

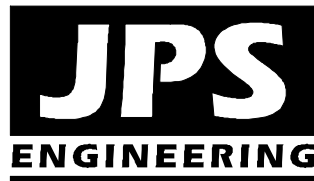
**PRELIMINARY & FINAL DRAINAGE REPORT
FOR
MAYBERRY, COLORADO SPRINGS – FILING NO. 1**

Prepared for:

Colorado Springs Mayberry, LLC
32823 Temecula Parkway
Temecula, CA 92592

January 15, 2007
Revised August 24, 2018
Revised January 15, 2019
Revised September 12, 2019
Revised April 24, 2020
Revised October 27, 2020

Prepared by:



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

**JPS Project No. 030502
EPC Project No. SF-18-025**

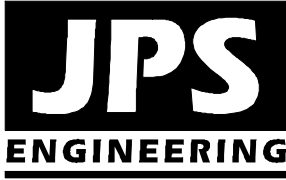
**FINAL DRAINAGE REPORT
MAYBERRY, COLORADO SPRINGS – FILING NO. 1
TABLE OF CONTENTS**

| | <u>PAGE</u> |
|--|--------------------|
| EXECUTIVE SUMMARY | i |
| DRAINAGE STATEMENT | ii |
| I. GENERAL LOCATION AND DESCRIPTION..... | 1 |
| II. DRAINAGE BASINS AND SUB-BASINS..... | 3 |
| III. DRAINAGE DESIGN CRITERIA | 5 |
| IV. DRAINAGE PLANNING FOUR STEP PROCESS..... | 6 |
| V. GENERAL DRAINAGE RECOMMENDATIONS | 7 |
| VI. DRAINAGE FACILITY DESIGN | 8 |
| VII. EROSION CONTROL | 14 |
| VIII. COST ESTIMATE AND DRAINAGE FEES..... | 15 |
| IX. MAINTENANCE | 15 |
| X. SUMMARY | 15 |

FINAL DRAINAGE REPORT
MAYBERRY, COLORADO SPRINGS – FILING NO. 1
TABLE OF CONTENTS (CONT.)

APPENDICES

| | |
|---------------|--|
| APPENDIX A | Soils Information |
| APPENDIX B1 | Hydrologic Calculations (Rational Method) |
| APPENDIX B2 | Hydrologic Calculations (SCS) |
| APPENDIX C | Detention Pond Calculations |
| APPENDIX D1 | Street Capacity & Storm Sewer Hydraulic Calculations |
| APPENDIX D2 | Culvert Hydraulic Calculations |
| APPENDIX D3 | Open Channel Hydraulic Calculations |
| APPENDIX E | Cost Estimate |
| APPENDIX F | Figures |
| FIGURE A1: | Vicinity Map |
| FIGURE A2: | Soils Map |
| FIGURE A3: | Floodplain Map |
| FIGURE EX1: | Major Basin / Historic Drainage Plan |
| FIGURE EX2: | Historic Drainage Plan |
| FIGURE D1: | Developed Drainage Plan |
| FIGURE D1.01: | Phase 1 Developed Drainage Plan |
| FIGURE D1.11: | Filing No. 1 Developed Drainage Plan |
| FIGURE D1.12: | East Site Developed Drainage Plan |
| FIGURE C1.5: | Detention Pond C1 Plan & Details |
| FIGURE C1.6: | Detention Pond C2.8 Plan & Details |



**MAYBERRY, COLORADO SPRINGS – FILING NO. 1
FINAL DRAINAGE REPORT
EXECUTIVE SUMMARY**

A. Background

- Mayberry, Colorado Springs (fka “Ellicott Town Center”) is a proposed mixed-use development with an approved PUD consisting of 1,048 residential units, 32-acres of commercial space, and associated land uses. The project is located on a 550.6-acre parcel on the south side of State Highway 94 approximately 2 miles west of Ellicott Highway.
- The proposed Mayberry, Colorado Springs Filing No. 1 subdivision consists of 98 single-family residential units on 228.0 acres at the north end of the development.
- The Mayberry, Colorado Springs Filing No. 1 site is located entirely within the Ellicott Consolidated Drainage Basin, which comprises about 13 square miles, or 8,320 acres. The Mayberry, Colorado Springs development area represents approximately 7 percent of the total area of the Ellicott Consolidated Basin.

B. General Drainage Concept

- Historic drainage from off-site areas upstream of the site will be conveyed through the development within grass-lined drainage swales and channels meandering through dedicated open space areas. These drainage channels will serve as “greenways,” with trails along the drainage channels linked to a network of trails running throughout the development.
- Developed drainage within the site will be conveyed through paved streets with curb and gutter and storm sewers, as well as grass-lined channels and drainage swales through open space areas.


C. Drainage Impacts

- Developed flows from Mayberry, Colorado Springs Filing No. 1 will be detained to historic levels through on-site detention ponds.
- Drainage facilities within public roads will be designed and constructed to El Paso County standards and dedicated to the County for maintenance.
- Drainage facilities such as channels running through private open space areas and detention ponds will be owned and maintained by the metropolitan district.

DRAINAGE STATEMENT

Engineer's Statement:

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



John P. Schwab, P.E. #29891



Developer's Statement:

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

By: 

Printed Name:

Colorado Springs Mayberry LLC
32823 Temecula Parkway, Temecula, CA 92592



Date

4-27-2020

El Paso County's Statement

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

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

Date

Conditions:

FLOODPLAIN STATEMENT

To the best of my knowledge and belief, no parts of the Ellicott Town Center Subdivision are located in a FEMA designated floodplain, as shown on FIRM panel No. 08041C0825F, dated March 17, 1997.

John P. Schwab, P.E. #29891

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Mayberry, Colorado Springs (formerly known as “Ellicott Town Center”) is a proposed subdivision located west of Ellicott, Colorado in El Paso County. The development is located on the south side of State Highway 94, approximately 1-1/2 miles west of Ellicott Highway, as shown in Figure A1 (Appendix F). The approved Ellicott Town Center Sketch Plan includes a total of 1,048 single-family dwelling units and 32 acres of commercial space. Mayberry, Colorado Springs Filing No. 1 consists of 98 single-family residential units on 228.0-acres near the north boundary of the project. Colorado Springs Mayberry, LLC is moving forward with development of Ellicott Town Center Filing No. 1, which was approved by the Board of County Commissioners on April 12, 2007 (Resolution No. 07-132).

B. Scope

This report is provided in support of recording of the “Mayberry, Colorado Springs Filing No. 1 Final Plat.” The report is intended to fulfill the El Paso County requirements for a Preliminary and Final Drainage Report (FDR). The report will provide a summary of site drainage issues impacting the proposed development, including analysis of impacts from upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This FDR report was prepared based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual, providing final design of required drainage facilities for this phase of the project.

C. Site Location and Description

The Ellicott Town Center parcel comprises the west half of Section 14 along with the contiguous east quarter of Section 15, as well the west half of the northeast quarter of Section 14, Township 14 South, Range 63 West of the 6th Principal Meridian. The site is located at an elevation of approximately 6,060 feet above mean sea level. The 550.6-acre site is currently undeveloped, with the exception of the existing Viewpoint Water Tank site at the northwest corner of the parcel. Filing No. 1 comprises 228.0-acres at the north end of the Ellicott Town Center development.

State Highway 94 borders the parcel to the north, and unplatted agricultural properties (zoned A35) border this parcel on the east and south sides. Unplatted property zoned RR3 borders this parcel to the west. The existing 2-1/2-acre lot Viewpoint Estates subdivision (72 lots on 236 acres) is located immediately northwest of this parcel, across State Highway 94. The 5-acre lot Antelope Park Ranchettes subdivision (44 lots on 240 acres) borders Viewpoint Estates to the northwest.

The Ellicott Town Center development will include 1,048 residential lots, along with associated commercial / mixed-use development and an elementary school. Filing No. 1 includes 98 single-

family residential lots at the north end of the development. Site improvements will include overlot grading and curb, gutter, and asphalt paving of the roads within the site.

The primary access to Ellicott Town Center will be provided by construction of New Log Road, which will run through the site from north to south as a minor arterial roadway (120' right-of-way). New Log Road will ultimately intersect with a new extension of Handle Road at the southerly site boundary, which will extend east to the existing Log Road south of SH94. Primary access to Filing No. 1 will be provided through construction of the New Log Road intersection at SH94. Secondary access will be provided through an existing approved access point east of New Log Road along the frontage of the former "Springs East Village" parcel. The secondary access will consist of gravel road extensions of Village Main Street and Springs Road with Filing No. 1. The secondary access road extensions will be paved with the adjoining future filing.

The intermittent streams throughout this area drain into the Black Squirrel Creek Basin which ultimately outfalls into the Arkansas River. The entire Filing No. 1 site is located within the Ellicott Consolidated Drainage Basin (CHBS1200). This basin conveys surface drainage to the West Fork of Black Squirrel Creek, which is located east of this parcel between the site and Ellicott Highway.

The terrain is generally flat with gentle northwest to southeast slopes ranging from one to two percent. Historic drainage patterns from the site are conveyed overland to the south and east boundaries of the site. The entire site is covered with native grasses, except for the existing water tank site at the northwest corner of the parcel.

D. General Soil Conditions

According to the Soil Survey of El Paso County prepared by the Soil Conservation Service, on-site soils are comprised primarily of "Blakeland series (type 8)" soils (see Figure A2). The Blakeland soils are characterized as well-drained loamy sand with rapid permeability, slow surface runoff rates, and moderate hazard of erosion. These soils are classified as hydrologic soils group "A" for drainage analysis purposes.

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," 2004.

David R. Sellon & Associates Inc., "Antelope Park Ranchettes Interior Drainage Plan," March, 1972.

El Paso County Planning Department, “Ellicott Valley Comprehensive Plan,” March, 1989.

El Paso County “Engineering Criteria Manual,” January 9, 2006.

El Paso County Resolution No. 15-042 (El Paso County adoption of “Chapter 6: Hydrology” and “Chapter 13, Section 3.2.1: Full Spectrum Detention” of the City of Colorado Springs Drainage Criteria Manual dated May 2014).

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C1025-F, March 17, 1997.

JPS Engineering, “Master Development Drainage Plan for Ellicott Town Center,” November 22, 2005 (Approved by El Paso County 12/02/05).

JPS Engineering, “Master Development Drainage Plan and Preliminary Drainage Report for Springs East Village,” March 21, 2002 (Approved by El Paso County 10/23/02).

JPS Engineering, “Master Development Drainage Plan and Preliminary Drainage Report for Viewpoint Village,” January 28, 2002 (Approved by El Paso County 9/11/02).

JPS Engineering, “Preliminary Drainage Report for Ellicott Town Center - Phase 1,” January 15, 2007.

Leigh Whitehead & Associates, Inc., “Master Development Drainage Plan for Sunset Village,” May, 2000 (Approved by El Paso County 8/31/00).

Pacific Summits Engineering, “Final Drainage Report for Viewpoint Estates,” January 6, 1998 (Approved by El Paso County 10/6/99).

United Planning and Engineering, “Preliminary Drainage Plan & Report for Springs East,” November 19, 1999.

United Planning and Engineering, “Drainage Plan & Report for Viewpoint Subdivision,” May, 2000.

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 primarily within the Ellicott Consolidated Drainage Basin (CHBS1200) as classified by El Paso County. This basin is comprised of the area tributary to the West Fork of Black Squirrel Creek, with the majority of the basin bounded by SH94 to the north

and Ellicott Highway to the east. No drainage planning study has been completed for the Ellicott Consolidated Drainage Basin or any adjacent drainage basins. El Paso County approved the “Sunset Village Master Development Drainage Plan (MDDP)” prepared by Leigh Whitehead. This MDDP covers the adjacent Telephone Exchange Drainage Basin, which borders the Ellicott Town Center parcel to the west. Based on the Drainage Report for Viewpoint Estates, stormwater detention ponds were constructed to maintain historic flows leaving the upstream developed areas. As such, the drainage analysis for major basins impacting the site will assume that historic flows enter this parcel from upstream.

The major drainage basins lying in and around the proposed development are depicted in Figure EX1. Ellicott Town Center is located primarily within the Ellicott Consolidated Drainage Basin, which comprises a tributary area of about 13 square miles, or 8,320 acres. The proposed subdivision represents a total of 551 acres of development, or 7 percent of the total basin area. An “on-site” drainage planning approach has been proposed based on the relatively small developed area in comparison to the remaining undeveloped basin area, which is primarily agricultural land.

The existing site topography has several off-site drainage basins that enter the north and west boundaries of the Ellicott Town Center parcel. Triple 30-inch CMP culverts cross SH94 at several locations along the north boundary of the site. These off-site basins combine with on-site flows, following existing grass-lined swales southeasterly through the site. The site historically consists of five major basins conveying flows towards the south and eastern boundaries of the site, as shown in Figure EX2. Flows from the majority of the site (Basins B-E) combine with the tributary areas downstream of the site, flowing southeasterly to an existing natural channel towards Black Squirrel Creek.

This western tributary downstream of the Ellicott Town Center parcel overtops Ellicott Highway at a low point 2-1/2 miles south of SH94 and combines with the West Fork of Black Squirrel Creek on the east side of Ellicott Highway. The roadway crossing significantly downstream of this site is an existing deficiency, and a future culvert should be constructed at the low point in Ellicott Highway in conjunction with future County roadway improvements.

Flows from the southwest corner of the site (Basins A and BB) combine with the tributary area in the Telephone Exchange Basin identified as Basin A32 (2.89 sm; $Q_5 = 92$ cfs, $Q_{100} = 438$ cfs) in the Sunset Village MDDP. This basin flows southeasterly and ultimately crosses Enoch Road and Ellicott Highway at the northeast corner of the Sunset Village Development.

B. Floodplain Impacts

Ellicott Town Center is located approximately one mile southwest of the 100-year floodplain limits for the West Fork of Black Squirrel Creek, as delineated by the Federal Emergency Management Agency (FEMA). The floodplain limits in the vicinity of the site are shown in Flood Insurance Rate Map (FIRM) Number 08041C0810G, dated December 7, 2018 (see Figure A3).

C. Sub-Basin Description

The developed drainage basins lying within the proposed development are depicted in Figure D1. The interior site layout has been delineated into several drainage basins (A-E) based on the proposed interior road layout and grading scheme. The natural drainage patterns will be impacted through development by site grading and concentration of runoff in subdivision street gutters, storm drains, and channels. The majority of sub-basins drain to the southeast, collecting in the interior roads and drainage channels. On-site flows will be diverted to proposed detention ponds located at the south and east boundaries of the site, and detained runoff flows will discharge to the southeast, following historic drainage paths.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

The Ellicott Consolidated Drainage Basin has not had a Drainage Basin Planning Study performed for the basin. The majority of areas within the basin are comprised of agricultural lands and rural residential uses.

A “Master Development Drainage Plan (MDDP)” for Ellicott Town Center was approved concurrent with the Amended Sketch Plan submittal, and a Preliminary Drainage Report for Phase One was approved with the Phase One PUD and Preliminary Plan. This Final Drainage Report fully conforms to the previously approved MDDP and Preliminary Drainage Report.

B. Hydrologic Criteria

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

- | | |
|---|---|
| • Design storm (minor) | 5-year |
| • Design storm (major) | 100-year |
| • Storm distribution | SCS Type IIA (eastern Colorado) |
| • 100-year, 24-hour rainfall | 4.4 inches per hour (NOAA isopluvial map) |
| • 5-year, 24-hour rainfall | 2.6 inches per hour (NOAA isopluvial map) |
| • Hydrologic soil type | B |
| • SCS curve number - undeveloped conditions | 61 (pasture / range) |
| • SCS curve number - developed conditions | 80 (1/8-1/4 acre lots) |
| • SCS curve number - developed conditions | 92 (commercial areas) |

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 | A | |
| | <u>C5</u> | <u>C100</u> |
| • Runoff Coefficients - undeveloped: | | |
| Existing pasture/range areas | 0.25 | 0.35 |
| • Runoff Coefficients - developed: | | |
| Proposed Residential (1/8-1/4 acre lots) | 0.375 | 0.545 |
| Proposed Neighborhood Commercial | 0.49 | 0.62 |

Composite runoff coefficients for the developed residential areas have been calculated based on average lot sizes between 1/8-acre and 1/4-acre. Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage basin drawings. While the hydrologic modeling spreadsheets in Appendix B provide comprehensive preliminary information for the overall Ellicott Town Center project, only the design points associated with Basin C are applicable to this Final Drainage Report.

IV. DRAINAGE PLANNING FOUR STEP PROCESS

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

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

Step 1: Employ Runoff Reduction Practices

- **Minimize Impacts:** The approved Planned Unit Development includes significant open space, play areas, and parks, resulting in a moderate level of impervious site development.
- **Minimize Directly Connected Impervious Areas (MDCIA):** The proposed development will include landscaped areas adjoining the proposed building and parking lots, providing for impervious areas to drain across pervious areas where feasible.
- **Grass Swales:** The proposed drainage plan incorporates grass-lined swales in selected locations to encourage stormwater infiltration while providing positive drainage through the site.

Step 2: Stabilize Drainageways

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

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The developed areas of the site will drain through proposed Full-Spectrum Extended Detention Basins (EDB) southeast of the developed areas. Site drainage will be routed through the extended detention basins, which will capture and slowly release the WQCV over an extended release period.
- Stormwater detention and WQCV for Filing No. 1 will be provided by Detention Pond C1, with the exception of a small area along the easterly fringe of the Filing No. 1. The narrow easterly strip will sheet flow into grass-lined Channel C1-C3 providing water quality for this small area.

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial or commercial land uses are proposed as part of the Filing No. 1 development.

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

Consistent with generally accepted practices in eastern El Paso County, the general concept for management of stormwater from development of Ellicott Town Center will be to construct several stormwater detention ponds along the south and east boundaries of the site to mitigate the impacts of developed runoff flows from the site.

Development of the Ellicott Town Center project will require site grading and paving, resulting in additional impervious areas across the site. The general drainage pattern will consist of grading away from home sites to swales and gutters along the internal roads within the subdivision, conveying runoff flows through the site. Runoff from the site will flow by street gutters to curb inlets at low points and road intersections, thence by storm drains and drainage channels to the proposed detention ponds. The storm inlets and storm sewer system within the development will be designed as the “minor” drainage system, sized for 5-year developed peak flows. The internal road system, drainage channels, and detention ponds will be designed as the “major” drainage system, sized for 100-year peak flows. Street flows within subdivision streets will be maintained below allowable levels in accordance with El Paso County drainage criteria.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions are depicted in Figure EX2. The site has been divided into six major basins (A, B, BB, C, D, and E). The undeveloped site currently has no drainage facilities within the parcel. The existing off-site drainage basins northwest of the site generally combine with on-site basins as shown on Figure EX2, flowing southeasterly through the site within existing grass-lined drainage swales and channels.

The Viewpoint Estates subdivision northwest of this site included two stormwater detention ponds on the north side of State Highway 94. As detailed in Appendix B1, rational method drainage calculations for upstream off-site Basins OA2 and EC12 have been calculated based on equivalent areas to reflect the design pond discharge rates as presented in the approved drainage report for Viewpoint Estates.

The site is impacted by several large off-site drainage areas within the Ellicott Consolidated Drainage Basin. Off-site flows from Basin EC11 north of this property cross State Highway 94 in a triple 30-inch CMP culvert crossing, and continue flowing southeasterly through an existing grass-lined swale across Basin D to Design Point #5, with historic peak flows of $Q_5 = 30.6$ cfs and $Q_{100} = 174.9$ cfs (SCS Method).

Off-site flows from Basin EC10 north of this property cross State Highway 94 in another triple 30-inch CMP culvert crossing near the northeast corner of this site. These flows drain through an existing grass-lined swale across Basin E to Design Point #6, with historic peak flows of $Q_5 = 19.1$ cfs and $Q_{100} = 111.4$ cfs (SCS Method). As shown on Sheet EX2, two existing driveway culverts on the south side of SH94 convey flows from the roadside ditch on the south side of SH94 easterly to converge with the existing swale on the downstream side of the triple 30-inch CMP culverts, combining with Basin EC10. These flows continue southeasterly in the existing swale within Basin E.

Drainage from Basins A-C continues flowing southeasterly off-site within existing broad natural channels through the adjoining properties to the south and east. The downstream drainage continues southeast to a more defined natural channel, forming the West Tributary to the Middle Fork of Black Squirrel Creek. Historic drainage from Basins D and E flows southeast to the westerly ditch along "Old" Log Road, then turns east and follows the southerly ditch of Handle Road to its confluence with the main channel of the Middle Fork of Black Squirrel Creek.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in Figures D1, D1.01, and D1.11 (Appendix F). The developed site has been divided into five major basins (A-E) and six major design points (DP1-DP6), as shown on the enclosed Drainage Plan. Hydrologic flow schematics and calculations are enclosed in Appendix B. The development of Ellicott Town Center Phase One lies within Basins C, D, and E, and developed flows from the initial phase of the project impact Design Points #5 and #6.

Off-site Basin EC11 will combine with flows from on-site Basins C and D at Design Point #5, with undetained developed peak flows of $Q_5 = 226.6$ cfs and $Q_{100} = 461.4$ cfs. Developed flows at this location will be detained to historic levels by routing flows through the proposed Detention Ponds C1, C4, and D prior to discharging at the easterly site boundary. Detention Pond C1 will be located at the southeast corner of the Filing No. 1 development area, and this pond will be constructed with the initial phase of development.

Off-site flows from Basin EC11 will be conveyed southerly through Channel C1 along the east side of Filing No. 1. Culverts C1.1, C1.6, and C1.9 will convey the off-site flows from Basin EC11 across the Phase 1 subdivision streets.

Storm sewer C1.2-C1.5A consists of a 30"-42" RCP system extending east on Village Main Street from Market Place Drive to connect with Storm Sewer C1.6 at the east boundary of Filing No. 1. Flows from Basins C1.2, C1.3, C1.4, C1.5, and C1.6 will be intercepted by storm inlets discharging into this system.

Storm sewer C1.8 consists of a 24-inch RCP storm sewer extending east on Mayberry Drive from Garden Park Avenue to connect with Storm Sewer C1.9 at the east boundary of Filing No. 1.

Combined Filing No. 1 flows from Basins C1.1-C1.9 will drain to Detention Pond C1 at the southeast corner of Filing No. 1. Developed peak flows entering Detention Pond C1 at Design Point #C1.10A are calculated as $Q_5 = 39.4$ cfs and $Q_{100} = 96.1$ cfs (Rational Method).

Future Detention Ponds C4 and D will mitigate developed drainage impacts from the development areas south and east of Filing No. 1, and the net discharge downstream of Design Point #5 will remain at historic levels.

3. Emergency Conditions Analysis

In the event of clogging, the storm inlets within the Filing No. 1 development area will overflow to the adjoining public streets, which all flow southeasterly. Emergency overflows would sheet flow southeasterly along the public streets, flowing into Detention Pond C1 and Channel C1-C3.

There are no significant upstream developed areas and no off-site detention facilities impacting the Filing No. 1 area.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the total developed flows from the site will exceed historic flows from the parcel. Due to the increased impervious areas in the developed site, the total undetained flow from the site would be significantly higher than the historic flow. The increase in developed flows will be mitigated by on-site stormwater detention ponds. The comparison of developed to historic discharges at key design points is summarized as follows:

| Design Point | Historic Flow | | | Developed Flow | | | Comparison of Developed to Historic Flow ($Q_5\%/Q_{100}\%$) |
|--------------|---------------|-------------|-----------------|----------------|-------------|-----------------|--|
| | Area (ac) | Q_5 (cfs) | Q_{100} (cfs) | Area (ac) | Q_5 (cfs) | Q_{100} (cfs) | |
| 5 | 508.2 | 30.6 | 174.9 | 512.9 | 226.6 | 461.4 | 741% / 264% (increase) ¹ |
| 6 | 324.7 | 19.1 | 111.4 | 319.7 | 19.0 | 111.0 | 99.5% / 99.6% (decrease) |

¹ Calculated developed flows to be detained to historic levels through on-site detention ponds

² Calculated 100-year historic flows of approx. 0.2-0.3 cfs/acre are generally consistent with pre-development flow estimates in Colorado Springs 2014 DCM Table 13-2

D. Detention Ponds

The total developed storm runoff downstream of the Filing No. 1 site will be maintained at historic levels by routing flows through the proposed Detention Pond C1 located southeast of the Filing No. 1 development area. The proposed detention facility has been sized to attenuate peak flows through the pond, based on the difference between outflow and inflow hydrographs.

Final pond sizing was performed based on a pond routing analysis utilizing the “UD-Detention” software package (see Appendix C), resulting in the following pond sizing parameters:

| Pond | Peak Inflow (Q₁₀₀, cfs) | Peak Outflow (Q₁₀₀, cfs) | Volume (ac-ft) |
|-------------|---|--|---------------------------|
| C1 | 63.7 | 11.5 | 5.0 |

Future Detention Ponds C4 and D will ultimately mitigate developed drainage impacts from the development areas south and east of Filing No. 1.

Temporary Detention Pond C2.8 will also be constructed at the northwest corner of Springs Road and Village Main Street with the initial phase of development. This pond will meet water quality requirements for the interim development areas east of the Filing No. 1 lots until Detention Pond D is constructed during a future development phase. Design calculations for Detention Pond C2.8 are also enclosed in Appendix C.

The proposed detention ponds will be privately owned and maintained by the Homeowners Association or Metropolitan District, under the terms of a “Private Detention Basin Maintenance Agreement” that will be recorded during final platting. Gravel maintenance access roads will be provided around the perimeter of detention pond to facilitate maintenance access.

The pond outlet structures will be designed to release historic flows southeast of the site towards the existing natural swale downstream. Based on the proposed approach of reducing developed flows to historic levels at the site boundaries, no significant downstream drainage impacts are anticipated, and no downstream drainage improvements are proposed.

E. On-Site Drainage Facility Design

Developed sub-basins and proposed drainage improvements are depicted in the enclosed Drainage Plan (Figure D1, D1.01, and D1.11). Hydraulic calculations for sizing of on-site drainage facilities are enclosed in Appendix D, and summarized as follows:

1. Street / Curb & Gutter Capacity

The interior roads on this relatively flat parcel will be graded with a minimum longitudinal slope of 1.0 percent. In accordance with Colorado Springs and El Paso County Drainage Criteria, the allowable minor storm street capacity for residential streets at minimum slope is approximately 12 cfs per side. Storm inlets will be installed at low points and intersections, and other locations where allowable street capacities are exceeded.

Street flow patterns within Filing No. 1 are depicted on Sh. D1.11 (Appendix F). Street drainage will flow easterly along the north side of Cattlemen Run to DP-C1.1 ($Q_5 = 5.4$ cfs and $Q_{100} = 18.0$ cfs), where these flows will be intercepted by Inlet C1.1 (10' Type R). Inlet C1.6A (5' Type R) will intercept flow from the south curb line of Cattlemen Run, and these combined flows will be conveyed south through Storm Sewer C1.6A (24") to junction Manhole C1.6C at the intersection with Village Main Street.

Street drainage will flow southerly along the west side of Marketplace Drive and easterly along the north side of Village Main Street to DP-C1.2 ($Q_5 = 16.9$ cfs and $Q_{100} = 35.9$ cfs), where these flows will be intercepted by Inlet C1.2 (10' Type R). An interim culvert will extend northwesterly from the back side of Inlet C1.2 to intercept sheet flow from the future development tract to the northwest. Flows from Inlets C1.7A, C1.7B, and C1.2 will combine in junction Manhole C1.2D, and the combined flows will be conveyed easterly through Storm Sewer C1.2D (36" RCP) to junction Manhole C1.3A at the intersection with Indian Grass Street.

Street drainage will flow southerly along the west side of Indian Grass Street and easterly along the north side of Village Main Street to DP-C1.3 ($Q_5 = 5.9$ cfs and $Q_{100} = 14.3$ cfs), where these flows will be intercepted by Inlet C1.3 (10' Type R), and conveyed to junction Manhole C1.3A. The combined flows will continue easterly through Storm Sewer C1.3A (36" RCP) to junction Manhole C1.4A at the intersection with Garden Park Avenue.

Street drainage will flow southerly along the west side of Garden Park Avenue and easterly along the north side of Village Main Street to DP-C1.4 ($Q_5 = 6.3$ cfs and $Q_{100} = 15.3$ cfs), where these flows will be intercepted by Inlet C1.4 (10' Type R), and conveyed to junction Manhole C1.4A. The combined flows will continue easterly through Storm Sewer C1.4A (42" RCP) to junction Manhole C1.5A at the intersection with Blanket Flower Street.

Street drainage will flow southerly along the west side of Blanket Flower Street and easterly along the north side of Village Main Street to DP-C1.5 ($Q_5 = 6.2$ cfs and $Q_{100} = 15.6$ cfs), where these flows will be intercepted by Inlet C1.5 (10' Type R), and conveyed to junction Manhole C1.5A. The combined flows will continue easterly through Storm Sewer C1.5A (42" RCP) to junction Manhole C1.6C at the intersection with Storm Sewer C1.6B, flowing south to Detention Pond C1.

Street drainage will flow southerly along the west side of Garden Park Avenue and easterly along the north side of Mayberry Drive to DP-C1.8 ($Q_5 = 7.5$ cfs and $Q_{100} = 18.4$ cfs), where these flows will be intercepted by Inlet C1.8 (10' Type R) and conveyed to Manhole C1.8. Storm Sewer C1.8 (24" RCP) will flow easterly to junction Manhole C1.9C at the intersection with Storm Sewer C1.6C.

On the east side of Garden Park Avenue, street drainage will flow easterly along the north side of Mayberry Drive to DP-C1.9 ($Q_5 = 7.0$ cfs and $Q_{100} = 17.0$ cfs) at the southeast corner of the Filing No. 1 residential area, where these flows will be intercepted by Inlet C1.9A (10' Type R) and conveyed to junction Manhole 1.9C. The combined flows will continue south through Storm Sewer C1.9C (60" RCP) into Detention Pond C1.

2. Storm Sewer System

CDOT Type R curb-opening inlets will be specified where required along the interior streets. These inlets will convey runoff to a storm sewer system consisting of reinforced concrete pipe (RCP) pipe, with a minimum pipe diameter of 18-inches. Inlet sizes have been determined based on a maximum allowable ponding depth of 12 inches for the major (100-year) storm, including a 20 percent clogging factor. Storm sewer sizing has been developed assuming full flow conditions with minor storm flows at the proposed minimum slope for each pipe segment. Storm sewer pipe slopes were set based on proposed street grades and detention pond bottom elevations at the storm sewer system outfall.

Riprap outlet protection sized for the 100-year storm event will be provided for erosion control at culvert and storm sewer pipe outlets. Sizing parameters and hydraulic grade line (HGL) calculations for the proposed storm sewer system are detailed in Appendix D1.

Hydraulic calculations for the proposed culvert pipes are detailed in Appendix D2.

3. Open Channels

Major drainage channels running through the proposed open space areas to the detention ponds at the site boundaries. These channels will generally be designed as stable grass-lined channels with subcritical flow regimes. Drainage channels will be designed to convey 100-year flows, with trapezoidal cross-sections, side slopes of 4:1, and minimum freeboard of 1-foot. The proposed channels will be seeded with native grasses for erosion control, and erosion control blanket (ECB) linings will be provided where needed based on calculated velocities. Hydraulic calculations for sizing the open channels are enclosed in Appendix D3, assuming a Manning's "n" value of 0.030 for non-irrigated native grass channels.

F. Analysis of Existing and Proposed Downstream Facilities

The general concept of the proposed drainage plan is to attenuate peak flows from the developed site by routing flows through the proposed on-site detention ponds. Combined flows from the Ellicott Town Center site flow southeasterly towards the existing Middle Fork of Black Squirrel Creek. The existing channels downstream of the site consist of broad grass-lined swales with no signs of active erosion. As previously discussed, there is an existing drainage crossing of Ellicott Highway approximately 2-1/2 miles downstream of this site where a future culvert should be installed. Recognizing that this historically deficient crossing is miles downstream of the site, no cost contribution to this off-site drainage improvement was requested during previous approval of the Ellicott Town Center MDDP, and no contribution is proposed at this time.

On-site stormwater detention ponds will be provided to mitigate developed drainage impacts, so no off-site or downstream drainage improvements are proposed.

G. Anticipated Drainage Problems and Solutions

The proposed stormwater detention ponds are designed to mitigate the impacts of developed drainage from this project. The overall drainage plan for the subdivision includes a system of improved public streets with curb and gutter, storm inlets, and storm sewers conveying developed flows to improved drainage channels running through the site. The primary drainage problems anticipated within this development will consist of maintenance of these storm sewer systems, culverts, drainage channels, and detention pond facilities. Care will need to be taken to implement proper erosion control measures in the proposed channels and swales, which will be designed to meet allowable velocity criteria.

A trail system will be constructed along the major drainage channels to provide maintenance access to the drainage facilities throughout the development. Proper construction and maintenance of the proposed detention facilities will minimize downstream drainage impacts. The proposed public streets will be owned and maintained by El Paso County. The proposed detention ponds and channels running through open space tracts and storm drains through private alleys will be privately owned and maintained by the homeowners association or metropolitan district.

VII. EROSION CONTROL

The Contractor will be required to implement best management practices (BMP's) for erosion control during construction. The proposed erosion control plan is included in the Grading & Erosion Control (GEC) Plans submitted with the subdivision construction drawings. Erosion control measures will include installation of silt fence at the toe of disturbed slopes and hay bales protecting drainage ditches. Cut and fill slopes will be stabilized during excavation if necessary and vegetation will be established for stabilization of the disturbed areas. All ditches have been designed to meet El Paso County criteria for slope and velocity.

Additionally, gravel vehicle tracking pads will be installed at construction access points and inlet protection will be provided to minimize conveyance of sediment into storm inlets.

Construction of the proposed stormwater detention pond will be phased at the beginning of overlot grading work to serve as a temporary sediment pond during the construction phase. Accumulated sediment will have to be removed from the pond prior to completion of sitework to restore design capacity of the detention pond.

VIII. COST ESTIMATE AND DRAINAGE FEES

The developer will pay all capital costs for Filing No. 1 roadway and drainage improvements. The engineer's cost estimate for proposed drainage improvements is approximately \$594,090, as detailed in Appendix E.

The Mayberry, Colorado Springs Filing No. 1 parcel is located entirely within the Ellicott Consolidated Drainage Basin, which currently does not have a drainage or bridge fee requirement. As such, no basin fees are applicable.

IX. MAINTENANCE

All proposed road and drainage construction within the Ellicott Town Center project will be performed to El Paso County Standards. Interior roads will be dedicated as public right-of-way. Roads and drainage facilities within the public right-of-way will be maintained by El Paso County upon final acceptance of these facilities after the warranty period. The Homeowners Association or Metropolitan District will maintain drainage channels and stormwater detention ponds within the proposed open space areas.

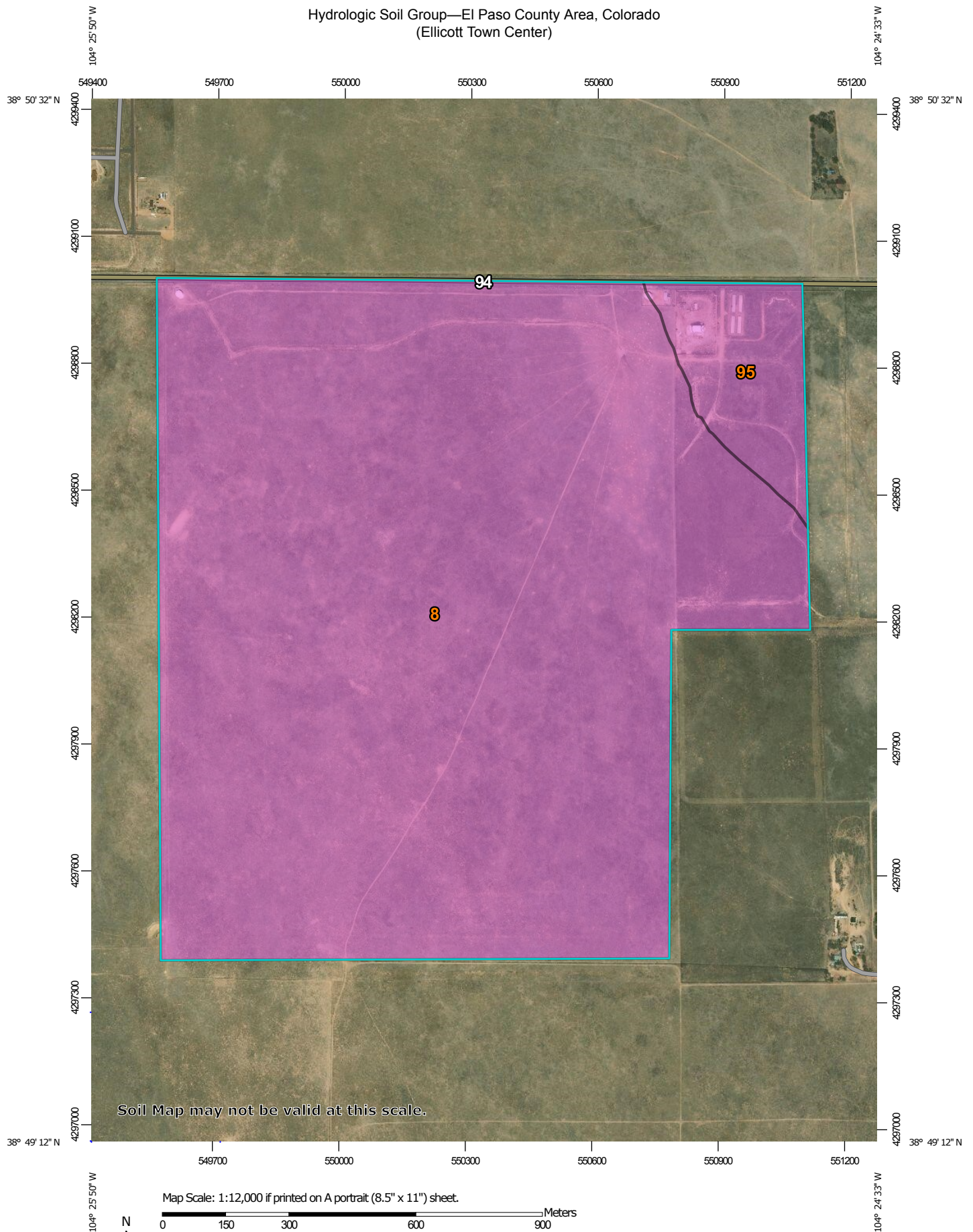
X. SUMMARY

Mayberry, Colorado Springs (fka "Ellicott Town Center") Filing No. 1 consists of 98 residential lots at the north end of the development, with access connections to State Highway 94 at New Log Road and Springs Road. The Mayberry, Colorado Springs development will generate an increase in undetained developed runoff from the site, which will be mitigated through on-site stormwater detention facilities.

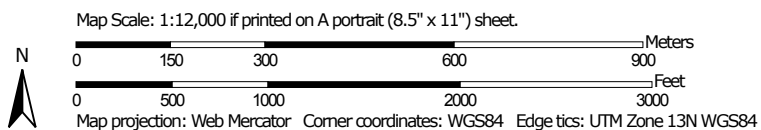
The proposed drainage patterns will remain consistent with historic conditions, and new drainage facilities constructed to El Paso County standards will safely convey runoff to adequate outfalls. Construction of the proposed Detention Pond C1 southeast of the Filing No. 1 development area will ensure that developed flows from Mayberry, Colorado Springs Filing No. 1 remain below historic levels. Construction and proper maintenance of the proposed drainage and erosion control facilities will ensure that this subdivision has no significant adverse drainage impacts on downstream or surrounding areas.

APPENDIX A
SCS SOILS INFORMATION

Hydrologic Soil Group—El Paso County Area, Colorado (Ellicott Town Center)



Soil Map may not be valid at this scale.



is severely eroded and blowouts have developed, the new seeding should be fertilized.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for 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 necessary 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 wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, the provision of undisturbed nesting cover is vital and should be included in plans for habitat development. 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 use as homesites. Shallow excavation is severely limited because cut banks cave in. This sandy soil requires special management practices to reduce water erosion and soil blowing. Capability subclasses IIIe, irrigated, and IVe, nonirrigated.

7—Bijou sandy loam, 3 to 8 percent slopes. This deep, well drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 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 brown sandy loam about 4 inches thick. The subsoil is brown or grayish brown sandy loam about 24 inches thick. The substratum is pale brown loamy coarse sand.

Included with this soil in mapping are small areas of Olney sandy loam, 3 to 5 percent slopes; Valent sand, 1 to 9 percent slopes; Vona sandy loam, 3 to 9 percent slopes; and Wigton loamy sand, 1 to 8 percent slopes.

Permeability of this Bijou soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Organic matter content of the surface layer is low. Surface runoff is slow, and the hazards of erosion and soil blowing are moderate.

Almost all areas of this soil are used for range.

This soil is suited to the production of native vegetation suitable for grazing. Because of the hazards of water erosion and soil blowing, the soil is not suited to nonirrigated crops.

Native vegetation is dominantly blue grama, sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is a suitable practice if the range has deteriorated. Seeding the native grasses is a good practice. If the range is severely eroded and blowouts have developed, the new seeding should be fertilized. Brush control and grazing management may be needed to improve the depleted range. Grazing should be managed so that enough forage is left standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for 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 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, by properly managing livestock grazing, and by reseeding range where needed.

This soil has good potential for use as homesites. Shallow excavation is severely limited because cut banks cave in. This soil requires special management practices to reduce water erosion and soil blowing. Capability subclass VIe.

*** 8—Blakeland loamy sand, 1 to 9 percent slopes.** This deep, somewhat excessively drained soil formed in alluvial and eolian material derived from arkosic sedimentary rock on uplands. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches.

Included with this soil in mapping are small areas of Bresser sandy loam, 0 to 3 percent slopes; Bresser sandy loam, 3 to 5 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; Truckton sandy loam, 3 to 9 percent slopes; and Stapleton sandy loam, 3 to 8 percent slopes. In some areas, mainly north of Colorado Springs in the Cottonwood Creek area, arkosic beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Blakeland soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Organic matter content of the surface layer is medium. Surface runoff is slow, the hazard of erosion is moderate, and the hazard of soil blowing is severe.

Most areas of this soil are used for range, homesites, and wildlife habitat.

Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. This soil is best suited to deep-rooted grasses.

Proper range management is necessary to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is 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.

This soil 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.

This soil has good potential for urban development. Soil blowing is a hazard if protective vegetation is removed. Special erosion control practices must be provided to minimize soil losses. Capability subclass VIe.

9—Blakeland complex, 1 to 9 percent slopes. This complex is on uplands, mostly in the Falcon area. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the frost-free period is about 135 days.

This complex is about 60 percent Blakeland loamy sand, about 30 percent Fluvaquent Haplaquolls, and 10 percent other soils.

Included with these soils in mapping are areas of Columbine gravelly sandy loam, 0 to 3 percent slopes, Ellicott loamy coarse sand, 0 to 5 percent slopes, and Ustic Torrifluvents, loamy.

The Blakeland soil is in the more sloping areas. It is deep and somewhat excessively drained. It formed in sandy alluvium and eolian material derived from arkosic sedimentary rock. Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches or more.

Permeability of the Blakeland soil is rapid. The effective rooting depth is more than 60 inches. The available water capacity is moderate to low. Surface runoff is slow, and the hazard of erosion is moderate.

The Fluvaquent Haplaquolls are in swale areas. They are deep, poorly drained soils. They formed in alluvium derived from arkosic sedimentary rock. Typically, the surface layer is brown. The texture is variable throughout. The water table is at a depth of 0 to 3 feet.

The Blakeland soil is well suited to deep-rooted grasses. Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. Rangeland vegetation on the Fluvaquent Haplaquolls is dominantly tall grasses, including sand bluestem, switchgrass, prairie cordgrass, little bluestem, and sand reedgrass. Cattails and bulrushes are common in the swampy areas.

Proper range management is needed to prevent excess removal of plant cover from these soils. It is also needed to maintain the productive grasses. Interseeding improves the existing vegetation. Deferment of grazing during the growing season increases plant vigor and soil stability, and it helps to maintain and improve range condition. Proper location of livestock watering facilities helps to control grazing of animals.

Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and low available water capacity are the main limitations to 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.

The Blakeland soil is well 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. Wetland wildlife can be attracted to the Fluvaquent Haplaquolls and the wetland habitat can be enhanced by several means. Shallow water developments can be created by digging or by blasting potholes to create open-water areas. Fencing to control livestock grazing is beneficial, and it allows wetland plants such as cattails, reed canarygrass, and rushes to grow. Control of unplanned burning and prevention of drainage that would remove water from the wetlands are good practices. Openland wildlife use the vegetation on these soils for nesting and escape cover. These shallow marsh areas are especially important for winter cover if natural vegetation is allowed to grow.

The Blakeland soil has good potential for homesites, roads, and streets. It needs to be protected from erosion when vegetation has been removed from building sites. The Fluvaquent Haplaquolls have poor potential for homesites. Their main limitations for this use are the high water table and the hazard of flooding. Capability subclass VIe.

10—Blendon sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in sandy arkosic alluvium on alluvial fans and terraces. The average annual precipitation is about 15 inches, the mean annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Permeability of the Crowfoot soil is moderate. 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 soils in this complex are used as rangeland, for recreation and 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.

Proper location of 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 main 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 species, 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.

The main limitations for urban uses are frost-action potential and slope on the Crowfoot soil and slope on the Tomah soil. Buildings and roads must be designed to overcome these limitations. Access roads must have adequate cut-slope grade and be provided with drains to control surface runoff. Maintaining the existing vegetation on building sites during construction helps to control erosion. Capability subclass VIe.

94—Travessilla-Rock outcrop complex, 8 to 90 percent slopes. This moderately sloping to extremely steep complex is mostly on rocky uplands (fig. 5). Elevation ranges from 6,200 to 6,700 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 140 days.

The Travessilla soil makes up about 45 percent of the complex. Rock outcrop about 30 percent, and included areas about 25 percent.

Included with this complex in mapping are areas of Bresser sandy loam, 5 to 9 percent slopes, Elbeth sandy loam, 8 to 15 percent slopes, Kettle gravelly loamy sand, 8 to 40 percent slopes, and Louviers silty clay loam, 3 to 18 percent slopes. The Elbeth and Kettle soils commonly are on the north-facing slopes.

The Travessilla soil is shallow and well drained. It formed in residuum derived from sandstone. Typically, the surface layer is light brownish gray sandy loam about 3 inches thick. The underlying material is pale brown sandy loam about 8 inches thick. Hard arkosic sandstone that has some fractures is at a depth of about 11 inches.

Permeability of the Travessilla soil is moderately rapid. Effective rooting depth is 6 to 20 inches. Available water capacity is low. Surface runoff is medium to rapid, and the hazard of erosion is high. Gullies are common along drainageways and trails.

Rock outcrop occurs mostly as ledges on cliffs.

This complex is used for urban development, as homesites, and for recreation and wildlife habitat.

This complex is suited to the production of ponderosa pine. The main limitations are the presence of stones and rock outcrop on the surface and a high hazard of erosion. Stones on the surface can hinder felling, yarding, and other operations involving the use of equipment. Practices must be used to minimize soil erosion when harvesting timber. The low available water capacity can influence seedling survival.

Wildlife on these soils is limited mostly to small animals such as cottontail, squirrel, and birds because of the extent of urban development. Ponderosa pine, mountain-mahogany, Gambel oak, and various grasses provide food, cover, and nesting areas.

This complex is extensively used for urban development and as homesites (fig. 6). The main limitations for these uses are depth to bedrock, rock outcrop, and steep slopes. Septic tank absorption fields do not function properly because of the depth to bedrock. Special designs for buildings and roads and streets are needed to overcome the limitations. Plans for homesite development should provide for the preservation of as many trees as possible because of their esthetic value. Capability subclass VIIe.

95—Truckton loamy sand, 1 to 9 percent slopes. This deep, well drained soil formed in alluvium and residuum derived from arkosic sedimentary rock on uplands. Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown loamy sand about 8 inches thick. The subsoil is brown sandy loam about 18 inches thick. The substratum is light yellowish brown coarse sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Blakeland loamy sand, 1 to 9 percent slopes; Bresser sandy loam, 3 to 5 percent slopes; Bresser sandy loam, 5 to 9 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; and Truckton sandy loam, 3 to 9 percent slopes.

Permeability of this Truckton 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 moderate to high.

Almost all areas of this soil are used as rangeland. A few areas of crops such as alfalfa and corn are grown under sprinkler irrigation.

This soil is well suited to the production of native vegetation suitable for grazing. It is best suited to deep-rooted grasses. The native vegetation is mainly cool- and warm-season grasses such as western wheatgrass, side-oats grama, and needleandthread.

Proper range management is needed to prevent excessive removal of the plant cover. Interseeding is used to improve the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Properly locating livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand is the main limitation for the establishment of trees and shrubs. The soil is 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.

This soil is suited to wildlife habitat. It is best suited to 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 use as homesites. The main limitation of this soil for roads and streets is frost action potential. Special designs for roads are needed to minimize this limitation. Practices are needed to control soil blowing and water erosion on construction sites where the plant cover has been removed. Capability subclass VIe, nonirrigated.

96—Truckton sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in alluvium and residuum derived from arkosic sedimentary rock on uplands. Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown sandy loam about 5 inches thick. The next layer is dark grayish brown sandy loam about 3 inches thick. The subsoil is brown sandy loam about 16 inches thick. The substratum is light yellowish brown coarse sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Blakeland loamy sand, 1 to 9 percent slopes; Bresser sandy loam, 0 to 3 percent slopes; Ellicott loamy coarse sand, 0 to 5 percent slopes; and Ustic Torrifluvents, loamy.

Permeability of this Truckton soil is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the hazards of erosion and soil blowing are moderate.

This soil is used mainly for cultivated crops. It is also used for livestock grazing, for wildlife habitat, and as homesites.

Crops are commonly grown in combination with summer fallow because moisture is insufficient for annual cropping. Alfalfa can also be grown on this soil. When this soil is used as cropland, crop residue management and minimum tillage are necessary conservation practices.

This soil is well suited to the production of native vegetation suitable for grazing (fig. 7). It favors deep-rooted grasses. The native vegetation is mainly cool- and warm-season grasses such as western wheatgrass, side-oats grama, and needleandthread.

Proper range management is needed to prevent excessive removal of the plant cover. Interseeding is used to improve the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Properly locating livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. 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 wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, undisturbed nesting cover is vital and should be provided in plans for habitat development. This is especially true in areas of intensive farming. 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 use as homesites. The main limitation of this soil for roads and streets is frost action potential. Special designs for roads are needed to overcome this limitation. Capability subclasses IIIe, nonirrigated, and IIe, irrigated.

97—Truckton sandy loam, 3 to 9 percent slopes. This deep, well drained soil formed in alluvium and residuum derived from arkosic sedimentary rock on uplands. Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown sandy loam about 5 inches thick. The next layer is dark grayish brown sandy loam about 3 inches thick. The subsoil is brown sandy loam about 16 inches thick. The substratum is light yellowish brown coarse sandy loam to a depth of 60 inches or more.

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 | Hydro-logic group | Flooding | | | Bedrock | | Potential frost action |
|---|-------------------|---------------|-----------------|---------|-----------|----------|------------------------|
| | | Frequency | Duration | Months | Depth | Hardness | |
| Alamosa: 1----- | C | Frequent----- | Brief----- | May-Jun | In >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. |
| 19: 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. |
| 118: Chaseville part----- | A | None----- | --- | --- | >60 | --- | Low. |
| Midway part----- | D | None----- | --- | --- | 10-20 | Rippable | Moderate. |
| Columbine: 19----- | A | None to rare | --- | --- | >60 | --- | Low. |
| Connerton: 120: 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. |
| 124: Cushman part----- | C | None----- | --- | --- | 20-40 | Rippable | Moderate. |
| Kutch part----- | C | None----- | --- | --- | 20-40 | Rippable | Moderate. |
| Elbeth: 25, 26----- | B | None----- | --- | --- | >60 | --- | Moderate. |
| 127: 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 | | |
| Tomah: 192, 193: | | | | | | | |
| Tomah part---- | B | None----- | --- | --- | >60 | --- | Moderate. |
| Crowfoot part-- | B | None----- | --- | --- | >60 | --- | Moderate. |
| Travessilla: 194: | | | | | | | |
| Travessilla part----- | D | None----- | --- | --- | 6-20 | Hard | Low. |
| Rock outcrop part----- | D | --- | --- | --- | --- | --- | --- |
| Truckton: 95, 96, 97-- | B | None----- | --- | --- | >60 | --- | Moderate. |
| 198: | | | | | | | |
| Truckton part-- | B | None----- | --- | --- | >60 | --- | Moderate. |
| Blakeland part-- | A | None----- | --- | --- | >60 | --- | Low. |
| 199, 1100: | | | | | | | |
| 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. |

¹This 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 B1

HYDROLOGIC CALCULATIONS (RATIONAL METHOD)

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

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

3.2 Time of Concentration

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

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

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

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

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

3.2.1 Overland (Initial) Flow Time

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

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

Where:

t_i = overland (initial) flow time (min)

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

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

S = average basin slope (ft/ft)

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

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

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

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

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

3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

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

L = waterway length (ft)

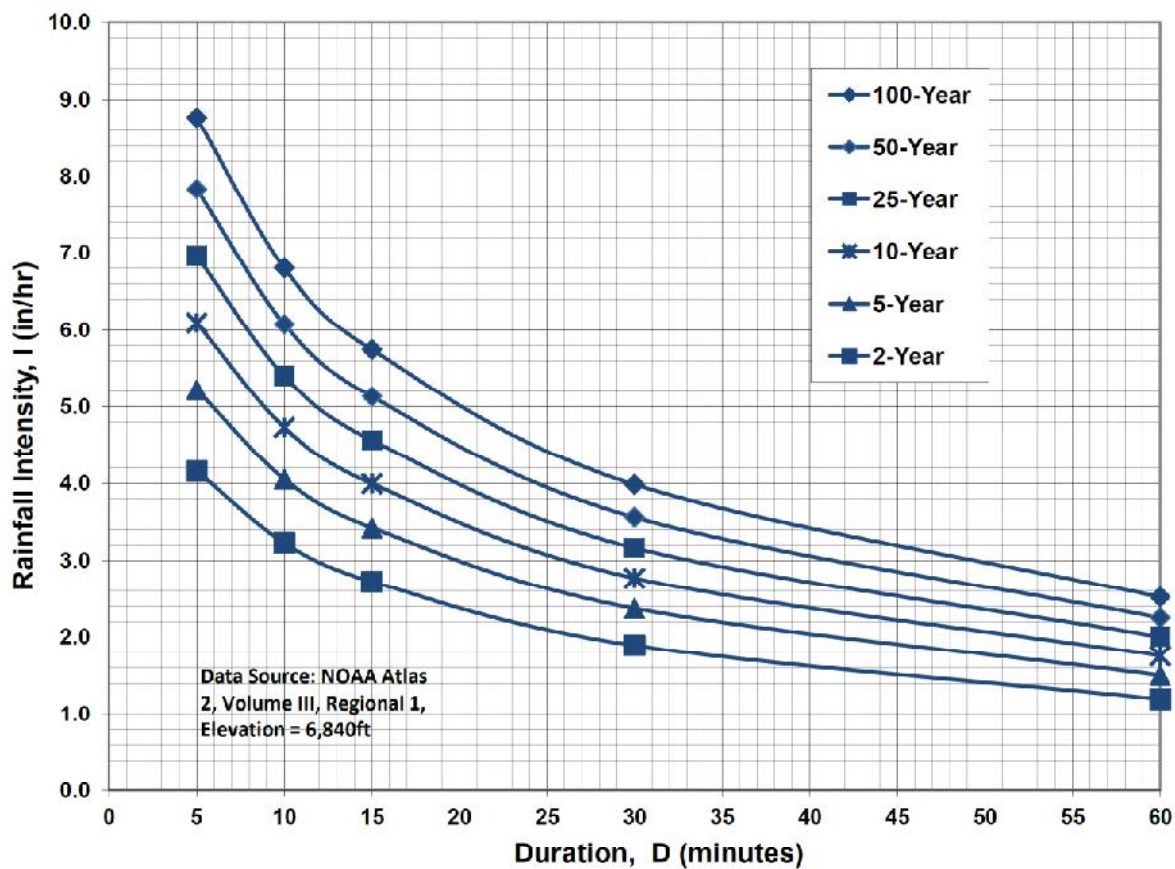
Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed.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

3.2.4 Minimum Time of Concentration

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

3.2.5 Post-Development Time of Concentration

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

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

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

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

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

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

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

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

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

MAYBERRY, COLORADO SPRINGS (ELLCOTT TOWN CENTER)
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS
5-YEAR C VALUES

| BASIN | TOTAL AREA (AC) | (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 |
|----------------|-----------------------|------|-------------------------------------|-------|--------------|-------------------------------------|------|------|--------------------------------------|------|---------------------|
| A1A | 2.80 | 0.9 | ROADWAY | 0.9 | 1.9 | GRASS | 0.08 | | | | 0.355 |
| C1.2 | 7.97 | 8.0 | COMMERCIAL | 0.49 | | | | | | | 0.490 |
| C1.7A | 0.58 | 0.6 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C1.7B | 4.34 | 4.3 | COMMERCIAL | 0.49 | | | | | | | 0.490 |
| C1.7A,C1.7B | 4.92 | | | | | | | | | | 0.476 |
| C1.2,C1.7 | 12.89 | | | | | | | | | | 0.485 |
| C1.3 | 3.02 | 3.0 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C1.2,C1.3,C1.7 | 15.91 | | | | | | | | | | 0.464 |
| C1.4 | 3.23 | 3.2 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C1.2-C1.4,C1.7 | 19.14 | | | | | | | | | | 0.449 |
| C1.5 | 3.18 | 3.2 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C1.2-C1.5,C1.7 | 22.32 | | | | | | | | | | 0.438 |
| C1.1 | 9.38 | 3.0 | RESIDENTIAL | 0.375 | 1.2 | COMMERCIAL | 0.49 | 5.2 | OPEN SPACE | 0.08 | 0.226 |
| C1.6 | 1.98 | 2.0 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C1.1,C1.6 | 11.36 | | | | | | | | | | 0.252 |
| C1.1-C1.7 | 33.68 | | | | | | | | | | 0.376 |
| C1.8 | 3.89 | 3.9 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C1.9 | 3.60 | 3.6 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C1.8-C1.9 | 7.49 | | | | | | | | | | 0.375 |
| C1.1-C1.9 | 41.17 | | | | | | | | | | 0.376 |
| C1.10 | 1.82 | 1.8 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C1.1-C1.10 | 42.99 | | | | | | | | | | 0.375 |
| C2.1 | 5.59 | 1.8 | RESIDENTIAL | 0.375 | 0.9 | COMMERCIAL | 0.49 | 2.9 | OPEN SPACE | 0.08 | 0.242 |
| C2.2 | 4.03 | 4.0 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C2.3 | 2.76 | 2.8 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C2.1-C2.3 | 12.38 | | | | | | | | | | 0.315 |
| C2.4 | 4.98 | 5.0 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C2.5 | 4.12 | 4.1 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C2.1-C2.5 | 21.48 | | | | | | | | | | 0.341 |
| C3 | 20.25 | 20.3 | PARK / OS | 0.08 | | | | | | | 0.080 |
| C2.1-C2.5,C3 | 41.73 | | | | | | | | | | 0.214 |
| C2.6 | 2.76 | 2.2 | SF LOTS (1/6-AC) | 0.375 | 0.6 | COMM / LT INDUSTRIAL | 0.59 | | | | 0.422 |
| C2.7 | 2.14 | 2.1 | COMM / LT INDUSTRIAL | 0.59 | | | | | | | 0.590 |
| C2.8 | 3.00 | 1.7 | SF LOTS (1/6-AC) | 0.375 | 1.4 | COMM / LT INDUSTRIAL | 0.59 | | | | 0.472 |
| C2.6-C2.8 | 7.90 | | | | | | | | | | 0.486 |

| | | | | | | | | | | | |
|------------------------|---------------|------|----------------------|-------|------|----------------------|------|--|--|--|--------------|
| D1.2 | 2.99 | 1.6 | SF LOTS (1/6-AC) | 0.375 | 1.4 | COMM / LT INDUSTRIAL | 0.59 | | | | 0.472 |
| C2.6-C2.8,D1.2 | 10.89 | | | | | | | | | | 0.482 |
| D1.1 | 3.60 | 3.6 | COMM / LT INDUSTRIAL | 0.59 | | | | | | | 0.590 |
| D1.3 | 2.87 | 1.6 | SF LOTS (1/6-AC) | 0.375 | 1.3 | COMM / LT INDUSTRIAL | 0.59 | | | | 0.472 |
| C2.6-C2.8,D1.1-D1.3 | 17.36 | | | | | | | | | | 0.503 |
| D1.4 | 4.19 | 4.2 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| D1.5 | 5.09 | 5.1 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| D1.6 | 3.33 | 3.3 | SF LOTS (1/6-AC) | 0.375 | | | | | | | 0.375 |
| C2.6-C2.8,D1.1-D1.6 | 29.97 | | | | | | | | | | 0.449 |
| D2 | 44.58 | 39.5 | MDR-RESIDENTIAL | 0.375 | 5.1 | LANDSCAPE/OS | 0.08 | | | | 0.341 |
| C2.6-C2.8,D1.1-D1.6,D2 | 74.55 | | | | | | | | | | 0.385 |
| C2,C3,D | 116.28 | | | | | | | | | | 0.323 |
| C1-C3,D | 159.27 | | | | | | | | | | 0.337 |
| C4 | 72.81 | 61.9 | MDR-RESIDENTIAL | 0.375 | 10.9 | LANDSCAPE/OS | 0.08 | | | | 0.331 |
| E | 2.4 | 0.3 | MDR-RESIDENTIAL | 0.375 | 2.1 | OPEN SPACE | 0.08 | | | | 0.114 |

MAYBERRY, COLORADO SPRINGS (ELLICOTT TOWN CENTER)
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

100-YEAR C VALUES

| BASIN | TOTAL AREA (AC) | (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 |
|---------------|-----------------------|------|-------------------------------------|-------|--------------|-------------------------------------|------|------|-------------------------------------|------|---------------------|
| A1A | 2.80 | 0.9 | ROADWAY | 0.96 | 1.9 | GRASS | 0.35 | | | 0.35 | 0.555 |
| C12 | 7.97 | 8.0 | COMMERCIAL | 0.62 | | | | | | | 0.620 |
| C1.7A | 0.58 | 0.6 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C1.7B | 4.34 | 4.3 | COMMERCIAL | 0.62 | | | | | | | 0.620 |
| C1.7AC1.7B | 4.92 | | | | | | | | | | 0.611 |
| C12.C1.7 | 12.89 | | | | | | | | | | 0.617 |
| C13 | 3.02 | 3.0 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C12.C1.3.C1.7 | 15.91 | | | | | | | | | | 0.603 |
| C14 | 3.23 | 3.2 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C12.C1.4.C1.7 | 19.14 | | | | | | | | | | 0.593 |
| C15 | 3.18 | 3.2 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C12.C1.5.C1.7 | 22.32 | | | | | | | | | | 0.586 |
| C1.1 | 9.38 | 3.0 | RESIDENTIAL | 0.545 | 1.2 | COMMERCIAL | 0.62 | 5.2 | OPEN SPACE | 0.35 | 0.447 |
| C16 | 1.98 | 2.0 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C1.1.C1.6 | 11.36 | | | | | | | | | | 0.464 |
| C1.1-C1.7 | 33.68 | | | | | | | | | | 0.545 |
| C18 | 3.89 | 3.9 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C19 | 3.60 | 3.6 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C18-C1.9 | 7.49 | | | | | | | | | | 0.545 |
| C1.1-C1.9 | 41.17 | | | | | | | | | | 0.545 |
| C1.10 | 1.82 | 1.8 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C1.1-C1.10 | 42.99 | | | | | | | | | | 0.545 |
| C2.1 | 5.59 | 1.8 | RESIDENTIAL | 0.545 | 0.9 | COMMERCIAL | 0.62 | 2.9 | OPEN SPACE | 0.35 | 0.457 |
| C2.2 | 4.03 | 4.0 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C2.3 | 2.76 | 2.8 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C2.1-C2.3 | 12.38 | | | | | | | | | | 0.505 |
| C2.4 | 4.98 | 5.0 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C2.5 | 4.12 | 4.1 | SF LOTS (1/6-AC) | 0.545 | | | | | | | 0.545 |
| C2.1-C2.5 | 21.48 | | | | | | | | | | 0.522 |
| C3 | 20.25 | 20.3 | PARK / OS | 0.35 | | | | | | | 0.350 |
| C2.1-C2.5.C3 | 41.73 | | | | | | | | | | 0.439 |
| C2.6 | 2.76 | 2.2 | SF LOTS (1/6-AC) | 0.545 | 0.6 | COMM / LT INDUSTRIAL | 0.7 | | | | 0.579 |
| C2.7 | 2.14 | 2.1 | COMM / LT INDUSTRIAL | 0.7 | | | | | | | 0.700 |
| C2.8 | 3.00 | 1.7 | SF LOTS (1/6-AC) | 0.545 | 1.4 | COMM / LT INDUSTRIAL | 0.7 | | | | 0.615 |
| C2.6-C2.8 | 7.90 | | | | | | | | | | 0.625 |

| | | | | | | | | | | |
|------------------------|--------|------|----------------------|-------|------|----------------------|------|--|--|-------|
| D1.2 | 2.99 | 1.6 | SF LOTS (1/6-AC) | 0.545 | 1.4 | COMM / LT INDUSTRIAL | 0.7 | | | 0.615 |
| C2.6-C2.8,D1.2 | 10.89 | | | | | | | | | 0.622 |
| D1.1 | 3.60 | 3.6 | COMM / LT INDUSTRIAL | 0.7 | | | | | | 0.700 |
| D1.3 | 2.87 | 1.6 | SF LOTS (1/6-AC) | 0.545 | 1.3 | COMM / LT INDUSTRIAL | 0.7 | | | 0.615 |
| C2.6-C2.8,D1.1-D1.3 | 17.36 | | | | | | | | | 0.637 |
| D1.4 | 4.19 | 4.2 | SF LOTS (1/6-AC) | 0.545 | | | | | | 0.545 |
| D1.5 | 5.09 | 5.1 | SF LOTS (1/6-AC) | 0.545 | | | | | | 0.545 |
| D1.6 | 3.33 | 3.3 | SF LOTS (1/6-AC) | 0.545 | | | | | | 0.545 |
| C2.6-C2.8,D1.1-D1.6 | 29.97 | | | | | | | | | 0.598 |
| D2 | 44.58 | 39.5 | MDR-RESIDENTIAL | 0.545 | 5.1 | LANDSCAPE/OS | 0.35 | | | 0.523 |
| C2.6-C2.8,D1.1-D1.6,D2 | 74.55 | | | | | | | | | 0.553 |
| C2,C3,D | 116.28 | | | | | | | | | 0.512 |
| C1-C3,D | 159.27 | | | | | | | | | 0.521 |
| C4 | 72.81 | 61.9 | MDR-RESIDENTIAL | 0.545 | 10.9 | LANDSCAPE/OS | 0.35 | | | 0.516 |
| E | 2.4 | 0.3 | MDR-RESIDENTIAL | 0.545 | 2.1 | OPEN SPACE | 0.35 | | | 0.372 |

MAYBERRY, COLORADO SPRINGS (ELLCOTT TOWN CENTER)
RATIONAL METHOD - HYDROLOGIC CALCULATIONS

DEVELOPED FLOWS

| BASIN | | C | | | | Overland Flow | | | Channel flow | | | | | | | | |
|----------------|--------|--------------|-----------|--------|----------|---------------|---------------|--------------------------|---------------------|--------------------------|---------------|------------------------------------|-------------------------|-------------------------------|--------------------------|-------|--------------------------|
| | | DESIGN POINT | AREA (AC) | 5-YEAR | 100-YEAR | LENGTH (FT) | SLOPE (FT/FT) | Tco ⁽¹⁾ (MIN) | CHANNEL LENGTH (FT) | CONVEYANCE COEFFICIENT C | SLOPE (FT/FT) | SCS ⁽²⁾ VELOCITY (FT/S) | Tt ⁽³⁾ (MIN) | TOTAL Tc ⁽⁴⁾ (MIN) | INTENSITY ⁽⁵⁾ | | PEAK FLOW ⁽⁶⁾ |
| FILING NO. 1 | | | | | | | | | | | | | | | | | |
| A1A | A1A | 2.80 | 0.355 | 0.555 | 40 | 0.020 | 6.8 | 2035 | 15.00 | 0.011 | 1.57 | 21.6 | 28.4 | 2.56 | 4.30 | 2.55 | 6.68 |
| | | | | | | | | | | | | | | | | | |
| C1.2 | C1.2 | 7.97 | 0.490 | 0.620 | | | 0.0 | 1000 | 20.00 | 0.009 | 1.90 | 8.8 | 8.8 | 4.32 | 7.26 | 16.88 | 35.87 |
| C1.7A | C1.7A | 0.58 | 0.375 | 0.545 | | | 0.0 | 680 | 20.00 | 0.013 | 2.28 | 5.0 | 5.0 | 5.17 | 8.68 | 1.12 | 2.74 |
| C1.7B | C1.7B | 4.34 | 0.490 | 0.620 | 100 | 0.020 | 8.9 | 400 | 20.00 | 0.01 | 2.00 | 3.3 | 12.2 | 3.83 | 6.43 | 8.15 | 17.31 |
| C1.7A,C1.7B | C1.7B1 | 4.92 | 0.476 | 0.611 | | | | | | | | | 12.2 | 3.83 | 6.43 | 8.97 | 19.33 |
| C1.2,C1.7 | C1.2D | 12.89 | 0.485 | 0.617 | | | | | | | | | 12.2 | 3.83 | 6.43 | 23.95 | 51.15 |
| | | | | | | | | | | | | | | | | | |
| C1.3 | | 3.02 | 0.375 | 0.545 | | | 0.0 | 280 | 20.00 | 0.01 | 2.00 | 2.3 | 2.3 | 5.17 | 8.68 | 5.85 | 14.29 |
| C1.2,C1.3,C1.7 | C1.3A | 15.91 | 0.464 | 0.603 | | | | | | | | | 14.5 | 3.57 | 5.99 | 26.34 | 57.47 |
| C1.4 | | 3.23 | 0.375 | 0.545 | | | 0.0 | 300 | 20.00 | 0.01 | 2.00 | 2.5 | 2.5 | 5.17 | 8.68 | 6.26 | 15.28 |
| C1.2-C1.4,C1.7 | C1.4A | 19.14 | 0.449 | 0.593 | | | | | | | | | 17.0 | 3.33 | 5.59 | 28.62 | 63.45 |
| C1.5 | | 3.18 | 0.375 | 0.545 | | | 0.0 | 300 | 20.00 | 0.01 | 2.00 | 2.5 | 2.5 | 5.17 | 8.68 | 6.16 | 15.04 |
| C1.2-C1.5,C1.7 | C1.5A | 22.32 | 0.438 | 0.586 | | | | | | | | | 19.5 | 3.12 | 5.25 | 30.55 | 68.61 |
| | | | | | | | | | | | | | | | | | |
| C1.1 | C1.1 | 9.38 | 0.226 | 0.447 | 100 | 0.017 | 13.4 | 1800 | 20.00 | 0.01 | 2.00 | 15.0 | 28.4 | 2.56 | 4.30 | 5.43 | 18.04 |
| C1.6 | | 1.98 | 0.375 | 0.545 | | | 0.0 | 280 | 20.00 | 0.01 | 2.00 | 2.3 | 2.3 | 5.17 | 8.68 | 3.84 | 9.37 |
| C1.1,C1.6 | C1.6B | 11.36 | 0.252 | 0.464 | | | | | | | | | 30.7 | 2.44 | 4.10 | 7.00 | 21.62 |
| C1.1-C1.7 | C1.7A | 33.68 | 0.376 | 0.545 | | | | | | | | | 30.7 | 2.44 | 4.10 | 30.96 | 75.30 |
| | | | | | | | | | | | | | | | | | |
| C1.8 | | 3.89 | 0.375 | 0.545 | | | 0.0 | 600 | 20.00 | 0.016 | 2.53 | 4.0 | 4.0 | 5.17 | 8.68 | 7.54 | 18.40 |
| C1.9 | | 3.60 | 0.375 | 0.545 | | | 0.0 | 580 | 20.00 | 0.012 | 2.19 | 4.4 | 4.4 | 5.17 | 8.68 | 6.98 | 17.03 |
| C1.8,C1.9 | C1.9A | 7.49 | 0.375 | 0.545 | | | | | | | | | 8.4 | 4.40 | 7.38 | 12.35 | 30.14 |
| C1.1-C1.9 | C1.9B | 41.17 | 0.376 | 0.545 | | | | | | | | | 30.7 | 2.44 | 4.10 | 37.84 | 92.05 |
| C1.10 | C1.10 | 1.82 | 0.375 | 0.545 | 50 | 0.020 | 7.5 | 1500 | 20.00 | 0.01 | 2.00 | 12.5 | 20.0 | 3.09 | 5.19 | 2.11 | 5.15 |
| C1.1-C1.10 | C1.10A | 42.99 | 0.375 | 0.545 | | | | | | | | | 30.7 | 2.44 | 4.10 | 39.41 | 96.12 |
| FILING NO. 2 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| C2.1 | | 5.59 | 0.242 | 0.457 | 100 | 0.016 | 13.4 | 650 | 20.00 | 0.01 | 2.00 | 5.4 | 18.8 | 3.18 | 5.34 | 4.30 | 13.63 |
| C2.2 | | 4.03 | 0.375 | 0.545 | | | 0.0 | 460 | 20.00 | 0.01 | 2.00 | 3.8 | 3.8 | 5.17 | 8.68 | 7.81 | 19.06 |
| C2.3 | | 2.76 | 0.375 | 0.545 | | | 0.0 | 260 | 20.00 | 0.01 | 2.00 | 2.2 | 2.2 | 5.17 | 8.68 | 5.35 | 13.06 |
| C2.1-C2.3 | C2.3A | 12.38 | 0.315 | 0.505 | | | | | | | | | 21.0 | 3.02 | 5.06 | 11.76 | 31.64 |
| | | | | | | | | | | | | | | | | | |
| C2.4 | | 4.98 | 0.375 | 0.545 | | | 0.0 | 560 | 20.00 | 0.012 | 2.19 | 4.3 | 4.3 | 5.17 | 8.68 | 9.65 | 23.56 |
| C2.5 | | 4.12 | 0.375 | 0.545 | | | 0.0 | 330 | 20.00 | 0.01 | 2.00 | 2.8 | 2.8 | 5.17 | 8.68 | 7.99 | 19.49 |
| C2.1-C2.5 | C2.5A | 21.48 | 0.341 | 0.522 | | | | | | | | | 23.8 | 2.83 | 4.75 | 20.73 | 53.27 |
| | | | | | | | | | | | | | | | | | |

| Overland Flow | | | | | Channel flow | | | | | | | | | | | | |
|------------------------|--------------|--------|----------|-------------|---------------|--------------------------|---------------------|--------------|---------------|------------------------------------|-------------------------|-------------------------------|-------------------------------|--------------------------|----------------|-------------------------|---------------------------|
| BASIN | DESIGN POINT | C | | LENGTH (FT) | SLOPE (FT/FT) | Tco ⁽¹⁾ (MIN) | CHANNEL LENGTH (FT) | CONVEYANCE C | SLOPE (FT/FT) | SCS ⁽²⁾ VELOCITY (FT/S) | Tt ⁽³⁾ (MIN) | TOTAL Tc ⁽⁴⁾ (MIN) | TOTAL Tc ⁽⁴⁾ (MIN) | INTENSITY ⁽⁵⁾ | | PEAK FLOW | |
| | | 5-YEAR | 100-YEAR | | | | | | | | | | | 5-YR (IN/HR) | 100-YR (IN/HR) | Q5 ⁽⁶⁾ (CFS) | Q100 ⁽⁶⁾ (CFS) |
| C3 | | 20.25 | 0.080 | 0.350 | | 0.0 | 1050 | 15.00 | 0.011 | 1.57 | 11.1 | 11.1 | 11.1 | 3.97 | 6.66 | 6.43 | 47.23 |
| Tc C2.5A TO DP-D2B | | | | | | | 2450 | 15.00 | 0.01 | 1.50 | 27.2 | | | | | | |
| C2.1-C2.5,C3 | C4.1 | 41.73 | 0.214 | 0.439 | | | | | | | | 30.7 | 30.7 | 2.44 | 4.10 | 21.83 | 75.15 |
| C2.6 | | 2.76 | 0.422 | 0.579 | 100 | 0.020 | 9.9 | 20.00 | 0.016 | 2.53 | 3.6 | 13.5 | 13.5 | 3.68 | 6.18 | 4.29 | 9.88 |
| C2.7 | | 2.14 | 0.590 | 0.700 | 100 | 0.020 | 7.4 | 20.00 | 0.013 | 2.28 | 2.9 | 10.3 | 10.3 | 4.08 | 6.85 | 5.15 | 10.26 |
| C2.8 | | 3.00 | 0.472 | 0.615 | | | 250 | 20.00 | 0.012 | 2.19 | 1.9 | 1.9 | 5.0 | 5.17 | 8.68 | 7.32 | 16.01 |
| C2.6-C2.8 | C2.8A | 7.90 | 0.486 | 0.625 | | | | | | | | 15.4 | 15.4 | 3.48 | 5.85 | 13.37 | 28.87 |
| D1.2 | | 2.99 | 0.472 | 0.615 | | 0.0 | 300 | 20.00 | 0.01 | 2.00 | 2.5 | 2.5 | 5.0 | 5.17 | 8.68 | 7.29 | 15.96 |
| C2.6-C2.8,D1.2 | D1.2A | 10.89 | 0.482 | 0.622 | | | | | | | | 17.9 | 17.9 | 3.26 | 5.47 | 17.10 | 37.04 |
| D1.1 | D1.1 | 3.60 | 0.590 | 0.700 | | 0.0 | 750 | 20.00 | 0.011 | 2.10 | 6.0 | 6.0 | 6.0 | 4.91 | 8.24 | 10.42 | 20.76 |
| D1.3 | | 2.87 | 0.472 | 0.615 | | 0.0 | 280 | 20.00 | 0.01 | 2.00 | 2.3 | 2.3 | 5.0 | 5.17 | 8.68 | 7.00 | 15.32 |
| C2.6-C2.8,D1.1-D1.3 | D1.3A | 17.36 | 0.503 | 0.637 | | | | | | | | 20.2 | 20.2 | 3.07 | 5.16 | 26.84 | 57.05 |
| D1.4 | D1.4 | 4.19 | 0.375 | 0.545 | | 0.0 | 550 | 20.00 | 0.012 | 2.19 | 4.2 | 4.2 | 5.0 | 5.17 | 8.68 | 8.12 | 19.82 |
| D1.5 | | 5.09 | 0.375 | 0.545 | | 0.0 | 280 | 20.00 | 0.01 | 2.00 | 2.3 | 2.3 | 5.0 | 5.17 | 8.68 | 9.87 | 24.08 |
| D1.6 | | 3.33 | 0.375 | 0.545 | | 0.0 | 1060 | 20.00 | 0.01 | 2.00 | 8.8 | 8.8 | 8.8 | 4.32 | 7.25 | 5.39 | 13.15 |
| C2.6-C2.8,D1.1-D1.6 | D1.6A | 29.97 | 0.449 | 0.598 | | | | | | | | 24.4 | 24.4 | 2.79 | 4.69 | 37.56 | 83.97 |
| PHASE 2 | | | | | | | | | | | | | | | | | |
| D2 | | 44.58 | 0.341 | 0.523 | 100 | 0.020 | 11.0 | 20.00 | 0.011 | 2.10 | 13.9 | 24.9 | 24.9 | 2.76 | 4.63 | 41.94 | 107.95 |
| C2.6-C2.8,D1.1-D1.6,D2 | D2A | 74.55 | 0.385 | 0.553 | | | | | | | | 4.3 | 5.0 | 5.17 | 8.68 | 148.35 | 357.81 |
| C2,C3,D | D2B | 116.28 | 0.323 | 0.512 | | | | | | | | 23.8 | 23.8 | 2.83 | 4.75 | 106.32 | 282.86 |
| C4 | C4 | 72.81 | 0.331 | 0.516 | 100 | 0.020 | 11.2 | 20.00 | 0.011 | 2.10 | 23.8 | 35.0 | 35.0 | 2.25 | 3.77 | 54.21 | 141.81 |
| E | E | 2.37 | 0.114 | 0.372 | | 0.0 | 1450 | 15.00 | 0.0083 | 1.37 | 17.7 | 17.7 | 17.7 | 3.27 | 5.50 | 0.88 | 4.85 |

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

APPENDIX B2

HYDROLOGIC CALCULATIONS (SCS METHOD)

TABLE 5-4
 RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL
 COVER COMPLEXES - RURAL CONDITIONS
 (Antecedent Moisture Condition II, and Ia = 0.2 S)
 (From: U.S. Dept. of Agriculture,
 Soil Conservation Service, 1977)

| Land Use | Cover Treatment or Practice | Hydrologic Condition | Runoff Curve Number by Hydrologic Soil Group | | | |
|--|-----------------------------|----------------------|--|----|----|----|
| | | | A | B | C | D |
| Fallow | Straight Row | ---- | 77 | 86 | 91 | 94 |
| Row Crops | Straight Row | Poor | 72 | 81 | 88 | 91 |
| | Straight Row | Good | 67 | 78 | 85 | 89 |
| | Contoured | Poor | 70 | 79 | 84 | 88 |
| | Contoured | Good | 65 | 75 | 82 | 86 |
| | Cont. & Terraced | Poor | 66 | 74 | 80 | 82 |
| | Cont. & Terraced | Good | 62 | 71 | 78 | 81 |
| Small Grain | Straight Row | Poor | 65 | 76 | 84 | 88 |
| | Straight Row | Good | 63 | 75 | 83 | 87 |
| | Contoured | Poor | 63 | 74 | 82 | 85 |
| | Contoured | Good | 61 | 73 | 81 | 84 |
| | Cont. & Terraced | Poor | 61 | 72 | 79 | 82 |
| | Cont. & Terraced | Good | 59 | 70 | 78 | 81 |
| Close-seeded legumes 1/ or rotation meadow | Straight Row | Poor | 66 | 77 | 85 | 89 |
| | Straight Row | Good | 58 | 72 | 81 | 85 |
| | Contoured | Poor | 64 | 75 | 83 | 85 |
| | Contoured | Good | 55 | 69 | 78 | 83 |
| | Cont. & Terraced | Poor | 63 | 73 | 80 | 83 |
| | Cont. & Terraced | Good | 51 | 67 | 76 | 80 |
| Pasture or range | | Poor | 68 | 79 | 86 | 89 |
| | | Fair | 49 | 69 | 79 | 84 |
| | | Good | 39 | 61 | 74 | 80 |
| | Contoured | Poor | 47 | 67 | 81 | 88 |
| | Contoured | Fair | 25 | 59 | 75 | 83 |
| | Contoured | Good | 6 | 35 | 70 | 79 |
| Meadow | | Good | 30 | 58 | 71 | 78 |
| Woods | | Poor | 45 | 66 | 77 | 83 |
| | | Fair | 36 | 60 | 73 | 79 |
| | | Good | 25 | 55 | 70 | 77 |
| Farmsteads | | ---- | 59 | 74 | 82 | 86 |
| Roads (dirt) 2/ (hard surface) 2/ | | ---- | 72 | 82 | 87 | 89 |
| | | ---- | 74 | 84 | 90 | 92 |

1/ Close-drilled or broadcast
 2/ Including right-of-way

TABLE 5-5
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL
COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition -II)
(From: U.S. Dept. of Agriculture,
Soil Conservation Service, 1977)

| <u>Land Use</u> | <u>Hydrologic Soil Group</u> | | | |
|---|--------------------------------|----------|----------|----------|
| | <u>A</u> | <u>B</u> | <u>C</u> | <u>D</u> |
| Open spaces, lawns, parks, golf courses, cemeteries, etc. | | | | |
| Good condition: grass cover on 75% or more of the area | 39* | 61 | 74 | 80 |
| Fair condition: grass cover on 50% to 75% of the area | 49* | 69 | 79 | 84 |
| Commercial and Business areas (85% Impervious) | 89* | 92 | 94 | 95 |
| Industrial Districts 72% Impervious) | 81* | 88 | 91 | 93 |
| Residential: 2/ | | | | |
| <u>Acres per Dwelling Unit</u> | <u>Average % Impervious</u> 3/ | | | |
| 1/8 acre or less < 1/4-1/8 ac. lots | 65 | 77* | 85 | 90 |
| 1/4 acre | 38 | 61* | 75 | 83 |
| 1/3 acre | 30 | 57* | 72 | 81 |
| 1/2 acre | 25 | 54* | 70 | 80 |
| 1 acre | 20 | 51* | 68 | 79 |
| Paved parking lots, roofs, driveways, etc. | 98 | 98 | 98 | 98 |
| Streets and Roads: | | | | |
| paved with curbs and storm sewers | 98 | 98 | 98 | 98 |
| gravel | 76* | 85 | 89 | 91 |
| dirt | 72* | 82 | 87 | 89 |

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).

2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

* Not to be used wherever overlot grading or filling is to occur.

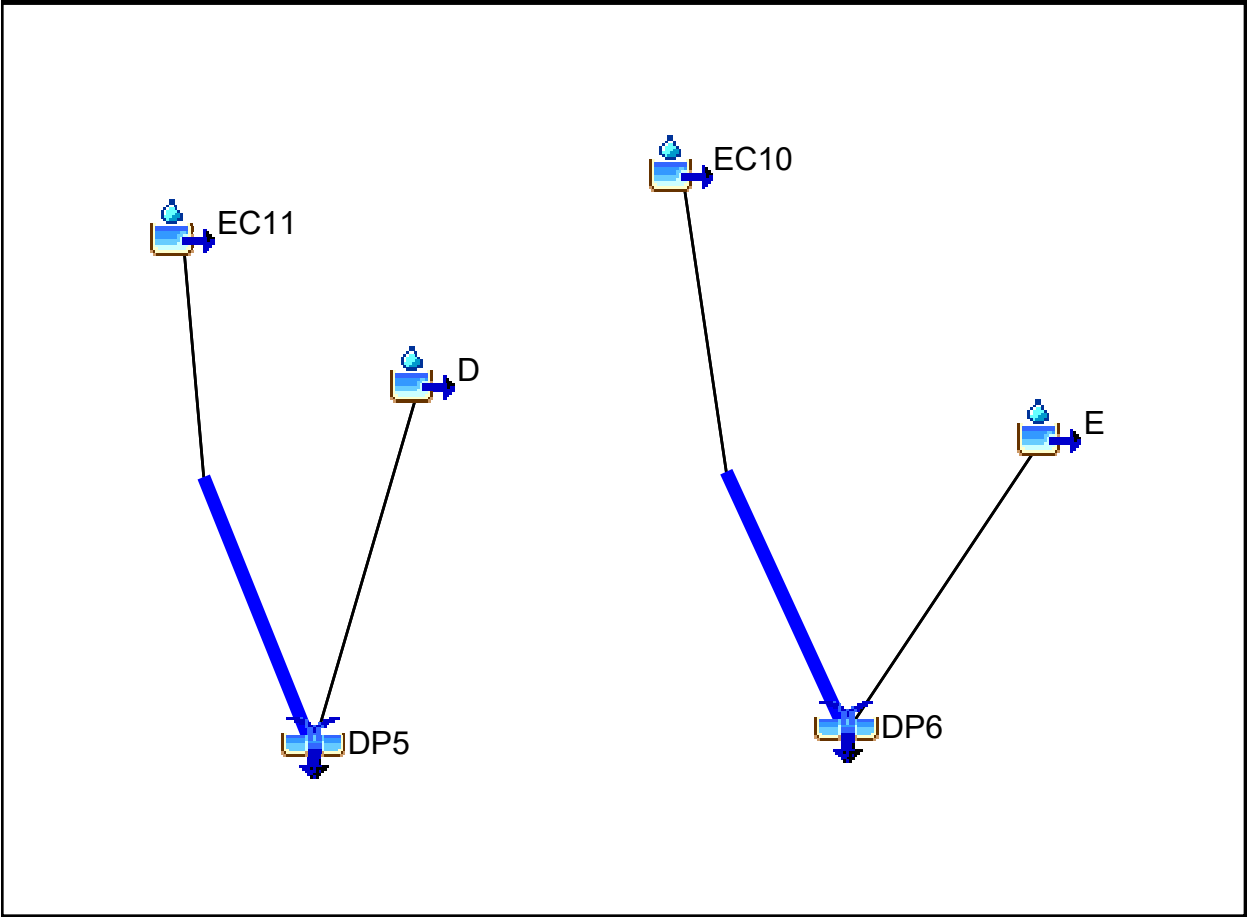
**ELLCOTT TOWN CENTER
COMPOSITE RUNOFF CURVE NUMBERS**

DEVELOPED CONDITIONS

CN-VALUES

| BASIN | TOTAL AREA (AC) | (AC) | SUB-AREA 1 DEVELOPMENT/ COVER | CN | AREA (AC) | SUB-AREA 2 DEVELOPMENT/ COVER | CN | (AC) | SUB-AREA 3 DEVELOPMENT/ COVER | CN | WEIGHTED CN-VALUE |
|-----------------|-----------------------|-------|-------------------------------------|----|--------------|-------------------------------------|----|------|-------------------------------------|----|----------------------|
| OA2 | 15.1 | 15.1 | MEADOW | 61 | | | | | | | 61.000 |
| OA1 | 66.8 | 66.8 | MEADOW | 61 | | | | | | | 61.000 |
| A | 60.0 | 43.6 | RESIDENTIAL | 80 | 16.4 | OPEN SPACE | 61 | | | | 74.805 |
| OA2,OA1,A | 141.9 | | | | | | | | | | 66.836 |
| EC12 | 30.3 | 30.3 | MEADOW | 61 | | | | | | | 61.000 |
| OB1 | 33.7 | 33.7 | MEADOW | 61 | | | | | | | 61.000 |
| B1 | 97.0 | 67.0 | RESIDENTIAL | 80 | 20.0 | COMMERCIAL | 92 | 10.0 | OPEN SPACE | 61 | 80.516 |
| B2 | 77.4 | 69.5 | RESIDENTIAL | 80 | 7.9 | OPEN SPACE | 61 | | | | 78.061 |
| EC12,OB1,B1,B2 | 238.4 | | | | | | | | | | 74.479 |
| BB | 20.3 | 18.3 | RESIDENTIAL | 80 | 2.0 | OPEN SPACE | 61 | | | | 78.128 |
| B3 | 59.1 | 50.7 | RESIDENTIAL | 80 | 8.4 | OPEN SPACE | 61 | | | | 77.299 |
| EC12,OB1,B1,B2 | 317.8 | | | | | | | | | | 75.236 |
| B4 | 4.5 | 4.5 | RESIDENTIAL | 80 | | | | | | | 80.000 |
| EC11 | 353.6 | 353.6 | MEADOW | 61 | | | | | | | 61.000 |
| C1.2 | 7.97 | 8.0 | COMMERCIAL | 92 | | | | | | | 92.000 |
| C1.7A | 0.58 | 0.6 | SF LOTS (1/6-AC) | 80 | | | | | | | 80.000 |
| C1.7B | 4.34 | 4.3 | COMMERCIAL | 92 | | | | | | | 92.000 |
| C1.7A,C1.7B | 4.92 | | | | | | | | | | 90.585 |
| C1.2,C1.7 | 12.89 | | | | | | | | | | 91.460 |
| C1.3 | 3.02 | 3.0 | SF LOTS (1/6-AC) | 80 | | | | | | | 80.000 |
| C1.2,C1.3,C1.7 | 15.91 | | | | | | | | | | 89.285 |
| C1.4 | 3.23 | 3.2 | SF LOTS (1/6-AC) | 80 | | | | | | | 80.000 |
| C1.2-C1.4,C1.7 | 19.14 | | | | | | | | | | 87.718 |
| C1.5 | 3.18 | 3.2 | SF LOTS (1/6-AC) | 80 | | | | | | | 80.000 |
| C1.2-C1.5,C1.7 | 22.32 | | | | | | | | | | 86.618 |
| C1.1 | 9.38 | 3.0 | RESIDENTIAL | 80 | 1.2 | COMMERCIAL | 92 | 5.2 | OPEN SPACE | 61 | 71.010 |
| C1.6 | 1.98 | 2.0 | SF LOTS (1/6-AC) | 80 | | | | | | | 80.000 |
| C1.1,C1.6 | 11.36 | | | | | | | | | | 72.577 |
| C1.1-C1.7 | 33.68 | | | | | | | | | | 81.882 |
| C1.8 | 3.89 | 3.9 | SF LOTS (1/6-AC) | 80 | | | | | | | 80.000 |
| C1.9 | 3.60 | 3.6 | SF LOTS (1/6-AC) | 80 | | | | | | | 80.000 |
| C1.8-C1.9 | 7.49 | | | | | | | | | | 80.000 |
| C1.1-C1.9 | 41.17 | | | | | | | | | | 81.540 |
| C1.10 | 1.82 | 1.8 | SF LOTS (1/6-AC) | 80 | | | | | | | 80.000 |
| C1.1-C1.10 | 42.99 | | | | | | | | | | 81.475 |
| EC11,C1.1-C1.10 | 396.59 | | | | | | | | | | 63.219 |

| | | | | | | | | | | | |
|------------------------|--------|-------|------------------|----|------|--------------|----|-----|------------|----|--------|
| C2.1 | 5.59 | 1.8 | RESIDENTIAL | 80 | 0.9 | COMMERCIAL | 92 | 2.9 | OPEN SPACE | 61 | 72,220 |
| C2.2 | 4.03 | 4.0 | SF LOTS (1/6-AC) | 80 | | | | | | | 80,000 |
| C2.3 | 2.76 | 2.8 | SF LOTS (1/6-AC) | 80 | | | | | | | 80,000 |
| C2.1-C2.3 | 12.38 | | | | | | | | | | 76,487 |
| C2.4 | 4.98 | 5.0 | SF LOTS (1/6-AC) | 80 | | | | | | | 80,000 |
| C2.5 | 4.12 | 4.1 | SF LOTS (1/6-AC) | 80 | | | | | | | 80,000 |
| C2.1-C2.5 | 21.48 | | | | | | | | | | 77,975 |
| EC11,C1.1-C2.5 | 418.07 | | | | | | | | | | 63,978 |
| C2.6 | 2.76 | 2.2 | SF LOTS (1/6-AC) | 80 | 0.6 | COMMERCIAL | 92 | | | | 82,609 |
| C2.7 | 2.14 | 2.1 | COMMERCIAL | 92 | | | | | | | 92,000 |
| C2.8 | 3.00 | 1.7 | SF LOTS (1/6-AC) | 80 | 1.4 | COMMERCIAL | 92 | | | | 85,400 |
| C2.6-C2.8 | 7.90 | | | | | | | | | | 86,213 |
| D1.2 | 2.99 | 1.6 | SF LOTS (1/6-AC) | 80 | 1.4 | COMMERCIAL | 92 | | | | 85,418 |
| C2.6-C2.8,D1.2 | 10.89 | | | | | | | | | | 85,994 |
| D1.1 | 3.60 | 3.6 | COMMERCIAL | 92 | | | | | | | 92,000 |
| D1.3 | 2.87 | 1.6 | SF LOTS (1/6-AC) | 80 | 1.3 | COMMERCIAL | 92 | | | | 85,394 |
| C2.6-C2.8,D1.1-D1.3 | 17.36 | | | | | | | | | | 87,141 |
| D1.4 | 4.19 | 4.2 | SF LOTS (1/6-AC) | 80 | | | | | | | 80,000 |
| D1.5 | 5.09 | 5.1 | SF LOTS (1/6-AC) | 80 | | | | | | | 80,000 |
| D1.6 | 3.33 | 3.3 | SF LOTS (1/6-AC) | 80 | | | | | | | 80,000 |
| C2.6-C2.8,D1.1-D1.6 | 29.97 | | | | | | | | | | 84,136 |
| C3 | 20.25 | 20.3 | PARK / MEADOW | 61 | | | | | | | 61,000 |
| D2 | 44.58 | 39.5 | MDR-RESIDENTIAL | 80 | 5.1 | LANDSCAPE/OS | 61 | | | | 77,826 |
| C2.6-C2.8,D1.1-D1.6,D2 | 94.80 | | | | | | | | | | 76,227 |
| C2,C3,D | 116.28 | | | | | | | | | | 76,550 |
| C1-C3,D | 159.27 | | | | | | | | | | 77,879 |
| EC11,C1-C3,D | 512.9 | | | | | | | | | | 66,242 |
| EC10 | 317.3 | 317.3 | MEADOW | 61 | | | | | | | 61,000 |
| E | 2.4 | 0.3 | RESIDENTIAL | 80 | 2.1 | OPEN SPACE | 61 | | | | 63,165 |
| EC10,E | 319.7 | | | | | | | | | | 61,016 |
| C4 | 72.8 | 61.9 | MDR-RESIDENTIAL | 80 | 10.9 | LANDSCAPE/OS | 61 | | | | 77,150 |



Run: Run 2

Project: ETC-H Simulation Run: Run 2

Start of Run: 01Jan3000, 01:00 Basin Model: Basin 1

End of Run: 02Jan3000, 01:30 Meteorologic Model: Met 2

Compute Time: 10Sep2019, 20:56:08 Control Specifications: Control 1

Volume Units: ☐ IN ☒ AC-FT

Global Summary Results for Run "Run 2"

| Hydrologic Element | Drainage Area (MI ²) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|--------------------|----------------------------------|----------------------|------------------|----------------|
| D | 0.24 | 20.3 | 01Jan3000, 13:13 | 3.5 |
| Reach-D | 0.55 | 24.4 | 01Jan3000, 14:07 | 7.8 |
| EC11 | 0.55 | 24.4 | 01Jan3000, 13:52 | 7.9 |
| DP5 | 0.79 | 30.6 | 01Jan3000, 14:04 | 11.3 |
| E | 0.01 | 1.4 | 01Jan3000, 13:03 | 0.1 |
| Reach-E | 0.50 | 18.9 | 01Jan3000, 14:19 | 7.0 |
| EC10 | 0.50 | 18.9 | 01Jan3000, 14:13 | 7.1 |
| DP6 | 0.51 | 19.1 | 01Jan3000, 14:18 | 7.2 |

Show Elements: All Elements

NOTE 40043: The basin model "Basin 1" contains 2 elements with no downstream connection: DP5, DP6

NOTE 15301: Began computing simulation run "Run 1" at time 10Sep2019, 20:55:48.

NOTE 20364: Found no parameter problems in meteorologic model "Met 1".

NOTE 40040: The basin model contains 2 outlets: DP5, DP6

NOTE 40049: Found no parameter problems in basin model "Basin 1".

NOTE 41743: Initial abstraction ratio for subbasin "D" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "EC11" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "E" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "EC10" is 0.2002.

NOTE 42413: Unit hydrograph volume for subbasin "D" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "EC11" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "E" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "EC10" is 1.0000 in.

NOTE 15302: Finished computing simulation run "Run 1" at time 10Sep2019, 20:55:49.

NOTE 40043: The basin model "Basin 1" contains 2 elements with no downstream connection: DP5, DP6

NOTE 40043: The basin model "Basin 1" contains 2 elements with no downstream connection: DP5, DP6

NOTE 15301: Began computing simulation run "Run 2" at time 10Sep2019, 20:56:08.

NOTE 20364: Found no parameter problems in meteorologic model "Met 2".

NOTE 40040: The basin model contains 2 outlets: DP5, DP6

NOTE 40049: Found no parameter problems in basin model "Basin 1".

NOTE 41743: Initial abstraction ratio for subbasin "D" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "EC11" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "E" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "EC10" is 0.2002.

NOTE 42413: Unit hydrograph volume for subbasin "D" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "EC11" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "E" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "EC10" is 1.0000 in.

Require

E

DP6

DP5

EC11

Reach-D

Meteorologic Models

Met 1

Hypothetical Storm

Met 2

Hypothetical Storm

Control Specifications

Control 1

Components Compute Results

Hypothetical Storm

Met Name: Met 2

Method: SCS Type 2

*Point Depth (IN) 2.6

Area Reduction: --None--

Basin 1

- C1-C3,D
- Reach-D
- EC11
- DP5
- E
- Reach-E
- EC10
- DP6

Meteorologic Models

- Met 1
- Met 2
- Hypothetical Storm
- Hypothetical Storm

Components

Compute

Results

Hypothetical Storm

Met Name: Met 2

Method: SCS Type 2

Point Depth (IV) 2.6

Area Reduction: --None--

Run: Run 2

Global Summary Results for Run "Run 2"

Project: ETC_D Simulation Run: Run 2

Start of Run: 01Jan3000, 01:00 Basin Model: Basin 1

End of Run: 02Jan3000, 01:30 Meteorologic Model: Met 2

Compute Time: 10Sep2019, 21:18:23 Control Specifications: Control 1

Volume Units: ☐ IN ☒ AC-FT

Show Elements: All Elements

| Hydrologic Element | Drainage Area (MI ²) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|--------------------|----------------------------------|----------------------|------------------|----------------|
| EC11 | 0.55 | 24.4 | 01Jan3000, 13:52 | 7.9 |
| Reach-D | 0.55 | 24.4 | 01Jan3000, 14:07 | 7.8 |
| C1-C3,D | 0.25 | 225.0 | 01Jan3000, 13:08 | 21.6 |
| DP5 | 0.80 | 226.6 | 01Jan3000, 13:08 | 29.4 |
| EC10 | 0.50 | 18.9 | 01Jan3000, 14:13 | 7.1 |
| Reach-E | 0.50 | 18.9 | 01Jan3000, 14:19 | 7.0 |
| E | 0.00 | 0.9 | 01Jan3000, 13:04 | 0.1 |
| DP6 | 0.50 | 19.0 | 01Jan3000, 14:18 | 7.1 |

NOTE 40043: The basin model "Basin 1" contains 2 elements with no downstream connection: DP5, DP6

NOTE 40043: The basin model "Basin 1" contains 2 elements with no downstream connection: DP5, DP6

NOTE 15301: Began computing simulation run "Run 1" at time 10Sep2019, 21:12:10.

NOTE 20364: Found no parameter problems in meteorologic model "Met 1".

NOTE 40040: The basin model contains 2 outlets: DP5, DP6

NOTE 40049: Found no parameter problems in basin model "Basin 1".

NOTE 41743: Initial abstraction ratio for subbasin "EC11" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "C1-C3,D" is 0.2007.

NOTE 41743: Initial abstraction ratio for subbasin "EC10" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "E" is 0.2006.

NOTE 42413: Unit hydrograph volume for subbasin "EC11" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "C1-C3,D" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "EC10" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "E" is 1.0000 in.

NOTE 15302: Finished computing simulation run "Run 1" at time 10Sep2019, 21:12:11.

NOTE 40043: The basin model "Basin 1" contains 2 elements with no downstream connection: DP5, DP6

NOTE 40043: The basin model "Basin 1" contains 2 elements with no downstream connection: DP5, DP6

NOTE 15301: Began computing simulation run "Run 2" at time 10Sep2019, 21:18:23.

NOTE 20364: Found no parameter problems in meteorologic model "Met 2".

NOTE 40040: The basin model contains 2 outlets: DP5, DP6

NOTE 40049: Found no parameter problems in basin model "Basin 1".

NOTE 41743: Initial abstraction ratio for subbasin "EC11" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "C1-C3,D" is 0.2007.

NOTE 41743: Initial abstraction ratio for subbasin "EC10" is 0.2002.

NOTE 41743: Initial abstraction ratio for subbasin "E" is 0.2006.

NOTE 42413: Unit hydrograph volume for subbasin "EC11" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "C1-C3,D" is 1.0000 in.

NOTE 42413: Unit hydrograph volume for subbasin "EC10" is 1.0000 in.

ELLCOTT TOWN CENTER

HISTORIC FLOWS

| HISTORIC FLOWS | | | | | | | | | | | | | | | | | | | | | | | |
|----------------|--------------|-----------|-----------|-------------------------|----------------|------|------|------------------------|---------------|-----------|--------------------------|-----------------|----------------|--------|---------------------|---|---------------------------------------|--|---------------------|-----------|-------------------------|-------------------------|---------------------------|
| BASIN | DESIGN POINT | AREA (AC) | AREA (SM) | RUNOFF COEFFICIENT (C5) | CURVE No. (CN) | S | Ia | PERCENT IMPERVIOUS (%) | Overland Flow | | | Channel flow | | | | Time of Concentration Tc ⁽²⁾ (MIN) | Total Lag Time Tl ⁽²⁾ (HR) | Total Lag Time Tl ⁽²⁾ (MIN) | Peak Flow | | | | |
| | | | | | | | | | LENGTH (FT) | SLOPE (%) | Tco ⁽¹⁾ (MIN) | HIGH ELEV. (FT) | LOW ELEV. (FT) | H (FT) | CHANNEL LENGTH (FT) | | | | CHANNEL LENGTH (MI) | SLOPE (%) | Tt ⁽¹⁾ (MIN) | Q5 ⁽³⁾ (CFS) | Q100 ⁽³⁾ (CFS) |
| EC11 D | EC11 | 353.6 | 0.55 | 0.08 | 61 | 6.39 | 1.28 | 2 | 1000 | 6.0 | 32.0 | 6180 | 6067 | 113 | 8945 | 1.69 | 1.3% | 46.37 | 78.34 | 47.00 | 24.4 | 149.5 | |
| | | 154.6 | 0.24 | 0.08 | 61 | 6.39 | 1.28 | 2 | | | 0.0 | 6067 | 6028 | 39 | 3850 | 0.73 | 1.0% | 26.38 | 26.38 | 15.83 | 20.3 | 141.5 | |
| | 5 | 508.2 | 0.79 | | | | | | | | | | | | | | | | 104.72 | 104.72 | 62.83 | 30.6 | 174.9 |
| EC10 E | EC10 | 317.3 | 0.50 | 0.08 | 61 | 6.39 | 1.28 | 2 | 1000 | 1.0 | 58.1 | 6140 | 6052 | 88 | 8100 | 1.53 | 1.1% | 45.53 | 103.59 | 62.15 | 18.9 | 110.6 | |
| | | 7.4 | 0.01 | 0.08 | 61 | 6.39 | 1.28 | 2 | | | 0.0 | 6052 | 6040 | 12 | 1200 | 0.23 | 1.0% | 10.80 | 10.80 | 6.48 | 1.4 | 9.1 | |
| EC10 E | 6 | 324.74 | 0.51 | | | | | | | | | | | | | | | | 114.39 | 114.39 | 68.63 | 19.1 | 111.4 |
| | | | | | | | | | | | | | | | | | | | | | | | |

DEVELOPED FLOWS

| DEVELOPED FLOWS | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|--------------|-----------|-----------|-------------------------|----------------|------|------|------------------------|---------------|-----------|--------------------------|-----------------|----------------|--------|---|---------------------------------------|--|-----------------------------------|-------------------------------------|---------------------|---------------------|-----------|-------------------------|
| BASIN | DESIGN POINT | AREA (AC) | AREA (SM) | RUNOFF COEFFICIENT (C5) | CURVE No. (CN) | S | Ia | PERCENT IMPERVIOUS (%) | Overland Flow | | | Channel flow | | | Time of Concentration Tc ⁽²⁾ (MIN) | Total Lag Time Tl ⁽²⁾ (HR) | Total Lag Time Tl ⁽²⁾ (MIN) | Peak Flow Q5 ⁽³⁾ (CFS) | Peak Flow Q100 ⁽³⁾ (CFS) | | | | |
| | | | | | | | | | LENGTH (FT) | SLOPE (%) | Tco ⁽¹⁾ (MIN) | HIGH ELEV. (FT) | LOW ELEV. (FT) | H (FT) | | | | | | CHANNEL LENGTH (FT) | CHANNEL LENGTH (MI) | SLOPE (%) | Tt ⁽¹⁾ (MIN) |
| EC11 | EC11 | 353.6 | 0.55 | 0.08 | 61 | 6.39 | 1.28 | 2 | 1000 | 6.0 | 32.0 | 6180 | 6067 | 113 | 8945 | 1.69 | 1.3% | 46.37 | 78.34 | 0.78 | 47.00 | 24.4 | 149.5 |
| | C1-C3,D | 159.3 | 0.25 | 0.331 | 77.879 | 2.84 | 0.57 | 44.2 | | | 0.0 | 6067 | 6028 | 39 | 3850 | 0.73 | 1.0% | 26.38 | 26.38 | 0.26 | 15.83 | 225.0 | 456.3 |
| | EC11,D | 5 | 512.87 | 0.80 | | | | | | | | | | | | | | | 104.72 | 1.05 | 62.83 | 226.6 | 461.4 |
| EC10 | EC10 | 317.3 | 0.50 | 0.08 | 61 | 6.39 | 1.28 | 2 | 1000 | 1.0 | 58.1 | 6140 | 6052 | 88 | 8100 | 1.53 | 1.1% | 45.53 | 103.59 | 1.04 | 62.15 | 18.9 | 110.6 |
| | E | 2.4 | 0.00 | 0.114 | 63.165 | 5.83 | 1.17 | 6.0 | | | 0.0 | 6052 | 6040 | 12 | 1450 | 0.27 | 0.8% | 13.44 | 13.44 | 0.13 | 8.07 | 0.9 | 4.0 |
| EC10,E | 6 | 319.67 | 0.50 | | | | | | | | | | | | | | | 117.03 | 1.17 | 70.22 | 19.0 | 111.0 | |
| | | | | | | | | | | | | | | | | | | | | | | | |

1) OVERLAND FLOW Tco = (1.8*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH*(0.5)/((SLOPE*(0.333)))

2) TRAVEL TIME, Tt = ((11.9*L^3)/H)^(0.385)

3) Tc = Tco + Tt

4) SCS LAG TIME, Tl = 0.6 * Tt

5) PEAK FLOWS CALCULATED BY HEC-HMS 4.3 (TYPE 2 STORM; 5-YR; 24-HR RAINFALL = 2.6 IN; 100-YR; 24-HR RAINFALL = 4.4 IN)

APPENDIX C

DETENTION POND CALCULATIONS

MAYBERRY, COLORADO SPRINGS (ELLCOTT TOWN CENTER)
IMPERVIOUS AREA CALCULATIONS

DEVELOPED CONDITIONS

| BASIN | TOTAL AREA (AC) | (AC) | SUB-AREA 1 DEVELOPMENT/ COVER | IMP. AREA (%) | AREA (AC) | SUB-AREA 2 DEVELOPMENT/ COVER | IMP. AREA (%) | (AC) | SUB-AREA 3 DEVELOPMENT COVER | IMP. AREA (%) | WEIGHTED IMP. AREA (%) |
|-------------------|-----------------------|------|-------------------------------------|---------------------|--------------|-------------------------------------|---------------------|------|------------------------------------|---------------------|------------------------------|
| A1A | 2.80 | 0.9 | ROADWAY | 100 | 1.9 | GRASS | 0 | | | | 33.571 |
| C1.2 | 7.97 | 8.0 | COMMERCIAL | 70 | | | | | | | 70.000 |
| C1.7A | 0.58 | 0.6 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C1.7B | 4.34 | 4.3 | COMMERCIAL | 70 | | | | | | | 70.000 |
| C1.7A-C1.7B | 4.92 | | | | | | | | | | 67.937 |
| C1.2-C1.7 | 12.89 | | | | | | | | | | 69.213 |
| C1.3 | 3.02 | 3.0 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C1.2-C1.3-C1.7 | 15.91 | | | | | | | | | | 66.040 |
| C1.4 | 3.23 | 3.2 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C1.2-C1.4-C1.7 | 19.14 | | | | | | | | | | 63.755 |
| C1.5 | 3.18 | 3.2 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C1.2-C1.5-C1.7 | 22.32 | | | | | | | | | | 62.152 |
| C1.1 | 9.38 | 3.0 | RESIDENTIAL | 52.5 | 1.2 | COMMERCIAL | 70 | 5.2 | OPEN SPACE | 0 | 25.672 |
| C1.6 | 1.98 | 2.0 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C1.1-C1.6 | 11.36 | | | | | | | | | | 30.348 |
| C1.1-C1.7 | 33.68 | | | | | | | | | | 51.424 |
| C1.8 | 3.89 | 3.9 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C1.9 | 3.60 | 3.6 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C1.8-C1.9 | 7.49 | | | | | | | | | | 52.500 |
| C1.1-C1.9 | 41.17 | | | | | | | | | | 51.620 |
| C1.10 | 1.82 | 1.8 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C1.1-C1.10 | 42.99 | | | | | | | | | | 51.657 |
| C2.1 | 5.59 | 1.8 | SF LOTS (1/6-AC) | 52.5 | 0.9 | COMMERCIAL | 70 | 2.9 | OPEN SPACE | 0 | 28.426 |
| C2.2 | 4.03 | 4.0 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C2.3 | 2.76 | 2.8 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C2.1-C2.3 | 12.38 | | | | | | | | | | 41.630 |
| C2.4 | 4.98 | 5.0 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C2.5 | 4.12 | 4.1 | SF LOTS (1/6-AC) | 52.5 | | | | | | | 52.500 |
| C2.1-C2.5 | 21.48 | | | | | | | | | | 46.235 |
| C3 | 20.25 | 20.3 | PARK / OS | 0 | | | | | | | 0.000 |
| C2.1-C2.5-C3 | 41.73 | | | | | | | | | | 23.799 |
| C2.6 | 2.76 | 2.2 | SF LOTS (1/6-AC) | 52.5 | 0.6 | COMM / LT INDUSTRIAL | 80 | | | | 58.478 |
| C2.7 | 2.14 | 2.1 | COMM / LT INDUSTRIAL | 80 | | | | | | | 80.000 |
| C2.8 | 3.00 | 2.0 | SF LOTS (1/6-AC) | 52.5 | 1.0 | COMM / LT INDUSTRIAL | 80 | | | | 61.667 |
| C2.6-C2.8 | 7.90 | | | | | | | | | | 65.519 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

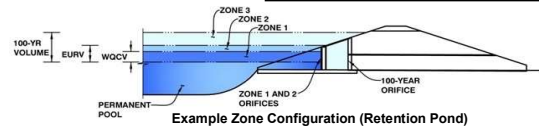
| INTERIM PHASE 1 DETENTION POND C2.8: | | | | | | | | | |
|--------------------------------------|--------|------|----------------------|------|------|----------------------|----|--|--------|
| C2.6 | 2.76 | 2.8 | VACANT | 0 | | | | | 0.000 |
| C2.7 | 2.14 | 2.1 | COMM / LT INDUSTRIAL | 80 | | | | | 80.000 |
| C2.8 | 3.00 | 3.0 | VACANT | 0 | | | | | 0.000 |
| C2.6-C2.8 | 7.90 | | | | | | | | 21.671 |
| D1.2 | 2.99 | 1.6 | SF LOTS (1/6-AC) | 52.5 | 1.4 | COMM / LT INDUSTRIAL | 80 | | 64.916 |
| C2.6-C2.8,D1.2 | 10.89 | | | | | | | | 65.354 |
| D1.1 | 3.60 | 3.6 | COMM / LT INDUSTRIAL | 80 | | | | | 80.000 |
| D1.3 | 2.87 | 1.6 | SF LOTS (1/6-AC) | 52.5 | 1.3 | COMM / LT INDUSTRIAL | 80 | | 64.861 |
| C2.6-C2.8,D1.1-D1.3 | 17.36 | | | | | | | | 68.309 |
| D1.4 | 4.19 | 4.2 | SF LOTS (1/6-AC) | 52.5 | | | | | 52.500 |
| D1.5 | 5.09 | 5.1 | SF LOTS (1/6-AC) | 52.5 | | | | | 52.500 |
| D1.6 | 3.33 | 3.3 | SF LOTS (1/6-AC) | 52.5 | | | | | 52.500 |
| C2.6-C2.8,D1.1-D1.6 | 29.97 | | | | | | | | 61.657 |
| D2 | 44.58 | 39.5 | SF LOTS (1/6-AC) | 52.5 | 5.1 | LANDSCAPE/OS | 0 | | 46.494 |
| C2.6-C2.8,D1.1-D1.6,D2 | 74.55 | | | | | | | | 52.590 |
| C2.C3.D | 116.28 | | | | | | | | 42.257 |
| C1-C3.D | 159.27 | | | | | | | | 44.795 |
| C4 | 72.81 | 61.9 | MDR-RESIDENTIAL | 52.5 | 10.9 | LANDSCAPE/OS | 0 | | 44.625 |
| E | 2.4 | 0.3 | MDR-RESIDENTIAL | 52.5 | 2.1 | OPEN SPACE | 0 | | 5.981 |

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: **Ellicott Town Center**

Basin ID: Pond C1



Required Volume Calculation

| | | |
|---|------------|-------------|
| Selected BMP Type = | EDB | |
| Watershed Area = | 42.99 | acres |
| Watershed Length = | 2.660 | ft |
| Watershed Slope = | 0.010 | ft/ft |
| Watershed Imperviousness = | 51.66% | percent |
| Percentage Hydrologic Soil Group A = | 100.0% | percent |
| Percentage Hydrologic Soil Group B = | 0.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Desired WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |
| Water Quality Capture Volume (WQCV) = | 0.755 | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 2.584 | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 1.765 | 1.19 inches |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 2.318 | 1.50 inches |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 2.850 | 1.75 inches |
| 25-yr Runoff Volume (P1 = 2 in.) = | 3.539 | 2.00 inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 4.391 | 2.25 inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 5.392 | 2.52 inches |
| 500-yr Runoff Volume (P1 = 3.14 in.) = | 7.703 | 3.14 inches |
| Approximate 2-yr Detention Volume = | 1.664 | acre-feet |
| Approximate 5-yr Detention Volume = | 2.189 | acre-feet |
| Approximate 10-yr Detention Volume = | 2.667 | acre-feet |
| Approximate 25-yr Detention Volume = | 3.256 | acre-feet |
| Approximate 50-yr Detention Volume = | 3.627 | acre-feet |
| Approximate 100-yr Detention Volume = | 4.072 | acre-feet |

Stage-Storage Calculation

| | | |
|--|-------|-----------|
| Zone 1 Volume (WQCV) = | 0.755 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 1.829 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 1.488 | acre-feet |
| Total Detention Basin Volume = | 4.072 | acre-feet |

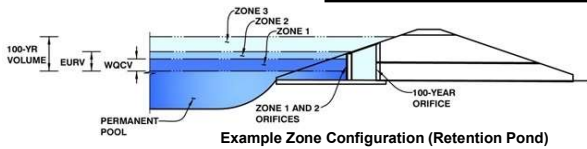
[illegible]

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: **Ellicott Town Center**

Basin ID: **Pond C1**



Example Zone Configuration (Retention Pond)

| | Stage (ft) | Zone Volume (ac-ft) | Outlet Type |
|-------------------|------------|---------------------|----------------------|
| Zone 1 (WQCV) | 2.06 | 0.755 | Orifice Plate |
| Zone 2 (EURV) | 4.71 | 1.829 | Orifice Plate |
| Zone 3 (100-year) | 6.48 | 1.488 | Weir&Pipe (Restrict) |
| | | 4.072 | Total |

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

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

Calculated Parameters for Underdrain

| | | |
|-------------------------------|-----|-----------------|
| Underdrain Orifice Area = | N/A | ft ² |
| Underdrain Orifice Centroid = | N/A | feet |

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

| | | |
|--|------|---|
| Invert of Lowest Orifice = | 0.00 | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Orifice Plate = | 4.71 | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | N/A | inches |
| Orifice Plate: Orifice Area per Row = | 5.91 | sq. inches (use rectangular openings) |

Calculated Parameters for Plate

| | | |
|----------------------------|-----------|-----------------|
| WQ Orifice Area per Row = | 4.104E-02 | ft ² |
| Elliptical Half-Width = | N/A | feet |
| Elliptical Slot Centroid = | N/A | feet |
| Elliptical Slot Area = | N/A | ft ² |

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

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|--------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Stage of Orifice Centroid (ft) | 0.00 | 1.57 | 3.04 | | | | | |
| Orifice Area (sq. inches) | 5.91 | 5.91 | 5.91 | | | | | |

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

| | Zone 3 Weir | Not Selected | |
|---------------------------------------|-------------|--------------|---|
| Overflow Weir Front Edge Height, Ho = | 4.56 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | 4.00 | N/A | feet |
| Overflow Weir Slope = | 0.00 | N/A | H:V (enter zero for flat grate) |
| Horiz. Length of Weir Sides = | 2.50 | N/A | feet |
| Overflow Grate Open Area % = | 70% | N/A | %, grate open area/total area |
| Debris Clogging % = | 50% | N/A | % |

Calculated Parameters for Overflow Weir

| | Zone 3 Weir | Not Selected | |
|--|-------------|--------------|-----------------|
| Height of Grate Upper Edge, H _u = | 4.56 | N/A | feet |
| Over Flow Weir Slope Length = | 2.50 | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | 7.21 | N/A | should be ≥ 4 |
| Overflow Grate Open Area w/o Debris = | 7.00 | N/A | ft ² |
| Overflow Grate Open Area w/ Debris = | 3.50 | N/A | ft ² |

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

| | Zone 3 Restrictor | Not Selected | |
|---|-------------------|--------------|--|
| Depth to Invert of Outlet Pipe = | 0.00 | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Outlet Pipe Diameter = | 18.00 | N/A | inches |
| Restrictor Plate Height Above Pipe Invert = | 9.70 | | inches |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

| | Zone 3 Restrictor | Not Selected | |
|--|-------------------|--------------|-----------------|
| Outlet Orifice Area = | 0.97 | N/A | ft ² |
| Outlet Orifice Centroid = | 0.46 | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | 1.65 | N/A | radians |

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | |
|-------------------------------------|-------|---|
| Spillway Invert Stage= | 6.50 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 10.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 1.00 | feet |

Calculated Parameters for Spillway

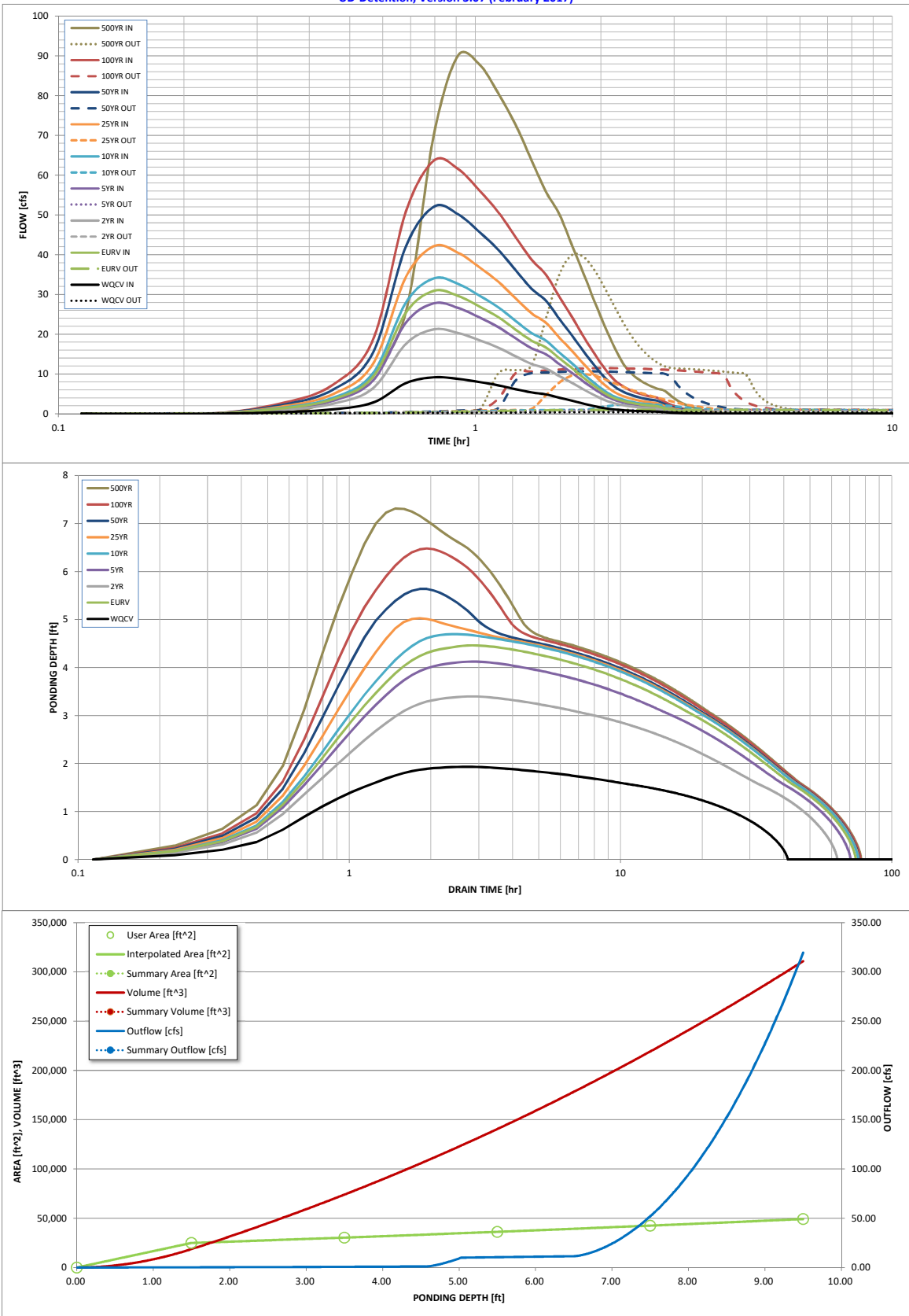
| | | |
|----------------------------------|------|-------|
| Spillway Design Flow Depth= | 1.26 | feet |
| Stage at Top of Freeboard = | 8.76 | feet |
| Basin Area at Top of Freeboard = | 1.07 | acres |

Routed Hydrograph Results

| | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|-------|-------|--------|--------|------------------|----------------|----------------|----------------|----------|
| Design Storm Return Period = | | | | | | | | | |
| One-Hour Rainfall Depth (in) = | 0.53 | 1.07 | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 3.14 |
| Calculated Runoff Volume (acre-ft) = | 0.755 | 2.584 | 1.765 | 2.318 | 2.850 | 3.539 | 4.391 | 5.392 | 7.703 |
| OPTIONAL Override Runoff Volume (acre-ft) = | | | | | | | | | |
| Inflow Hydrograph Volume (acre-ft) = | 0.755 | 2.583 | 1.763 | 2.316 | 2.848 | 3.537 | 4.389 | 5.389 | 7.697 |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.13 | 0.32 | 0.74 |
| Predevelopment Peak Q (cfs) = | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.7 | 5.6 | 13.6 | 31.8 |
| Peak Inflow Q (cfs) = | 9.2 | 30.9 | 21.2 | 27.8 | 34.0 | 42.1 | 52.1 | 63.7 | 90.1 |
| Peak Outflow Q (cfs) = | 0.4 | 1.0 | 0.7 | 0.9 | 2.4 | 10.0 | 10.6 | 11.5 | 39.9 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 6.4 | 7.2 | 13.7 | 1.9 | 0.8 | 1.3 |
| Structure Controlling Flow = | Plate | Plate | Plate | Plate | Overflow Grate 1 | Outlet Plate 1 | Outlet Plate 1 | Outlet Plate 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | 0.2 | 1.3 | 1.4 | 1.5 | 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 | 66 | 57 | 63 | 67 | 66 | 64 | 63 | 59 |
| Time to Drain 99% of Inflow Volume (hours) = | 40 | 70 | 61 | 67 | 72 | 71 | 71 | 71 | 69 |
| Maximum Ponding Depth (ft) = | 1.93 | 4.46 | 3.40 | 4.12 | 4.69 | 5.03 | 5.64 | 6.48 | 7.31 |
| Area at Maximum Ponding Depth (acres) = | 0.60 | 0.76 | 0.69 | 0.74 | 0.78 | 0.80 | 0.84 | 0.90 | 0.96 |
| Maximum Volume Stored (acre-ft) = | 0.682 | 2.391 | 1.623 | 2.143 | 2.575 | 2.835 | 3.335 | 4.066 | 4.848 |

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



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

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 4

Designer: JPS
Company: JPS
Date: September 12, 2019
Project: Ellicott Town Center
Location: Pond C1

1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area, I_a
- B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * 0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * \text{Area}$)
- G) For Watersheds Outside of the Denver Region,
Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV \text{ OTHER}} = (d_6 * (V_{DESIGN} / 0.43))$)
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired)
- I) Predominant Watershed NRCS Soil Group
- J) Excess Urban Runoff Volume (EURV) Design Volume
 For HSG A: $EURV_A = 1.68 * i^{1.28}$
 For HSG B: $EURV_B = 1.36 * i^{1.08}$
 For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$

$I_a = 51.7$ %

$i = 0.517$

Area = 42.990 ac

$d_6 =$ in

Choose One

☐ Water Quality Capture Volume (WQCV)

☒ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 0.755$ ac-ft

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

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

Choose One

☒ A

☐ B

☐ C / D

EURV = 2.584 ac-ft

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = 2.0 : 1

3. Basin Side Slopes

- A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = 4.00 ft / ft

4. Inlet

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

Concrete Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 4

Designer: JPS
Company: JPS
Date: September 12, 2019
Project: Ellicott Town Center
Location: Pond C1

5. Forebay

A) Minimum Forebay Volume
($V_{\text{FMIN}} = \underline{\quad 3\% \quad}$ of the WQCV)

$V_{\text{FMIN}} = \underline{\quad 0.023 \quad}$ ac-ft

B) Actual Forebay Volume

$V_F = \underline{\quad 0.025 \quad}$ ac-ft

C) Forebay Depth
($D_F = \underline{\quad 30 \quad}$ inch maximum)

$D_F = \underline{\quad 24.0 \quad}$ in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge

$Q_{100} = \underline{\quad 96.10 \quad}$ cfs

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

$Q_F = \underline{\quad 1.92 \quad}$ cfs

E) Forebay Discharge Design

Choose One
☐ Berm With Pipe
☒ Wall with Rect. Notch
☐ Wall with V-Notch Weir

F) Discharge Pipe Size (minimum 8-inches)

Calculated $D_p = \underline{\quad \quad}$ in

G) Rectangular Notch Width

Calculated $W_N = \underline{\quad 7.2 \quad}$ in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
☒ Concrete
☐ Soft Bottom

F) Slope of Trickle Channel

$S = \underline{\quad 0.0050 \quad}$ ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum)

$D_M = \underline{\quad 2.5 \quad}$ ft

B) Surface Area of Micropool (10 ft² minimum)

$A_M = \underline{\quad 10 \quad}$ sq ft

C) Outlet Type

Choose One
☒ Orifice Plate
☐ Other (Describe):

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

$D_{\text{orifice}} = \underline{\quad 1.00 \quad}$ inches

E) Total Outlet Area

$A_{\text{ot}} = \underline{\quad 17.73 \quad}$ square inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 4

Designer: JPS
Company: JPS
Date: September 12, 2019
Project: Ellicott Town Center
Location: Pond C1

8. Initial Surcharge Volume

- A) Depth of Initial Surcharge Volume
(Minimum recommended depth is 4 inches)
- B) Minimum Initial Surcharge Volume
(Minimum volume of 0.3% of the WQCV)
- C) Initial Surcharge Provided Above Micropool

$D_{IS} = 6$ in

$V_{IS} = 98.7$ cu ft

$V_s = 5.0$ cu ft

9. Trash Rack

- A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5 * (e^{-0.095D})$
- B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open area to the total screen area for the material specified.)

Other (Y/N): N

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

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

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

- F) Height of Water Quality Screen (H_{TR})

- G) Width of Water Quality Screen Opening ($W_{opening}$)
(Minimum of 12 inches is recommended)

$A_t = 621$ square inches

S.S. Well Screen with 60% Open Area

User Ratio =

$A_{total} = 1035$ sq. in.

$H = 4.71$ feet

$H_{TR} = 84.52$ inches

$W_{opening} = 12.2$ inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 4 of 4

Designer: JPS
Company: JPS
Date: September 12, 2019
Project: Ellicott Town Center
Location: Pond C1

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)

4.00

11. Vegetation

Choose One

☐ Irrigated

☒ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Access Ramp for periodic sediment removal with skid loader as needed

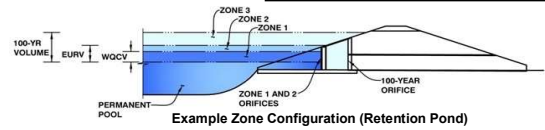
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Ellicott Town Center

Basin ID: Pond C2.8



Required Volume Calculation

| | | |
|---|------------|-----------|
| Selected BMP Type = | EDB | |
| Watershed Area = | 7.90 | acres |
| Watershed Length = | 900 | ft |
| Watershed Slope = | 0.015 | ft/ft |
| Watershed Imperviousness = | 21.67% | percent |
| Percentage Hydrologic Soil Group A = | 100.0% | percent |
| Percentage Hydrologic Soil Group B = | 0.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Desired WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |
| Water Quality Capture Volume (WQCV) = | 0.081 | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.156 | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.104 | acre-feet |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 0.140 | acre-feet |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 0.178 | acre-feet |
| 25-yr Runoff Volume (P1 = 2 in.) = | 0.243 | acre-feet |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 0.359 | acre-feet |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 0.531 | acre-feet |
| 500-yr Runoff Volume (P1 = 3.14 in.) = | 0.939 | acre-feet |
| Approximate 2-yr Detention Volume = | 0.097 | acre-feet |
| Approximate 5-yr Detention Volume = | 0.130 | acre-feet |
| Approximate 10-yr Detention Volume = | 0.165 | acre-feet |
| Approximate 25-yr Detention Volume = | 0.213 | acre-feet |
| Approximate 50-yr Detention Volume = | 0.254 | acre-feet |
| Approximate 100-yr Detention Volume = | 0.332 | acre-feet |

Stage-Storage Calculation

| | | |
|--|-------|-----------|
| Zone 1 Volume (WQCV) = | 0.081 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 0.076 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 0.176 | acre-feet |
| Total Detention Basin Volume = | 0.332 | acre-feet |

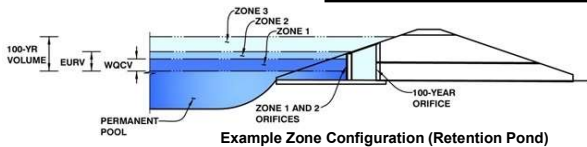
[illegible]

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: **Ellicott Town Center**

Basin ID: **Pond C2.8**



Example Zone Configuration (Retention Pond)

| | Stage (ft) | Zone Volume (ac-ft) | Outlet Type |
|-------------------|------------|---------------------|----------------------|
| Zone 1 (WQCV) | 1.03 | 0.081 | Orifice Plate |
| Zone 2 (EURV) | 1.49 | 0.076 | Orifice Plate |
| Zone 3 (100-year) | 2.44 | 0.176 | Weir&Pipe (Restrict) |
| | | 0.332 | Total |

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

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

Calculated Parameters for Underdrain

| | | |
|-------------------------------|-----|-----------------|
| Underdrain Orifice Area = | N/A | ft ² |
| Underdrain Orifice Centroid = | N/A | feet |

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

| | | |
|--|------|---|
| Invert of Lowest Orifice = | 0.00 | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Orifice Plate = | 1.49 | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | 6.60 | inches |
| Orifice Plate: Orifice Area per Row = | 0.72 | sq. inches (diameter = 15/16 inch) |

Calculated Parameters for Plate

| | | |
|----------------------------|-----------|-----------------|
| WQ Orifice Area per Row = | 5.000E-03 | ft ² |
| Elliptical Half-Width = | N/A | feet |
| Elliptical Slot Centroid = | N/A | feet |
| Elliptical Slot Area = | N/A | ft ² |

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

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|--------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Stage of Orifice Centroid (ft) | 0.00 | 0.50 | 0.99 | | | | | |
| Orifice Area (sq. inches) | 0.72 | 0.72 | 0.72 | | | | | |

| | 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) and Grate (Flat or Sloped)

| | Zone 3 Weir | Not Selected | |
|---|-------------|--------------|---|
| Overflow Weir Front Edge Height, H _o = | 2.30 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | 4.00 | N/A | feet |
| Overflow Weir Slope = | 0.00 | N/A | H:V (enter zero for flat grate) |
| Horiz. Length of Weir Sides = | 2.50 | N/A | feet |
| Overflow Grate Open Area % = | 70% | N/A | %, grate open area/total area |
| Debris Clogging % = | 50% | N/A | % |

Calculated Parameters for Overflow Weir

| | Zone 3 Weir | Not Selected | |
|--|-------------|--------------|-----------------|
| Height of Grate Upper Edge, H _t = | 2.30 | N/A | feet |
| Over Flow Weir Slope Length = | 2.50 | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | 16.54 | N/A | should be ≥ 4 |
| Overflow Grate Open Area w/o Debris = | 7.00 | N/A | ft ² |
| Overflow Grate Open Area w/ Debris = | 3.50 | N/A | ft ² |

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

| | Zone 3 Restrictor | Not Selected | |
|---|-------------------|--------------|--|
| Depth to Invert of Outlet Pipe = | 0.00 | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Outlet Pipe Diameter = | 18.00 | N/A | inches |
| Restrictor Plate Height Above Pipe Invert = | 5.20 | | inches |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

| | Zone 3 Restrictor | Not Selected | |
|--|-------------------|--------------|-----------------|
| Outlet Orifice Area = | 0.42 | N/A | ft ² |
| Outlet Orifice Centroid = | 0.25 | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | 1.13 | N/A | radians |

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | |
|-------------------------------------|------|---|
| Spillway Invert Stage= | 3.00 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 3.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 1.00 | feet |

Calculated Parameters for Spillway

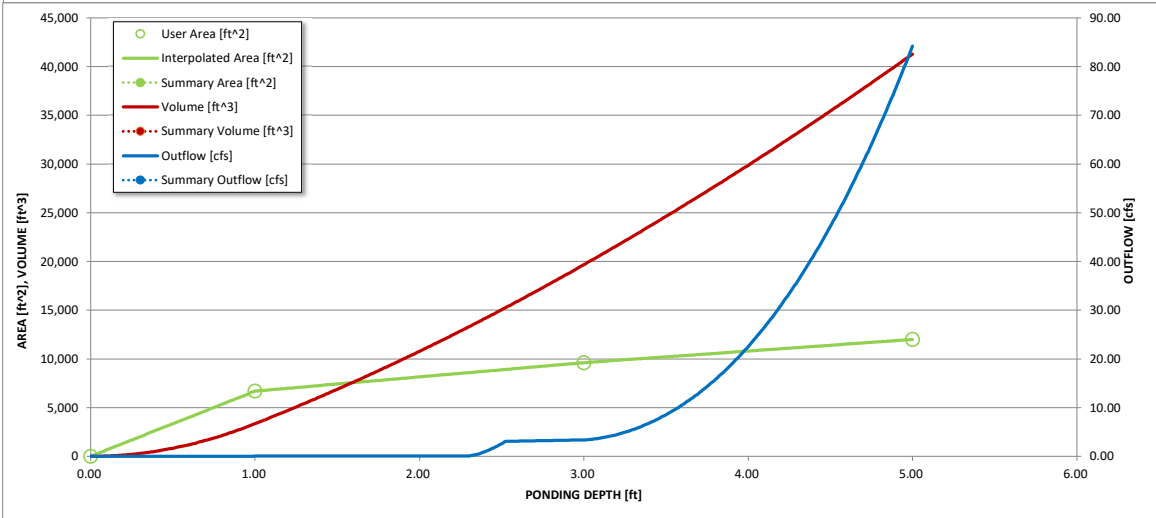
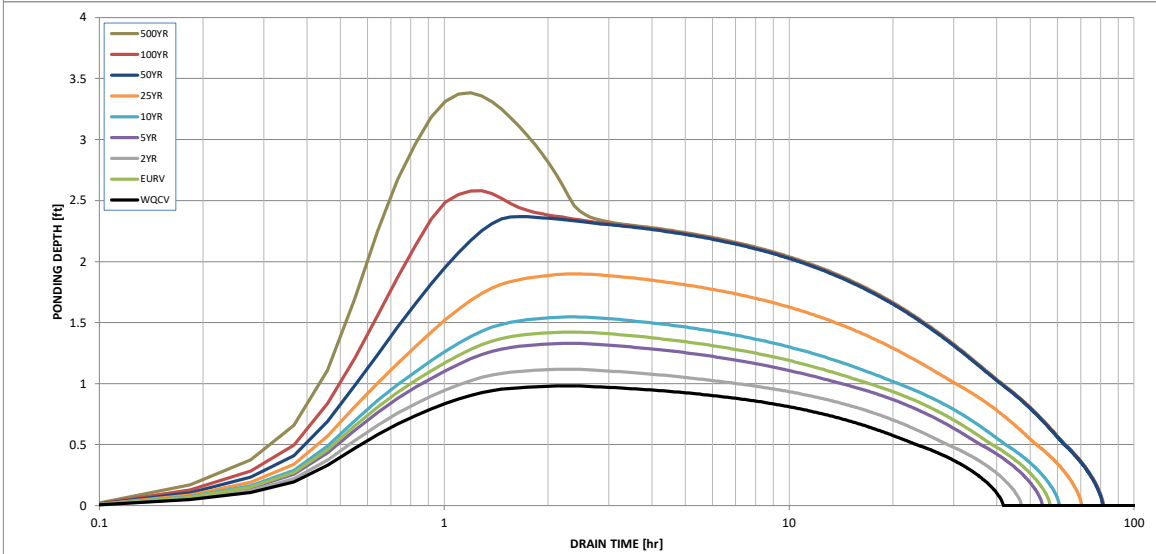
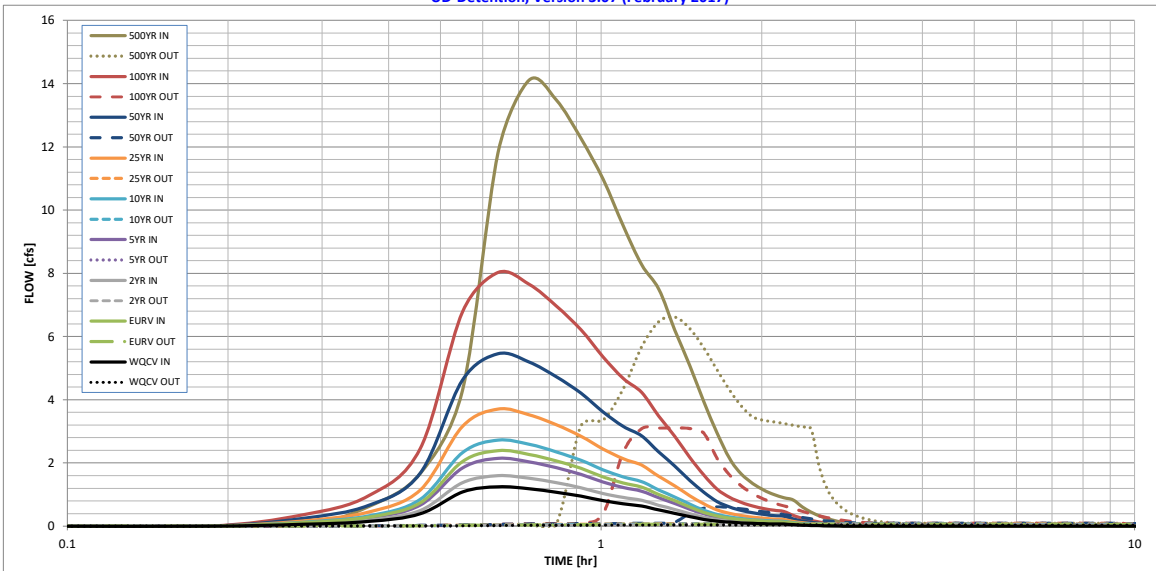
| | | |
|----------------------------------|------|-------|
| Spillway Design Flow Depth= | 0.63 | feet |
| Stage at Top of Freeboard = | 4.63 | feet |
| Basin Area at Top of Freeboard = | 0.27 | acres |

Routed Hydrograph Results

| | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|-------|-------|--------|--------|---------|---------|------------------|----------------|----------|
| Design Storm Return Period = | | | | | | | | | |
| One-Hour Rainfall Depth (in) = | 0.53 | 1.07 | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 3.14 |
| Calculated Runoff Volume (acre-ft) = | 0.081 | 0.156 | 0.104 | 0.140 | 0.178 | 0.243 | 0.359 | 0.531 | 0.939 |
| OPTIONAL Override Runoff Volume (acre-ft) = | | | | | | | | | |
| Inflow Hydrograph Volume (acre-ft) = | 0.080 | 0.156 | 0.103 | 0.139 | 0.177 | 0.243 | 0.359 | 0.530 | 0.939 |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.17 | 0.42 | 0.96 |
| Predevelopment Peak Q (cfs) = | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 1.4 | 3.3 | 7.6 |
| Peak Inflow Q (cfs) = | 1.3 | 2.4 | 1.6 | 2.1 | 2.7 | 3.7 | 5.5 | 8.0 | 14.1 |
| Peak Outflow Q (cfs) = | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.6 | 3.1 | 6.6 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 1.8 | 0.9 | 0.5 | 0.5 | 0.9 | 0.9 |
| Structure Controlling Flow = | Plate | Plate | Plate | Plate | Plate | Plate | Overflow Grate 1 | Outlet Plate 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | 0.1 | 0.4 | 0.5 |
| 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 | 51 | 43 | 49 | 54 | 62 | 69 | 66 | 59 |
| Time to Drain 99% of Inflow Volume (hours) = | 40 | 55 | 45 | 52 | 58 | 67 | 76 | 74 | 71 |
| Maximum Ponding Depth (ft) = | 0.98 | 1.42 | 1.12 | 1.33 | 1.55 | 1.90 | 2.37 | 2.58 | 3.38 |
| Area at Maximum Ponding Depth (acres) = | 0.15 | 0.17 | 0.16 | 0.16 | 0.17 | 0.18 | 0.20 | 0.21 | 0.23 |
| Maximum Volume Stored (acre-ft) = | 0.074 | 0.145 | 0.094 | 0.130 | 0.165 | 0.227 | 0.317 | 0.360 | 0.537 |

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



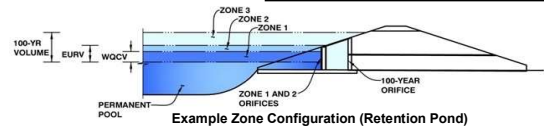
| S-A-V-D Chart Axis Override | X-axis | Left Y-Axis | Right Y-Axis |
|-----------------------------|--------|-------------|--------------|
| minimum bound | | | |
| maximum bound | | | |

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Ellicott Town Center

Basin ID: Pond C4



Required Volume Calculation

| | | |
|---|------------|-----------|
| Selected BMP Type = | EDB | |
| Watershed Area = | 72.81 | acres |
| Watershed Length = | 3.100 | ft |
| Watershed Slope = | 0.011 | ft/ft |
| Watershed Imperviousness = | 44.63% | percent |
| Percentage Hydrologic Soil Group A = | 100.0% | percent |
| Percentage Hydrologic Soil Group B = | 0.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Desired WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |
| Water Quality Capture Volume (WQCV) = | 1.165 | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 3.629 | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 2.467 | acre-feet |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 3.253 | acre-feet |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 4.026 | acre-feet |
| 25-yr Runoff Volume (P1 = 2 in.) = | 5.078 | acre-feet |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 6.469 | acre-feet |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 8.139 | acre-feet |
| 500-yr Runoff Volume (P1 = 3.14 in.) = | 12.016 | acre-feet |
| Approximate 2-yr Detention Volume = | 2.322 | acre-feet |
| Approximate 5-yr Detention Volume = | 3.066 | acre-feet |
| Approximate 10-yr Detention Volume = | 3.761 | acre-feet |
| Approximate 25-yr Detention Volume = | 4.634 | acre-feet |
| Approximate 50-yr Detention Volume = | 5.206 | acre-feet |
| Approximate 100-yr Detention Volume = | 5.952 | acre-feet |

Stage-Storage Calculation

| | | |
|---|-------|-----------------|
| Zone 1 Volume (WQCV) = | 1.165 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 2.464 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 2.323 | acre-feet |
| Total Detention Basin Volume = | 5.952 | acre-feet |
| Initial Surge Volume (ISV) = | 152 | ft ³ |
| Initial Surge Depth (ISD) = | 0.50 | ft |
| Total Available Detention Depth (H_{total}) = | 7.00 | ft |
| Depth of Trickle Channel (H_{TC}) = | 0.50 | ft |
| Slope of Trickle Channel (S_{TC}) = | 0.005 | ft/ft |
| Slopes of Main Basin Sides (S_{main}) = | 4 | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | 3 | |

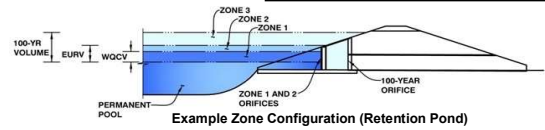
[illegible]

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Ellicott Town Center

Basin ID: Pond D

Required Volume Calculation

| | | |
|---|------------|-----------|
| Selected BMP Type = | EDB | |
| Watershed Area = | 116.28 | acres |
| Watershed Length = | 3.790 | ft |
| Watershed Slope = | 0.010 | ft/ft |
| Watershed Imperviousness = | 42.26% | percent |
| Percentage Hydrologic Soil Group A = | 100.0% | percent |
| Percentage Hydrologic Soil Group B = | 0.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Desired WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |
| Water Quality Capture Volume (WQCV) = | 1,800 | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 5,405 | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 3,668 | acre-feet |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 4,844 | acre-feet |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 6,009 | acre-feet |
| 25-yr Runoff Volume (P1 = 2 in.) = | 7,625 | acre-feet |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 9,811 | acre-feet |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 12,465 | acre-feet |
| 500-yr Runoff Volume (P1 = 3.14 in.) = | 18,638 | acre-feet |
| Approximate 2-yr Detention Volume = | 3,450 | acre-feet |
| Approximate 5-yr Detention Volume = | 4,562 | acre-feet |
| Approximate 10-yr Detention Volume = | 5,611 | acre-feet |
| Approximate 25-yr Detention Volume = | 6,938 | acre-feet |
| Approximate 50-yr Detention Volume = | 7,820 | acre-feet |
| Approximate 100-yr Detention Volume = | 9,008 | acre-feet |

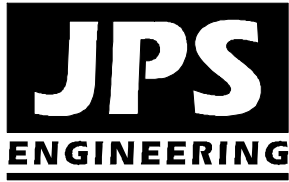
Stage-Storage Calculation

| | | |
|--|-------|-----------|
| Zone 1 Volume (WQCV) = | 1.800 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 3.605 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 3.602 | acre-feet |
| Total Detention Basin Volume = | 9.008 | acre-feet |

[illegible]

APPENDIX D1

STREET CAPACITY & STORM SEWER HYDRAULIC CALCULATIONS



**MAYBERRY, COLORADO SPRINGS - FILING NO. 1
(fka "ELLCOTT TOWN CENTER")
STREET CAPACITY ANALYSIS**

TYPICAL STREET CAPACITY ASSUMPTIONS:

| Road Type | Min. Slope | Curb-Curb Width (ft) | Minor Storm Capacity ^a (Q₅, cfs) | Major Storm Capacity ^b (Q₁₀₀, cfs) |
|------------------|-------------------|-----------------------------|---|---|
| Residential | 1.0% | 30' | 11.3 | 232.4 |

^a Maximum allowable spread at Q₅ is to crown of street.

$$Q = 112.6 * S^{(1/2)}$$

^b Maximum allowable flow depth at Q₁₀₀ is 12-inches at flowline.

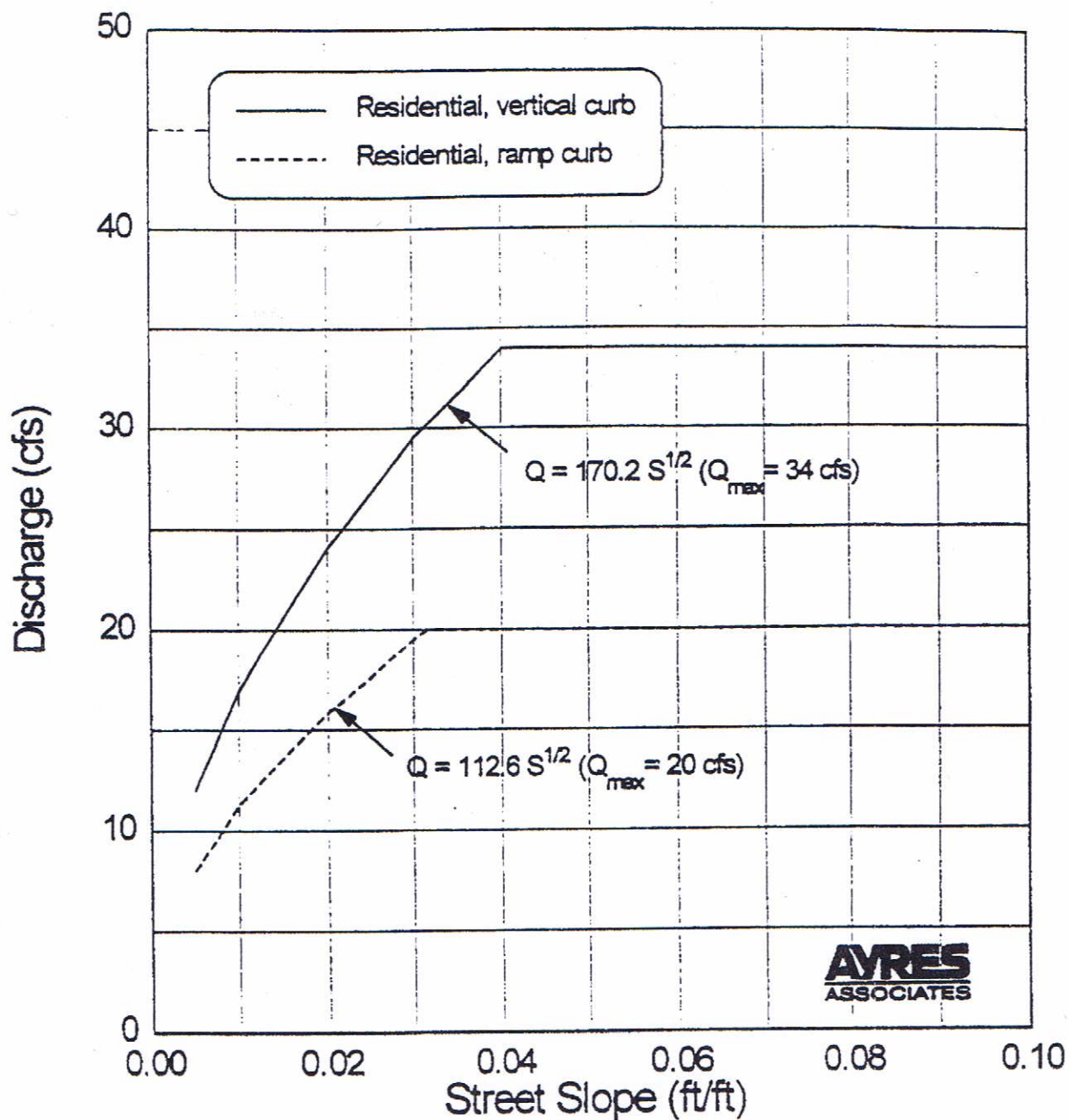
| Road (Design Point) | Min. Street Grade | Allowable Minor Storm Capacity (cfs) | Peak Flow (Q₅, cfs) | Inlet Required? |
|----------------------------|--------------------------|---|---------------------------------------|------------------------|
| Cattlemen Run (C1.1) | 1.0% | 11.3 | 5.4 | No |
| Village Main St. (C1.2) | 1.0% | 11.3 | 35.9 | Yes |
| Market Place Dr (C1.7B) | 1.0% | 11.3 | 17.3 | Yes |
| Mayberry Drive (C1.8) | 1.0% | 11.3 | 18.4 | Yes |
| | | | | |

TABLE 6 - 1

Allowable Use of Streets in El Paso County

| Street Classification | Use of Streets | | Cross Flow In Streets | |
|---|---|---|--|---|
| | Initial Storm | Major Storm | Initial Storm | Major Storm |
| <p>Arterial Local with Ramp Curb & Gutter</p> <p>Arterial Local with 8 in. Vertical Curb & Gutter</p> | <p>Maximum flow spread to crown. Maximum flow rate of 15 cfs per side.</p> <p>The depth of flow shall not exceed 6 inches at the gutter flowline. Maximum flow rate of 25 cfs per side.</p> | <p>Same as Local Street with Curb & Gutter</p> <p>Same as Local Street with Curb & Gutter</p> | <p>Same as Local Street with Curb & Gutter</p> <p>Same as Local Street with Curb & Gutter</p> | <p>Same as Local Street with Curb & Gutter</p> <p>Same as Local Street with Curb & Gutter</p> |
| <p>Local with Ramp Curb & Gutter</p> <p>Local with 8 in. Vertical Curb & Gutter</p> | <p>Maximum flow spread to street crown. Maximum flow rate of 20 cfs per side.</p> <p>The depth of flow shall not exceed 6 inches at the gutter flowline. Maximum flow rate of 34 cfs per side.</p> <p>Flow must not encroach upon road shoulder area.</p> | <p>Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the gutter flowline shall not exceed 12 inches.</p> <p>Same as above.</p> <p>Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the edge of road shoulder shall not exceed 6 inches.</p> | <p>Where cross pans are allowed, the depth of flow shall not exceed 6 inches at the flowline.</p> <p>Same as above.</p> <p>Requires culvert. Flow shall not encroach upon the road shoulder.</p> | <p>Where cross pans are allowed, the depth of flow shall not exceed 12 inches at the flowline.</p> <p>Same as above.</p> <p>Requires culvert. Depth of flow shall not exceed 6 inches at the edge of the road shoulder.</p> |
| <p>Collector with 8 in. Vertical Curb & Gutter</p> <p>Collector with Roadside Ditch</p> | <p>Same as Local Streets with 8 in. Vertical Curb & Gutter</p> <p>Same as Local Streets with Roadside Ditch.</p> | <p>Same as Local Streets with Curb & Gutter.</p> <p>Same as Local Streets with Roadside Ditch.</p> | <p>Same as Local Streets with Curb & Gutter.</p> <p>Same as Local Streets with Roadside Ditch.</p> | <p>Same as Local Streets with Curb & Gutter.</p> <p>Same as Local Streets with Roadside Ditch.</p> |
| <p>Arterial with Curb & Gutter</p> <p>Arterial with Roadside Ditch</p> | <p>The depth of flow shall not exceed 6 inches at the gutter flowline. Maximum flow rate of 34 cfs per side. One ten foot lane in each direction must remain free of water.</p> <p>Flow must not encroach upon road shoulder area.</p> | <p>Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the gutter flowline shall not exceed 8 inches and there shall be no curb overtopping.</p> <p>Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water shall not encroach upon the road shoulder.</p> | <p>No cross flow is allowed on the road surface.</p> <p>Requires culvert. Flow shall not encroach upon the road shoulder.</p> | <p>12 in. max. depth at gutter flowline or 4 in. max. depth at crown, whichever is more limiting.</p> <p>Requires culvert. Flow shall not encroach upon the road shoulder.</p> |
| Highway / Freeway | No encroachment of water is allowed on any traffic lanes. | No encroachment of water is allowed on any traffic lanes. | No cross flow is allowed on the road surface. | No cross flow is allowed on the road surface. |

RESIDENTIAL STREET (34' Flowline to flowline)



Interim Release October 12, 1994
City of Colorado Springs

Use this graph to determine the allowable street capacity per side, initial storm, for the typical street section using a 2% crown.

MAYBERRY, COLORADO SPRINGS (ELLCOTT TOWN CENTER) FILING NO. 1
STORM INLET SIZING SUMMARY

| INLET | BASIN FLOW | | | INLET FLOW | | | INLET CONDITION / TYPE | INLET SIZE | INLET CAPACITY (CFS) |
|-------|------------|----------------------------------|------------------------------------|-----------------------------|---------------------|-----------------------|-------------------------------|---------------|----------------------------|
| | DP | Q5 FLOW (CFS) ¹ | Q100 FLOW (CFS) ^a | INLET FLOW % OF BASIN | Q5 FLOW (CFS) | Q100 FLOW (CFS) | | | |
| C1.2 | C1.2 | 16.9 | 35.9 | 100 | 16.9 | 35.9 | SUMP TYPE R | 10.0 | 25.5 ^b |
| C1.7A | C1.7A | 1.1 | 2.7 | 100 | 1.1 | 2.7 | SUMP TYPE R | 5.0 | 12.3 |
| C1.7B | C1.7B | 8.2 | 17.3 | 100 | 8.2 | 17.3 | SUMP TYPE R | 10.0 | 25.5 |
| C1.3 | C1.3 | 5.9 | 14.3 | 100 | 5.9 | 14.3 | SUMP TYPE R | 10.0 | 25.5 |
| C1.4 | C1.4 | 6.3 | 15.3 | 100 | 6.3 | 15.3 | SUMP TYPE R | 10.0 | 25.5 |
| C1.5 | C1.5 | 6.2 | 15.0 | 100 | 6.2 | 15.0 | SUMP TYPE R | 10.0 | 25.5 |
| C1.1 | C1.1 | 5.4 | 18.0 | 100 | 5.4 | 18.0 | SUMP TYPE R | 10.0 | 25.5 |
| C1.6A | C1.6 | 3.8 | 9.4 | 10 | 0.4 | 0.9 | SUMP TYPE R | 5.0 | 12.3 |
| C1.6B | C1.6 | 3.8 | 9.4 | 90 | 3.4 | 8.5 | SUMP TYPE R | 5.0 | 12.3 |
| C1.8 | C1.8 | 7.5 | 18.4 | 100 | 7.5 | 18.4 | SUMP TYPE R | 10.0 | 25.5 |
| C1.9A | C1.9 | 7.0 | 17.0 | 100 | 7.0 | 17.0 | SUMP TYPE R | 10.0 | 25.5 |
| C2.3A | C2.3A | 11.8 | 31.6 | 100 | 11.8 | 31.6 | SUMP TYPE R (FILING NO. 4) | 15.0 | 39.1 |
| C2.8A | C2.8A | 13.4 | 28.9 | 100 | 13.4 | 28.9 | SUMP TYPE R | 15.0 | 39.1 |
| C2.8B | C2.5 | 8.0 | 19.5 | 10 | 0.8 | 2.0 | SUMP TYPE R | 5.0 | 12.3 |

^a REFER TO RATIONAL METHOHD HYDROLOGY CALCULATIONS FOR CONTRIBUTING BASINS & DEVELOPED FLOW CALCULATIONS

^b ADDITIONAL UPSTREAM INLET CAPACITY TO BE PROVIDED WITHIN COMMERCIAL DEVELOPMENT AREA

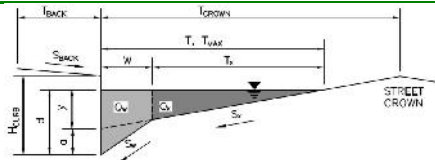
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Ellicott Town Center - Typical 5' Type R Inlet (Sump Condition)

Project:

Inlet ID:

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

 $T_{BACK} = 12.0$ ft $S_{BACK} = 0.020$ ft/ft $n_{BACK} = 0.020$ $H_{CURB} = 6.00$ inches $T_{CROWN} = 15.0$ ft $W = 2.00$ ft $S_X = 0.020$ ft/ft $S_W = 0.083$ ft/ft $S_O = 0.000$ ft/ft $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

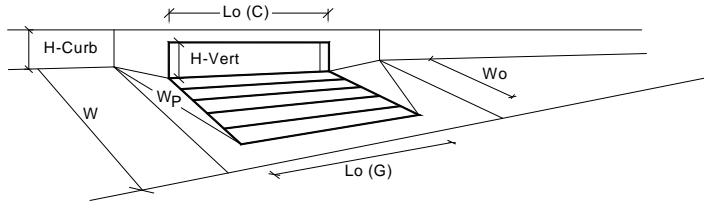
| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|--------|
| $T_{MAX} =$ | 15.0 | 15.0 | ft |
| $d_{MAX} =$ | 6.0 | 12.0 | inches |

**MINOR STORM Allowable Capacity is based on Depth Criterion****MAJOR STORM Allowable Capacity is based on Depth Criterion**

| | Minor Storm | Major Storm | |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | SUMP | SUMP | cfs |

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



| Design Information (Input) | | MINOR | | MAJOR | | |
|--|--------------------------|------------------------------|-------|--------------------------|---------|---|
| Type of Inlet | CDOT Type R Curb Opening | Type = | | CDOT Type R Curb Opening | | |
| Local Depression (additional to continuous gutter depression 'a' from above) | | a _{local} = | 3.00 | 3.00 | inches | |
| Number of Unit Inlets (Grate or Curb Opening) | | No = | 1 | 1 | | |
| Water Depth at Flowline (outside of local depression) | | Ponding Depth = | 6.0 | 12.0 | inches | |
| Grate Information | | | | | | <input checked="" type="checkbox"/> Override Depths |
| Length of a Unit Grate | | L _o (G) = | N/A | N/A | feet | |
| Width of a Unit Grate | | W _o = | N/A | N/A | feet | |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | | A _{ratio} = | N/A | N/A | | |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70) | | C _r (G) = | N/A | N/A | | |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | | C _w (G) = | N/A | N/A | | |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | | C _o (G) = | N/A | N/A | | |
| Curb Opening Information | | | | | | |
| Length of a Unit Curb Opening | | L _o (C) = | 5.00 | 5.00 | feet | |
| Height of Vertical Curb Opening in Inches | | H _{vert} = | 6.00 | 6.00 | inches | |
| Height of Curb Orifice Throat in Inches | | H _{throat} = | 6.00 | 6.00 | inches | |
| Angle of Throat (see USDCM Figure ST-5) | | Theta = | 63.40 | 63.40 | degrees | |
| Side Width for Depression Pan (typically the gutter width of 2 feet) | | W _p = | 2.00 | 2.00 | feet | |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | | C _r (C) = | 0.10 | 0.10 | | |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | | C _w (C) = | 3.60 | 3.60 | | |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | | C _o (C) = | 0.67 | 0.67 | | |
| Low Head Performance Reduction (Calculated) | | | | | | |
| Depth for Grate Midwidth | | d _{Grate} = | N/A | N/A | ft | |
| Depth for Curb Opening Weir Equation | | d _{Curb} = | 0.33 | 0.83 | ft | |
| Combination Inlet Performance Reduction Factor for Long Inlets | | RF _{Combination} = | 0.77 | 1.00 | | |
| Curb Opening Performance Reduction Factor for Long Inlets | | RF _{Curb} = | 1.00 | 1.00 | | |
| Grated Inlet Performance Reduction Factor for Long Inlets | | RF _{Grate} = | N/A | N/A | | |
| Total Inlet Interception Capacity (assumes clogged condition) | | | | | | |
| Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK) | | Q _a = | 5.4 | 12.3 | cfs | |
| | | Q _{PEAK REQUIRED} = | 4.0 | 8.0 | cfs | |

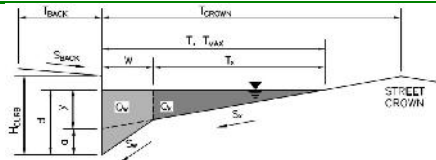
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Ellicott Town Center - Typical 10' Type R Inlet (Sump Condition)

Project:

Inlet ID:

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

MINOR STORM Allowable Capacity is based on Depth Criterion**MAJOR STORM Allowable Capacity is based on Depth Criterion** $T_{BACK} = 12.0$ ft $S_{BACK} = 0.020$ ft/ft $n_{BACK} = 0.020$ $H_{CURB} = 6.00$ inches $T_{CROWN} = 15.0$ ft $W = 2.00$ ft $S_X = 0.020$ ft/ft $S_W = 0.083$ ft/ft $S_O = 0.000$ ft/ft $n_{STREET} = 0.016$

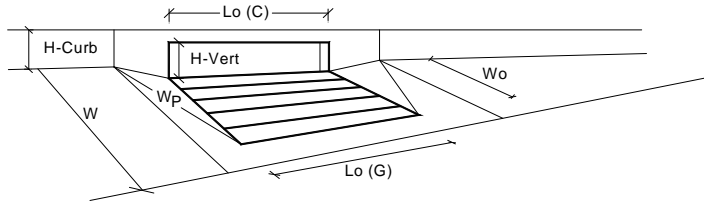
| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|--------|
| $T_{MAX} =$ | 15.0 | 15.0 | ft |
| $d_{MAX} =$ | 6.0 | 12.0 | inches |



| | Minor Storm | Major Storm | |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | SUMP | SUMP | cfs |

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



| Design Information (Input) | | MINOR | | MAJOR | |
|--|--------------------------|------------------------------|--------------------------|-------|---|
| Type of Inlet | CDOT Type R Curb Opening | Type = | CDOT Type R Curb Opening | | |
| Local Depression (additional to continuous gutter depression 'a' from above) | | a _{local} = | 3.00 | 3.00 | inches |
| Number of Unit Inlets (Grate or Curb Opening) | | No = | 1 | 1 | |
| Water Depth at Flowline (outside of local depression) | | Ponding Depth = | 6.0 | 12.0 | inches |
| Grate Information | | | MINOR | MAJOR | <input checked="" type="checkbox"/> Override Depths |
| Length of a Unit Grate | | L _g (G) = | N/A | N/A | feet |
| Width of a Unit Grate | | W _o = | N/A | N/A | feet |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | | A _{ratio} = | N/A | N/A | |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70) | | C _r (G) = | N/A | N/A | |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | | C _w (G) = | N/A | N/A | |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | | C _o (G) = | N/A | N/A | |
| Curb Opening Information | | | MINOR | MAJOR | |
| Length of a Unit Curb Opening | | L _c (C) = | 10.00 | 10.00 | feet |
| Height of Vertical Curb Opening in Inches | | H _{vert} = | 6.00 | 6.00 | inches |
| Height of Curb Orifice Throat in Inches | | H _{throat} = | 6.00 | 6.00 | inches |
| Angle of Throat (see USDCM Figure ST-5) | | Theta = | 63.40 | 63.40 | degrees |
| Side Width for Depression Pan (typically the gutter width of 2 feet) | | W _p = | 2.00 | 2.00 | feet |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | | C _r (C) = | 0.10 | 0.10 | |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | | C _w (C) = | 3.60 | 3.60 | |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | | C _o (C) = | 0.67 | 0.67 | |
| Low Head Performance Reduction (Calculated) | | | MINOR | MAJOR | |
| Depth for Grate Midwidth | | d _{grate} = | N/A | N/A | ft |
| Depth for Curb Opening Weir Equation | | d _{curb} = | 0.33 | 0.83 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | | RF _{Combination} = | 0.57 | 1.00 | |
| Curb Opening Performance Reduction Factor for Long Inlets | | RF _{Curb} = | 0.93 | 1.00 | |
| Grated Inlet Performance Reduction Factor for Long Inlets | | RF _{Grate} = | N/A | N/A | |
| Total Inlet Interception Capacity (assumes clogged condition) | | | MINOR | MAJOR | |
| | | Q _a = | 8.3 | 25.5 | cfs |
| | | Q _{PEAK REQUIRED} = | 10.0 | 21.0 | cfs |

WARNING: Inlet Capacity less than Q Peak for Minor Storm

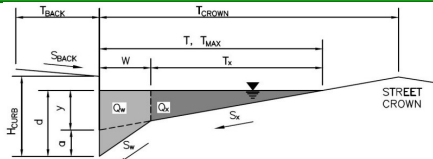
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Ellicott Town Center - Typical 15' Type R Inlet (Sump Condition)

Project:

Inlet ID:

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

MINOR STORM Allowable Capacity is based on Depth Criterion**MAJOR STORM** Allowable Capacity is based on Depth Criterion $T_{BACK} = 12.0$ ft $S_{BACK} = 0.020$ ft/ft $n_{BACK} = 0.020$ $H_{CURB} = 6.00$ inches $T_{CROWN} = 15.0$ ft $W = 2.00$ ft $S_x = 0.020$ ft/ft $S_W = 0.083$ ft/ft $S_0 = 0.000$ ft/ft $n_{STREET} = 0.016$

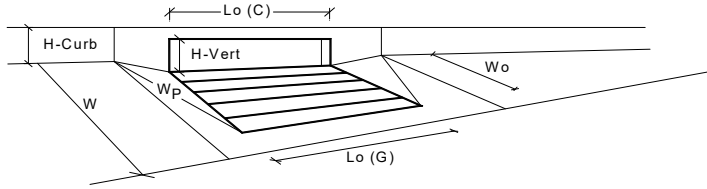
| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|--------|
| $T_{MAX} =$ | 15.0 | 15.0 | ft |
| $d_{MAX} =$ | 6.0 | 12.0 | inches |

☐☐

| | Minor Storm | Major Storm | |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | SUMP | SUMP | cfs |

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



| Design Information (Input) | | MINOR | | MAJOR | |
|--|--------------------------|-----------------------|--------------------------|-------|---|
| Type of Inlet | CDOT Type R Curb Opening | Type = | CDOT Type R Curb Opening | | |
| Local Depression (additional to continuous gutter depression 'a' from above) | | a_{local} = | 3.00 | 3.00 | inches |
| Number of Unit Inlets (Grate or Curb Opening) | | No = | 1 | 1 | |
| Water Depth at Flowline (outside of local depression) | | Ponding Depth = | 6.0 | 12.0 | inches |
| Grate Information | | | MINOR | MAJOR | <input checked="" type="checkbox"/> Override Depths |
| Length of a Unit Grate | | $L_g (G)$ = | N/A | N/A | feet |
| Width of a Unit Grate | | W_o = | N/A | N/A | feet |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | | A_{ratio} = | N/A | N/A | |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70) | | $C_r (G)$ = | N/A | N/A | |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | | $C_w (G)$ = | N/A | N/A | |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | | $C_o (G)$ = | N/A | N/A | |
| Curb Opening Information | | | MINOR | MAJOR | |
| Length of a Unit Curb Opening | | $L_o (C)$ = | 15.00 | 15.00 | feet |
| Height of Vertical Curb Opening in Inches | | H_{vert} = | 6.00 | 6.00 | inches |
| Height of Curb Orifice Throat in Inches | | H_{throat} = | 6.00 | 6.00 | inches |
| Angle of Throat (see USDCM Figure ST-5) | | Theta = | 63.40 | 63.40 | degrees |
| Side Width for Depression Pan (typically the gutter width of 2 feet) | | W_p = | 2.00 | 2.00 | feet |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | | $C_r (C)$ = | 0.10 | 0.10 | |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | | $C_w (C)$ = | 3.60 | 3.60 | |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | | $C_o (C)$ = | 0.67 | 0.67 | |
| Low Head Performance Reduction (Calculated) | | | MINOR | MAJOR | |
| Depth for Grate Midwidth | | d_{Grate} = | N/A | N/A | ft |
| Depth for Curb Opening Weir Equation | | d_{Curb} = | 0.33 | 0.83 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | | $RF_{Combination}$ = | 0.57 | 1.00 | |
| Curb Opening Performance Reduction Factor for Long Inlets | | RF_{Curb} = | 0.79 | 1.00 | |
| Grated Inlet Performance Reduction Factor for Long Inlets | | RF_{Grate} = | N/A | N/A | |
| Total Inlet Interception Capacity (assumes clogged condition) | | | MINOR | MAJOR | |
| WARNING: Inlet Capacity less than Q Peak for Minor Storm | | Q_a = | 9.7 | 39.1 | cfs |
| | | $Q_{PEAK REQUIRED}$ = | 11.3 | 35.9 | cfs |

**MAYBERRY, COLORADO SPRINGS (ELLCOTT TOWN CENTER) FILING NO. 1
STORM SEWER SIZING SUMMARY**

| PIPE FLOW | | | | PIPE CAPACITY | | |
|-----------|------------------------|---------------------|-----------------------|---------------|-----------------------|--------------------------------|
| PIPE | BASINS | Q5 FLOW (CFS) | Q100 FLOW (CFS) | PIPE SIZE | MIN. PIPE SLOPE | FULL PIPE CAPACITY (CFS) |
| | | | | | | |
| | | | | | | |
| C1.2 | C1.2 | 16.9 | 35.9 | 30 | 1.0% | 41.0 |
| | | | | | | |
| C1.7A | C1.7A | 1.1 | 2.7 | 18 | 1.0% | 10.5 |
| | | | | | | |
| C1.7B | C1.7A,C1.7B | 9.3 | 20.0 | 24 | 1.0% | 22.6 |
| C1.2D | C1.2,C1.7A-B | 26.2 | 55.9 | 36 | 0.89% | 62.9 |
| | | | | | | |
| C1.3 | C1.3 | 5.9 | 14.3 | 18 | 1.9% | 14.5 |
| C1.3A | C1.2,C1.3,C1.7A-B | 32.1 | 70.2 | 36 | 1.41% | 79.2 |
| | | | | | | |
| C1.4 | C1.4 | 6.3 | 15.3 | 18 | 2.2% | 15.6 |
| C1.4A | C1.2-C1.4,C1.7A-B | 38.4 | 85.5 | 42 | 0.85% | 92.8 |
| | | | | | | |
| C1.5 | C1.5 | 6.2 | 15.0 | 18 | 2.1% | 15.2 |
| C1.5A | C1.2-C1.5,C1.7A-B | 44.6 | 100.5 | 42 | 1.0% | 100.6 |
| | | | | | | |
| C1.1 | C1.1 | 5.4 | 18.0 | 24 | 1.0% | 22.6 |
| C1.6A | C1.6 | 5.8 | 18.9 | 18 | 1.0% | 10.5 |
| | | | | | | |
| C1.6B | C1.6 | 3.4 | 8.5 | 18 | 1.0% | 10.5 |
| C1.6C | C1.1,C1.2-C1.6,C1.7A-B | 53.8 | 127.9 | 48 | 0.80% | 128.5 |
| | | | | | | |
| C1.8 | C1.8 | 7.5 | 18.4 | 24 | 1.0% | 22.6 |
| | | | | | | |
| C1.9 | C1.9 | 7.0 | 17.0 | 24 | 1.0% | 22.6 |
| C1.9C | C1.1-C1.9 | 68.3 | 163.3 | 60 | 0.50% | 184.2 |
| | | | | | | |
| C2.3A | C2.3A | 11.8 | 31.6 | 30 | 0.6% | 31.8 |
| | | | | | | |
| | | | | | | |
| C2.8A | C2.8 | 13.4 | 28.9 | 30 | 0.5% | 29.0 |
| C2.8B | C2.8 | 14.2 | 30.9 | 30 | 0.5% | 29.0 |
| | | | | | | |

ASSUMPTIONS:

1. STORM DRAIN PIPE ASSUMED TO BE RCP OR HDPE

Hydraulic Analysis Report

Project Data

Project Title: ETC Filing No. 1 - SD
Designer: JPS
Project Date: Thursday, August 16, 2018
Project Units: U.S. Customary Units
Notes:

Channel Analysis: SD-C1.2

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 2.5000 ft
Longitudinal Slope: 0.0100 ft/ft
Manning's n: 0.0130
Depth: 2.5000 ft

Result Parameters

Flow: 41.0171 cfs
Area of Flow: 4.9087 ft²
Wetted Perimeter: 7.8540 ft
Hydraulic Radius: 0.6250 ft
Average Velocity: 8.3559 ft/s
Top Width: 0.0000 ft
Froude Number: 0.0000
Critical Depth: 2.1509 ft
Critical Velocity: 9.1300 ft/s
Critical Slope: 0.0093 ft/ft
Critical Top Width: 1.73 ft
Calculated Max Shear Stress: 1.5600 lb/ft²
Calculated Avg Shear Stress: 0.3900 lb/ft²

Channel Analysis: SD-C1.7A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 10.5043 cfs

Area of Flow: 1.7671 ft²

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 5.9442 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.2451 ft

Critical Velocity: 6.6989 ft/s

Critical Slope: 0.0098 ft/ft

Critical Top Width: 1.13 ft

Calculated Max Shear Stress: 0.9360 lb/ft²

Calculated Avg Shear Stress: 0.2340 lb/ft²

Channel Analysis: SD-C1.7B

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

Result Parameters

Flow: 22.6224 cfs

Area of Flow: 3.1416 ft²

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 7.2009 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.6953 ft

Critical Velocity: 7.9674 ft/s

Critical Slope: 0.0095 ft/ft

Critical Top Width: 1.44 ft

Calculated Max Shear Stress: 1.2480 lb/ft²

Calculated Avg Shear Stress: 0.3120 lb/ft²

Channel Analysis: SD-C1.2D

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 3.0000 ft

Longitudinal Slope: 0.0089 ft/ft

Manning's n: 0.0130

Depth: 3.0000 ft

Result Parameters

Flow: 62.9231 cfs

Area of Flow: 7.0686 ft²

Wetted Perimeter: 9.4248 ft

Hydraulic Radius: 0.7500 ft

Average Velocity: 8.9018 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 2.5518 ft

Critical Velocity: 9.8203 ft/s

Critical Slope: 0.0084 ft/ft

Critical Top Width: 2.14 ft

Calculated Max Shear Stress: 1.6661 lb/ft²

Calculated Avg Shear Stress: 0.4165 lb/ft²

Channel Analysis: SD-C1.3

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0190 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 14.4792 cfs

Area of Flow: 1.7671 ft²

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 8.1936 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.3938 ft

Critical Velocity: 8.4583 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 0.77 ft

Calculated Max Shear Stress: 1.7784 lb/ft²

Calculated Avg Shear Stress: 0.4446 lb/ft²

Channel Analysis: SD-C1.3A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 3.0000 ft

Longitudinal Slope: 0.0141 ft/ft

Manning's n: 0.0130

Depth: 3.0000 ft

Result Parameters

Flow: 79.2000 cfs

Area of Flow: 7.0686 ft²

Wetted Perimeter: 9.4248 ft

Hydraulic Radius: 0.7500 ft

Average Velocity: 11.2045 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 2.7627 ft

Critical Velocity: 11.6333 ft/s

Critical Slope: 0.0122 ft/ft

Critical Top Width: 1.62 ft

Calculated Max Shear Stress: 2.6395 lb/ft²

Calculated Avg Shear Stress: 0.6599 lb/ft²

Channel Analysis: SD-C1.4

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0220 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 15.5805 cfs

Area of Flow: 1.7671 ft²

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 8.8167 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.4172 ft

Critical Velocity: 9.0117 ft/s

Critical Slope: 0.0190 ft/ft

Critical Top Width: 0.68 ft

Calculated Max Shear Stress: 2.0592 lb/ft²

Calculated Avg Shear Stress: 0.5148 lb/ft²

Channel Analysis: SD-C1.4A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 3.5000 ft

Longitudinal Slope: 0.0085 ft/ft

Manning's n: 0.0130

Depth: 3.5000 ft

Result Parameters

Flow: 92.7576 cfs

Area of Flow: 9.6211 ft²

Wetted Perimeter: 10.9956 ft

Hydraulic Radius: 0.8750 ft

Average Velocity: 9.6410 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 2.9805 ft

Critical Velocity: 10.6254 ft/s

Critical Slope: 0.0080 ft/ft

Critical Top Width: 2.49 ft

Calculated Max Shear Stress: 1.8564 lb/ft²

Calculated Avg Shear Stress: 0.4641 lb/ft²

Channel Analysis: SD-C1.5

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0210 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 15.2222 cfs

Area of Flow: 1.7671 ft²

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 8.6140 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.4099 ft

Critical Velocity: 8.8307 ft/s

Critical Slope: 0.0181 ft/ft

Critical Top Width: 0.71 ft

Calculated Max Shear Stress: 1.9656 lb/ft²

Calculated Avg Shear Stress: 0.4914 lb/ft²

Channel Analysis: SD-C1.5A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 3.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 3.5000 ft

Result Parameters

Flow: 100.6098 cfs

Area of Flow: 9.6211 ft²

Wetted Perimeter: 10.9956 ft

Hydraulic Radius: 0.8750 ft

Average Velocity: 10.4572 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 3.0762 ft

Critical Velocity: 11.2307 ft/s

Critical Slope: 0.0090 ft/ft

Critical Top Width: 2.28 ft

Calculated Max Shear Stress: 2.1840 lb/ft²

Calculated Avg Shear Stress: 0.5460 lb/ft²

Channel Analysis: SD-C1.1

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

Result Parameters

Flow: 22.6224 cfs

Area of Flow: 3.1416 ft²

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 7.2009 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.6953 ft

Critical Velocity: 7.9674 ft/s

Critical Slope: 0.0095 ft/ft

Critical Top Width: 1.44 ft

Calculated Max Shear Stress: 1.2480 lb/ft²

Calculated Avg Shear Stress: 0.3120 lb/ft²

Channel Analysis: SD-C1.6A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 10.5043 cfs

Area of Flow: 1.7671 ft²

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 5.9442 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.2451 ft

Critical Velocity: 6.6989 ft/s

Critical Slope: 0.0098 ft/ft

Critical Top Width: 1.13 ft

Calculated Max Shear Stress: 0.9360 lb/ft²

Calculated Avg Shear Stress: 0.2340 lb/ft²

Channel Analysis: SD-C1.6B

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 10.5043 cfs

Area of Flow: 1.7671 ft²

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 5.9442 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.2451 ft

Critical Velocity: 6.6989 ft/s

Critical Slope: 0.0098 ft/ft

Critical Top Width: 1.13 ft

Calculated Max Shear Stress: 0.9360 lb/ft²

Calculated Avg Shear Stress: 0.2340 lb/ft²

Channel Analysis: SD-C1.6C

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 4.0000 ft

Longitudinal Slope: 0.0080 ft/ft

Manning's n: 0.0130

Depth: 4.0000 ft

Result Parameters

Flow: 128.4785 cfs

Area of Flow: 12.5664 ft²

Wetted Perimeter: 12.5664 ft

Hydraulic Radius: 1.0000 ft

Average Velocity: 10.2240 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 3.3945 ft

Critical Velocity: 11.3010 ft/s

Critical Slope: 0.0076 ft/ft

Critical Top Width: 2.87 ft

Calculated Max Shear Stress: 1.9968 lb/ft²

Calculated Avg Shear Stress: 0.4992 lb/ft²

Channel Analysis: SD-C1.8

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

Result Parameters

Flow: 22.6224 cfs

Area of Flow: 3.1416 ft²

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 7.2009 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.6953 ft

Critical Velocity: 7.9674 ft/s

Critical Slope: 0.0095 ft/ft

Critical Top Width: 1.44 ft

Calculated Max Shear Stress: 1.2480 lb/ft²

Calculated Avg Shear Stress: 0.3120 lb/ft²

Channel Analysis: SD-C1.9

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

Result Parameters

Flow: 22.6224 cfs

Area of Flow: 3.1416 ft²

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 7.2009 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.6953 ft

Critical Velocity: 7.9674 ft/s

Critical Slope: 0.0095 ft/ft

Critical Top Width: 1.44 ft

Calculated Max Shear Stress: 1.2480 lb/ft²

Calculated Avg Shear Stress: 0.3120 lb/ft²

Channel Analysis: SD-C1.9C

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 5.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0130

Depth: 5.0000 ft

Result Parameters

Flow: 184.1607 cfs

Area of Flow: 19.6350 ft²

Wetted Perimeter: 15.7080 ft

Hydraulic Radius: 1.2500 ft

Average Velocity: 9.3792 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 3.8843 ft

Critical Velocity: 11.2521 ft/s

Critical Slope: 0.0056 ft/ft

Critical Top Width: 4.16 ft

Calculated Max Shear Stress: 1.5600 lb/ft²

Calculated Avg Shear Stress: 0.3900 lb/ft²

Channel Analysis: SD-C2.3A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.5000 ft

Longitudinal Slope: 0.0060 ft/ft

Manning's n: 0.0130

Depth: 2.5000 ft

Result Parameters

Flow: 31.7717 cfs

Area of Flow: 4.9087 ft²

Wetted Perimeter: 7.8540 ft

Hydraulic Radius: 0.6250 ft

Average Velocity: 6.4725 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.9189 ft

Critical Velocity: 7.8583 ft/s

Critical Slope: 0.0068 ft/ft

Critical Top Width: 2.11 ft

Calculated Max Shear Stress: 0.9360 lb/ft²

Calculated Avg Shear Stress: 0.2340 lb/ft²

Channel Analysis: SD-C2.8A-B

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.5000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0130

Depth: 2.5000 ft

Result Parameters

Flow: 29.0035 cfs

Area of Flow: 4.9087 ft²

Wetted Perimeter: 7.8540 ft

Hydraulic Radius: 0.6250 ft

Average Velocity: 5.9085 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.8359 ft

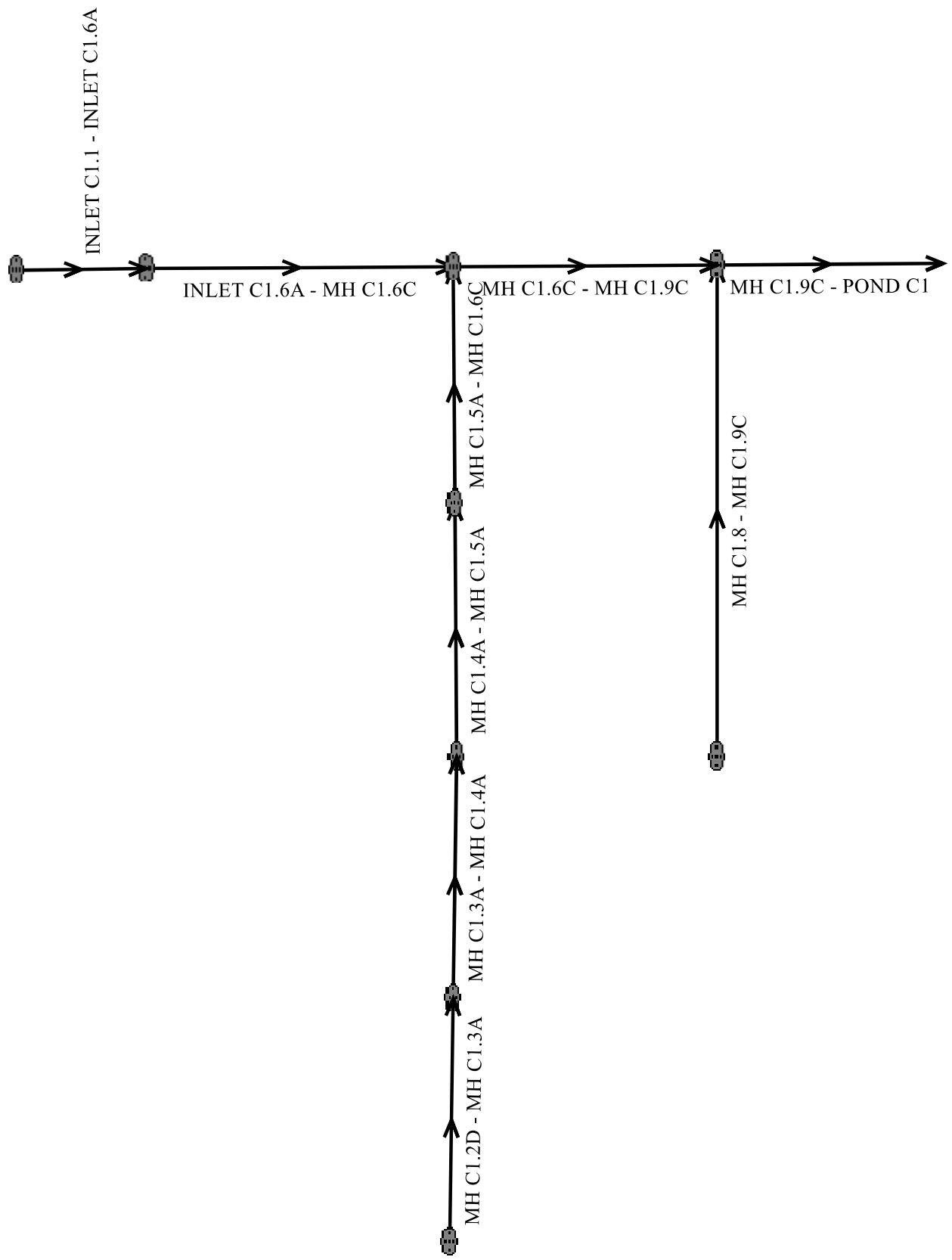
Critical Velocity: 7.5068 ft/s

Critical Slope: 0.0063 ft/ft

Critical Top Width: 2.21 ft

Calculated Max Shear Stress: 0.7800 lb/ft²

Calculated Avg Shear Stress: 0.1950 lb/ft²



UDSewer Results Summary

Project Title: Ellicott Town Center - Storm Sewer C1 – 100-Year Analysis
Project Description: Default system

Table of Contents

[Top](#)

[System Input](#)

[Manhole Input](#)

[Manhole Output](#)

[Sewer Input](#)

[Sewer Flow](#)

[Sewer Sizing](#)

[EGL/HGL Summary](#)

[Excavation Estimate](#)

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in): 2.52
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 12.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6053.90

Manhole Input Summary:

[illegible]

Manhole Output Summary:

[illegible]

Sewer Input Summary:

| | | Elevation | | | Loss Coefficients | | | Given Dimensions | | |
|--------------------------|-------------------|------------------------|-----------|----------------------|-------------------|-----------|--------------|------------------|-----------------|-----------------|
| Element Name | Sewer Length (ft) | Downstream Invert (ft) | Slope (%) | Upstream Invert (ft) | Manning's n | Bend Loss | Lateral Loss | Cross Section | Rise (ft or in) | Span (ft or in) |
| MH C1.9C - POND C1 | 116.83 | 6048.25 | 0.5 | 6048.83 | 0.013 | 0.03 | 1.00 | CIRCULAR | 60.00 in | 60.00 in |
| MH C1.6C - MH C1.9C | 311.01 | 6049.83 | 1.1 | 6053.11 | 0.013 | 0.05 | 1.00 | CIRCULAR | 48.00 in | 48.00 in |
| MH C1.5A - MH C1.6C | 159.20 | 6053.61 | 1.0 | 6055.20 | 0.013 | 1.32 | 1.00 | CIRCULAR | 42.00 in | 42.00 in |
| MH C1.4A - MH C1.5A | 328.84 | 6055.30 | 1.3 | 6059.56 | 0.013 | 0.05 | 1.00 | CIRCULAR | 42.00 in | 42.00 in |
| MH C1.3A - MH C1.4A | 276.18 | 6059.86 | 1.4 | 6063.75 | 0.013 | 0.05 | 1.00 | CIRCULAR | 36.00 in | 36.00 in |
| MH C1.2D - MH C1.3A | 313.54 | 6064.05 | 0.9 | 6066.83 | 0.013 | 0.05 | 1.00 | CIRCULAR | 36.00 in | 36.00 in |
| INLET C1.6A - MH C1.6C | 436.48 | 6055.11 | 1.6 | 6062.07 | 0.013 | 0.05 | 1.00 | CIRCULAR | 24.00 in | 24.00 in |
| INLET C1.1 - INLET C1.6A | 32.82 | 6062.17 | 1.0 | 6062.50 | 0.013 | 0.05 | 1.00 | CIRCULAR | 24.00 in | 24.00 in |
| MH C1.8 - MH C1.9C | 457.18 | 6051.83 | 1.1 | 6057.00 | 0.013 | 1.32 | 1.00 | CIRCULAR | 24.00 in | 24.00 in |

Sewer Flow Summary:

| | Full Flow Capacity | | Critical Flow | | Normal Flow | | | | | | |
|--------------------------|--------------------|----------------|---------------|----------------|-------------|----------------|---------------|--------------------|------------|------------------------|---------|
| Element Name | Flow (cfs) | Velocity (fps) | Depth (in) | Velocity (fps) | Depth (in) | Velocity (fps) | Froude Number | Flow Condition | Flow (cfs) | Surcharged Length (ft) | Comment |
| MH C1.9C - POND C1 | 184.01 | 9.37 | 43.96 | 10.59 | 43.98 | 10.59 | 1.00 | Pressurized | 163.30 | 116.83 | |
| MH C1.6C - MH C1.9C | 147.91 | 11.77 | 40.66 | 11.27 | 34.46 | 13.25 | 1.43 | Supercritical Jump | 127.90 | 228.26 | |
| MH C1.5A - MH C1.6C | 100.83 | 10.48 | 36.89 | 11.22 | 34.30 | 11.95 | 1.19 | Pressurized | 100.50 | 159.20 | |
| MH C1.4A - MH C1.5A | 114.82 | 11.93 | 34.55 | 10.10 | 27.00 | 13.08 | 1.65 | Pressurized | 85.50 | 328.84 | |
| MH C1.3A - MH C1.4A | 79.37 | 11.23 | 31.92 | 10.59 | 26.32 | 12.68 | 1.55 | Pressurized | 70.20 | 276.18 | |
| MH C1.2D - MH C1.3A | 62.98 | 8.91 | 29.09 | 9.13 | 26.39 | 10.06 | 1.23 | Pressurized | 55.90 | 313.54 | |
| INLET C1.6A - MH C1.6C | 28.64 | 9.12 | 18.77 | 7.17 | 14.23 | 9.74 | 1.73 | Supercritical Jump | 18.90 | 207.98 | |
| INLET C1.1 - INLET C1.6A | 22.75 | 7.24 | 18.34 | 6.99 | 16.11 | 8.03 | 1.30 | Supercritical | 18.00 | 0.00 | |
| MH C1.8 - MH C1.9C | 24.12 | 7.68 | 18.53 | 7.07 | 15.69 | 8.45 | 1.39 | Pressurized | 18.40 | 457.18 | |

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

| | | | Existing | | Calculated | | Used | | | |
|--------------------------|-----------------|---------------|----------|----------|------------|----------|----------|----------|-------------|---------|
| Element Name | Peak Flow (cfs) | Cross Section | Rise | Span | Rise | Span | Rise | Span | Area (ft^2) | Comment |
| MH C1.9C - POND C1 | 163.30 | CIRCULAR | 60.00 in | 60.00 in | 60.00 in | 60.00 in | 60.00 in | 60.00 in | 19.63 | |
| MH C1.6C - MH C1.9C | 127.90 | CIRCULAR | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 12.57 | |
| MH C1.5A - MH C1.6C | 100.50 | CIRCULAR | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 9.62 | |
| MH C1.4A - MH C1.5A | 85.50 | CIRCULAR | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 9.62 | |
| MH C1.3A - MH C1.4A | 70.20 | CIRCULAR | 36.00 in | 36.00 in | 36.00 in | 36.00 in | 36.00 in | 36.00 in | 7.07 | |
| MH C1.2D - MH C1.3A | 55.90 | CIRCULAR | 36.00 in | 36.00 in | 36.00 in | 36.00 in | 36.00 in | 36.00 in | 7.07 | |
| INLET C1.6A - MH C1.6C | 18.90 | CIRCULAR | 24.00 in | 24.00 in | 21.00 in | 21.00 in | 24.00 in | 24.00 in | 3.14 | |
| INLET C1.1 - INLET C1.6A | 18.00 | CIRCULAR | 24.00 in | 24.00 in | 24.00 in | 24.00 in | 24.00 in | 24.00 in | 3.14 | |
| MH C1.8 - MH C1.9C | 18.40 | CIRCULAR | 24.00 in | 24.00 in | 24.00 in | 24.00 in | 24.00 in | 24.00 in | 3.14 | |

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

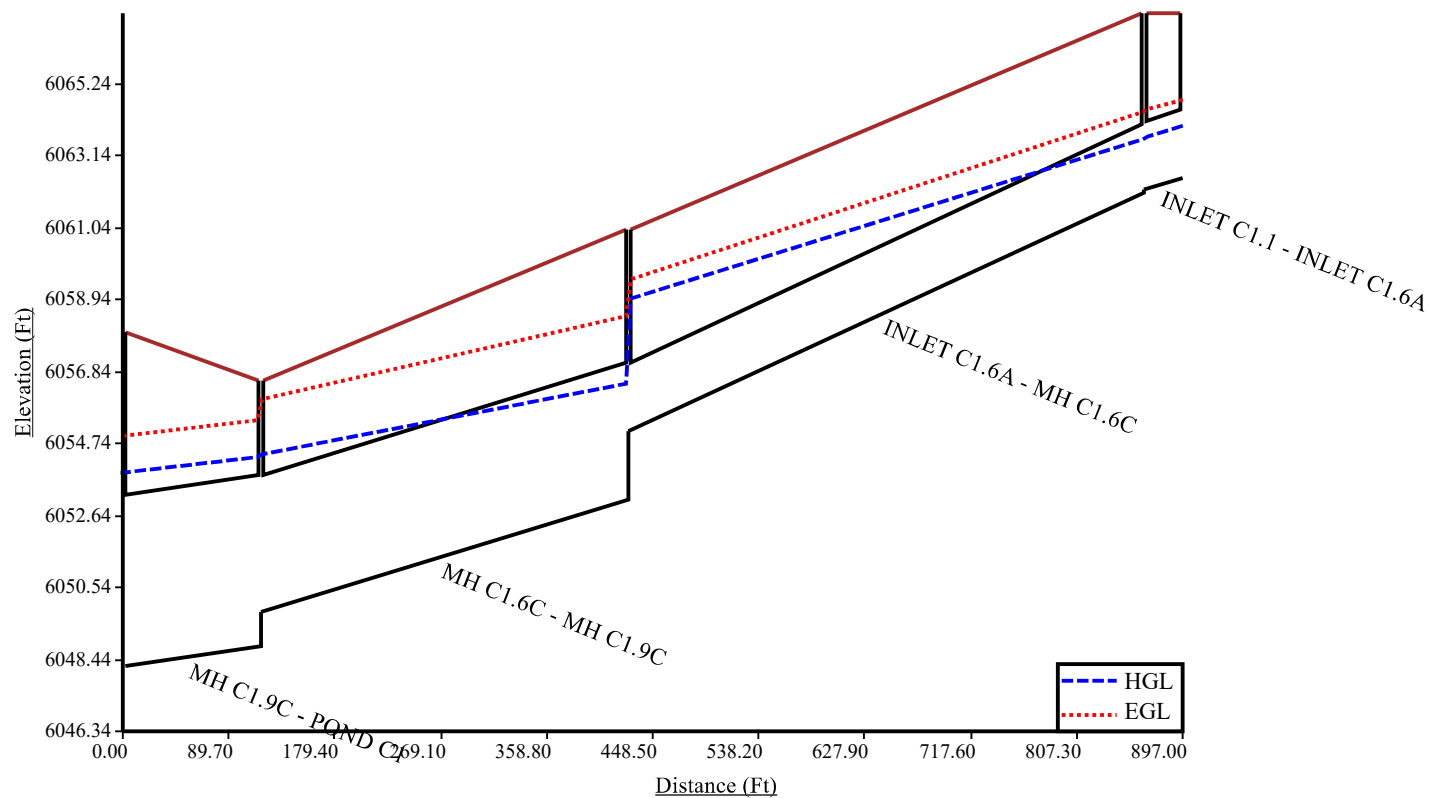
Grade Line Summary:

Tailwater Elevation (ft): 6053.90

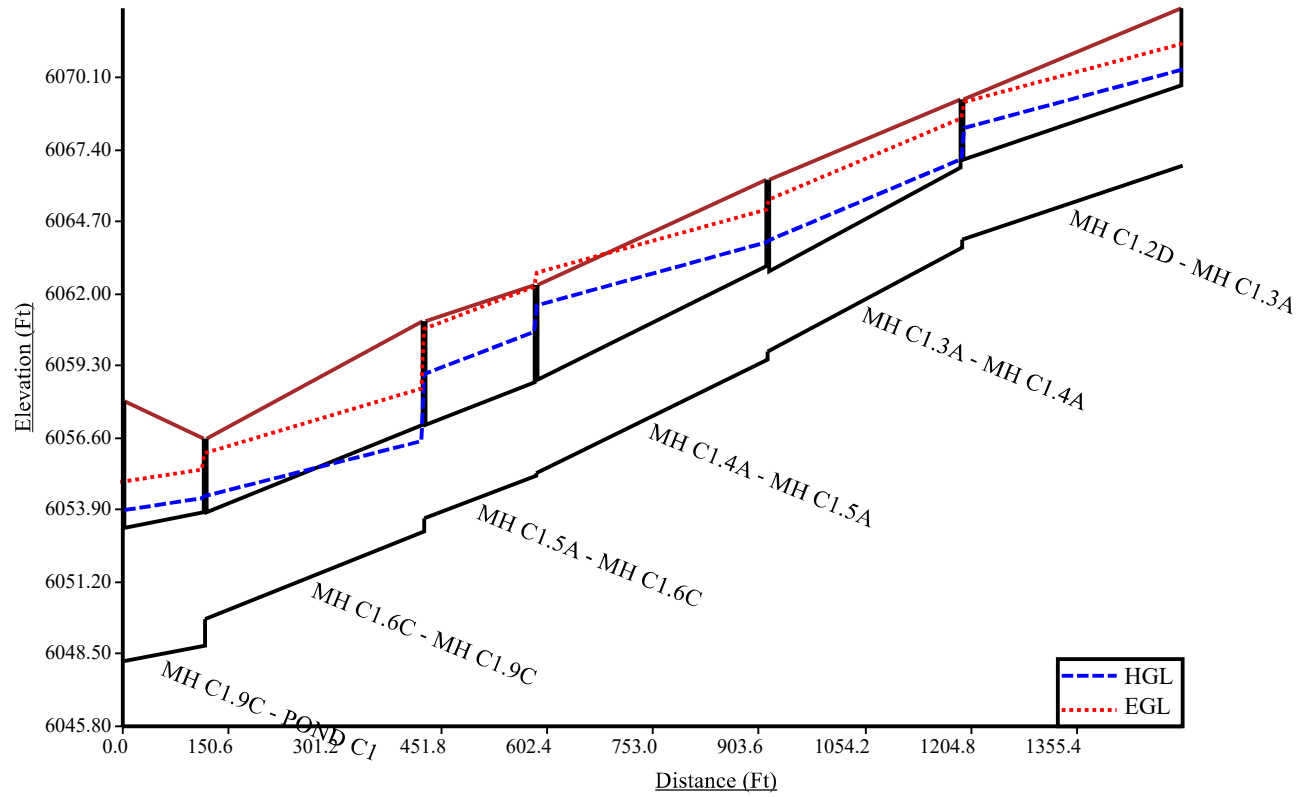
| Element Name | Invert Elev. | | Downstream Manhole Losses | | HGL | | EGL | |
|--------------------------|-----------------|---------------|---------------------------|-------------------|-----------------|---------------|-----------------|---------------|
| | Downstream (ft) | Upstream (ft) | Bend Loss (ft) | Lateral Loss (ft) | Downstream (ft) | Upstream (ft) | Downstream (ft) | Upstream (ft) |
| MH C1.9C - POND C1 | 6048.25 | 6048.83 | 0.00 | 0.00 | 6053.90 | 6054.36 | 6054.97 | 6055.43 |
| MH C1.6C - MH C1.9C | 6049.83 | 6053.11 | 0.08 | 0.00 | 6054.44 | 6056.50 | 6056.05 | 6058.47 |
| MH C1.5A - MH C1.6C | 6053.61 | 6055.20 | 2.24 | 0.00 | 6059.01 | 6060.59 | 6060.71 | 6062.29 |
| MH C1.4A - MH C1.5A | 6055.30 | 6059.56 | 0.06 | 0.47 | 6061.59 | 6063.95 | 6062.82 | 6065.18 |
| MH C1.3A - MH C1.4A | 6059.86 | 6063.75 | 0.08 | 0.00 | 6064.03 | 6067.07 | 6065.56 | 6068.60 |
| MH C1.2D - MH C1.3A | 6064.05 | 6066.83 | 0.05 | 0.56 | 6068.24 | 6070.43 | 6069.21 | 6071.40 |
| INLET C1.6A - MH C1.6C | 6055.11 | 6062.07 | 0.03 | 1.05 | 6058.98 | 6063.63 | 6059.54 | 6064.43 |
| INLET C1.1 - INLET C1.6A | 6062.17 | 6062.50 | 0.03 | 0.05 | 6063.71 | 6064.03 | 6064.51 | 6064.79 |
| MH C1.8 - MH C1.9C | 6051.83 | 6057.00 | 0.70 | 0.54 | 6056.14 | 6059.15 | 6056.68 | 6059.68 |

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = $\text{Bend } K * V_{\text{fr}}^2 / (2 * g)$
- Lateral loss = $V_{\text{fo}}^2 / (2 * g) - \text{Junction Loss } K * V_{\text{fr}}^2 / (2 * g)$.
- Friction loss is always Upstream EGL - Downstream EGL.

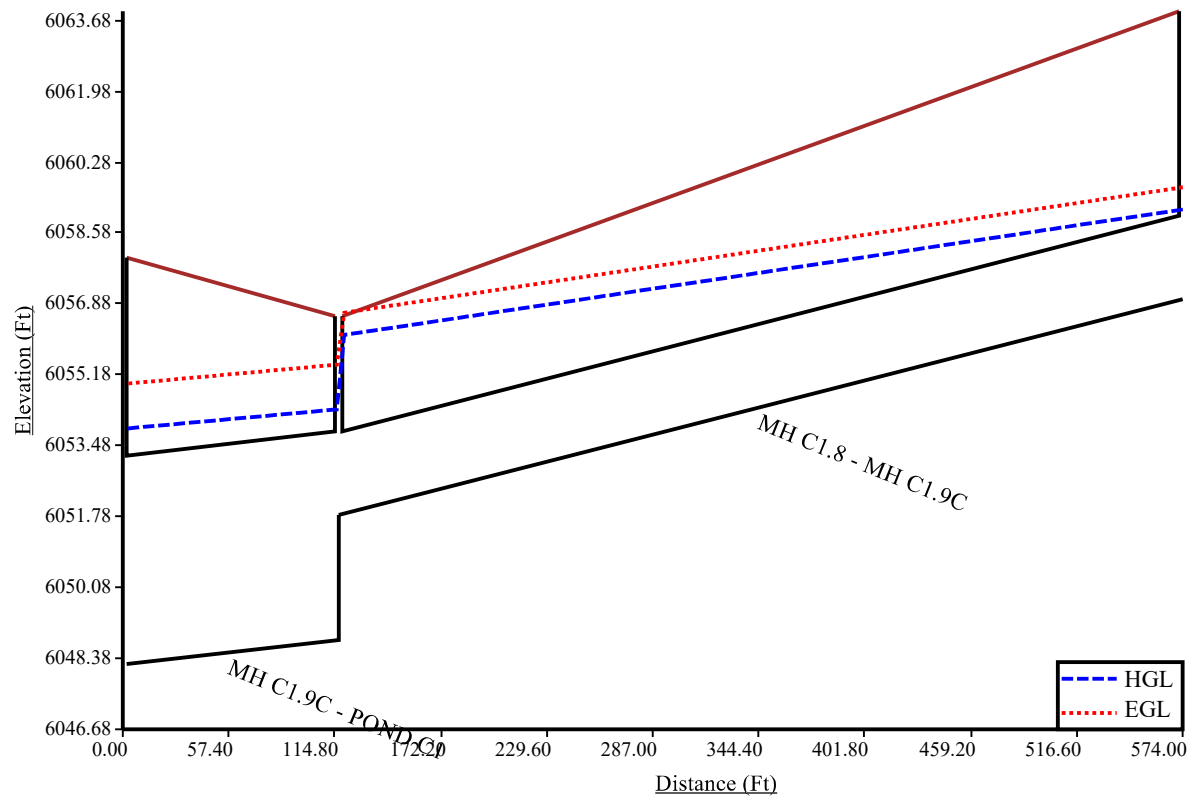
C1.1-OUTFALL



C1.2D-OUTFALL



C1.8-OUTFALL



APPENDIX D2

CULVERT HYDRAULIC CALCULATIONS

ELLICOTT TOWN CENTER FILING NO. 1
CULVERT DESIGN SUMMARY

| BASIN | DESIGN POINT | 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 |
|-------|-----------------|------------------|-------------------|--------------------|------------------------|------------------|---------------------|----------------------------------|-------------------------------------|---|-----------------------------------|------------------------------------|---------------------------------------|---|-------------------------------------|
| C1.1 | EC11 | 6066.23 | 6060.50 | 6059.94 | 110.7 | 1 | 3.0 | 24.4 | 24.4 | 6063.5 | 6062.8 | 149.5 | 149.5 | 6066.8 | 6066.6 |
| C1.6 | EC11 | 6059.69 | 6055.38 | 6054.83 | 110.7 | 1 | 3.0 | 24.4 | 24.4 | 6058.4 | 6056.2 | 149.5 | 149.5 | 6060.3 | 6060.1 |
| C1.9 | EC11 | 6055.41 | 6049.98 | 6047.67 | 131.2 | 1 | 3.5 | 24.4 | 24.4 | 6053.5 | 6050.4 | 149.5 | 149.5 | 6055.7 | 6055.6 |
| | | | | | | | | | | | | | | | |

¹ Q₅ MAX. ALLOWABLE HEADWATER, HW/D = 1.0

² Q₁₀₀ MAX. ALLOWABLE HEADWATER = 12" DEPTH AT GUTTER FLOWLINE (PER DCM TABLE 6-1)

HY-8 Culvert Analysis Report

Crossing Discharge Data – Culvert C1.1

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

Minimum Flow: 10 cfs

Design Flow: 24.4 cfs

Maximum Flow: 149.5 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing C1.1

| Headwater Elevation (ft) | Total Discharge (cfs) | Culvert C1.1 Discharge (cfs) | Roadway Discharge (cfs) | Iterations |
|-----------------------------|-----------------------|---------------------------------|----------------------------|-------------|
| 6061.86 | 10.00 | 10.00 | 0.00 | 1 |
| 6062.76 | 23.95 | 23.95 | 0.00 | 1 |
| 6062.78 | 24.40 | 24.40 | 0.00 | 1 |
| 6064.30 | 51.85 | 51.85 | 0.00 | 1 |
| 6065.43 | 65.80 | 65.80 | 0.00 | 1 |
| 6066.29 | 79.75 | 74.83 | 4.80 | 10 |
| 6066.38 | 93.70 | 75.72 | 17.80 | 6 |
| 6066.45 | 107.65 | 76.46 | 31.14 | 5 |
| 6066.51 | 121.60 | 76.99 | 44.43 | 4 |
| 6066.56 | 135.55 | 77.57 | 57.92 | 4 |
| 6066.61 | 149.50 | 78.05 | 71.29 | 3 |
| 6066.23 | 74.18 | 74.18 | 0.00 | Overtopping |

Rating Curve Plot for Crossing: Crossing C1.1

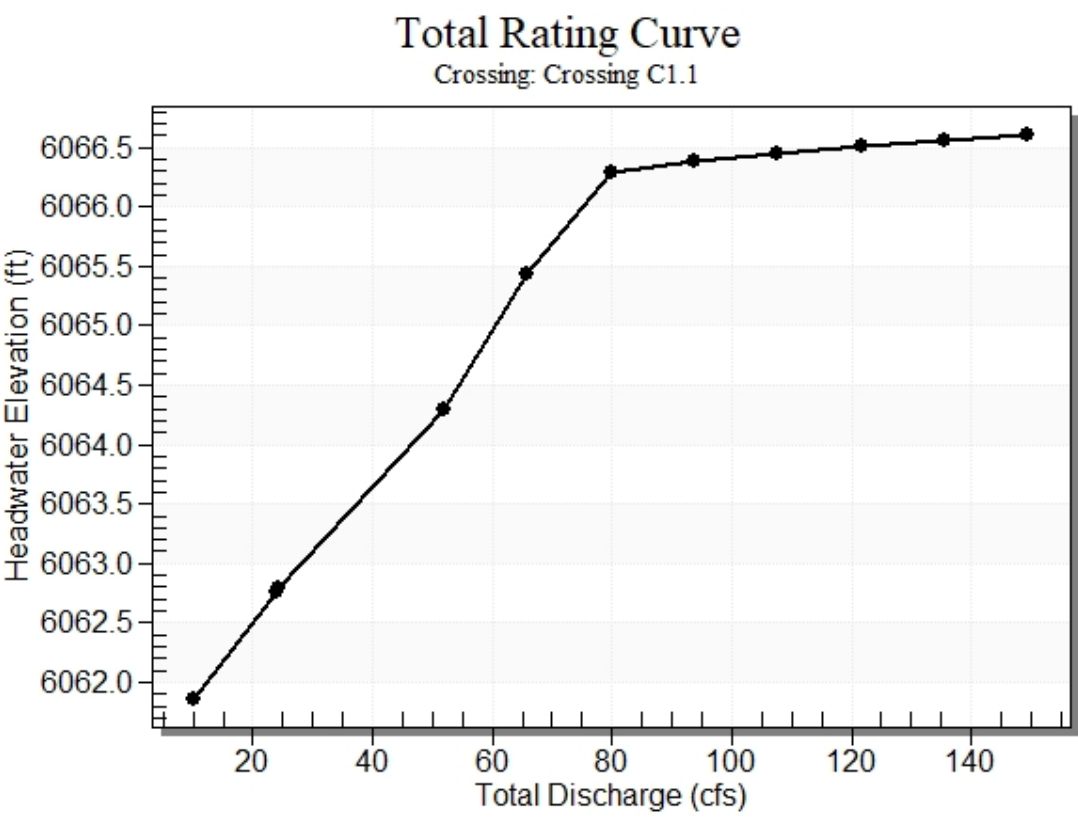


Table 2 - Culvert Summary Table: Culvert C1.1

| 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 | 6061.86 | 1.365 | 0.0* | 1-S2n | 0.910 | 0.997 | 0.935 | 0.359 | 5.129 | 2.953 |
| 23.95 | 23.95 | 6062.76 | 2.259 | 1.371 | 1-S2n | 1.468 | 1.575 | 1.468 | 0.589 | 6.738 | 3.927 |
| 24.40 | 24.40 | 6062.78 | 2.283 | 0.035 | 1-S2n | 1.484 | 1.590 | 1.527 | 0.595 | 6.531 | 3.951 |
| 51.85 | 51.85 | 6064.30 | 3.769 | 3.795 | 7-M2c | 3.000 | 2.339 | 2.339 | 0.899 | 8.770 | 4.976 |
| 65.80 | 65.80 | 6065.43 | 4.797 | 4.927 | 7-M2c | 3.000 | 2.597 | 2.597 | 1.021 | 10.120 | 5.336 |
| 79.75 | 74.83 | 6066.29 | 5.609 | 5.796 | 7-M2c | 3.000 | 2.717 | 2.717 | 1.129 | 11.117 | 5.642 |
| 93.70 | 75.72 | 6066.38 | 5.696 | 5.884 | 7-M2c | 3.000 | 2.728 | 2.728 | 1.228 | 11.219 | 5.908 |
| 107.65 | 76.46 | 6066.45 | 5.768 | 5.952 | 7-M2c | 3.000 | 2.736 | 2.736 | 1.320 | 11.306 | 6.144 |
| 121.60 | 76.99 | 6066.51 | 5.820 | 6.011 | 7-M2c | 3.000 | 2.741 | 2.741 | 1.404 | 11.368 | 6.358 |
| 135.55 | 77.57 | 6066.56 | 5.878 | 6.064 | 7-M2c | 3.000 | 2.747 | 2.747 | 1.484 | 11.437 | 6.553 |
| 149.50 | 78.05 | 6066.61 | 5.926 | 6.113 | 7-M2c | 3.000 | 2.752 | 2.752 | 1.560 | 11.494 | 6.733 |

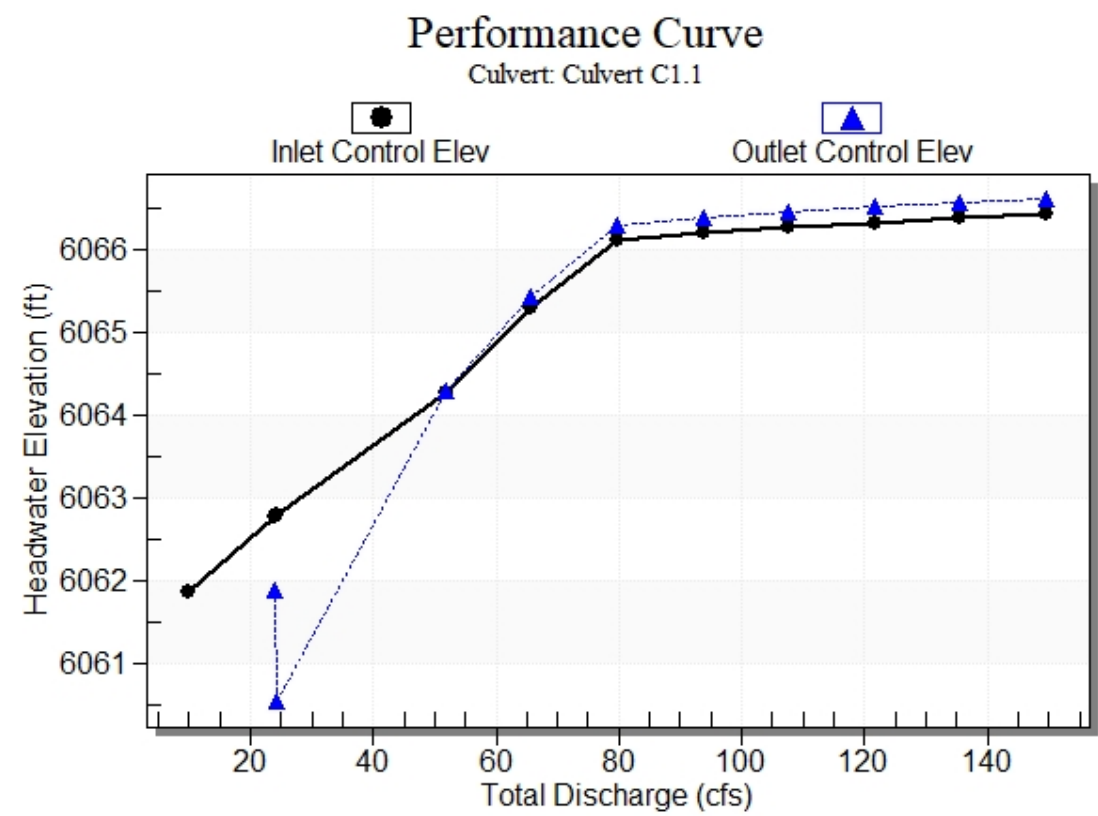
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 6060.50 ft, Outlet Elevation (invert): 6059.94 ft

Culvert Length: 110.70 ft, Culvert Slope: 0.0051

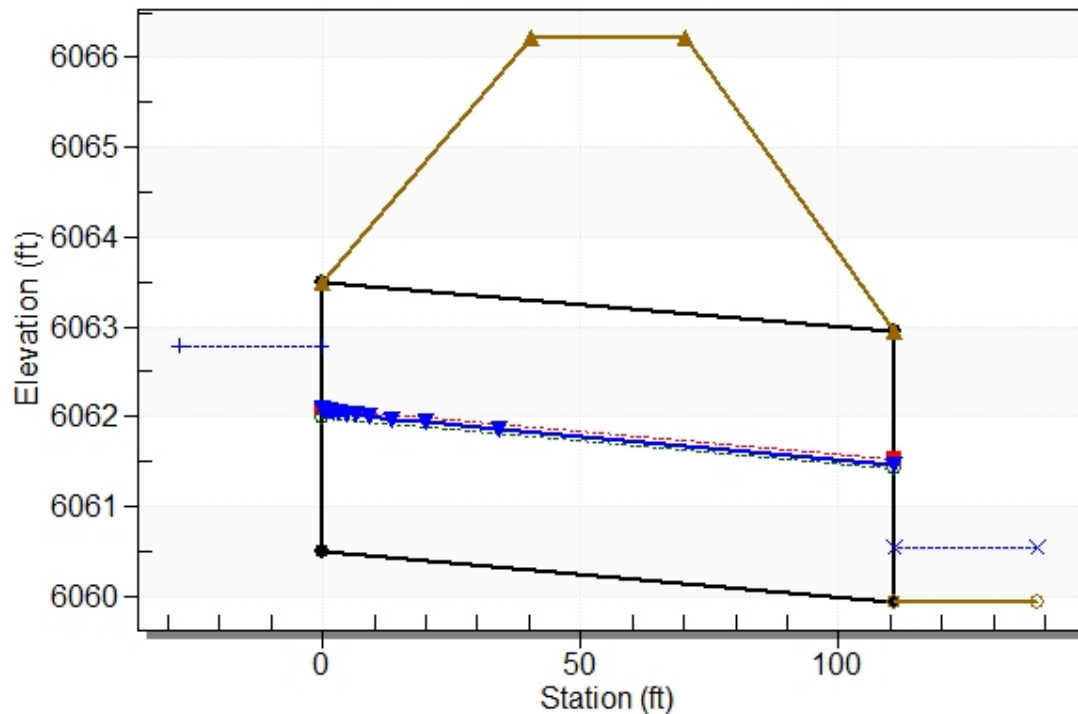
Culvert Performance Curve Plot: Culvert C1.1



Water Surface Profile Plot for Culvert: Culvert C1.1

Crossing - Crossing C1.1, Design Discharge - 24.4 cfs

Culvert - Culvert C1.1, Culvert Discharge - 24.4 cfs



Site Data - Culvert C1.1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6060.50 ft

Outlet Station: 110.70 ft

Outlet Elevation: 6059.94 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1.1

Barrel Shape: Circular

Barrel Diameter: 3.00 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 C1.1)

| Flow (cfs) | Water Surface Elev (ft) | Depth (ft) | Velocity (ft/s) | Shear (psf) | Froude Number |
|------------|-------------------------|------------|-----------------|-------------|---------------|
| 10.00 | 6060.30 | 0.36 | 2.95 | 0.38 | 0.93 |
| 23.95 | 6060.53 | 0.59 | 3.93 | 0.62 | 1.00 |
| 24.40 | 6060.53 | 0.59 | 3.95 | 0.63 | 1.00 |
| 51.85 | 6060.84 | 0.90 | 4.98 | 0.95 | 1.06 |
| 65.80 | 6060.96 | 1.02 | 5.34 | 1.08 | 1.08 |
| 79.75 | 6061.07 | 1.13 | 5.64 | 1.20 | 1.09 |
| 93.70 | 6061.17 | 1.23 | 5.91 | 1.30 | 1.10 |
| 107.65 | 6061.26 | 1.32 | 6.14 | 1.40 | 1.11 |
| 121.60 | 6061.34 | 1.40 | 6.36 | 1.49 | 1.12 |
| 135.55 | 6061.42 | 1.48 | 6.55 | 1.57 | 1.13 |
| 149.50 | 6061.50 | 1.56 | 6.73 | 1.65 | 1.14 |

Tailwater Channel Data - Crossing C1.1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

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

Channel Slope: 0.0170

Channel Manning's n: 0.0300

Channel Invert Elevation: 6059.94 ft

Roadway Data for Crossing: Crossing C1.1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6066.23 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

Crossing Discharge Data – Culvert C1.6

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

Minimum Flow: 10 cfs

Design Flow: 24.4 cfs

Maximum Flow: 149.5 cfs

Table 4 - Summary of Culvert Flows at Crossing: Crossing C1.6

| Headwater Elevation (ft) | Total Discharge (cfs) | Culvert C1.6 Discharge (cfs) | Roadway Discharge (cfs) | Iterations |
|-----------------------------|-----------------------|---------------------------------|----------------------------|-------------|
| 6055.32 | 10.00 | 10.00 | 0.00 | 1 |
| 6056.22 | 23.95 | 23.95 | 0.00 | 1 |
| 6056.24 | 24.40 | 24.40 | 0.00 | 1 |
| 6057.76 | 51.85 | 51.85 | 0.00 | 1 |
| 6058.89 | 65.80 | 65.80 | 0.00 | 1 |
| 6059.76 | 79.75 | 74.89 | 4.85 | 10 |
| 6059.84 | 93.70 | 75.78 | 17.85 | 6 |
| 6059.91 | 107.65 | 76.47 | 31.15 | 5 |
| 6059.97 | 121.60 | 76.99 | 44.46 | 4 |
| 6060.02 | 135.55 | 77.52 | 57.96 | 4 |
| 6060.07 | 149.50 | 77.99 | 71.23 | 3 |
| 6059.69 | 74.17 | 74.17 | 0.00 | Overtopping |

Rating Curve Plot for Crossing: Crossing C1.6

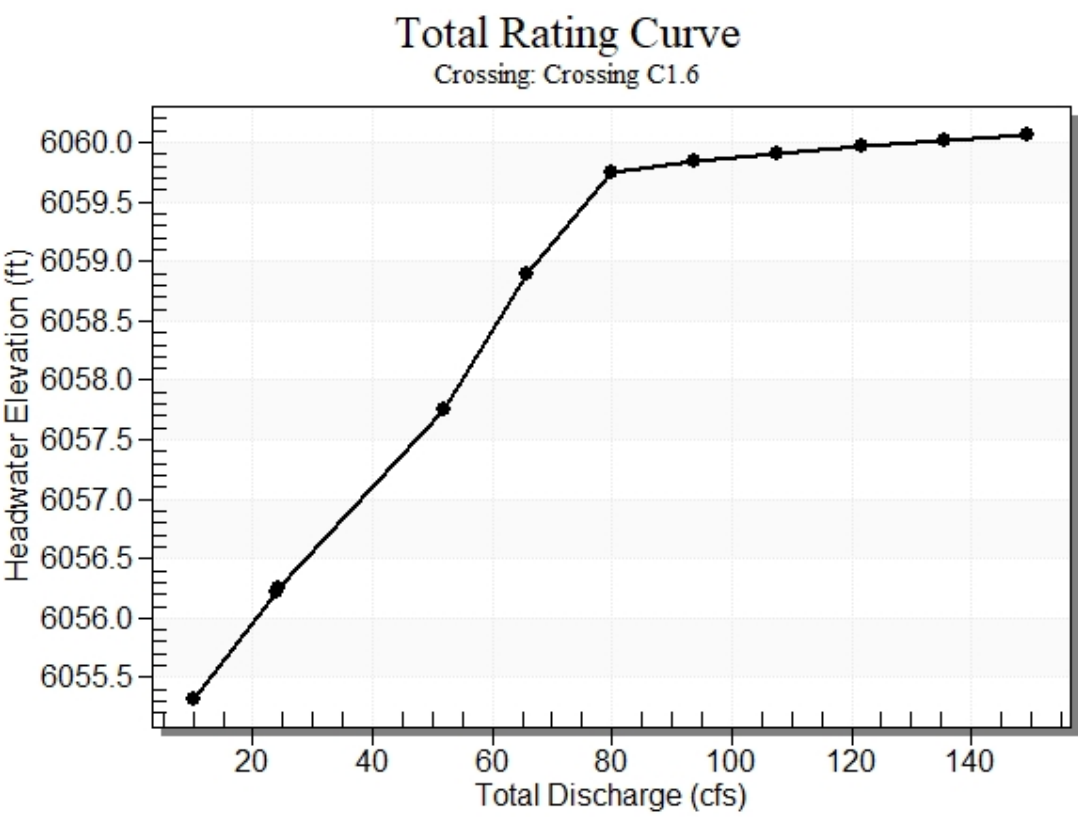


Table 5 - Culvert Summary Table: Culvert C1.6

| 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 | 6055.32 | 1.365 | 0.0* | 1-S2n | 0.910 | 0.997 | 0.935 | 0.286 | 5.130 | 2.659 |
| 23.95 | 23.95 | 6056.22 | 2.259 | 1.371 | 1-S2n | 1.468 | 1.575 | 1.468 | 0.476 | 6.738 | 3.618 |
| 24.40 | 24.40 | 6056.24 | 2.283 | 0.0* | 1-S2n | 1.484 | 1.590 | 1.527 | 0.481 | 6.532 | 3.642 |
| 51.85 | 51.85 | 6057.76 | 3.769 | 3.795 | 7-M2c | 3.000 | 2.339 | 2.339 | 0.740 | 8.770 | 4.681 |
| 65.80 | 65.80 | 6058.89 | 4.797 | 4.927 | 7-M2c | 3.000 | 2.597 | 2.597 | 0.846 | 10.120 | 5.053 |
| 79.75 | 74.89 | 6059.76 | 5.615 | 5.795 | 7-M2c | 3.000 | 2.718 | 2.718 | 0.942 | 11.125 | 5.369 |
| 93.70 | 75.78 | 6059.84 | 5.702 | 5.884 | 7-M2c | 3.000 | 2.728 | 2.728 | 1.030 | 11.226 | 5.645 |
| 107.65 | 76.47 | 6059.91 | 5.769 | 5.952 | 7-M2c | 3.000 | 2.736 | 2.736 | 1.111 | 11.306 | 5.890 |
| 121.60 | 76.99 | 6059.97 | 5.821 | 6.011 | 7-M2c | 3.000 | 2.741 | 2.741 | 1.188 | 11.368 | 6.113 |
| 135.55 | 77.52 | 6060.02 | 5.873 | 6.065 | 7-M2c | 3.000 | 2.746 | 2.746 | 1.260 | 11.431 | 6.316 |
| 149.50 | 77.99 | 6060.07 | 5.920 | 6.112 | 7-M2c | 3.000 | 2.751 | 2.751 | 1.328 | 11.487 | 6.503 |

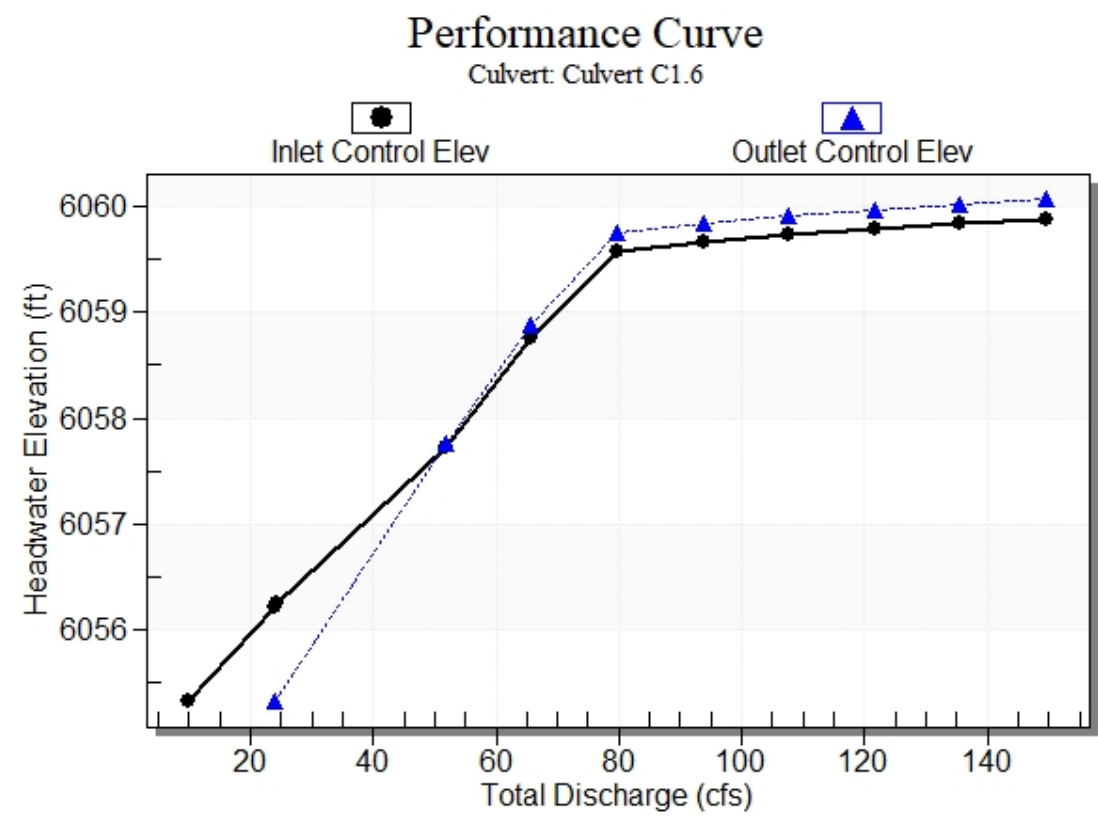
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 6053.96 ft, Outlet Elevation (invert): 6053.40 ft

Culvert Length: 110.68 ft, Culvert Slope: 0.0051

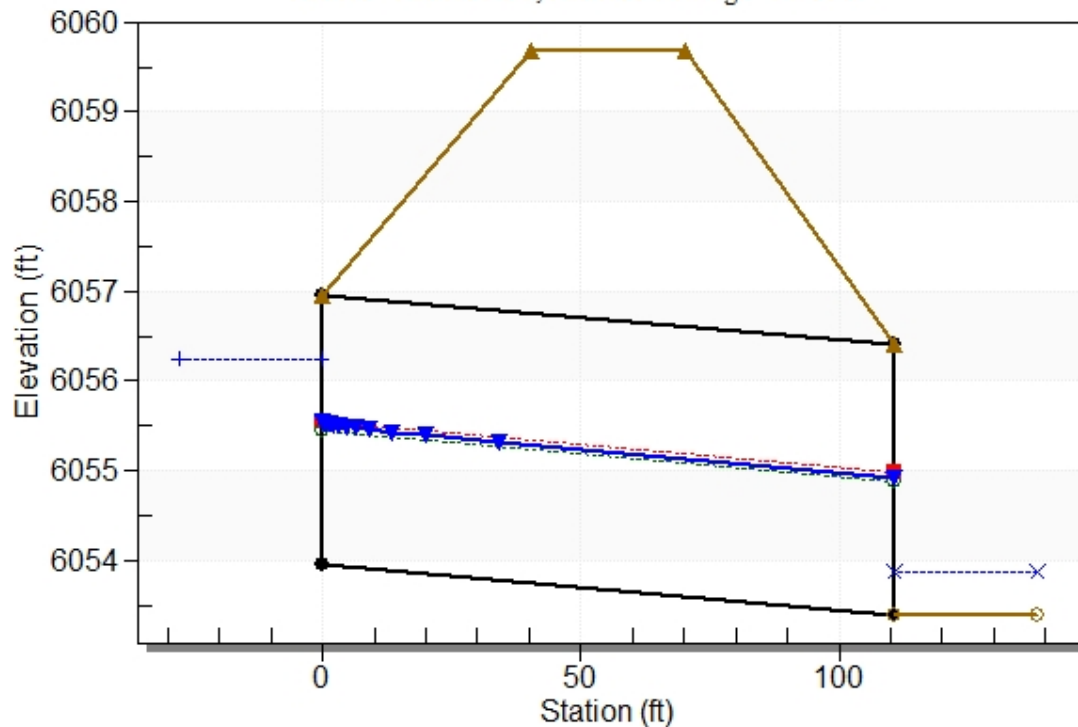
Culvert Performance Curve Plot: Culvert C1.6



Water Surface Profile Plot for Culvert: Culvert C1.6

Crossing - Crossing C1.6, Design Discharge - 24.4 cfs

Culvert - Culvert C1.6, Culvert Discharge - 24.4 cfs



Site Data - Culvert C1.6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6053.96 ft

Outlet Station: 110.68 ft

Outlet Elevation: 6053.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1.6

Barrel Shape: Circular

Barrel Diameter: 3.00 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 6 - Downstream Channel Rating Curve (Crossing: Crossing C1.6)

| Flow (cfs) | Water Surface Elev (ft) | Depth (ft) | Velocity (ft/s) | Shear (psf) | Froude Number |
|------------|-------------------------|------------|-----------------|-------------|---------------|
| 10.00 | 6053.69 | 0.29 | 2.66 | 0.31 | 0.91 |
| 23.95 | 6053.88 | 0.48 | 3.62 | 0.51 | 0.99 |
| 24.40 | 6053.88 | 0.48 | 3.64 | 0.52 | 0.99 |
| 51.85 | 6054.14 | 0.74 | 4.68 | 0.79 | 1.05 |
| 65.80 | 6054.25 | 0.85 | 5.05 | 0.91 | 1.07 |
| 79.75 | 6054.34 | 0.94 | 5.37 | 1.01 | 1.09 |
| 93.70 | 6054.43 | 1.03 | 5.64 | 1.11 | 1.10 |
| 107.65 | 6054.51 | 1.11 | 5.89 | 1.19 | 1.11 |
| 121.60 | 6054.59 | 1.19 | 6.11 | 1.27 | 1.12 |
| 135.55 | 6054.66 | 1.26 | 6.32 | 1.35 | 1.13 |
| 149.50 | 6054.73 | 1.33 | 6.50 | 1.43 | 1.14 |

Tailwater Channel Data - Crossing C1.6

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

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

Channel Slope: 0.0172

Channel Manning's n: 0.0300

Channel Invert Elevation: 6053.40 ft

Roadway Data for Crossing: Crossing C1.6

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6059.69 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

Crossing Discharge Data – Culvert C1.9

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

Minimum Flow: 10 cfs

Design Flow: 24.4 cfs

Maximum Flow: 149.5 cfs

Table 7 - Summary of Culvert Flows at Crossing: Crossing C1.9

| Headwater Elevation (ft) | Total Discharge (cfs) | Culvert C1.9 Discharge (cfs) | Roadway Discharge (cfs) | Iterations |
|-----------------------------|-----------------------|---------------------------------|----------------------------|-------------|
| 6049.60 | 10.00 | 10.00 | 0.00 | 1 |
| 6050.41 | 23.95 | 23.95 | 0.00 | 1 |
| 6050.43 | 24.40 | 24.40 | 0.00 | 1 |
| 6051.61 | 51.85 | 51.85 | 0.00 | 1 |
| 6052.27 | 65.80 | 65.80 | 0.00 | 1 |
| 6052.90 | 79.75 | 79.75 | 0.00 | 1 |
| 6053.81 | 93.70 | 93.70 | 0.00 | 1 |
| 6054.84 | 107.65 | 107.65 | 0.00 | 1 |
| 6055.48 | 121.60 | 115.84 | 5.60 | 14 |
| 6055.57 | 135.55 | 116.89 | 18.54 | 6 |
| 6055.64 | 149.50 | 117.66 | 31.74 | 5 |
| 6055.41 | 114.87 | 114.87 | 0.00 | Overtopping |

Rating Curve Plot for Crossing: Crossing C1.9

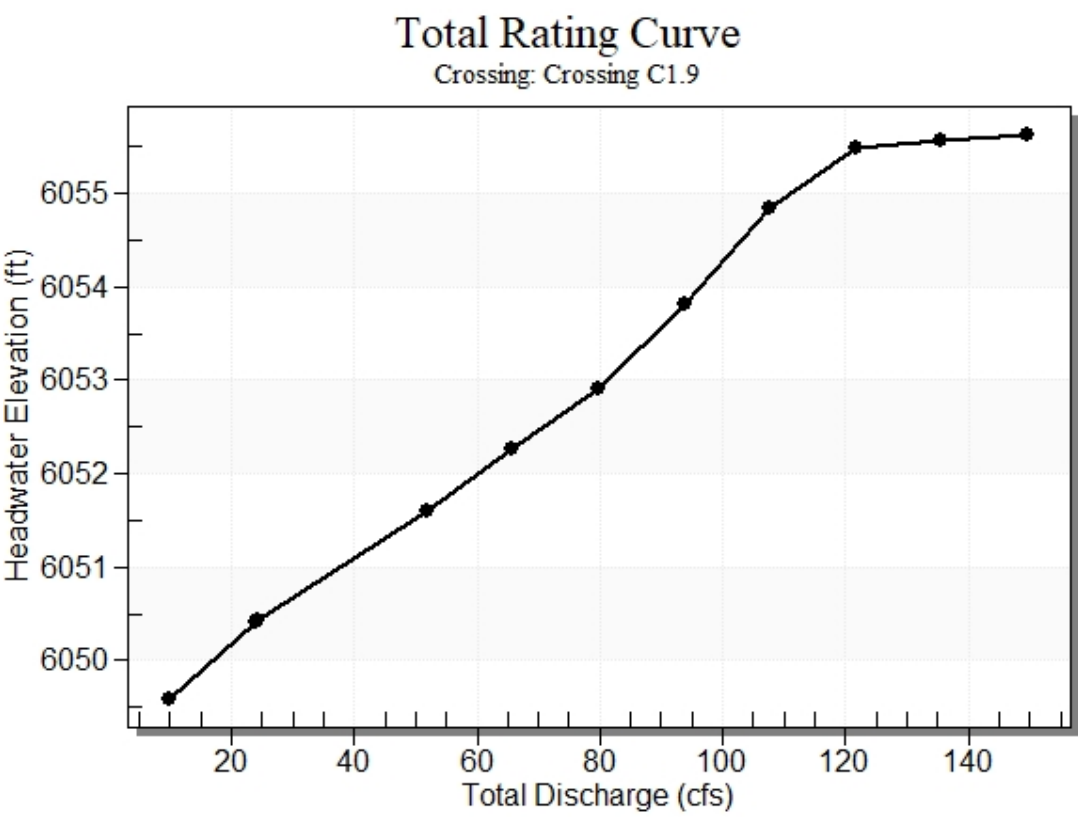


Table 8 - Culvert Summary Table: Culvert C1.9

| 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 | 6049.60 | 1.297 | 0.0* | 1-S2n | 0.871 | 0.954 | 0.871 | 0.438 | 5.157 | 1.660 |
| 23.95 | 23.95 | 6050.41 | 2.111 | 1.061 | 1-S2n | 1.377 | 1.502 | 1.377 | 0.722 | 6.585 | 2.226 |
| 24.40 | 24.40 | 6050.43 | 2.134 | 0.100 | 1-S2n | 1.391 | 1.517 | 1.391 | 0.730 | 6.619 | 2.240 |
| 51.85 | 51.85 | 6051.61 | 3.309 | 2.505 | 1-S2n | 2.188 | 2.247 | 2.188 | 1.111 | 7.950 | 2.839 |
| 65.80 | 65.80 | 6052.27 | 3.897 | 3.972 | 7-M2c | 2.633 | 2.540 | 2.540 | 1.264 | 8.800 | 3.052 |
| 79.75 | 79.75 | 6052.90 | 4.582 | 4.598 | 7-M2c | 3.500 | 2.787 | 2.787 | 1.402 | 9.708 | 3.232 |
| 93.70 | 93.70 | 6053.81 | 5.400 | 5.511 | 7-M2c | 3.500 | 2.991 | 2.991 | 1.527 | 10.701 | 3.388 |
| 107.65 | 107.65 | 6054.84 | 6.366 | 6.538 | 7-M2c | 3.500 | 3.148 | 3.148 | 1.643 | 11.808 | 3.527 |
| 121.60 | 115.84 | 6055.48 | 7.002 | 7.182 | 7-M2c | 3.500 | 3.218 | 3.218 | 1.752 | 12.513 | 3.652 |
| 135.55 | 116.89 | 6055.57 | 7.088 | 7.267 | 7-M2c | 3.500 | 3.226 | 3.226 | 1.853 | 12.608 | 3.767 |
| 149.50 | 117.66 | 6055.64 | 7.151 | 7.335 | 7-M2c | 3.500 | 3.231 | 3.231 | 1.950 | 12.677 | 3.873 |

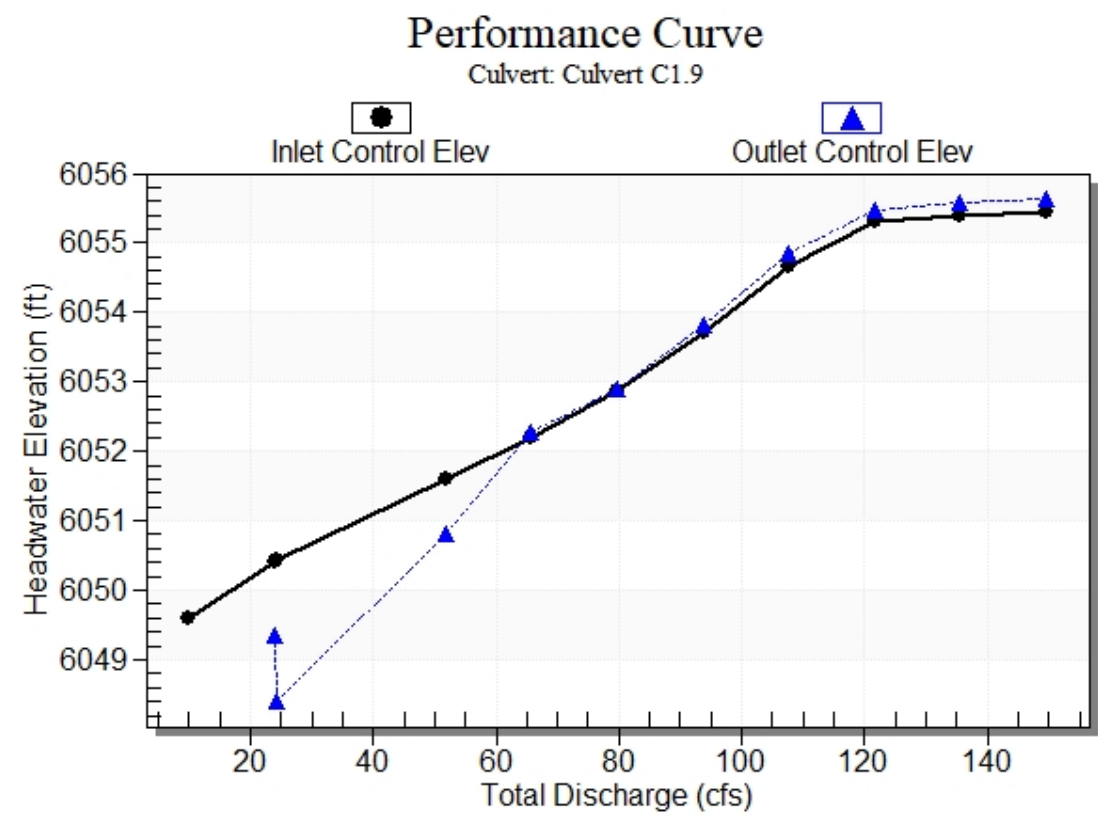
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 6048.30 ft, Outlet Elevation (invert): 6047.67 ft

Culvert Length: 131.20 ft, Culvert Slope: 0.0048

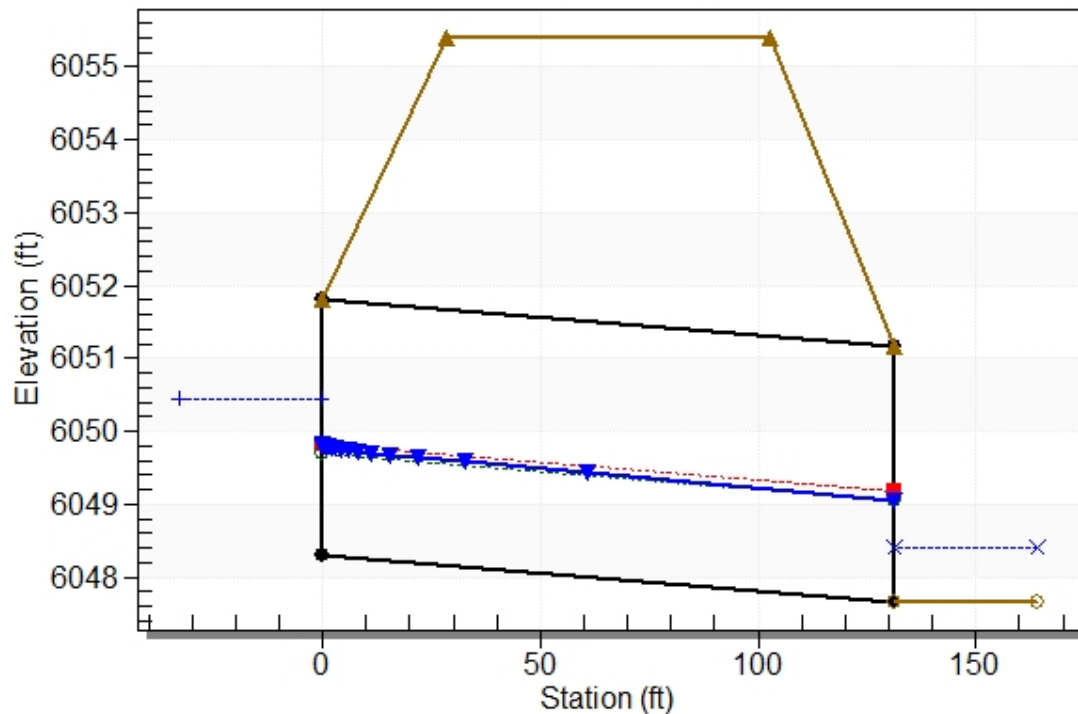
Culvert Performance Curve Plot: Culvert C1.9



Water Surface Profile Plot for Culvert: Culvert C1.9

Crossing - Crossing C1.9, Design Discharge - 24.4 cfs

Culvert - Culvert C1.9, Culvert Discharge - 24.4 cfs



Site Data - Culvert C1.9

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6048.30 ft

Outlet Station: 131.20 ft

Outlet Elevation: 6047.67 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1.9

Barrel Shape: Circular

Barrel Diameter: 3.50 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 9 - Downstream Channel Rating Curve (Crossing: Crossing C1.9)

| Flow (cfs) | Water Surface Elev (ft) | Depth (ft) | Velocity (ft/s) | Shear (psf) | Froude Number |
|------------|-------------------------|------------|-----------------|-------------|---------------|
| 10.00 | 6048.11 | 0.44 | 1.66 | 0.11 | 0.47 |
| 23.95 | 6048.39 | 0.72 | 2.23 | 0.18 | 0.50 |
| 24.40 | 6048.40 | 0.73 | 2.24 | 0.18 | 0.51 |
| 51.85 | 6048.78 | 1.11 | 2.84 | 0.28 | 0.54 |
| 65.80 | 6048.93 | 1.26 | 3.05 | 0.32 | 0.54 |
| 79.75 | 6049.07 | 1.40 | 3.23 | 0.35 | 0.55 |
| 93.70 | 6049.20 | 1.53 | 3.39 | 0.38 | 0.56 |
| 107.65 | 6049.31 | 1.64 | 3.53 | 0.41 | 0.56 |
| 121.60 | 6049.42 | 1.75 | 3.65 | 0.44 | 0.57 |
| 135.55 | 6049.52 | 1.85 | 3.77 | 0.46 | 0.57 |
| 149.50 | 6049.62 | 1.95 | 3.87 | 0.49 | 0.58 |

Tailwater Channel Data - Crossing C1.9

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

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

Channel Slope: 0.0040

Channel Manning's n: 0.0300

Channel Invert Elevation: 6047.67 ft

Roadway Data for Crossing: Crossing C1.9

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6055.41 ft

Roadway Surface: Paved

Roadway Top Width: 74.00 ft

APPENDIX D3

OPEN CHANNEL HYDRAULIC CALCULATIONS

TABLE 10-2 (Continued)

TYPICAL ROUGHNESS COEFFICIENTS FOR OPEN CHANNELS

| <u>Type of Channel and Description</u> | | <u>Minimum</u> | <u>Normal</u> | <u>Maximum</u> |
|--|--|----------------|---------------|----------------|
| c. | Concrete bottom float finished with sides of | | | |
| | 1. Dressed stone in mortar | 0.015 | 0.017 | 0.020 |
| | 2. Random stone in mortar | 0.017 | 0.020 | 0.024 |
| | 3. Cement rubble masonry, plastered | 0.016 | 0.020 | 0.024 |
| | 4. Cement rubble masonry | 0.020 | 0.025 | 0.030 |
| | 5. Dry rubble or riprap | 0.020 | 0.030 | 0.035 |
| d. | Gravel bottom with sides of | | | |
| | 1. Formed concrete | 0.017 | 0.020 | 0.025 |
| | 2. Random stone in mortar | 0.020 | 0.023 | 0.026 |
| | 3. Dry rubble or riprap | 0.023 | 0.033 | 0.036 |
| e. | Asphalt | | | |
| | 1. Smooth | | 0.013 | |
| | 2. Rough | | 0.016 | |
| f. | Grassed | 0.030 | 0.040 | 0.050 |

TABLE 10-3

MAXIMUM PERMISSIBLE DESIGN
OPEN CHANNEL FLOW VELOCITIES IN EARTH*

| <u>Soil Types</u> | <u>Permissible Mean Channel Velocity (ft/sec)</u> |
|---|---|
| Fine Sand (noncolloidal) | 2.0 |
| Coarse Sand (noncolloidal) | 4.0 |
| Sandy Loam (noncolloidal) | 2.5 |
| Silt Loam (noncolloidal) | 3.0 |
| Ordinary Firm Loam | 3.5 |
| Silty Clay | 3.5 |
| Fine Gravel | 5.0 |
| Stiff Clay (very colloidal) | 5.0 |
| Graded, Loam to Cobbles (noncolloidal) | 5.0 |
| Graded, Silt to Cobbles (colloidal) | 5.5 |
| Alluvial Silts (noncolloidal) | 3.5 |
| Alluvial Silts (colloidal) | 5.0 |
| Coarse Gravel (noncolloidal) | 6.0 |
| Cobbles and Shingles | 5.5 |
| Hard Shales and Hard Pans | 6.0 |
| Soft Shales | 3.5 |
| Soft Sandstone | 8.0 |
| Sound rock (usu. igneous or hard metamorphic) | 20.0 |

* These velocities shall be used in conjunction with scour calculations and as approved by City/County.

TABLE 10-4

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

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

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

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

MAYBERRY, COLORADO SPRINGS - FILING NO. 1
(fka "ELLCOTT TOWN CENTER")
CHANNEL CALCULATIONS
DEVELOPED FLOWS

PROPOSED CHANNELS

| CHANNEL | DESIGN POINT | PROPOSED SLOPE (%) | BOTTOM WIDTH (B, FT) | SIDE SLOPE (Z) | CHANNEL DEPTH (FT) | FRICTION FACTOR (n) | Q100 FLOW (CFS) | Q100 DEPTH (FT) | Q100 VELOCITY (FT/S) | Q100 MAX. SHEAR STRESS (PSF) | CHANNEL LINING |
|---------------|--------------|--------------------|----------------------|----------------|--------------------|---------------------|-----------------|-----------------|----------------------|------------------------------|------------------|
| C1A | EC11 | 1.70 | 12 | 4:1 | 2.5 | 0.030 | 149.5 | 1.3 | 6.5 | 1.4 | GRASS/ECB |
| C1B | EC11 | 2.57 | 12 | 4:1 | 2.5 | 0.030 | 149.5 | 1.2 | 7.5 | 1.9 | GRASS/ECB |
| C2.3A (TEMP.) | C2.3A | 0.50 | 0 | 3:1 | 2.0 | 0.030 | 31.6 | 1.8 | 3.2 | 0.6 | GRASS |
| C2.8 | C2.8A | 0.50 | 0 | 3:1 | 2.0 | 0.030 | 26.7 | 1.7 | 3.0 | 0.5 | GRASS |
| C3 | EC11A* | 0.40 | 12 | 4:1 | 3.0 | 0.030 | 160.8 | 2.0 | 4.0 | 0.5 | GRASS |

* EC11A FLOW = DP-EC11 (Q100=149.5 cfs) + DETENTION POND C1 DISCHARGE (Q100 = 11.3 cfs)

- 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) Vmax = 5.0 fps for 100-year flows w/ grass-lined channels
- 5) Vmax = 8.0 fps for 100-year flows w/ Erosion Control Blankets (Tensar Eronet P300 or equal)

Hydraulic Analysis Report

Project Data

Project Title: ETC-Channels
Designer: JPS
Project Date: Thursday, July 19, 2018
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Channel Analysis-C1A

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 12.0000 ft
Longitudinal Slope: 0.0170 ft/ft
Manning's n: 0.0300
Flow: 149.5000 cfs

Result Parameters

Depth: 1.3318 ft
Area of Flow: 23.0761 ft²
Wetted Perimeter: 22.9822 ft
Hydraulic Radius: 1.0041 ft
Average Velocity: 6.4786 ft/s
Top Width: 22.6543 ft
Froude Number: 1.1312
Critical Depth: 1.4301 ft
Critical Velocity: 5.8991 ft/s
Critical Slope: 0.0130 ft/ft
Critical Top Width: 23.44 ft
Calculated Max Shear Stress: 1.4128 lb/ft²
Calculated Avg Shear Stress: 1.0651 lb/ft²

Channel Analysis: Channel Analysis-C1B

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 12.0000 ft
Longitudinal Slope: 0.0257 ft/ft
Manning's n: 0.0300
Flow: 149.5000 cfs

Result Parameters

Depth: 1.1914 ft
Area of Flow: 19.9752 ft²
Wetted Perimeter: 21.8248 ft
Hydraulic Radius: 0.9153 ft
Average Velocity: 7.4843 ft/s
Top Width: 21.5314 ft
Froude Number: 1.3693
Critical Depth: 1.4307 ft
Critical Velocity: 5.8959 ft/s
Critical Slope: 0.0130 ft/ft
Critical Top Width: 23.45 ft
Calculated Max Shear Stress: 1.9107 lb/ft²
Calculated Avg Shear Stress: 1.4678 lb/ft²

Channel Analysis: Channel Analysis-C2.8

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 3.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0050 ft/ft
Manning's n: 0.0300
Flow: 26.7000 cfs

Result Parameters

Depth: 1.7094 ft
Area of Flow: 8.7666 ft²
Wetted Perimeter: 10.8115 ft
Hydraulic Radius: 0.8109 ft
Average Velocity: 3.0457 ft/s
Top Width: 10.2567 ft
Froude Number: 0.5805
Critical Depth: 1.3753 ft
Critical Velocity: 4.7055 ft/s
Critical Slope: 0.0160 ft/ft
Critical Top Width: 8.25 ft
Calculated Max Shear Stress: 0.5333 lb/ft²
Calculated Avg Shear Stress: 0.2530 lb/ft²

Channel Analysis: Channel Analysis-C3

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 12.0000 ft
Longitudinal Slope: 0.0040 ft/ft
Manning's n: 0.0300
Flow: 160.8000 cfs

Result Parameters

Depth: 2.0241 ft
Area of Flow: 40.6774 ft²
Wetted Perimeter: 28.6912 ft
Hydraulic Radius: 1.4178 ft
Average Velocity: 3.9531 ft/s
Top Width: 28.1929 ft
Froude Number: 0.5800
Critical Depth: 1.4917 ft
Critical Velocity: 5.9997 ft/s
Critical Slope: 0.0129 ft/ft
Critical Top Width: 23.93 ft
Calculated Max Shear Stress: 0.5052 lb/ft²
Calculated Avg Shear Stress: 0.3539 lb/ft²

Channel Analysis: Channel Analysis-C2.3A

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 3.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0050 ft/ft
Manning's n: 0.0300
Flow: 31.6000 cfs

Result Parameters

Depth: 1.8209 ft
Area of Flow: 9.9475 ft²
Wetted Perimeter: 11.5166 ft
Hydraulic Radius: 0.8637 ft
Average Velocity: 3.1767 ft/s
Top Width: 10.9256 ft
Froude Number: 0.5867
Critical Depth: 1.4712 ft
Critical Velocity: 4.8668 ft/s
Critical Slope: 0.0156 ft/ft
Critical Top Width: 8.83 ft
Calculated Max Shear Stress: 0.5681 lb/ft²
Calculated Avg Shear Stress: 0.2695 lb/ft²

APPENDIX E
COST ESTIMATE

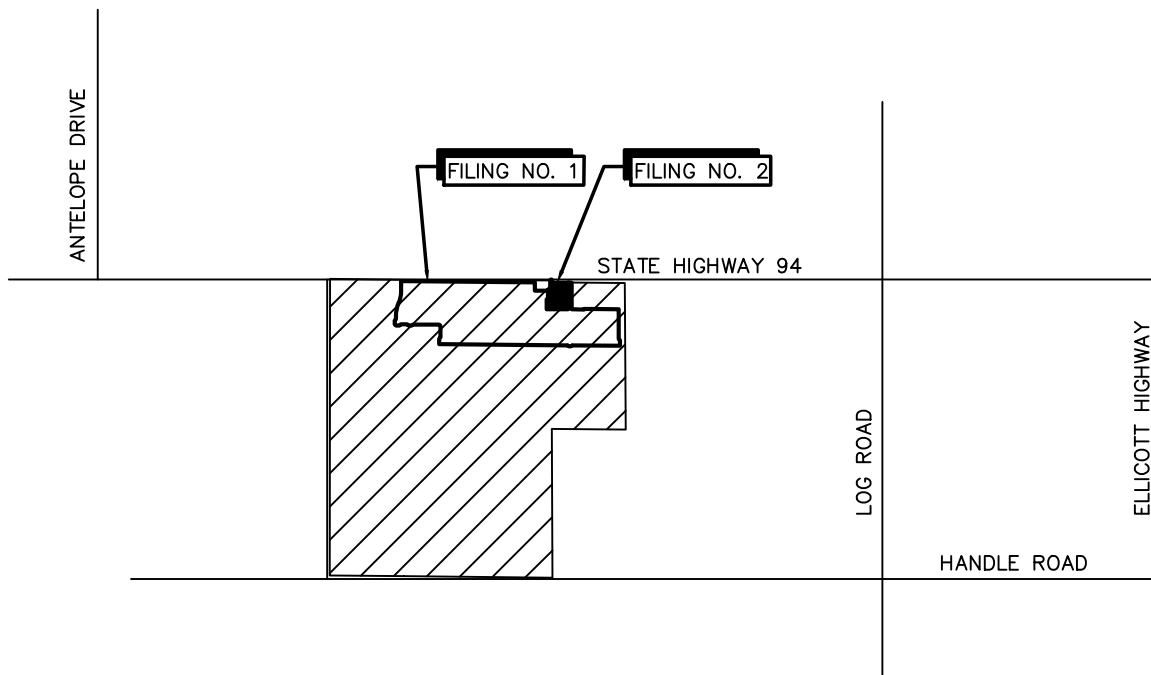
MAYBERRY, COLORADO SPRINGS FILING NO. 1
(fka "ELLCOTT TOWN CENTER")
ENGINEER'S COST ESTIMATE
DRAINAGE IMPROVEMENTS

| Item No. | Item | Quantity | Unit | Unit Cost (\$\$) | Total Cost (\$\$) |
|----------|--|----------|------|------------------|-------------------|
| 208 | Erosion Control Blanket Channel Lining | 1,715 | SY | \$6 | \$10,290 |
| 506 | Riprap (d50 = 12") | 20 | CY | \$98 | \$1,960 |
| 603 | 18" RCP Storm Sewer | 309 | LF | \$65 | \$20,085 |
| 603 | 24" RCP Storm Sewer | 982 | LF | \$78 | \$76,596 |
| 603 | 30" RCP Storm Sewer | 278 | LF | \$97 | \$26,966 |
| 603 | 36" RCP Storm Sewer | 811 | LF | \$120 | \$97,320 |
| 603 | 42" RCP Storm Sewer | 619 | LF | \$160 | \$99,040 |
| 603 | 48" RCP Storm Sewer | 311 | LF | \$195 | \$60,645 |
| 603 | 60" RCP Storm Sewer | 117 | LF | \$288 | \$33,696 |
| 603 | 18" RCP FES | 1 | EA | \$390 | \$390 |
| 603 | 30" RCP FES | 1 | EA | \$582 | \$582 |
| 603 | 36" RCP FES | 4 | EA | \$720 | \$2,880 |
| 603 | 42" RCP FES | 2 | EA | \$960 | \$1,920 |
| 604 | 5' Type R Storm Inlet | 3 | EA | \$5,542 | \$16,626 |
| 604 | 10' Type R Storm Inlet | 8 | EA | \$7,627 | \$61,016 |
| 604 | 15' Type R Storm Inlet | 1 | EA | \$9,918 | \$9,918 |
| 604 | Storm Manhole | 8 | EA | \$6,395 | \$51,160 |
| 604 | Detention Pond Forebay | 1 | EA | \$4,000 | \$4,000 |
| 604 | Detention Pond Outlet Structure | 2 | EA | \$8,000 | \$16,000 |
| 604 | Detention Pond Spillway | 1 | EA | \$3,000 | \$3,000 |
| | TOTAL | | | | \$594,090 |

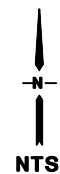
APPENDIX F

FIGURES

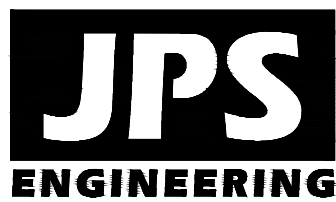
Z:\090001.EllicottTC\dwg\Civil\A1.dwg Jan 30, 2020 - 3:02pm



VICINITY MAP
NTS

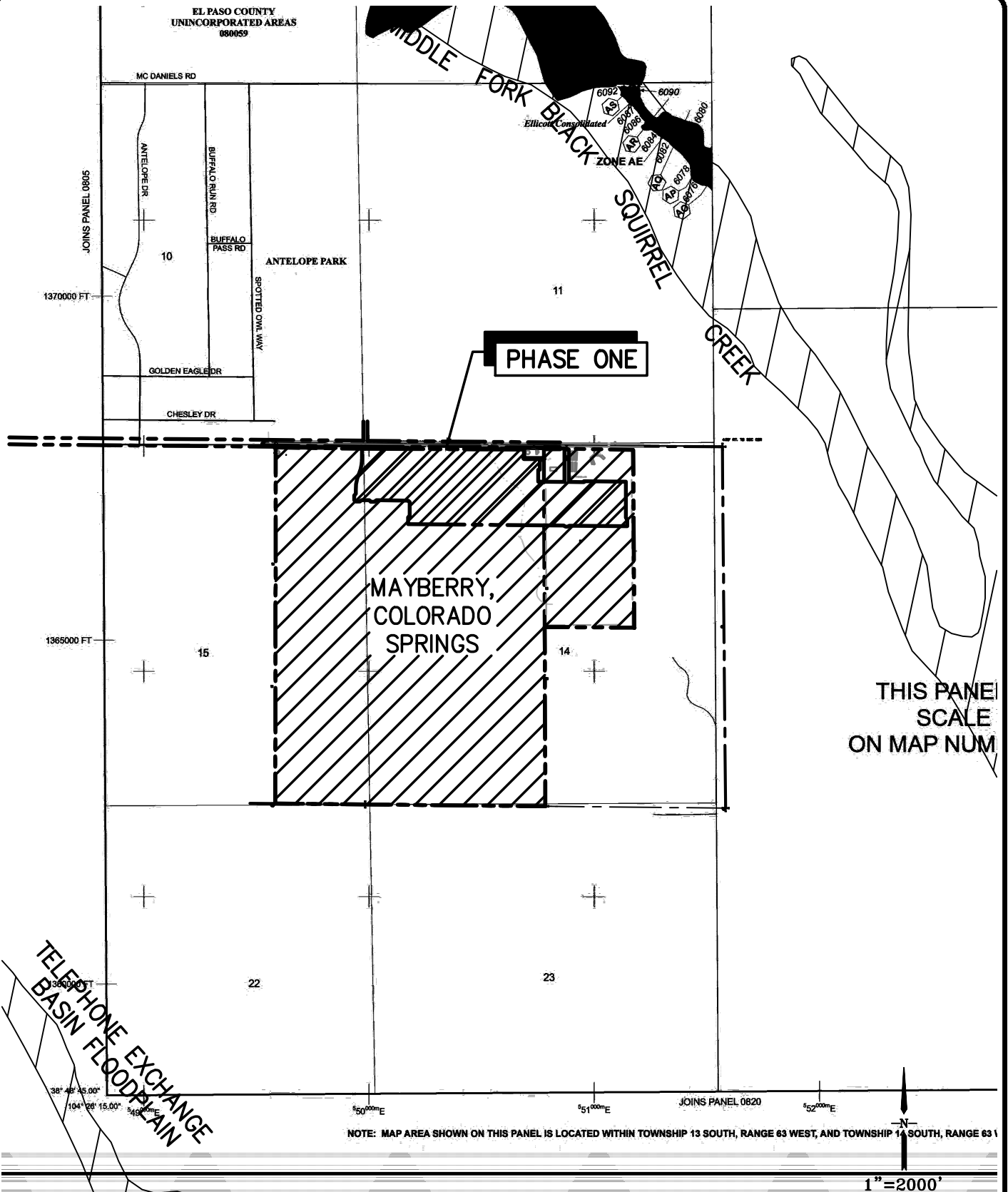


**VICINITY
MAP**



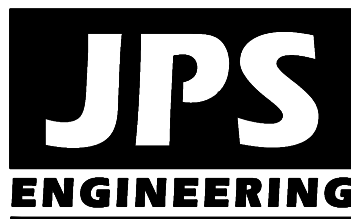
**MAYBERRY
COLORADO SPRINGS**

FIGURE A1
JPS PROJ NO. 090001



REF: FIRM PANEL 08041C0810G, DATED 12/07/18

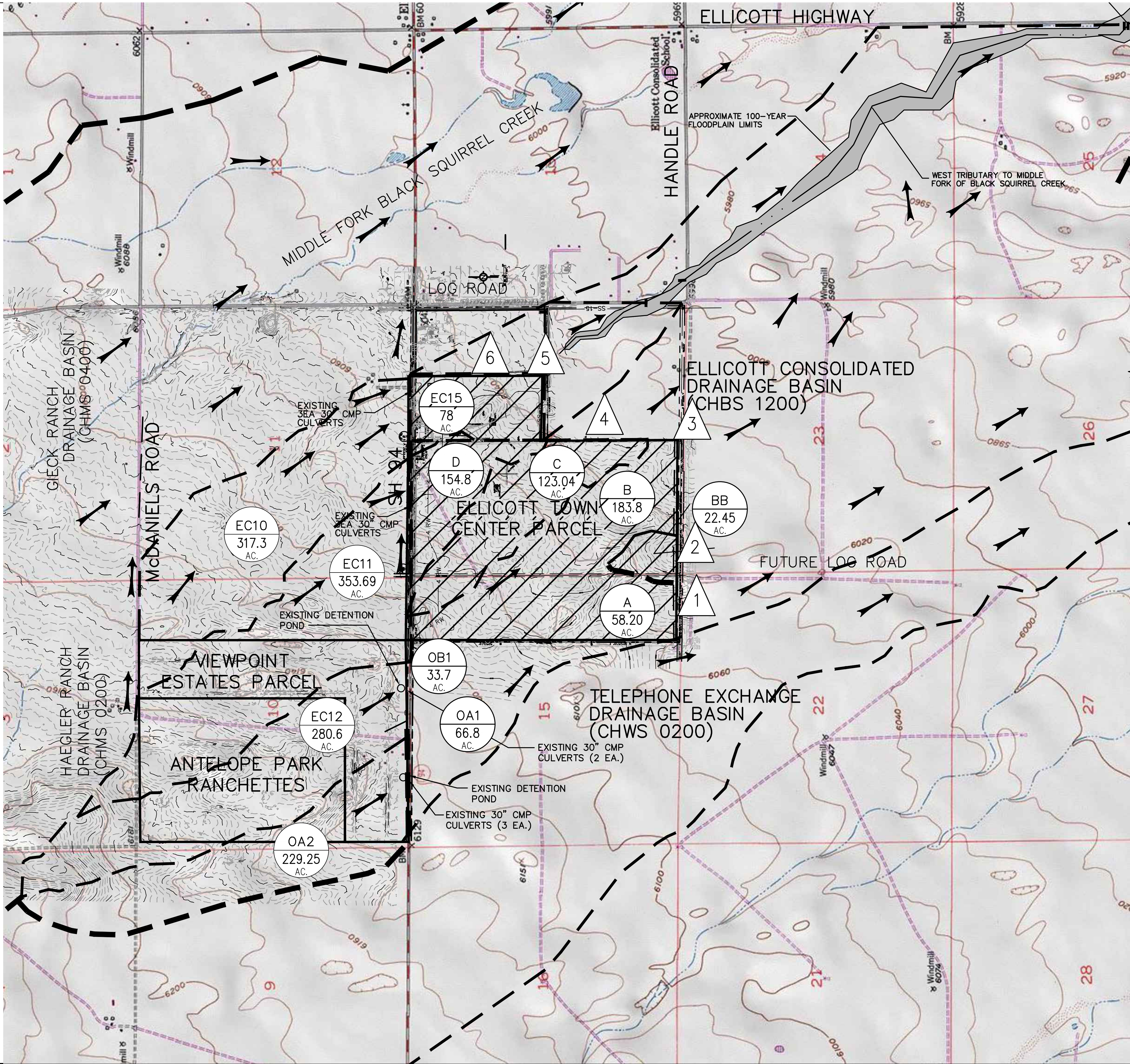
MAYBERRY,
COLORADO SPRINGS



FLOODPLAIN MAP

FIGURE A3
JPS PROJ NO. 090001

Z:\090001\Ellicott\TDC.dwg\Civil\EX1 - F1.dwg Sep 16, 2019 -- 8:26am



| SUMMARY HYDROLOGY TABLE | | |
|-------------------------|----------------------|------------------------|
| DESIGN POINT | Q ₅ (CFS) | Q ₁₀₀ (CFS) |
| 1 | 4.9 | 34.4 |
| 2 | 11.3 | 28.0 |
| 3 | 8.7 | 60.8 |
| 4 | 5.5 | 42.2 |
| (REFER TO MDDP) | | |
| 5 | 30.6 | 174.9 |
| 6 | 19.1 | 111.4 |

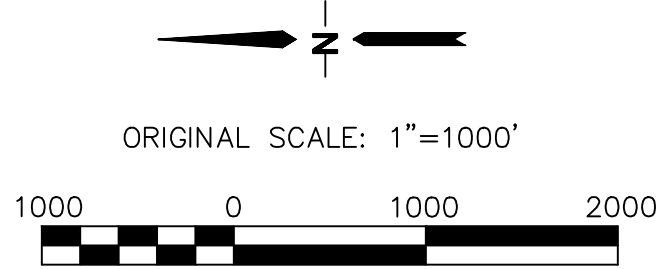
LEGEND

OD1
296
AC. DRAINAGE BASIN
AREA (AC)

5 DESIGN POINT

MAJOR BASIN LINE

BASIN LINE

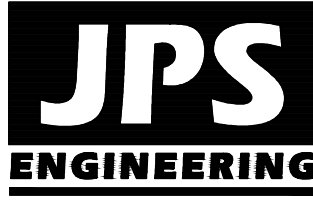


ELLICOTT TOWN CENTER

MAJOR BASIN / HISTORIC DRAINAGE PLAN

| | |
|-----------------------|------------------------|
| HORZ. SCALE: 1"=1000' | DRAWN: MJP |
| VERT. SCALE: N/A | DESIGNED: JPS |
| SURVEYED: UP&E | CHECKED: JPS |
| CREATED: 12/3/00 | LAST MODIFIED: 9/12/19 |
| PROJECT NO: 090001 | MODIFIED BY: BJJ |

SHEET: EX1

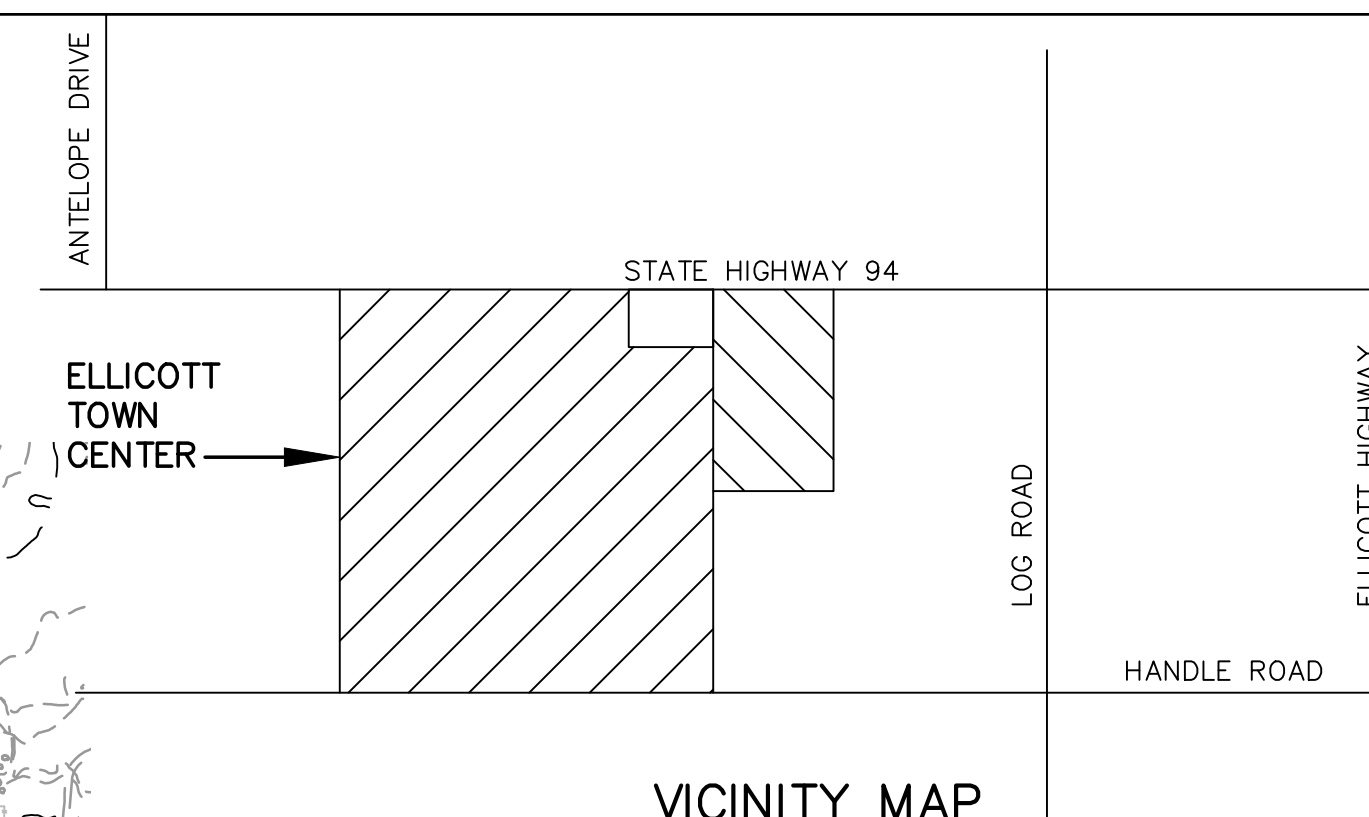
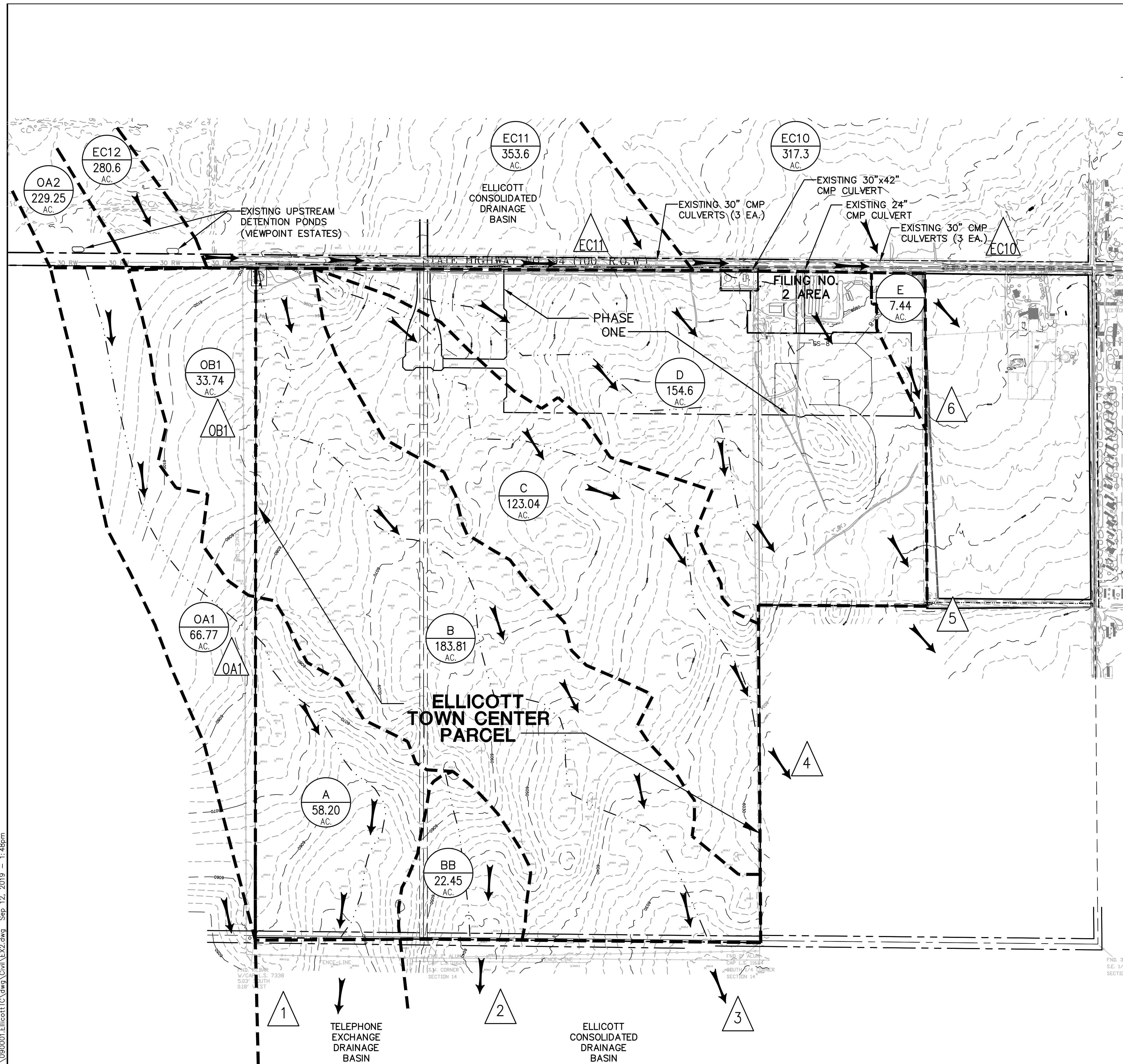







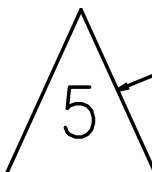
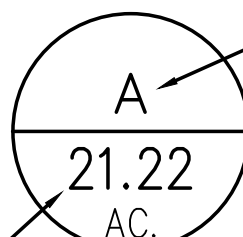

19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
john@jpsengr.com



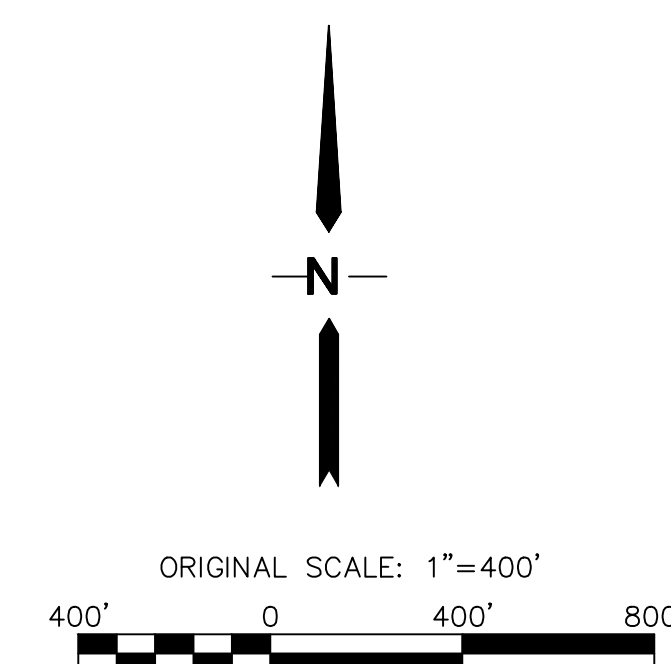
CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL BEFORE YOU DIG
BEFORE YOU DIG GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES

| No. | REVISION | BY | DATE |
|-----|----------|----|------|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |



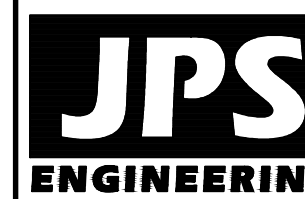
- ### LEGEND
- | | |
|---|-------------------------------|
|  | FILING LIMITS |
|  | DRAINAGE BASIN BOUNDARY |
|  | FLOWLINE |
|  | EXISTING CONTOUR |
|  | PROPOSED FLOW DIRECTION ARROW |
|  | DESIGN POINT |
|  | BASIN DESIGNATION |
|  | BASIN AREA (ACRES) |

| <u>DESIGN POINT</u> | <u>Q5 (CFS)</u> | <u>Q100 (CFS)</u> |
|--------------------------------------|---------------------|-----------------------|
| OA1 | 2.9 | 20.1 |
| 1 | 4.9 | 34.4 |
| 2 | 11.3 | 28.0 |
| OB1 | 2.3 | 15.7 |
| 3 | 8.7 | 60.8 |
| 4 | 5.5 | 42.2 |
| (REFER TO ELLICOTT TOWN CENTER MDDP) | | |
| EC11 | 24.4 | 149.5 |
| 5 | 30.5 | 174.9 |
| EC10 | 18.9 | 110.6 |
| 6 | 19.1 | 111.4 |
| (REFER TO FIL. 1 FDR--APP. B2) | | |



ELLCOTT TOWN CENTER

HISTORIC DRAINAGE PLAN



19 E. Willamette Ave.
Colorado Springs, CO
80903

PH: 719-477-9429
FAX: 719-471-0766
www.ipsenqr.com

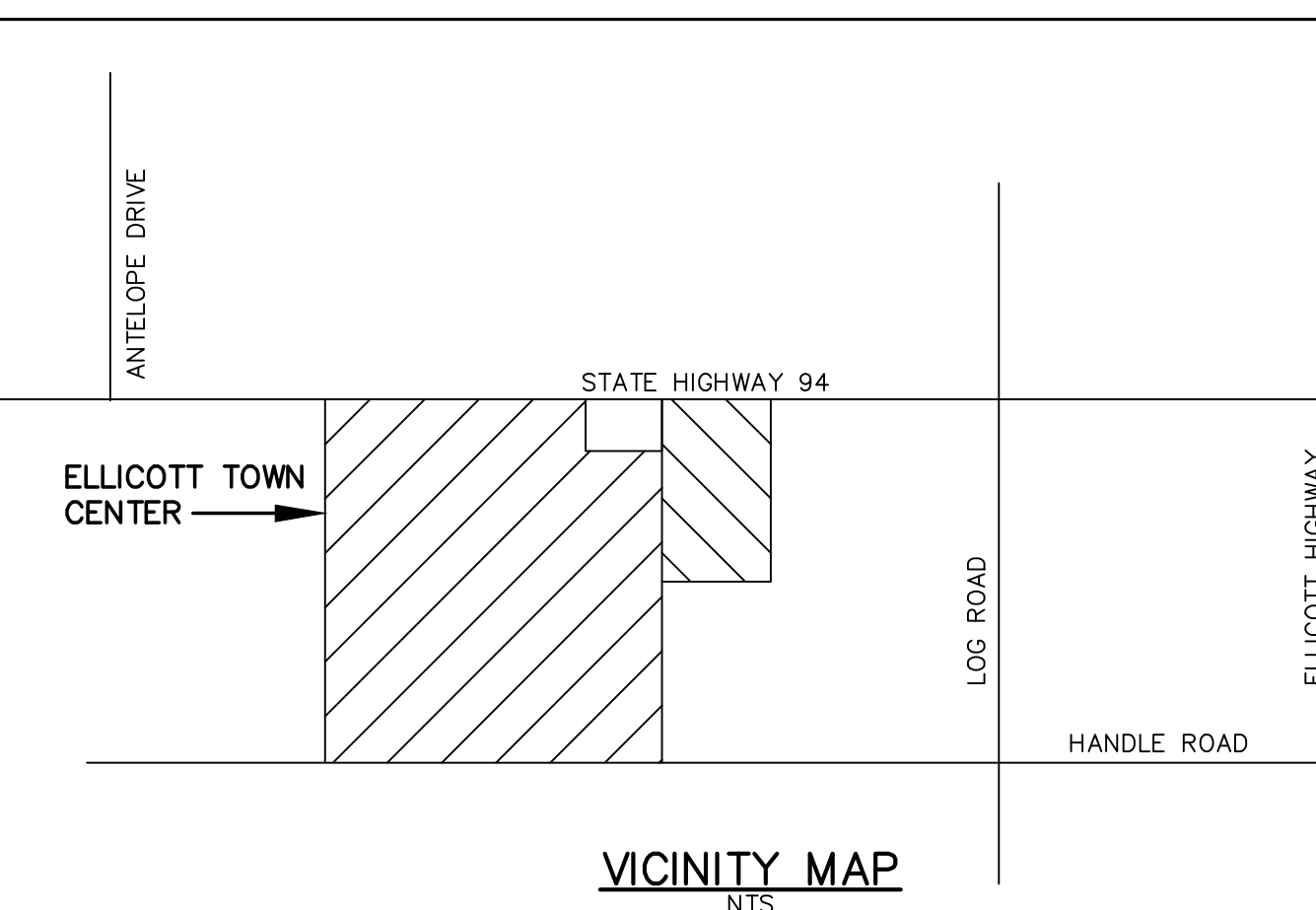
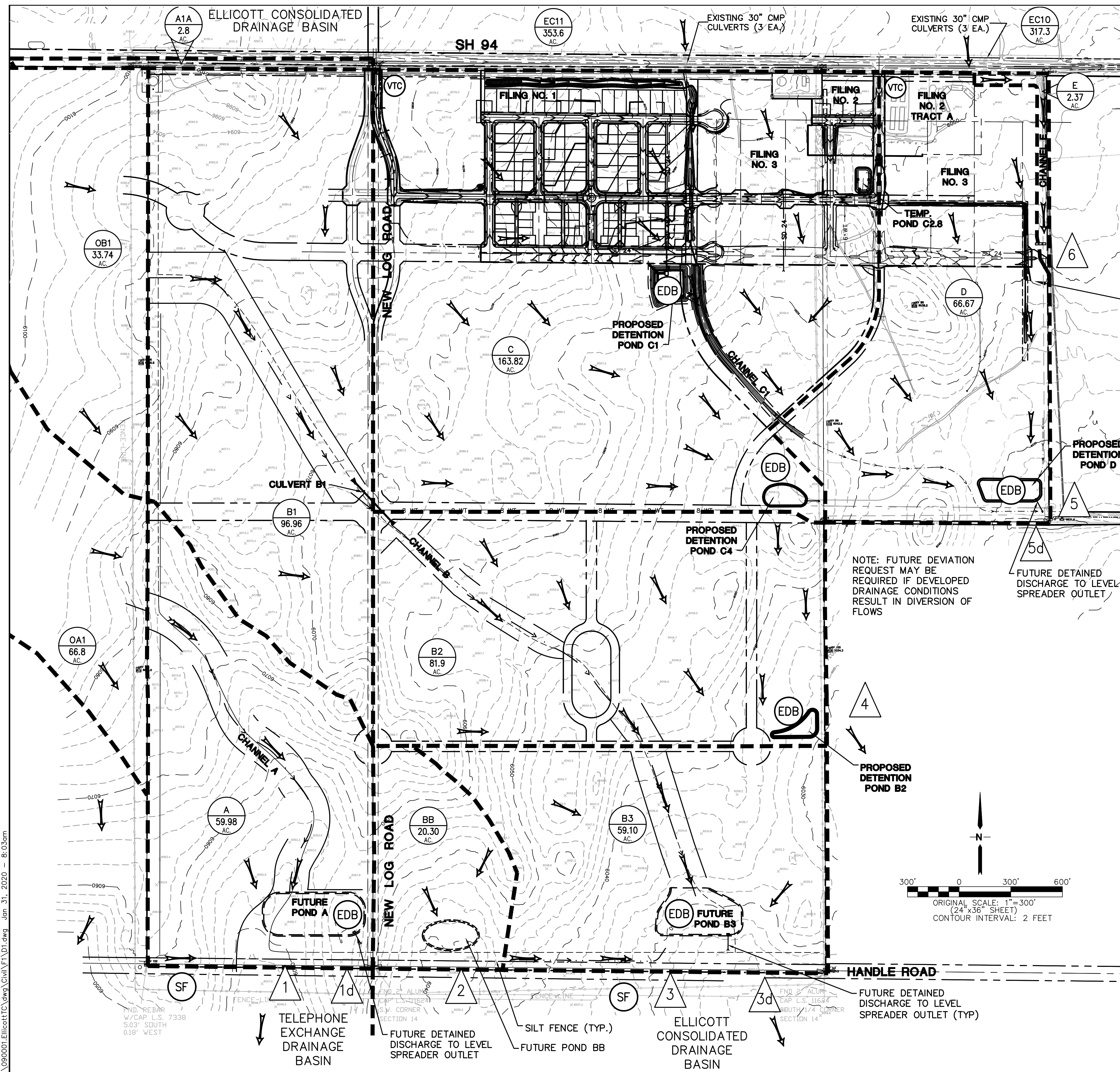


CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND

| No. | REVISION | BY | DATE |
|-----|----------|----|------|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| | | | |
|---------------|-----------|----------------|---------|
| HORIZ. SCALE: | 1" = 400' | DRAWN: | M |
| VERT. SCALE: | N/A | DESIGNED: | JF |
| SURVEYED: | UP&E | CHECKED: | JF |
| CREATED: | 12/03/00 | LAST MODIFIED: | 9/12/01 |
| PROJECT NO: | 090001 | MODIFIED BY: | B |

| | | |
|------|----------------|-------|
| 400' | DRAWN: | M |
| N/A | DESIGNED: | JF |
| P&E | CHECKED: | JF |
| /00 | LAST MODIFIED: | 9/12/ |
| 0001 | MODIFIED BY: | B |



— DIVERSION OF DEVELOPED
FLOW FROM BASIN E TO
BASIN D (TO DET. POND D)
(5.1 AC)

LEGEND:

- FILING LIMITS

— DRAINAGE BASIN BOUNDARY

- - - SUB-BASIN BOUNDARY

← PROPOSED FLOW DIRECTION ARROW

△ DESIGN POINT

△ "DETAINED" FLOW FROM DESIGN POINT

○ OA1
66.8
AC DEVELOPED BASIN DESIGNATION

BASIN AREA (ACRES)

* CALCULATED EQUIVALENT AREAS

—○— SILT FENCE

—— STRAW BALES

—— RIPRAP

— 6490 — EXISTING CONTOURS

— 6490 — PROPOSED CONTOURS

× 99.00 PROPOSED SPOT ELEVATION (FLOWLINE)

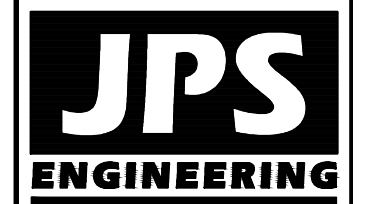
1.5% PROPOSED STREET PROFILE GRADE

○ (EDB) EXTENDED DETENTION BASIN

SUMMARY HYDROLOGY TABLE

| DESIGN POINT | Q ₅ (CFS) | Q ₁₀₀ (CFS) |
|-----------------|-------------------------|---------------------------|
| 1 | 11.3 | 51.9 |
| 1d | 4.9 | 34.4 |
| 2 | 0 | 0 |
| 3 | 58.0 | 184.7 |
| 3d | 8.7 | 60.8 |
| 4 | 5.8 | 12.3 |
| (REFER TO MDDP) | | |
| 5 | 226.6 | 461.4 |
| 5d | 30.6 | 174.9 |
| 6 | 19.0 | 111.0 |

MAYBERRY, COLORADO SPRINGS



19 E. Willamette Ave.
Colorado Springs, CO
80903

PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com



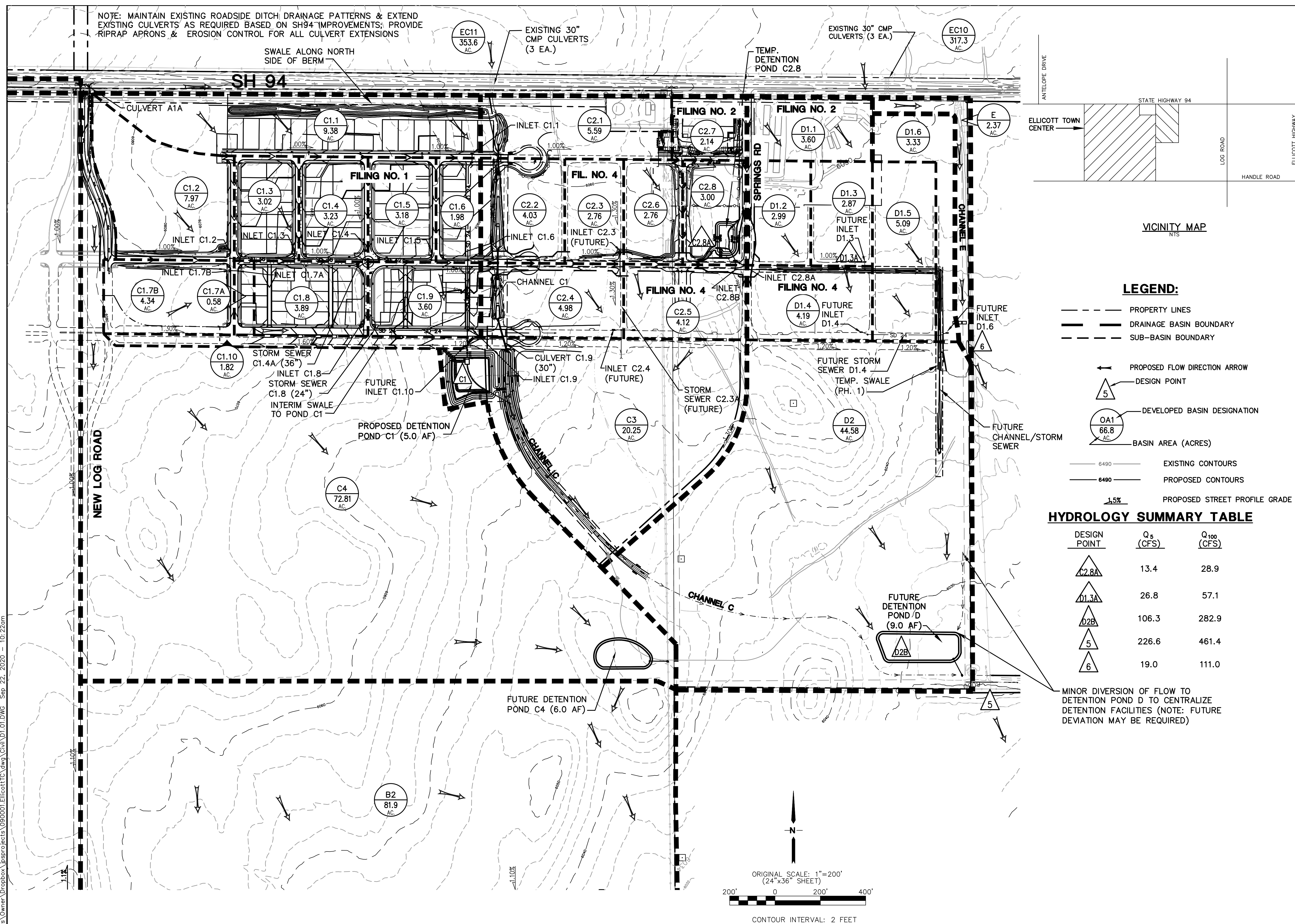
CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES.

[illegible]

DEVELOPED DRAINAGE PLAN

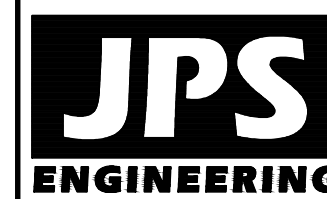
| | | | |
|---------------|-----------|----------------|---------|
| HORIZ. SCALE: | 1" = 300' | DRAWN: | MJP |
| VERT. SCALE: | N/A | DESIGNED: | JPS |
| SURVEYED: | UP&E | CHECKED: | JPS |
| CREATED: | 12/03/00 | LAST MODIFIED: | 1/30/20 |
| PROJECT NO: | 090001 | MODIFIED BY: | BJJ |

D1



MAYBERRY, COLORADO SPRINGS

PHASE 1 DEVELOPED DRAINAGE PLAN



19 E. Willamette Ave
Colorado Springs, CO
80903

PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com



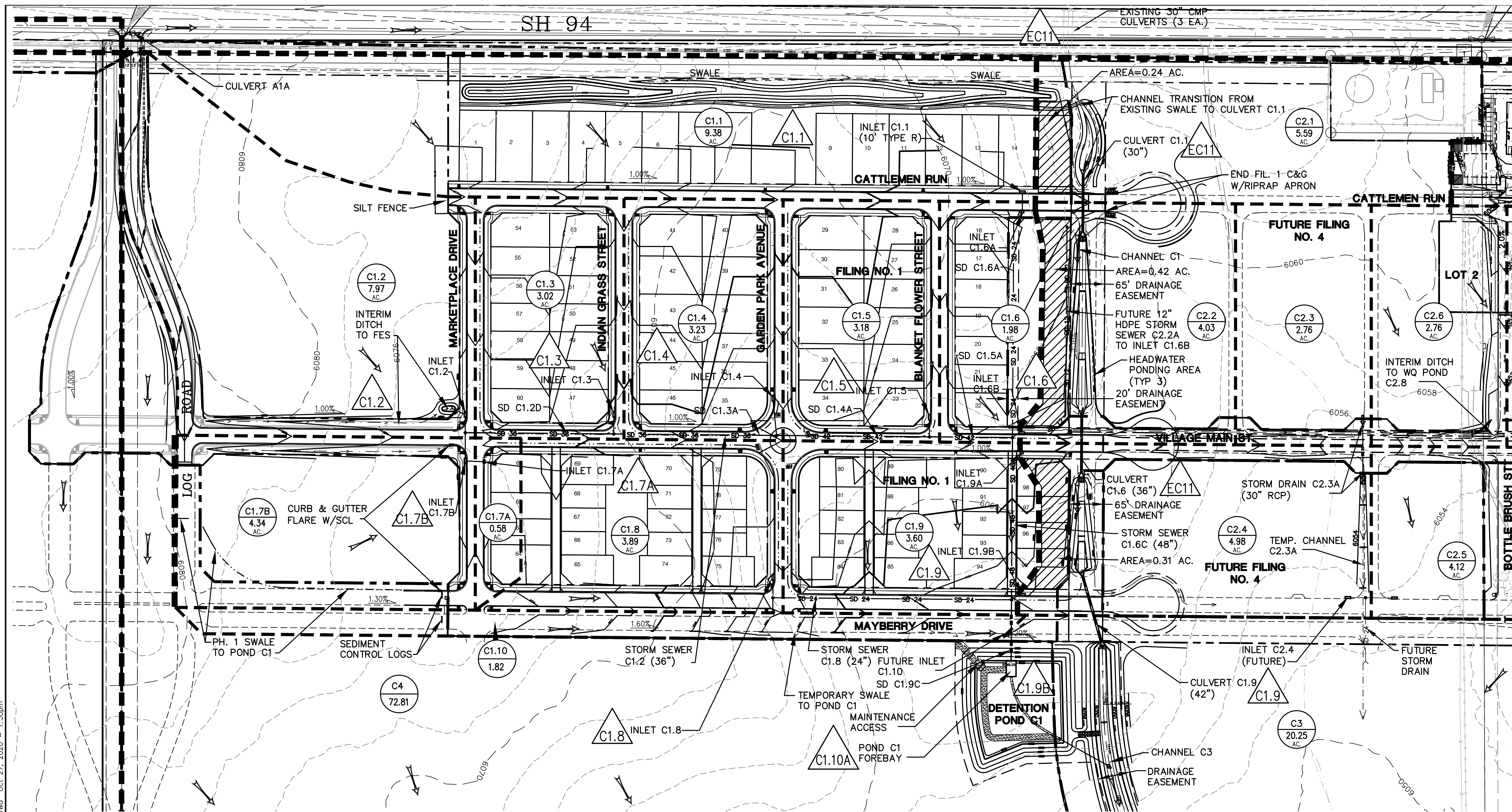
CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND

| No. | REVISION | BY | DATE |
|-----|----------|----|------|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| | | | |
|---------------|----------|----------------|-----------|
| HORIZ. SCALE: | 1"=200' | DRAWN: | RMD |
| VERT. SCALE: | N/A | DESIGNED: | JPS |
| SURVEYED: | UP&E | CHECKED: | JPS |
| CREATED: | 12/03/00 | LAST MODIFIED: | 9/22/2001 |
| PROJECT NO: | 090001 | MODIFIED BY: | B.J. |

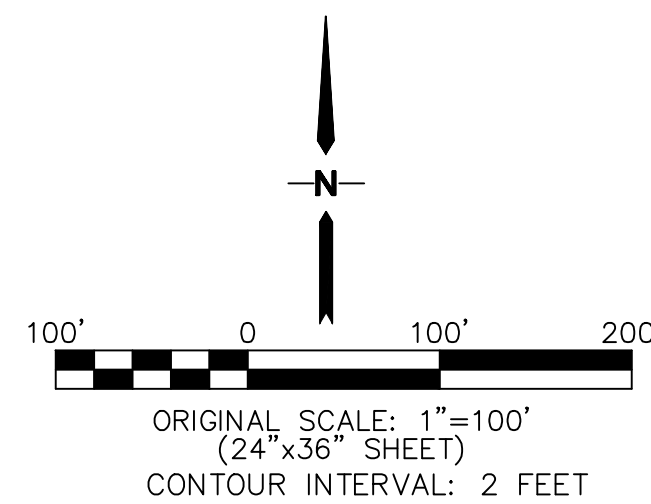
SHEET: **D1.01**

C:\Users\Owner\Dropbox\jpsprojects\090001\Ellicott\TTC.dwg Oct 27, 2020 - 1:30pm

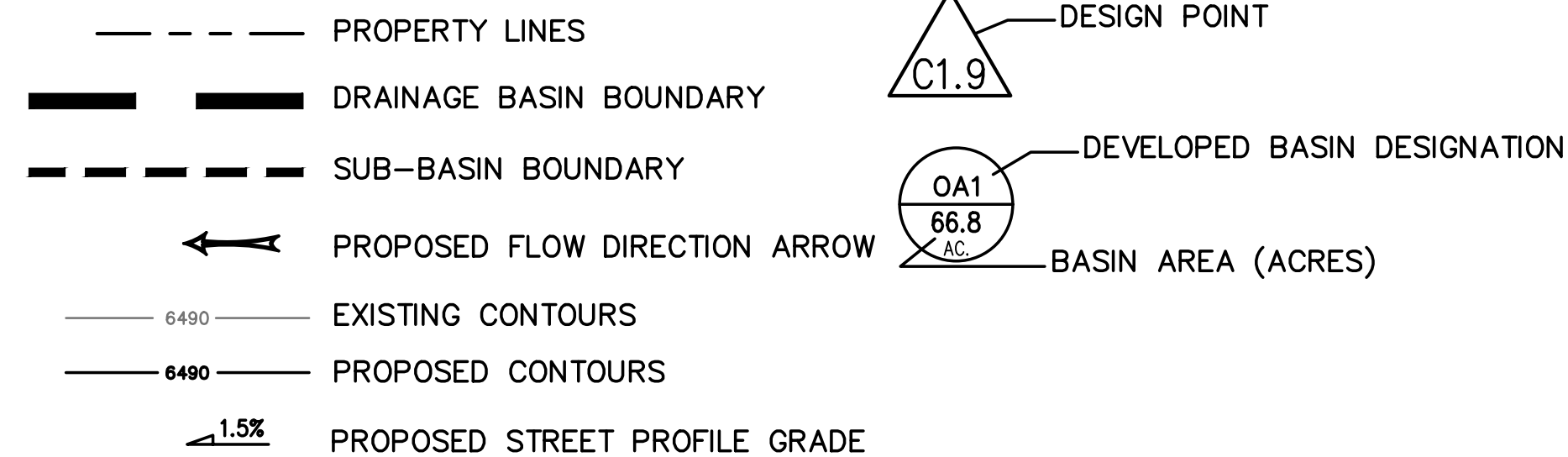


SUMMARY HYDROLOGY TABLE

| DESIGN POINT | Q5 (CFS) | Q100 (CFS) |
|--------------|----------|------------|
| EC11 | 9.6 | 64.0 |
| C1.1 | 5.4 | 18.0 |
| C1.2 | 16.9 | 35.9 |
| C1.3 | 5.9 | 14.3 |
| C1.4 | 6.3 | 15.3 |
| C1.5 | 6.2 | 15.6 |
| C1.6 | 3.8 | 9.4 |
| C1.7A | 1.1 | 2.7 |
| C1.7B | 8.2 | 17.3 |
| C1.8 | 7.5 | 18.4 |
| C1.9 | 7.0 | 17.0 |
| C1.9B | 37.8 | 92.1 |
| C1.10A | 39.4 | 96.1 |



LEGEND:



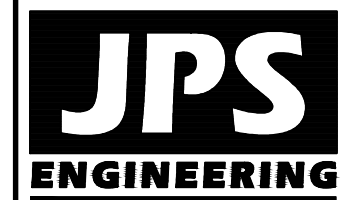
WATER QUALITY NOTES:

- DEVIATION REQUEST PROCESSED TO ALLOW DEVELOPED FLOW FROM WEST SIDE OF BASIN C2.1 (LOT 15) AND BASIN C2.4 (LOTS 95-98) TO SHEET FLOW INTO CHANNEL C1. (APPROX. 0.6 ACRES)
- FUTURE FILING NO. 3 DEVELOPMENT SHALL PROVIDE AREA DRAINS TO COLLECT FLOW FROM THE WEST SIDE OF BASIN C2.2 (EAST SIDE OF LOTS 16-22) AND CONVEY THIS DEVELOPED FLOW TO INLET C1.6B.



MAYBERRY, COLORADO SPRINGS - FILING NO. 1

FILING NO. 1 DEVELOPED DRAINAGE PLAN



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

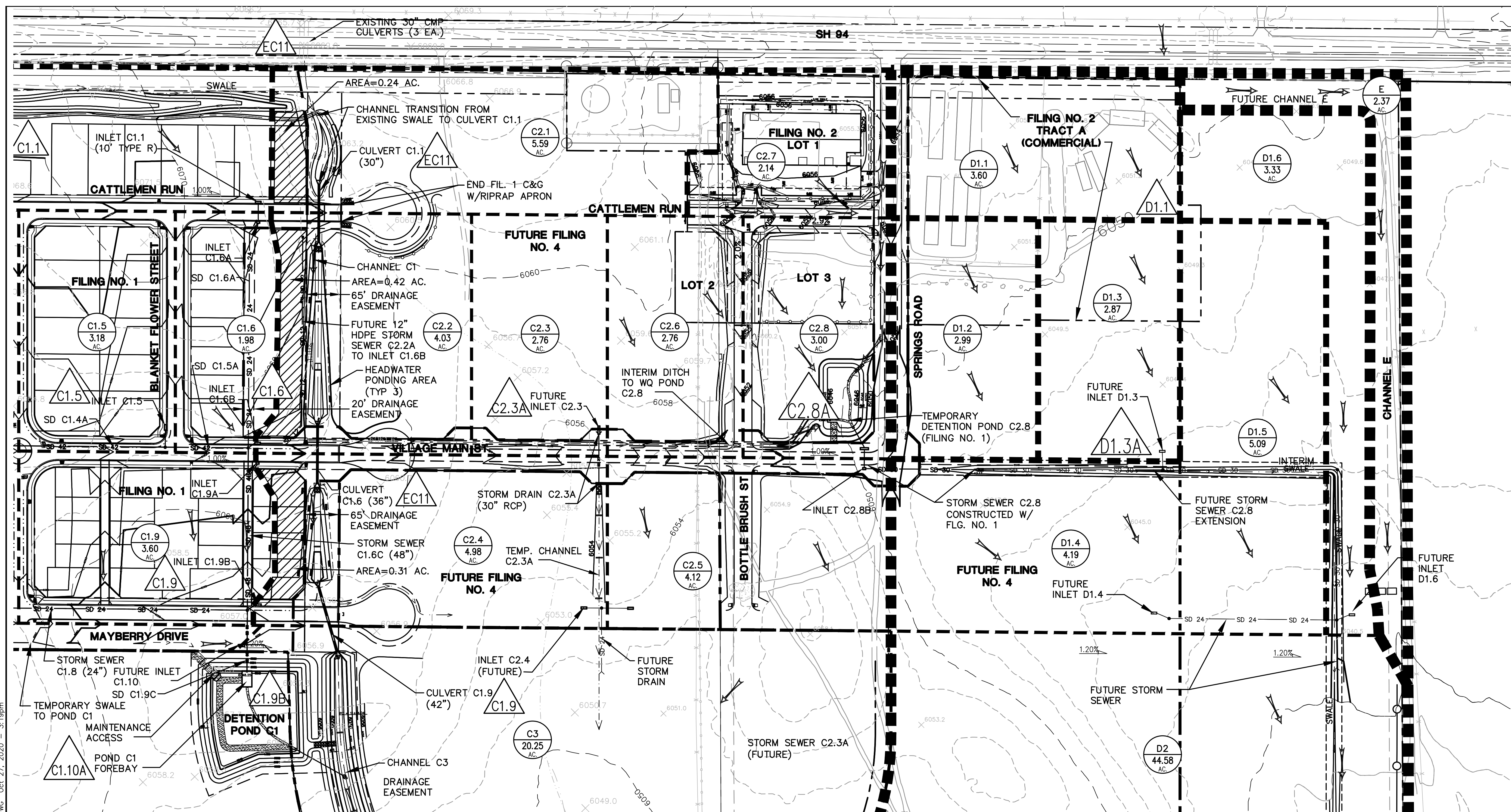


CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 2-48 HOURS BEFORE ANY
DRAINAGE WORK IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES

| No. | REVISION | BY | DATE |
|-----|----------|----|------|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| | |
|----------------------|-------------------------|
| HORZ. SCALE: 1"=100' | DRAWN: BJJ |
| VERT. SCALE: N/A | DESIGNED: JPS |
| SURVEYED: UP&E | CHECKED: JPS |
| CREATED: 12/03/00 | LAST MODIFIED: 07/27/20 |
| PROJECT NO: 090001 | MODIFIED BY: BJJ |
| SHEET: | |

D1.11

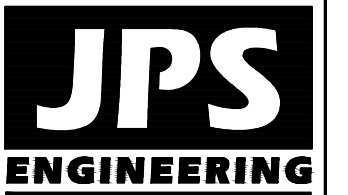


LEGEND:

-
- - - - - PROPERTY LINES
 ——— DRAINAGE BASIN BOUNDARY
 - - - - - SUB-BASIN BOUNDARY
 ← PROPOSED FLOW DIRECTION ARROW
 — 6490 — EXISTING CONTOURS
 — 6490 — PROPOSED CONTOURS
 1.5% PROPOSED STREET PROFILE GRADE
 [Hatched Box] AREA EXCLUDED FROM WATER QUALITY FACILITIES

| SUMMARY HYDROLOGY TABLE | | |
|-------------------------|--------------|----------------|
| DESIGN POINT | Q 5 (CFS) | Q 100 (CFS) |
| C2.3A | 11.8 | 31.6 |
| C2.8A | 13.4 | 28.9 |
| D1.1 | 10.4 | 20.8 |
| D1.3A | 26.8 | 57.1 |

MAYBERRY, COLORADO SPRINGS - FILING NO. 1-2



19 E. Willamette Ave.
Colorado Springs, CO
80903

PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

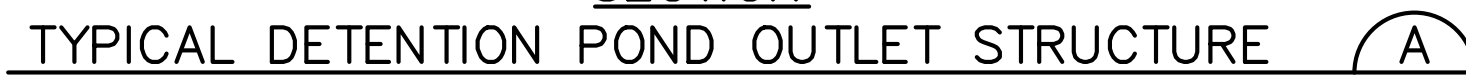


**CALL UTILITY NOTIFICATION
CENTER OF COLORADO**
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES.

[illegible]EAST SITE / FILING NO. 2
DEVELOPED DRAINAGE PLAN

| | | | |
|---------------|---------|----------------|----------|
| HORIZ. SCALE: | 1"=100' | DRAWN: | BJJ |
| VERT. SCALE: | N/A | DESIGNED: | JPS |
| SURVEYED: | RAMPART | CHECKED: | JPS |
| CREATED: | 3/28/19 | LAST MODIFIED: | 10/27/20 |
| PROJECT NO: | 090001 | MODIFIED BY: | BJJ |

D1.12



- ORIFICE PLATE AND TRASH RACK
DETAILS AND NOTES B
NTS

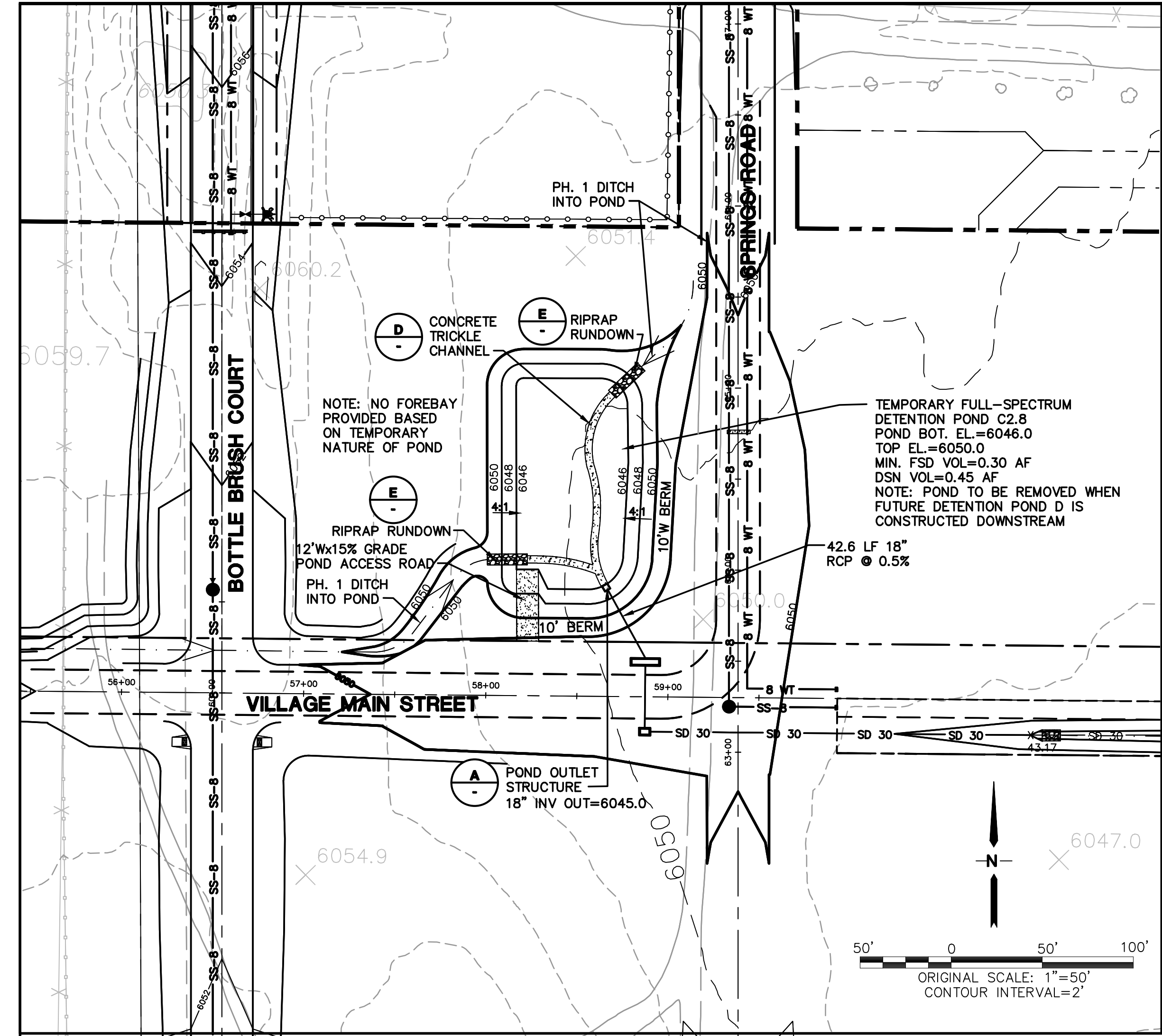
POND C-1 PLAN & DETAILS

MAYBERRY, COLORADO SPRINGS - FILING NO. 1

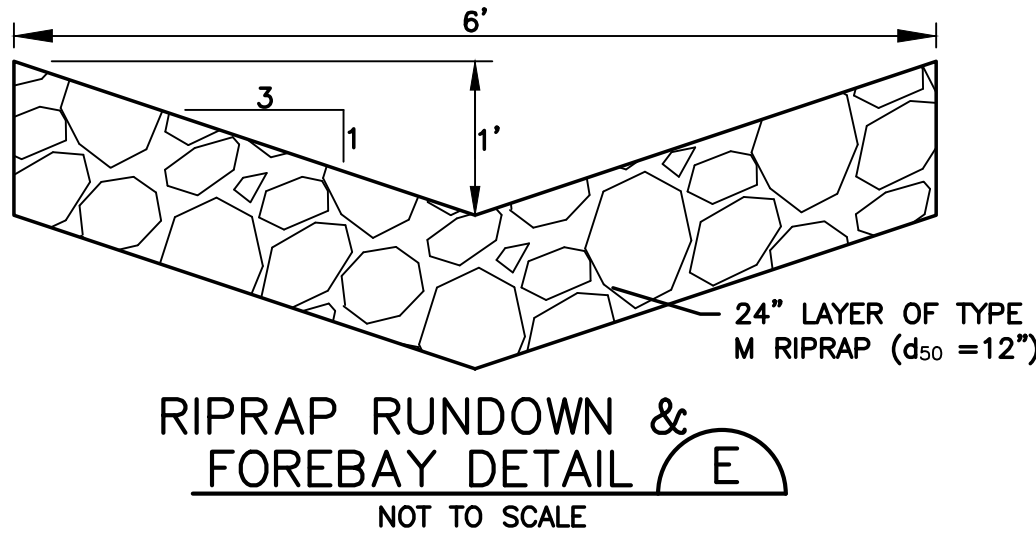
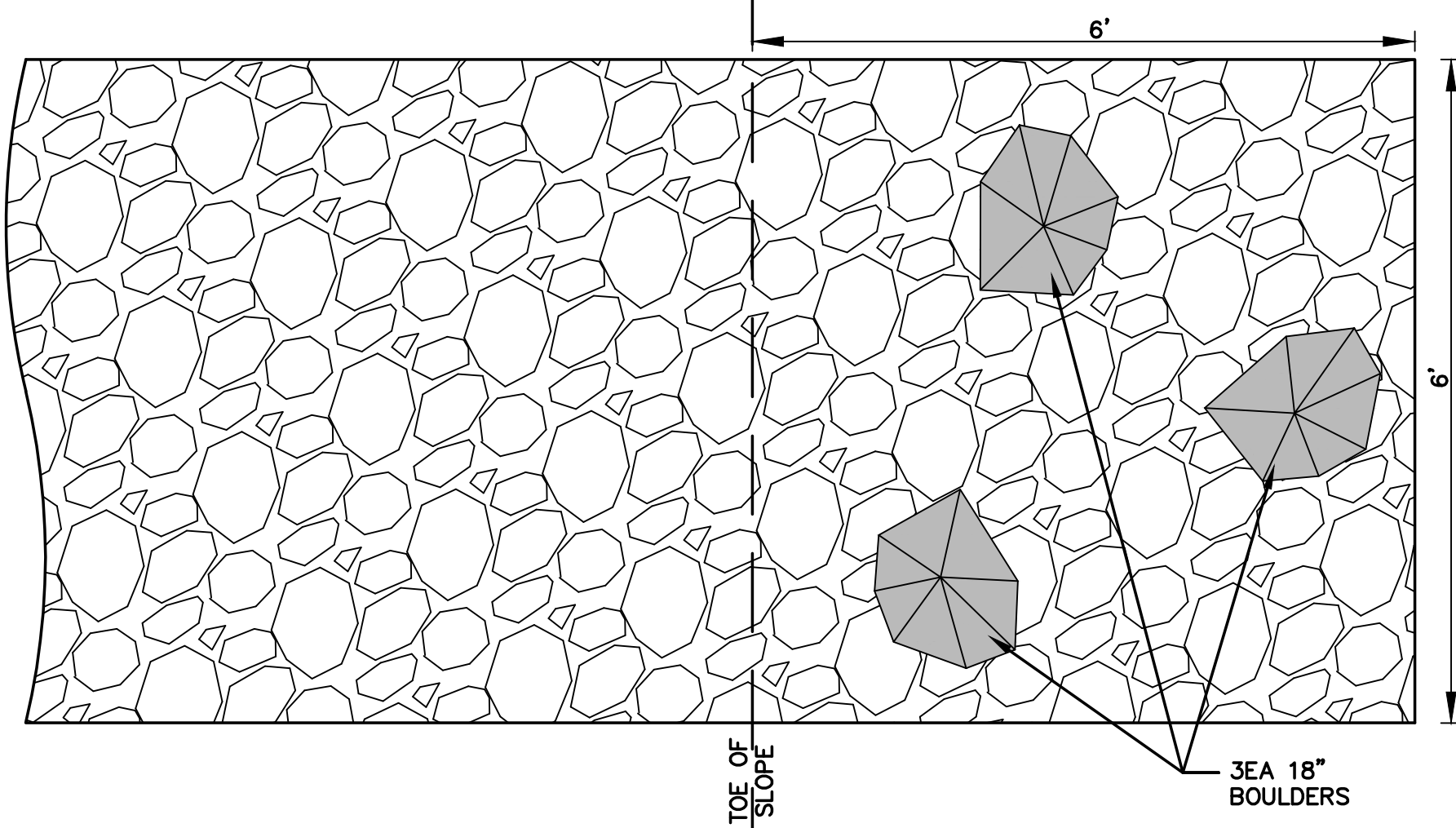
| | | | |
|---------------|--------|----------------|---------|
| HORIZ. SCALE: | 1"=50' | DRAWN: | BJS |
| VERT. SCALE: | N/A | DESIGNED: | JPS |
| SURVEYED: | UP&E | CHECKED: | JPS |
| CREATED: | 4/4/06 | LAST MODIFIED: | 4/17/20 |
| PROJECT NO: | 090001 | MODIFIED BY: | BJS |

C1.5

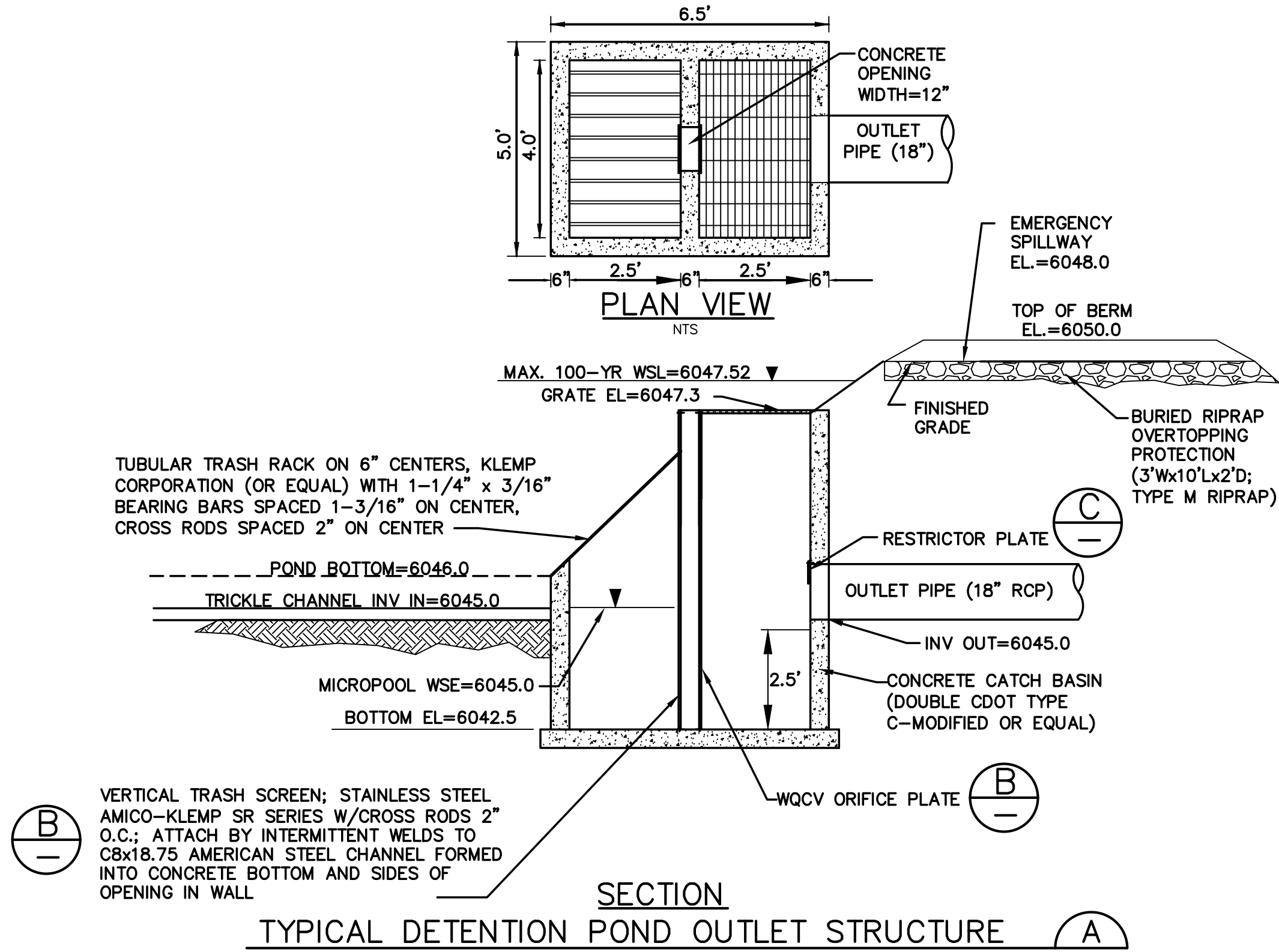
G:\Users\Owner\Dropbox\psprojects\090001\Ellicott\110.dwg\Civil\GEC\C1.6.dwg Sep 17, 2020 -- 2:44pm



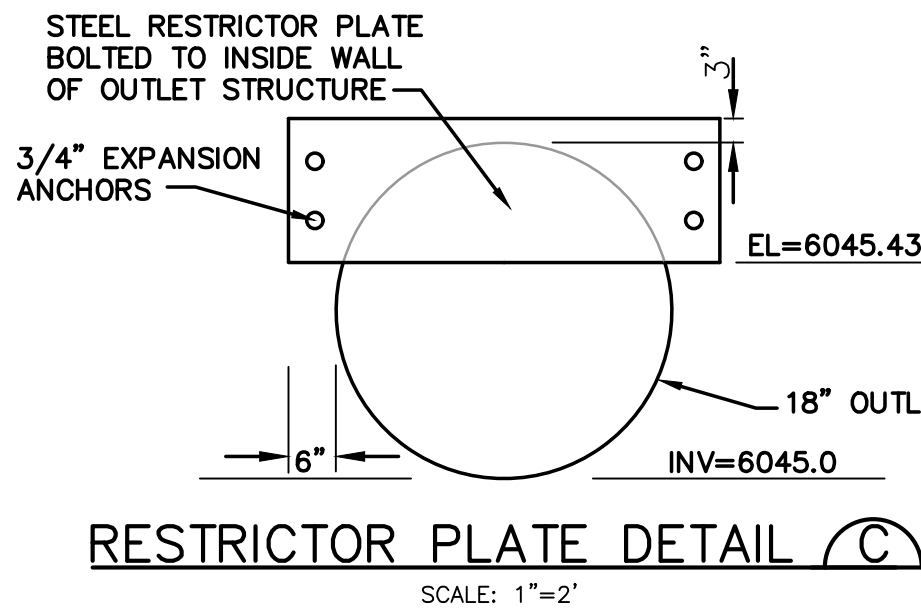
TEMPORARY POND C2.8 PLAN



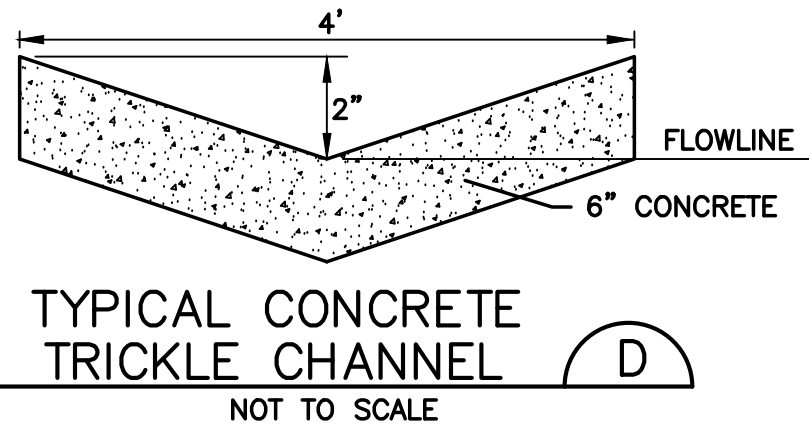
RIPRAP RUNDOWN & FOREBAY DETAIL (E)
NOT TO SCALE



SECTION
TYPICAL DETENTION POND OUTLET STRUCTURE (A)
SCALE: NTS



RESTRICTOR PLATE DETAIL (C)
SCALE: 1"=2"



TYPICAL CONCRETE TRICKLE CHANNEL (D)
NOT TO SCALE

- ORIFICE PLATE NOTES:
1. MINIMIZE THE NUMBER OF COLUMNS.
 2. PROVIDE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND CONCRETE.
 3. BOLT PLATE TO CONCRETE 12" MAX. ON CENTER.

EURV AND WQCV TRASH RACKS:

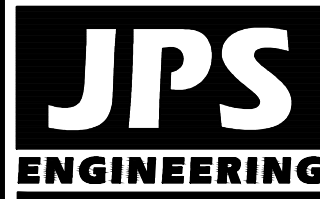
1. WELL-SCREEN TRASH RACKS (FOR CIRCULAR ORIFICES) SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.
2. STRUCTURAL DESIGN OF TRASH RACKS BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF THE RACK.

OVERFLOW TRASH RACKS:

1. ALL TRASH RACKS SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE AND PROVIDED WITH HINGED AND LOCKABLE OR BOLTABLE ACCESS PANELS.
2. TRASH RACKS SHALL BE STAINLESS STEEL, ALUMINUM, OR STEEL. STEEL TRASH RACKS SHALL BE HOT DIP GALVANIZED AND MAY BE HOT POWDER COATED AFTER GALVANIZING.
3. TRASH RACKS SHALL BE DESIGNED SUCH THAT THE DIAGONAL DIMENSION OF EACH OPENING IS SMALLER THAN THE DIAMETER OF THE OUTLET PIPE.
4. STRUCTURAL DESIGN OF TRASH RACKS SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF THE RACK.

ORIFICE PLATE AND TRASH RACK
DETAILS AND NOTES (B)
NTS

MAYBERRY, COLORADO SPRINGS - FILING NO. 1



19 E. Willamette Ave.
Colorado Springs, CO
80903

PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com



CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL BEFORE YOU DIG
BEFORE YOU DIG GRADE OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES

| No. | REVISION | BY | DATE |
|-----|--------------|-----|---------|
| 1/A | EPC COMMENTS | JPS | 1/15/19 |
| 2/A | EPC COMMENTS | JPS | 9/12/19 |
| 3/A | EPC COMMENTS | JPS | 1/31/20 |
| 4/E | EPC COMMENTS | JPS | 4/17/20 |
| 5/A | EPC COMMENTS | JPS | 9/17/20 |

POND C2.8 PLAN & DETAILS

HORZ. SCALE: 1"=50'
VERT. SCALE: N/A
SURVEYED: UP&E
CREATED: 1/15/19
PROJECT NO: 090001

DRAWN: RMD
DESIGNED: JPS
CHECKED: JPS
LAST MODIFIED: 9/17/20
MODIFIED BY: BJJ

SHEET:

C1.6