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	5.281	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	7.385	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.477	acre-feet		
Approximate 5-yr Detention Volume =	0.714	acre-feet		
Approximate 10-yr Detention Volume =	1.199	acre-feet		
Approximate 25-yr Detention Volume =	1.517	acre-feet		
Approximate 50-yr Detention Volume =	1.601	acre-feet		
Approximate 100-yr Detention Volume =	1.989	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.357	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.348	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.284	acre-feet
Total Detention Basin Volume =	1.989	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
	--	0.90	--	--	--	10	0.000	9	0.000
Bot EL=7404.0	--	1.00	--	--	--	6,258	0.144	321	0.007
	--	3.00	--	--	--	10,299	0.236	16,878	0.387
	--	5.00	--	--	--	14,948	0.343	42,125	0.967
	--	7.00	--	--	--	20,501	0.471	77,574	1.781
Spillway=7412.0	--	9.00	--	--	--	26,643	0.612	124,718	2.863
Top EL=7414.0	--	11.00	--	--	--	32,800	0.753	184,161	4.228
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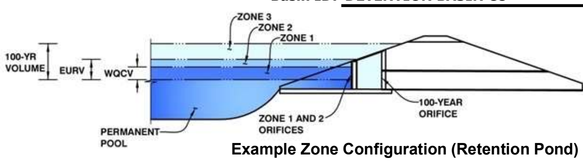
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WALDEN WP2 FILING NO. 5

Basin ID: DETENTION BASIN C8



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.88	0.357	Orifice Plate
Zone 2 (EURV)	4.19	0.348	Orifice Plate
Zone 3 (100-year)	7.43	1.284	Weir&Pipe (Restrict)
Total (all zones)		1.989	

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	4.19	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	16.80	inches
Orifice Plate: Orifice Area per Row =	1.72	sq. inches (diameter = 1-7/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.194E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

A=1.62sq inches. So D=1.5in would be a better fit.

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	1.40	2.79					
Orifice Area (sq. inches)	1.72	1.72	1.72					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

User Input: Overflow Weir (Dropbox 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, Ho =	4.19	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	6.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.19	N/A	feet
Overflow Weir Slope Length =	6.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.60	N/A	
Overflow Grate Open Area w/o Debris =	25.06	N/A	ft^2
Overflow Grate Open Area w/ Debris =	12.53	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	21.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.91	N/A	ft^2
Outlet Orifice Centroid =	0.93	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.42	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	9.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	18.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.91	feet
Stage at Top of Freeboard =	10.91	feet
Basin Area at Top of Freeboard =	0.75	acres
Basin Volume at Top of Freeboard =	4.16	acre-ft

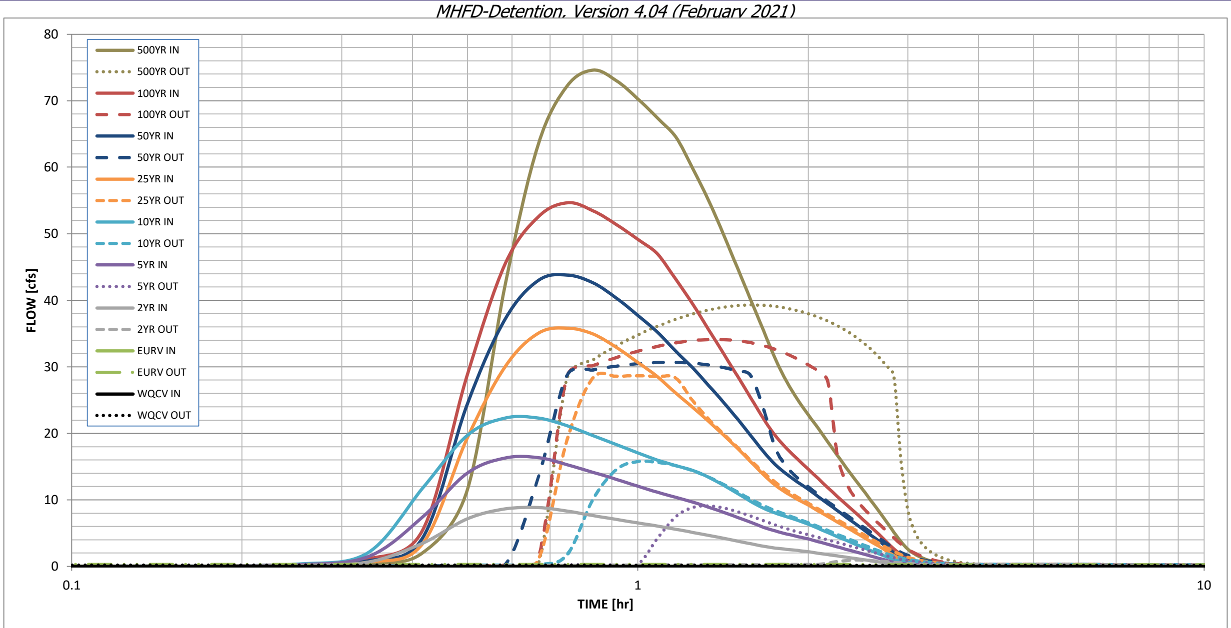
Routed Hydrograph Results

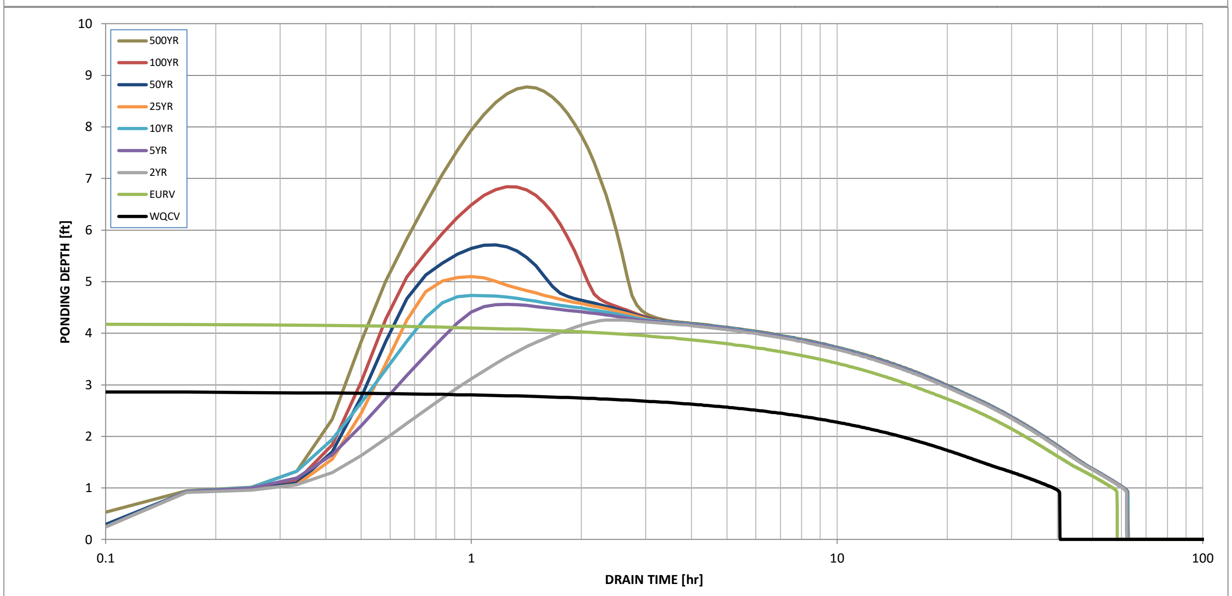
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

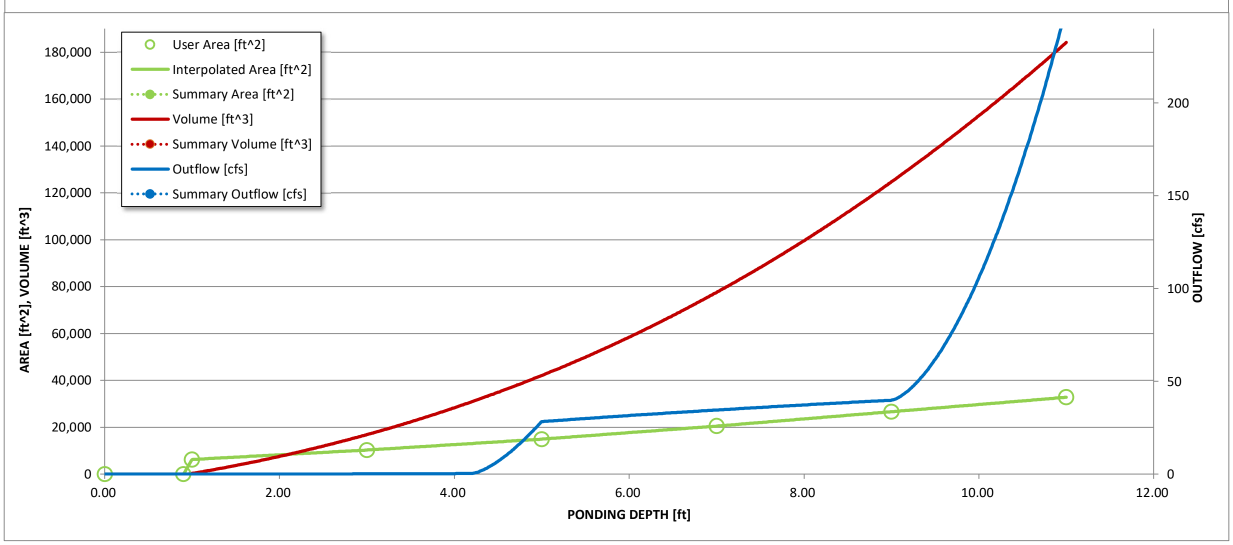
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.357	0.705	0.805	1.518	2.205	3.344	4.152	5.281	7.385
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.805	1.518	2.205	3.344	4.152	5.281	7.385
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	3.9	11.0	16.7	29.9	37.6	47.9	67.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.10	0.27	0.41	0.74	0.93	1.18	1.65
Peak Inflow Q (cfs) =	N/A	N/A	8.9	16.4	22.3	35.8	43.8	54.7	74.6
Peak Outflow Q (cfs) =	0.2	0.3	1.0	9.1	15.8	28.6	30.7	34.1	39.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.9	1.0	0.8	0.7	0.6
Structure Controlling Flow =	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.03	0.3	0.6	1.1	1.2	1.3	1.5
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	54	57	53	49	45	42	38	33
Time to Drain 99% of Inflow Volume (hours) =	**40**	57	60	59	58	56	54	52	48
Maximum Ponding Depth (ft) =	2.87	4.19	4.26	4.56	4.73	5.10	5.71	6.84	8.77
Area at Maximum Ponding Depth (acres) =	0.23	0.30	0.30	0.32	0.33	0.35	0.39	0.46	0.60
Maximum Volume Stored (acre-ft) =	0.357	0.707	0.725	0.821	0.876	0.998	1.227	1.702	2.724

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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.

Time Interval: 5.00 min

SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:05:00	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	0.02	0.00	0.06
0:15:00	0.00	0.00	0.17	0.27	0.34	0.23	0.29	0.28	0.42
0:20:00	0.00	0.00	0.64	1.43	2.04	0.65	0.84	1.09	2.02
0:25:00	0.00	0.00	3.48	7.42	11.72	3.39	4.22	5.39	11.57
0:30:00	0.00	0.00	7.15	14.06	19.73	19.36	24.48	28.91	42.37
0:35:00	0.00	0.00	8.64	16.30	22.29	30.05	37.20	45.50	63.40
0:40:00	0.00	0.00	8.86	16.36	22.32	35.06	42.97	52.55	72.20
0:45:00	0.00	0.00	8.31	15.28	21.13	35.83	43.81	54.67	74.59
0:50:00	0.00	0.00	7.63	14.14	19.66	34.92	42.64	53.47	73.02
0:55:00	0.00	0.00	7.06	13.09	18.33	32.92	40.33	51.37	70.29
1:00:00	0.00	0.00	6.54	12.05	17.06	30.66	37.73	49.16	67.39
1:05:00	0.00	0.00	6.08	11.13	15.98	28.50	35.21	46.95	64.55
1:10:00	0.00	0.00	5.58	10.39	15.17	26.06	32.35	43.16	59.79
1:15:00	0.00	0.00	5.12	9.68	14.44	23.92	29.83	39.41	55.04
1:20:00	0.00	0.00	4.68	8.91	13.42	21.80	27.23	35.63	49.90
1:25:00	0.00	0.00	4.24	8.14	12.21	19.76	24.67	31.99	44.82
1:30:00	0.00	0.00	3.82	7.37	10.97	17.73	22.14	28.60	40.06
1:35:00	0.00	0.00	3.41	6.63	9.76	15.73	19.65	25.32	35.46
1:40:00	0.00	0.00	3.04	5.89	8.75	13.81	17.27	22.21	31.19
1:45:00	0.00	0.00	2.77	5.32	8.03	12.21	15.31	19.64	27.72
1:50:00	0.00	0.00	2.58	4.88	7.46	11.03	13.86	17.71	25.05
1:55:00	0.00	0.00	2.39	4.49	6.92	10.06	12.66	16.08	22.78
2:00:00	0.00	0.00	2.20	4.13	6.34	9.21	11.61	14.64	20.76
2:05:00	0.00	0.00	1.99	3.73	5.71	8.34	10.50	13.20	18.71
2:10:00	0.00	0.00	1.78	3.33	5.09	7.50	9.44	11.82	16.73
2:15:00	0.00	0.00	1.58	2.95	4.49	6.69	8.41	10.53	14.87
2:20:00	0.00	0.00	1.39	2.58	3.93	5.92	7.43	9.32	13.13
2:25:00	0.00	0.00	1.20	2.22	3.39	5.17	6.49	8.17	11.48
2:30:00	0.00	0.00	1.02	1.88	2.88	4.44	5.57	7.03	9.87
2:35:00	0.00	0.00	0.84	1.54	2.38	3.72	4.67	5.91	8.28
2:40:00	0.00	0.00	0.67	1.21	1.90	3.01	3.79	4.80	6.72
2:45:00	0.00	0.00	0.50	0.90	1.44	2.32	2.92	3.70	5.17
2:50:00	0.00	0.00	0.34	0.62	1.04	1.64	2.08	2.64	3.72
2:55:00	0.00	0.00	0.24	0.44	0.79	1.08	1.39	1.78	2.59
3:00:00	0.00	0.00	0.18	0.35	0.64	0.75	0.99	1.24	1.86
3:05:00	0.00	0.00	0.15	0.29	0.52	0.54	0.72	0.88	1.35
3:10:00	0.00	0.00	0.12	0.23	0.42	0.39	0.53	0.62	0.97
3:15:00	0.00	0.00	0.10	0.19	0.35	0.29	0.40	0.43	0.69
3:20:00	0.00	0.00	0.08	0.15	0.28	0.22	0.30	0.29	0.48
3:25:00	0.00	0.00	0.06	0.12	0.22	0.16	0.23	0.20	0.33
3:30:00	0.00	0.00	0.05	0.09	0.17	0.12	0.17	0.14	0.24
3:35:00	0.00	0.00	0.04	0.07	0.13	0.10	0.13	0.11	0.18
3:40:00	0.00	0.00	0.03	0.05	0.10	0.08	0.10	0.09	0.14
3:45:00	0.00	0.00	0.03	0.04	0.07	0.06	0.08	0.07	0.11
3:50:00	0.00	0.00	0.02	0.03	0.05	0.04	0.06	0.05	0.09
3:55:00	0.00	0.00	0.01	0.02	0.04	0.03	0.04	0.04	0.06
4:00:00	0.00	0.00	0.01	0.01	0.03	0.02	0.03	0.03	0.05
4:05:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.03
4:10:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: JPS
Company: JPS
Date: January 7, 2022
Project: Walden WP2 Filing No. 5
Location: Detention Basin C8

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 17.7 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.177

C) Contributing Watershed Area — Area = 40.590 ac

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

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

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

F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$) — V_{DESIGN} = 0.357 ac-ft

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

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

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

J) Excess Urban Runoff Volume (EURV) Design Volume — $EURV_{DESIGN}$ = 0.707 ac-f t
- 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 de[...] — $EURV_{DESIGN\ USER}$ = ______ ac-f t

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will im[...] — ______ : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or fla[...] — ______ ft / ft

4. Inlet

A) Describe means of providing energy dissipatio[...] inflow locations:

> Revise. There are two forebays for Pond C8.
>
> Each forebay needs it's own design calculations (volume, discharge, rectangular notch, etc.) that is proportional to what goes into each forebay versus the total volume for the entire pond.

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV) — V_{FMIN} = 0.011 ac-ft

B) Actual Forebay Volume — V_F = 0.017 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} = 50.20 cfs
- ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 1.00 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 = 5.6 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**JPS**
Company:	**JPS**
Date:	**January 7, 2022**
Project:	**Walden WP2 Filing No. 5**
Location:	**Detention Basin C8**

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (●) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One: (●) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.44 inches
E) Total Outlet Area	A_{ot} = 5.16 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 47 cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 5.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 173 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 244 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 4.19 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 78.28 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches **VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: January 7, 2022
Project: Walden WP2 Filing No. 5
Location: Detention Basin C8

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	Buried 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 sediment removal as needed

Notes:

APPENDIX D2

WATER QUALITY CALCULATIONS – RAIN GARDENS C4 & C12

WALDEN PRESERVE

IMPERVIOUS AREA CALCULATIONS

BASIN	TOTAL AREA (AC)	SOIL TYPE	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	% IMP.	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	% IMP.	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	% IMP.	WEIGHTED PERCENT IMPERVIOUS
OA1,A1-A9	341.96	B										6.20
OB1,B1-B4	90.90	B										25.00
B5	4.78	B	4.78	2.5-AC. LOTS	11.0							11.00
B6	7.91	B	7.91	5-AC. LOTS	7.0							7.00
B5,B6	12.69	B										8.51
B7	3.24	B	3.24	1-AC LOTS	20.0							20.00
B8	28.74	B	28.74	1-AC LOTS	20.0							20.00
B5-B8	44.67	B										16.73
B9	10.23	B	10.23	1-AC LOTS	20.0							20.00
B10	16.90	B	71.17	1-AC LOTS	20.0							20.00
B5-B10	71.80	B										17.97
OB1,B1-B10	162.70	B										21.90
OA1,OB1,A,B	504.66	B										11.26
OC1	128.95	B	128.95	1/2-AC. LOTS	25.0							25.00
C1	10.14	B	5.0	1-AC. LOTS	20.0	5.1	5-AC. LOTS	7.0				13.41
C2	11.02	B	11.02	1-AC LOTS	20.0							20.00
C1-C2	**21.16**	**B**										**16.84**
C3	2.04	B	2.04	1-AC LOTS	20.0							20.00
C4	15.59	B	15.59	1-AC LOTS	20.0							20.00
C3-C4	**17.63**	**B**										**20.00**
C1-C4	38.79	B										18.28
C5	26.83	B	19.5	1-AC. LOTS	20.0	7.3	5-AC. LOTS	7.0				16.46
C6	0.99	B	0.99	1-AC LOTS	20.0							20.00
C8	12.77	B	12.77	1-AC LOTS	20.0							20.00
C5,C6,C8	**40.59**	**B**										**17.66**
C9	4.50	B	4.5	1-AC LOTS	20.0							20.00
OC1,C1-C9	212.83	B										22.27
OA1-OC1,A1-C9	717.49	B										14.53
OC2	81.72	B	81.72	1/2-AC. LOTS	25.0							25.00
C10	2.86	B	2.86	1-AC LOTS	20.0							20.00
C11	8.63	B	8.63	1-AC LOTS	20.0							20.00
C12	17.77	B	17.77	1-AC LOTS	20.0							20.00
C10-C12	**29.26**	**B**										**18.05**
C13	22.44	B	22.44	MEADOW	0.0							0.00
OC2,C11-C13	133.42	B										19.27
OD1	3.30	B	3.30	1-AC LOTS	20.0							20.00
OD2	4.50	B	4.50	FOREST	0.0							0.00
OD3	10.30	B	10.30	FOREST	0.0							0.00
OD4	6.00	B	6.00	FOREST	0.0							0.00
D	10.27	B	10.27	1-AC LOTS	20.0							20.00
OD1-OD4, D	34.37	B										7.90
OA1-OD1,A-D	885.28	B										14.98

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: JPS
Company: JPS
Date: January 7, 2022
Project: Walden WP2 Filing No. 5
Location: Rain Garden C4

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 20.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.200
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time (WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)	WQCV = 0.09 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 767,963 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = 5,923 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 4.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 3072 sq ft
D) Actual Flat Surface Area	A_{Actual} = 5343 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 6667 sq ft
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T= 6,005 cu ft
3. Growing Media	Choose One ◉ 18" Rain Garden Growing Media ○ Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One ◉ YES ○ NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 2.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 5,923 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 1 3/4 in

Design Procedure Form: Rain Garden (RG)

Designer:	**JPS**
Company:	**JPS**
Date:	**January 7, 2022**
Project:	**Walden WP2 Filing No. 5**
Location:	**Rain Garden C4**

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

Notes:

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: JPS
Company: JPS
Date: January 7, 2022
Project: Walden WP2 Filing No. 5
Location: Rain Garden C12

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 18.1 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.181
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time (WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)	WQCV = 0.09 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 1,274,566 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = 9,123 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 4.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 4601 sq ft
D) Actual Flat Surface Area	A_{Actual} = 8917 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 10390 sq ft
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T= 9,654 cu ft
3. Growing Media	Choose One: (●) 18" Rain Garden Growing Media; ( ) Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One: (●) YES; ( ) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 2.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 9,123 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 2 3/16 in

Design Procedure Form: Rain Garden (RG)

Designer: JPS
Company: JPS
Date: January 7, 2022
Project: Walden WP2 Filing No. 5
Location: Rain Garden C12

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

Notes:

APPENDIX E

DRAINAGE COST ESTIMATE

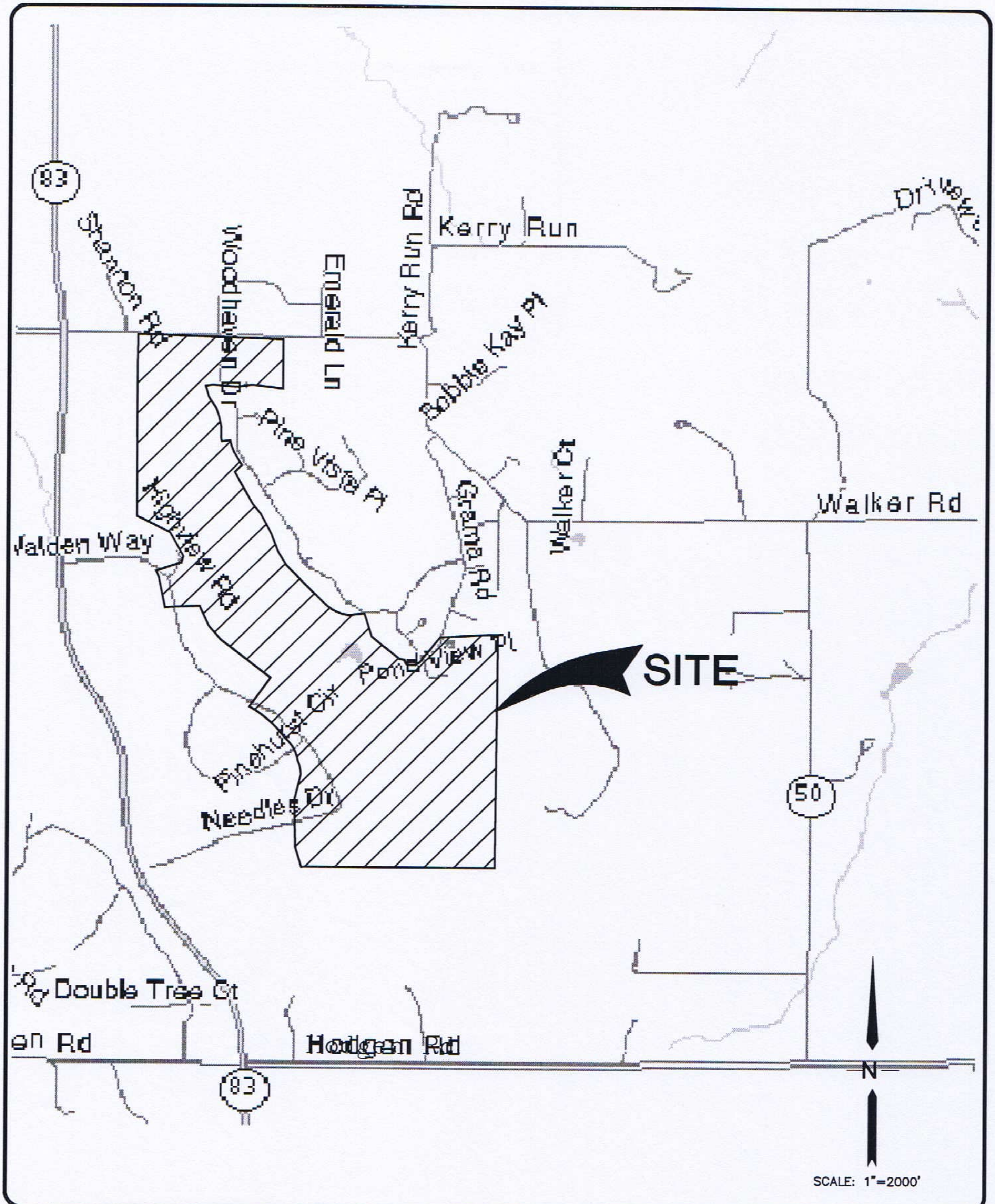
WALDEN PRESERVE 2 FILING NO. 5
DRAINAGE IMPROVEMENTS COST ESTIMATE

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	PUBLIC DRAINAGE IMPROVEMENTS (NON-REIMBURSABLE)				
	18" RCP Culvert	167	LF	$67	$11,189
	24" RCP Culvert	104	LF	$81	$8,424
	30" RCP Culvert	81	LF	$100	$8,100
	18" RCP FES	6	EA	$402	$2,412
	24" RCP FES	2	EA	$486	$972
	30" RCP FES	2	EA	$600	$1,200
	Riprap (d_{50} = 12")	32	TN	$83	$2,656
	SUBTOTAL				**$34,953**
	Contingency @ 15%				$5,243
	TOTAL				**$40,196**
	PRIVATE DRAINAGE IMPROVEMENTS (NON-REIMBURSABLE)				
	12" HDPE Storm Sewer (Rain Garden Discharge Pipe)	132	LF	$60	$7,920
	24" HDPE Storm Sewer (Detention Pond Discharge)	200	LF	$81	$16,200
	12" FES	2	EA	$360	$720
	24" FES	1	EA	$486	$486
	Riprap (d_{50} = 12")	10	TN	$83	$830
	Detention Pond C8 Outlet Structure	1	LS	$8,000	$8,000
	Detention Pond C8 Forebays / Spillway	1	LS	$7,000	$7,000
	Rain Garden C4	1	LS	$10,000	$10,000
	Rain Garden C12	1	LS	$10,000	$10,000
	SUBTOTAL				**$61,156**
	Contingency @ 15%				$9,173
	TOTAL				**$70,329**
	TOTAL DRAINAGE IMPROVEMENTS				**$110,525**
	Note: This estimate does not include costs for street improvements (curb & gutter, crosspans, etc.)				

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

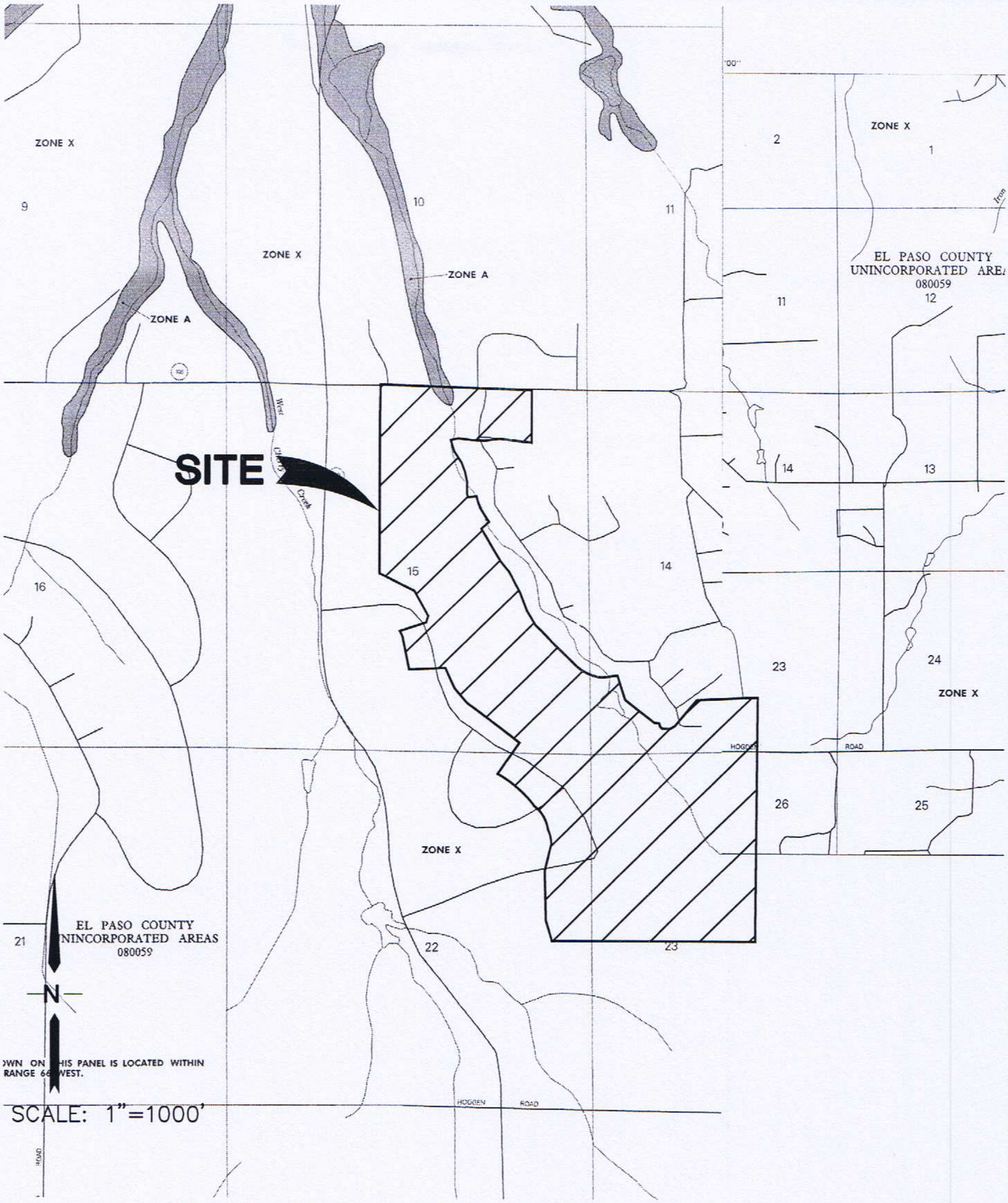
JPS ENGINEERING

WALDEN PRESERVE

FIGURE A1

JPS PROJ NO. 040201

J:\jpsprojects\040201.walden\WALDEN PRESERVE 2\DWG\CIVIL\A1.dwg, 8/14/2014 2:51:45 PM



FIRM PANELS 08041C0285F & 08041C0325F (MARCH 17, 1997)

FLOODPLAIN MAP	JPS ENGINEERING	WALDEN PRESERVE FIGURE FP-1 JPS PROJ NO. 040201

J:\jpsprojects\040201.walden\WALDEN PRESERVE 2\DWG\CIVIL\FP-1.dwg Sep 17, 2014 - 9:41am

National Flood Hazard Layer FIRMette

FEMA

104°46'W 39°5'40"N

104°45'22"W 39°5'12"N

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

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

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

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

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

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

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

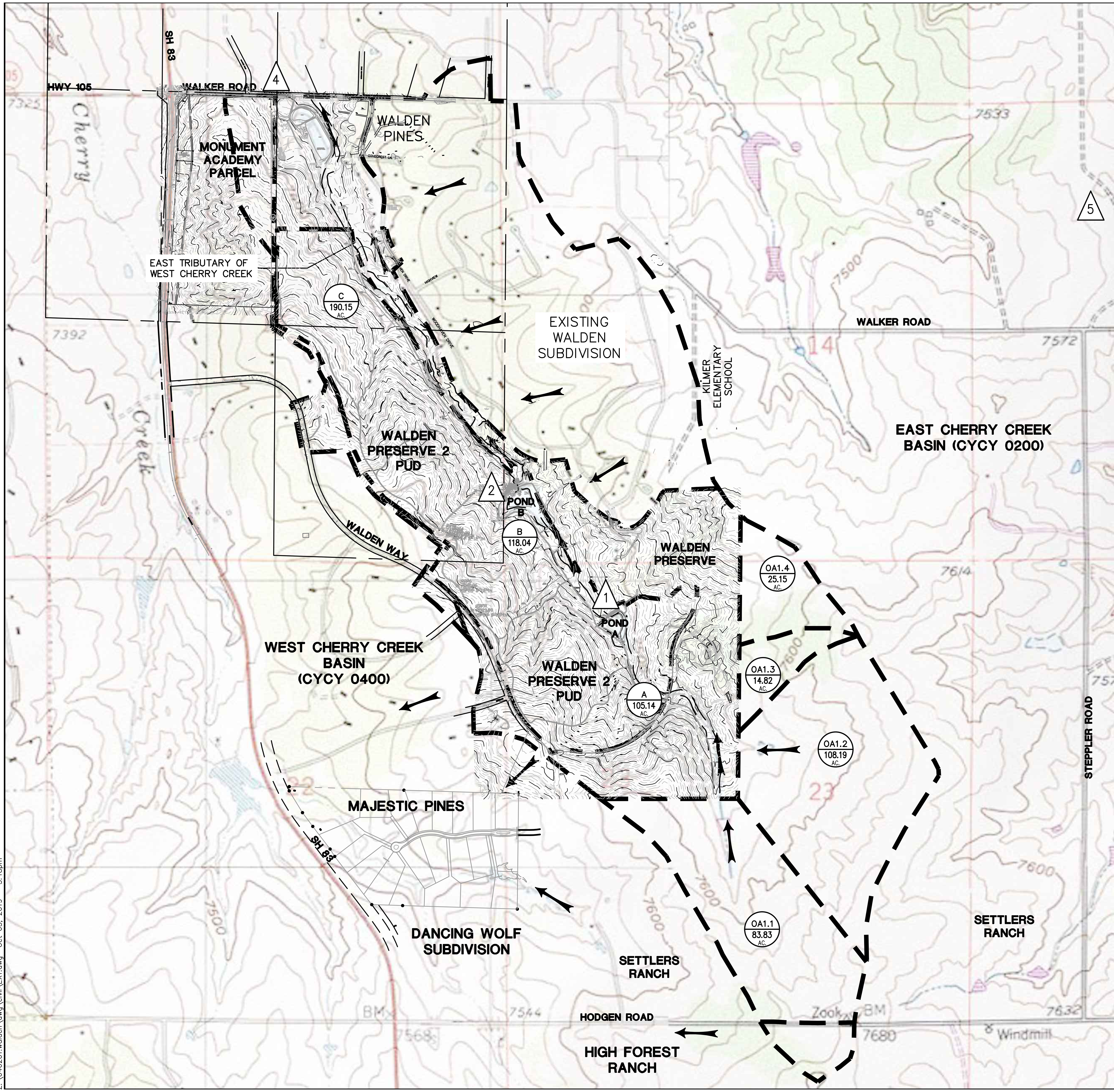
N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/13/2022 at 2:32 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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



LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- EXISTING CONTOUR (6520)
- FLOWLINE
- DESIGN POINT (FROM "WALDEN PRESERVE MDDP") (5)
- BASIN DESIGNATION (BD)
- BASIN AREA (ACRES) (524 AC)

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
1	39.4	240.8
2	73.4	321.3
4	234.8	620.0

N

GRAPHIC SCALE

600 0 300 600 1200

ORIGINAL SCALE: 1"=600'
CONTOUR INTERVAL=20'

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CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

WALDEN PRESERVE SUBDIVISION

MAJOR BASIN / HISTORIC DRAINAGE PLAN

HORZ. SCALE:	1"=600'	DRAWN:	MJP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	PINNACLE	CHECKED:	JPS
CREATED:	7/22/02	LAST MODIFIED:	10/03/19
PROJECT NO:	040201	MODIFIED BY:	BJJ
SHEET:	EX1		

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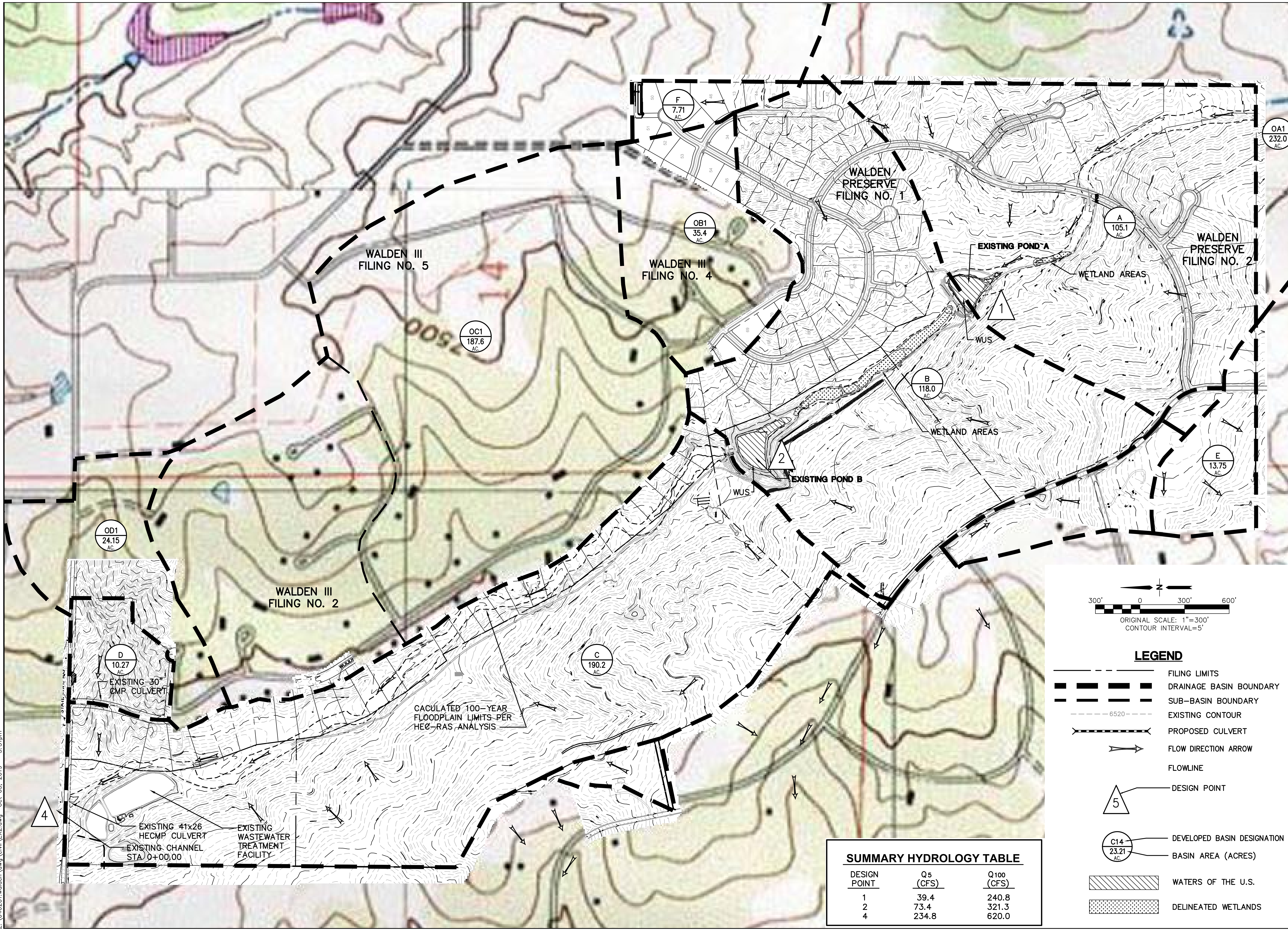

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
1	39.4	240.8
2	73.4	321.3
4	234.8	620.0

WALDEN PRESERVE

HISTORIC DRAINAGE PLAN

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No.	REVISION	BY	DATE

HORZ. SCALE: 1"=300'	DRAWN: MJP
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: PINNACLE	CHECKED: JPS
CREATED: 9/30/11	LAST MODIFIED: 10/03/19
PROJECT NO: 040201	MODIFIED BY: BJJ
SHEET:	EX2

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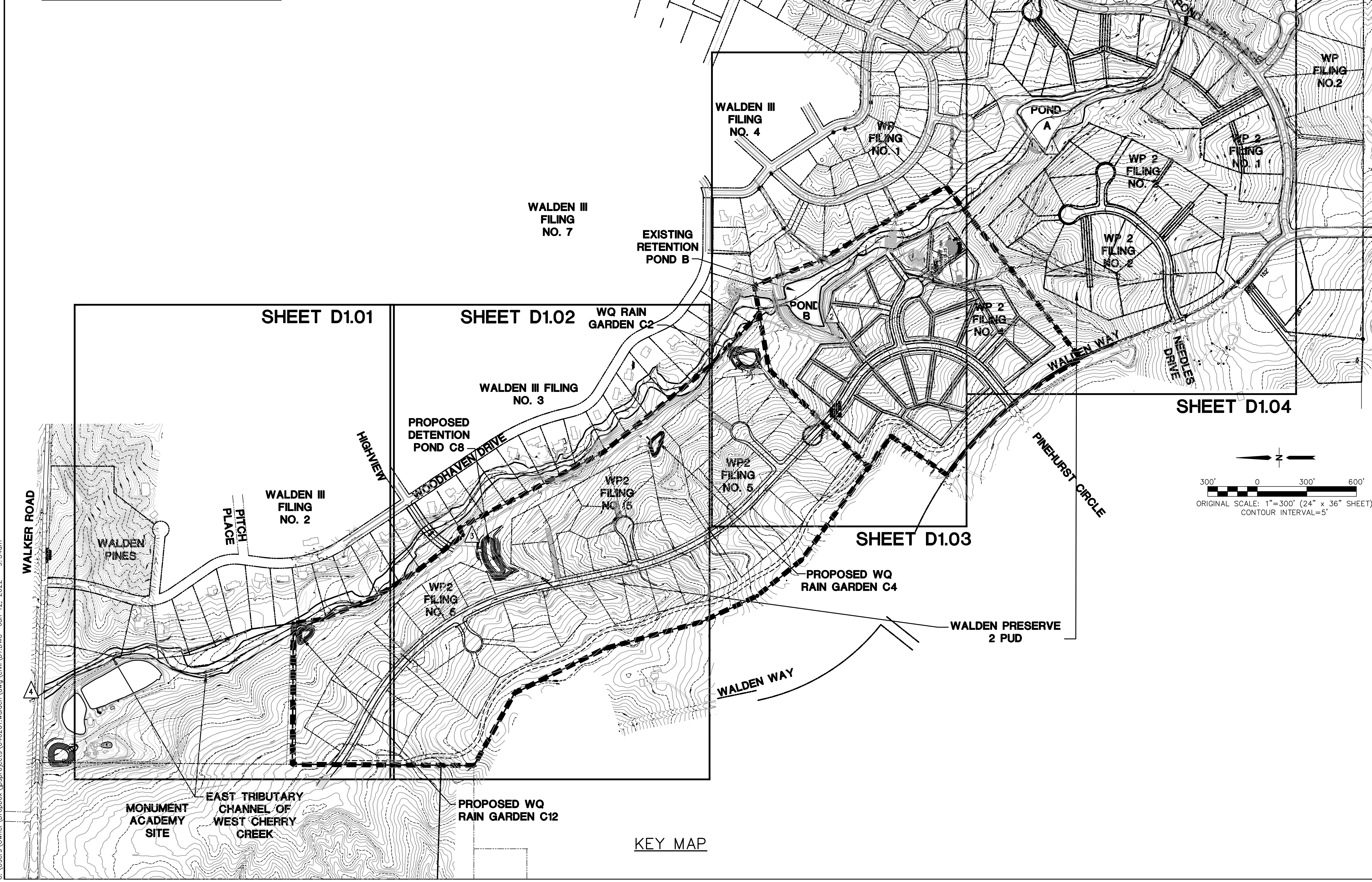
SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
1	99.6	285.5
2	189.1	508.9
3	295.8	764.9
4 (DEVELOPED)	324.4	845.4
4 (DETAINED)	226.7	601.4



KEY MAP

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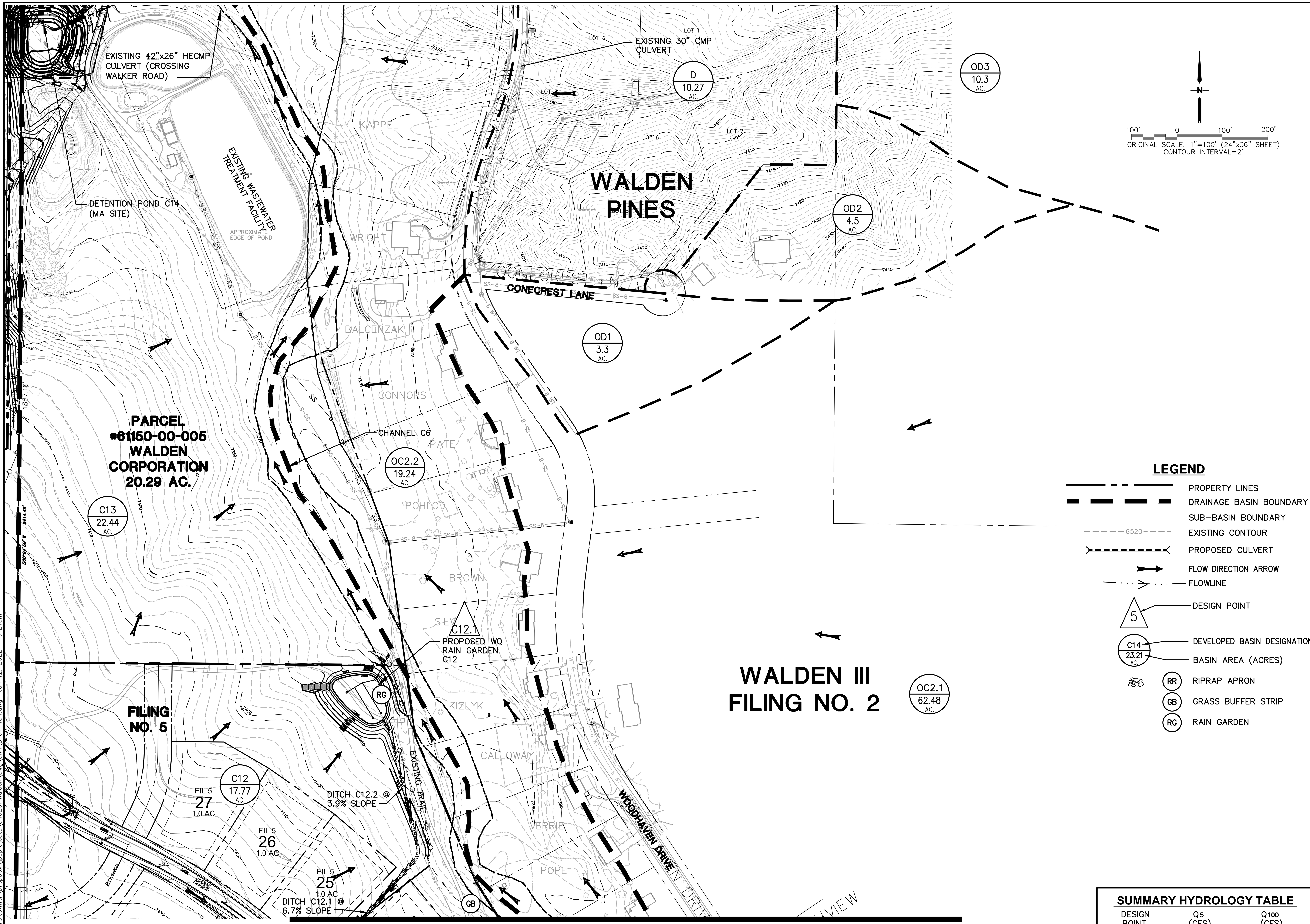
No.	REVISION	BY	DATE

WALDEN PRESERVE

MASTER DEVELOPMENT DRAINAGE PLAN

HORZ. SCALE:	1"=300'	DRAWN:	MJP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	RAMPART	CHECKED:	JPS
CREATED:	10/04/11	LAST MODIFIED:	1/12/22
PROJECT NO:	040201	MODIFIED BY:	BJJ
SHEET:	D1		



MATCH LINE - SEE SHEET D1.02

N

100' 0 100' 200'

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

LEGEND

- PROPERTY LINES
- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- PROPOSED CULVERT
- FLOW DIRECTION ARROW
- FLOWLINE
- 5 — DESIGN POINT
- C14 — DEVELOPED BASIN DESIGNATION
- 23.21 AC. — BASIN AREA (ACRES)
- RR — RIPRAP APRON
- GB — GRASS BUFFER STRIP
- RG — RAIN GARDEN

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
C12.1	30.5	72.4

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No.	REVISION	BY	DATE

WALDEN PRESERVE

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=100'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RAMPART	CHECKED: JPS
CREATED: 10/03/11	LAST MODIFIED: 1/10/22
PROJECT NO: 040201	MODIFIED BY: BJJ

SHEET: D1.01

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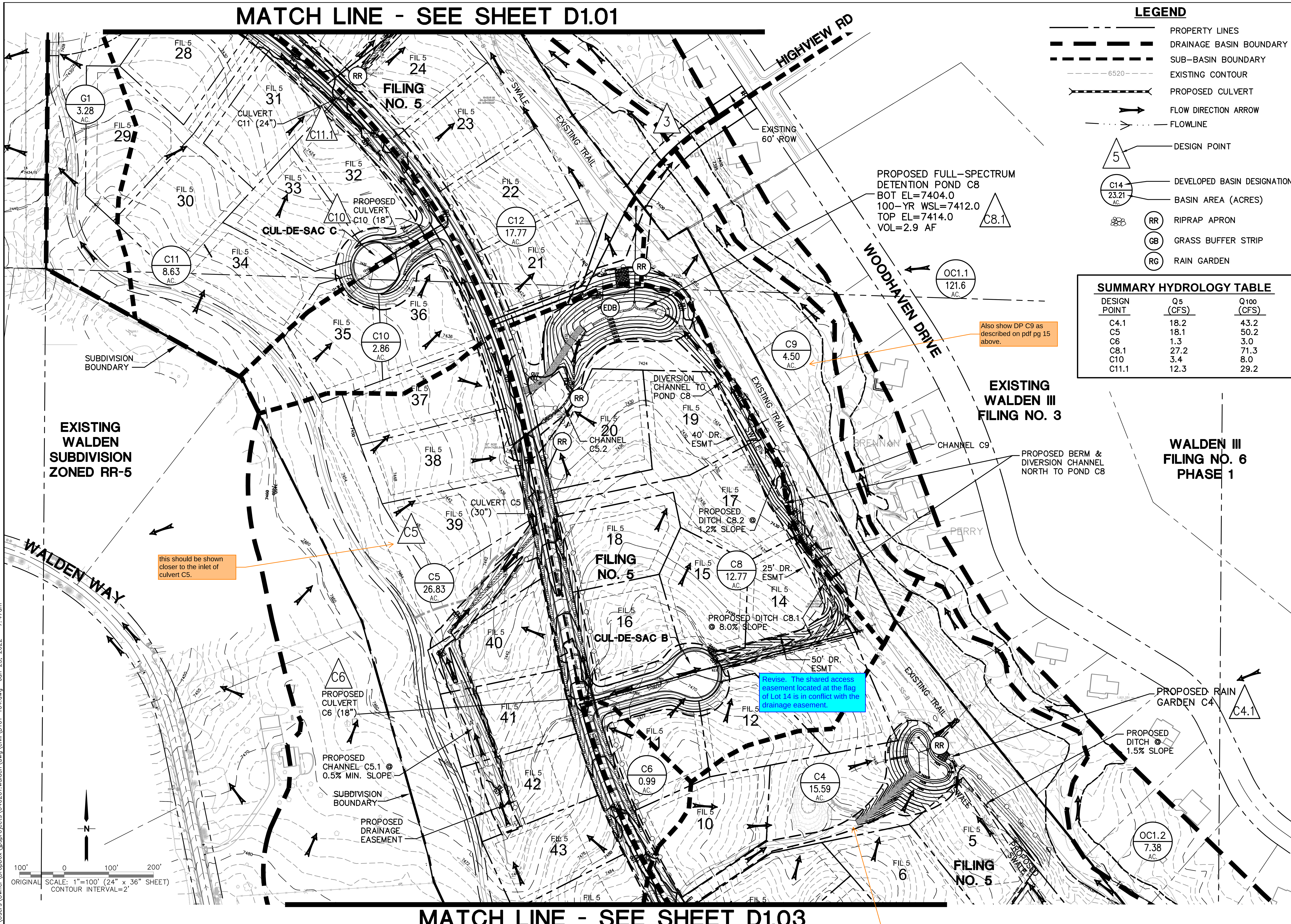

Also show DP C9 as described on pdf pg 15 above.

this should be shown closer to the inlet of culvert C5.

Revise. The shared access easement located at the flag of Lot 14 is in conflict with the drainage easement.

Show DP C4.1, as described on pdf pg 15 above.

LEGEND

- PROPERTY LINES
- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- EXISTING CONTOUR
- PROPOSED CULVERT
- FLOW DIRECTION ARROW
- FLOWLINE
- DESIGN POINT
- DEVELOPED BASIN DESIGNATION
- BASIN AREA (ACRES)
- RR RIPRAP APRON
- GB GRASS BUFFER STRIP
- RG RAIN GARDEN

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
C4.1	18.2	43.2
C5	18.1	50.2
C6	1.3	3.0
C8.1	27.2	71.3
C10	3.4	8.0
C11.1	12.3	29.2

WALDEN PRESERVE

DEVELOPED DRAINAGE PLAN

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No.	REVISION	BY	DATE

HORZ. SCALE: 1"=100'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RAMPART	CHECKED: JPS
CREATED: 10/03/11	LAST MODIFIED: 1/25/22
PROJECT NO: 040201	MODIFIED BY: BJJ

SHEET: D1.02

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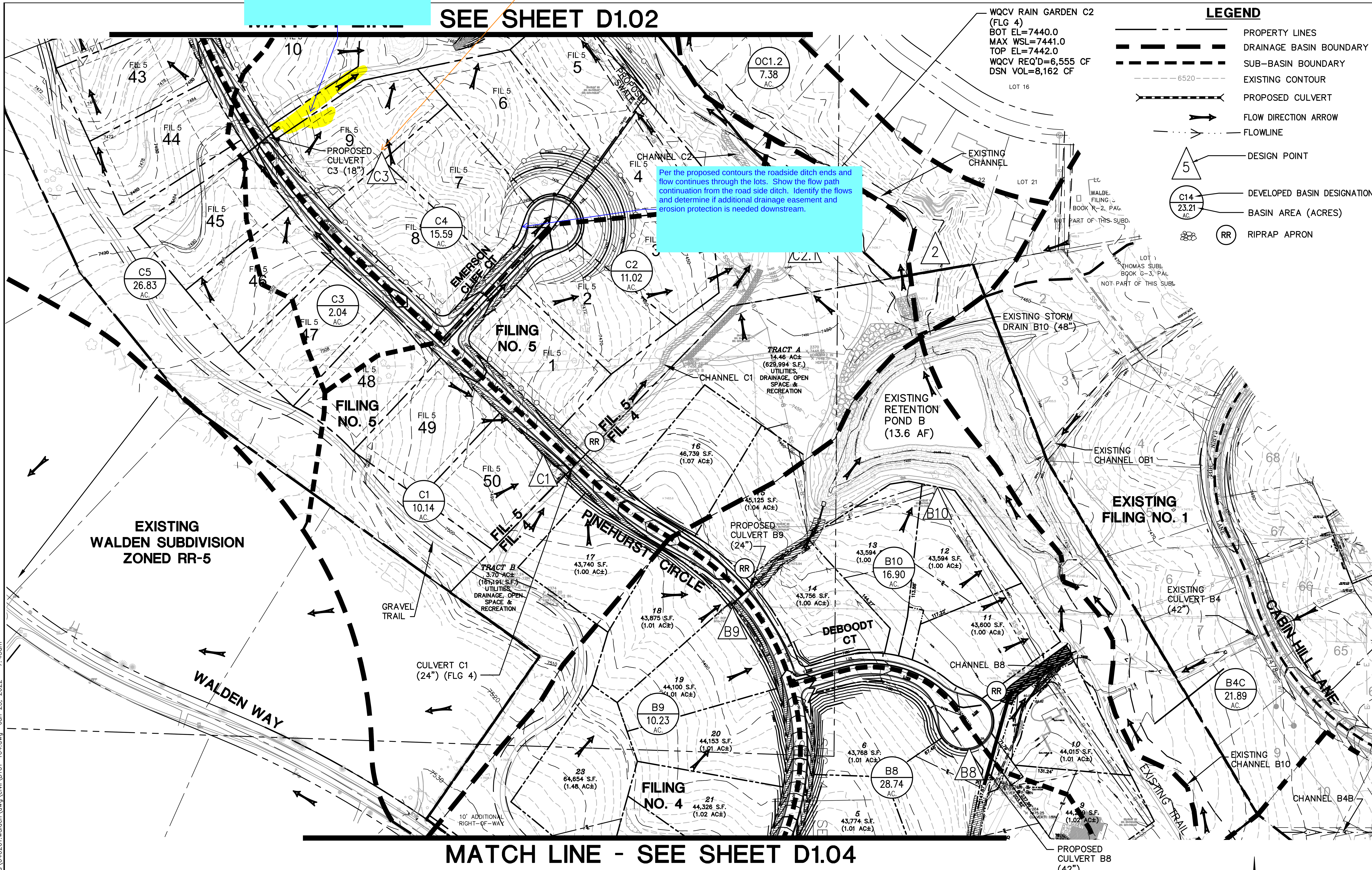
This is still concentrated flow traveling on a steep path. Provide hydraulic analysis verifying no additional erosion protection is needed or extend erosion protection as necessary. Typical for all pipe outfalls. Construction easement is required for offsite work.

Is this DP supposed to be at the outlet of culvert C3? It is unclear from the narrative description on pdf pg 14-15 above.

Per the proposed contours the roadside ditch ends and flow continues through the lots. Show the flow path continuation from the road side ditch. Identify the flows and determine if additional drainage easement and erosion protection is needed downstream.



SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
B8	32.4	84.9
B9	10.0	23.7
B10	53.5	126.9
C1	9.7	23.0
C2.1	18.3	43.6
C3	2.2	5.1

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No.	REVISION	BY	DATE

WALDEN PRESERVE

DEVELOPED DRAINAGE PLAN

HORZ. SCALE:	1"=100'	DRAWN:	BJJ
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	RAMPART	CHECKED:	JPS
CREATED:	10/03/11	LAST MODIFIED:	1/25/22
PROJECT NO:	040201	MODIFIED BY:	BJJ
SHEET:	D1.03		