FINAL DRAINAGE REPORT
FOR
LATIGO TRAILS FILING NO. 9
AND
ADDENDUM TO MASTER DEVELOPMENT/
PRELIMINARY DRAINAGE PLAN
FOR LATIGO TRAILS,
EL PASO COUNTY, COLORADO

September 2022

Prepared For:

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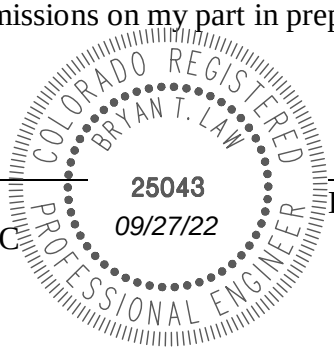
Job No. 25175.02

PCD File No.: SF2136

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 El Paso County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.



09/27/22

Bryan T. Law, Colorado P.E. # 25043 Date
For and On Behalf of JR Engineering, LLC

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

Business Name: BRJM, LLC

By:

Robert C. Irwin
Title: Manager
Address: 17 S. Wahsatch Ave.
Colorado Springs CO 80903

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

Approved
By: Elizabeth Nijkamp, PE
Date:03/29/2023
El Paso County Department of Public Works

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

Conditions:

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PURPOSE

The purpose of this report is to serve as the Final Drainage Report for Latigo Trails Filing 9 known as the "site" from herein, and to amend the "Master Development/Preliminary Drainage Plan for Latigo Trails" (MDDP) by URS, dated October 2001. The proposed Latigo Trails Development that this report covers, known herein as the "proposed development" consists of five filings (9-13). Filing 9 will be discussed further in this report.

This drainage study identifies and analyzes the proposed drainage patterns, determines proposed runoff quantities, sizes drainage facilities, presents solutions to on and off-site drainage impacts resulting from this development, and safely routes developed storm water runoff to the appropriate outfall facilities as delineated in previous reports.

GENERAL LOCATION AND DESCRIPTION

Location

The Latigo Trails proposed development is located within Sections 8, 9, 16, & 17, Township 12 South, Range 64 West of the 6th Principal Meridian, El Paso County, Colorado. The site is bound by Future Latigo Trails Filing 12 to the East, The Trails Filing 2-B and The Trails Filing 7-A and 7-C to the North, The West line of Section 17, Township 12 South, Range 64 West of the Sixth Principal Meridian to the West, and by the Meridian Ranch development to the south. A vicinity map is presented in Appendix A.

Description of Property

The Latigo Trails proposed development contains approximately 599 acres and will be comprised of 176, 2.5 acre lots or larger. Filing 9 consists of 39 of the lots and is 106.6 acres. The site is currently unoccupied and undeveloped. The existing ground cover is sparse vegetation and open space, typical of a Colorado rolling range land condition. It should be noted that Filings 2, 7, and 8 are currently developed, and therefore, this report covers the undeveloped portions, including Filings 9 – 13. Previously developed areas part of the 2001 MDDP for Latigo Trails by URS, will remain unchanged and as is.

Approximately 305 acres will drain to the Gieck Ranch basin. In general the Gieck Ranch basin flows form northwest to southeast across the proposed development.

Filing 9 known as "the site" from herein is comprised of 39 lots. The site is bound by The Trails Filing No. 2-B to the north, single family residences to the west, and by future Latigo Trails Filing No. 12 to the east.

Per a NRCS web soil survey of the area, the site is made up of B soils. Type B soils are typically moderately deep to deep and moderately well drained to well drained soils that have a moderate infiltration when thoroughly wet. A NRCS soil survey map has been presented in Appendix A.

Floodplain Statement

Based on the FEMA FIRM Map numbers 08041C0339G and 0841C0552G, both dated December 7, 2018, the site lies Zone X. Zone X is defined as area outside the Special Flood Hazard Area (SFHA) and higher than the elevation of the 0.2-percent-annual-chance (or 500-year) flood. All proposed development within the site will occur in Zone X.

MAJOR DRAINAGE BASINS AND SUB-BASINS

Addendum to Master Development/ Preliminary Drainage Plan

For Trails Filing 9, the MDDP will be amended as follows:

a. Portions of Filing 9 will drain to the existing South Pond. The existing pond, outlet structure, and spillway crest will be revised and the pond designed per 2021 El Paso County Drainage Criteria.
b. The potential detention areas shown in the MDDP are eliminated and instead developed flows will be conveyed south by a system of swales, and culverts to the two full-spectrum EDBs: the existing South Pond and the proposed G1 pond. The eliminated potential detention areas are shown in Appendix E within the excerpt of the "Master Development/Preliminary Drainage Plan Latigo Trails" by URS, dated October 4, 2001. The eliminated detention areas (labeled with a red X) in general follow the proposed Conestoga Trail South from west to east. More specifically, thesse areas are: north of design point V4c, near design point V18a, near design point V18b, north of design point V21, and north of design point V24.
c. Proposed Pond G1 has been sized and designed to meet 2021 El Paso County Drainage Criteria. Pond G19 will be evaluated with the development of future Filings (10-12) and the MDDP shall be amended as needed.

Major Basin Descriptions

The site lies within the Gieck Ranch Drainage Basin. A Master Development Drainage Plan (MDDP) has been approved for Latigo Trails and is titled "Master Development/Preliminary Drainage Plan for Latigo Trails", by URS, dated October 2001; it is referenced and used as a Master Plan for the project. The "Final Drainage Report Addendum No. 1 for The Trails Filing No. 7 Subdivision," by URS, dated February 2007, and the "Final Drainage Report for the Trails Filing No. 8 and Addendum to Mater Development/Preliminary Drainage Plan for Latigo Trails", by JR Engineering, dated January, 3 2007 are also referenced for this report. Excerpts of referenced reports can be found in Appendix E.

<u>Existing South Pond-Ultimate</u>

The existing South Pond was built with the Trails Filing 7 as described in the "Final Drainage Report Addendum No. 1 for The Trails Filing No. 7 Subdivision" (PCD No.: SF-04-005). This Filing 9 report proposes to modify the existing South Pond to provide water quality and detention for the

existing off-site drainage areas tributary to the existing South Pond and the proposed Filing 9 site development. The existing and proposed conditions were re-analyzed using the Rational Method for the development of Filing 9. The pond was also re-analyzed to provide water quality and detention per the full-spectrum design methodology to include the future developed areas of Filing No. 12, which will be the ultimate condition. The ultimate condition refers to the future where the Filing 12 area is developed and contributes additional flows to the South Pond. It was assumed that Filing 12 would also be large single-family lots, in concurrence with the surrounding developments. The ultimate condition analysis determined that 42.3 acres of on-site developed flow and 194.8 acres of off-site developed flows contribute to the pond with 15.1% impervious for flows of 98 and 357 cfs for the 5- and 100-year storm events, respectively. It is anticipated that a storage volume of 10.7 ac.-ft. will be needed for the ultimate condition. From the approved Filing 7 report, it was determined that the maximum storage volume of the existing South Pond is 7.8 Ac-ft. The pond will be modified with the construction of Filing 9 to support the additional Filing 9 flows, see the Water Quality section for detailed design. Filing 9 modifications will increase the pond's volume to the anticipated ultimate volume required. The ultimate condition information is shown for information only, and upon future development of Filing 12, the South Pond will need to be re-analyzed to determine what additional modifications are needed.

Pond G1

The location of deign point G1 in the MDDP has remained consistent in location, as is shown in Appendix E called out within an excerpt of the original MDDP report. The original MDDP developed flows for this design point with an area of 20.3 acres, are 21 cfs and 48 cfs for the 5-year and 100-year storms respectively. This report re-analyzed the conditions for the contributing on-site and off-site basins and calculated a total tributary area of 15.2 acres (13.2 acres on-site, 2.0 acres off-site) with 10 and 35 cfs for the 5- and 100-year storms, respectively. Pond G1 was sized for the development of Filing 9 and designed per current criteria & full-spectrum design methodology based on WQCV, Excess Urban Runoff Volume (EURV), and 100-year detention. Therefore, the release rates will be less than proposed in the MDDP which will be released south into the Meridian Ranch development. Only the proposed development of Filing 9 and one off-site basin contribute flows to Pong G1, and no future Latigo Trails Filing Developments will affect these pond flows. See the Water Quality section for detailed design of the proposed G1 Pond with the development of Filing 9.

Historical Gieck Ranch Drainage Basin

As stated in the approved MDDP report, runoff from the Gieck Ranch Drainage Basin flows to the south and east across the proposed development and drains to small unnamed ephemeral streams flowing onto the Meridian Ranch development to the south and toward Eastonville Road to the east. The approved MDDP proposed that there would be several drainage points from the Gieck Ranch Drainage Basin that discharge to the south: G1, G2, G5, G6, G11a, G11b, G12, G13, G14a, G14b, G15, G17a, G17b, G18, and G19. These roughly totaled a 100-year discharge of 1,256 cfs along the various design points. See the approved reports for the calculated flows at each design point.

Proposed Gieck Ranch Drainage Basin

This report proposes that the Filing 9 drainage system will be compromised of swales, culverts, and detention ponds. The proposed drainage design is in conformance with the approved "Master Development/Preliminary Drainage Plan for Latigo Trails" report as runoff flows split and go either southeast or southwest towards the Meridian Ranch boundary. Though the drainage direction remained the same, the on-site and off-site areas were re-analyzed using the Rational Method as described in the El Paso County Drainage Criteria. The original MDDP potential detention areas were modified and now four full-spectrum ponds within the Gieck Ranch basin are proposed for the ultimate development of Latigo Trails Filing 9-12: G1, G18, G19, and the existing South Pond.

Pond G18 will be built with the development of Filing 9 and fully built in future Filing 12 as described in the "Final Drainage Report for Latigo Trails Filing No. 9 and Addendum to Master Development/ Preliminary Drainage Plan for Latigo Trails", by JR Engineering, dated September 2021. Pond G19 will be built with future Filings 11-12. Pond G1 shall be built with the development of Filing 9, as described in this report. The existing South Pond outlet structure and spillway crest shall be modified with the development of Filing 9, as described in this report. In the approved "Master Development/Preliminary Drainage Plan for Latigo Trails" report, there are several possible detention areas that are proposed along the north-half Conestoga Trail South roadway. This report proposes the use of the proposed G1 pond as well as the existing South Pond instead of those proposed possible detention areas.

Excerpts of referenced approved reports are shown in Appendix E and a map of proposed basins is presented in Appendix F.

LATIGO TRAILS FILING NO. 9 BASINS AND SUB-BASINS

Existing Sub-basin Drainage

The existing basin delineation for Latigo Trials Filing 9 as shown in Appendix F is as follows;

Existing Basin A is approximately 7.27 acres and in the existing condition is comprised of undeveloped land and a dirt road. Historically runoff from this basin flows from north to south to DP1 where the flows enter an existing culvert and flow off-site. The peak flow rate for the basin at DP1 in the 5 and 100-year storm are 2.0 cfs and 14.4 cfs, respectively.

Basin OS1 is approximately 2.00 acres and in its existing condition is comprised of undeveloped areas to the west of our project site. More information about the existing conditions can be found in the approved MDDP or amendments. Flow will follow the historic path overland from both the north and south towards DP2 where it will enter into Existing Basin B and follow the drainage patterns of that basin as described below towards DP4.1. The peak flow rate for the basin at DP2 in the 5 and 100-year storm are 0.6 cfs and 4.1 cfs, respectively.

Basin OS2 is approximately 2.12 acres and in its existing condition is comprised of parts of 2 rural lots developed in Trails Filing 2 and part of the existing Conestoga Trail South roadway. Additionally, there is an existing roadside swale. More information about the existing conditions can be found in the approved MDDP or amendments. The historic drainage path generally flows southeast and eventually flows towards the Meridian Ranch development. Flow will follow the historic path overland towards DP3 where it will enter Existing Basin B and follow the drainage patterns of that basin as described below towards DP4.1. The peak flow rate for basin at DP3 in the 5 and 100-year storm are 2.1 cfs and 6.9 cfs, respectively.

Existing Basin B is approximately 30.17 acres and in its existing condition is comprised of undeveloped land, part of the existing Conestoga Trail South, and a dirt road. Historically runoff from this basin flows from north to south and west to east to DP4. The peak flow rate for the basin at DP4 in the 5 and 100-year storm are 6.5 cfs and 44.2 cfs respectively. Flows are combined at DP4.1 for a total runoff of 8.2 cfs and 51.1 cfs for the 5 and 100-year storm, respectively. The runoff flows into an existing culvert and flows to the south off-site.

Basin OS3 is approximately 51.16 acres and in its existing condition is comprised of parts of 21 rural lots developed in Trails Filing 2, part of the existing Conestoga Trail South, Oregon Wagon Trail, and Purple Mountain Trail roadways. Additionally, there are some existing buildings, existing swales, and culverts that direct flows from the west to east side of Conestoga Trail South. More information about the existing conditions can be found in the approved MDDP or amendments. The historic drainage path generally flows southeast crosses existing culverts that crosses the existing Conestoga Trail South road and eventually flows towards the Meridian Ranch development. Runoff from this basin will flow south overland and enter into Existing Basin C at DP5. The peak flow rate

for the basin at DP5 in the 5 and 100-year storm are 27.6 cfs and 105.5 cfs, respectively. From there they will follow the drainage patterns as described in Existing Basin C towards DP7.1, and eventually flow south off-site through an existing culvert.

Basin OS4 is approximately 3.70 acres and in its existing condition is comprised of parts of 2 rural lots developed in Trails Filing 2 and part of the Purple Mountain Trail roadway. More information about the existing conditions can be found in the approved MDDP or amendments. The historic drainage path generally flows southeast and eventually flows towards the Meridian Ranch development. Runoff from this basin will flow south overland and enter into Existing Basin C at DP6. The peak flow rate for the basin at DP6 in the 5 and 100-year storm are 2.0 cfs and 8.2 cfs, respectively. From there they will follow the drainage patterns as described in Existing Basin C towards DP7.1, and eventually flow south off-site through an existing culvert.

Existing Basin C is approximately 25.25 acres and in its existing condition is comprised of undeveloped land. Historically runoff from this basin flows from northwest to southeast to DP7. The peak flow rate for the basin at DP7 in the 5 and 100-year storm are 5.0 cfs and 36.9 cfs respectively. Flows are combined at DP7.1 for a total runoff of 30.8 cfs and 135.7 cfs for the 5 and 100-year storm, respectively. The runoff flows into an existing culvert and flows to the south off-site.

Basin OS5 is approximately 3.99 acres and in its existing condition is comprised of parts of 4 rural lots developed in Trails Filing 2. More information about the existing conditions can be found in the approved MDDP or amendments. The historic drainage path generally flows southeast and eventually flows towards the Meridian Ranch development. Runoff from this basin will flow south overland and enter into Existing Basin D at DP8. The peak flow rate for the basin at DP8 in the 5 and 100-year storm are 2.2 cfs and 9.3 cfs, respectively. From there they will follow the drainage patterns as described in Existing Basin D towards DP9.1, and eventually flow south off-site through an existing culvert.

Existing Basin D is approximately 13.42 acres and in its existing condition is comprised of undeveloped land. Historically runoff from this basin flows from north to south to DP8. The peak flow rate for the basin at DP9 in the 5 and 100-year storm are 2.9 cfs and 21.5 cfs respectively. Flows are combined at DP9.1 for a total runoff of 4.7 cfs and 28.9 cfs for the 5 and 100-year storm, respectively. The runoff flows into an existing culvert and flows to the south off-site.

Basin OS6 is approximately 2.33 acres and in its existing condition is comprised of parts of 5 rural lots developed in Trails Filing 2. More information about the existing conditions can be found in the approved MDDP or amendments. The historic drainage path generally flows southeast and eventually flows towards the Meridian Ranch development. Runoff from this basin will flow south overland and enter into Existing Basin E at DP10. The peak flow rate for the basin at DP10 in the 5 and 100-year storm are 1.2 cfs and 4.9 cfs, respectively. From there they will follow the drainage patterns as described in Existing Basin E towards DP11.1, and eventually flows east off-site.

Existing Basin E is approximately 31.05 acres and in its existing condition is comprised of undeveloped land and existing dirt roads. Historically runoff from this basin flows from north to south and west to east to DP11. The peak flow rate for the basin at DP11 in the 5 and 100-year storm are 6.0 cfs and 44.4 cfs respectively. Flows are combined at DP11.1 for a total runoff of 7.0 cfs and 48.4 cfs for the 5 and 100-year storm, respectively. The runoff flows east off-site and then continues south.

Basin OS7 is approximately 63.10 acres and in its existing condition is comprised of parts of 26 rural lots developed in Trails Filing 2, parts of 2 lots developed in Trails Filing 7-C, part of the Conestoga Trail North, and Oregon Wagon Trail roadways. Additionally, there are some existing buildings, existing swales, and culverts that direct flows from the north to south side of Oregon Wagon Trail. More information about the existing conditions can be found in the approved MDDP or amendments. The historic drainage path generally flows southeast and eventually flows towards the Meridian Ranch development. Runoff from this basin will flow south and east overland and enter into Existing Basin F at DP12. The peak flow rate for the basin at DP12 in the 5 and 100-year storm are 29.0 cfs and 111.4 cfs, respectively. From there they will follow the drainage patterns as described in Existing Basin F towards DP13.1, into Basin OS8 and eventually be routed to the existing South Pond.

Basin OS8 is approximately 68.29 acres and in its existing condition is comprised of parts of 10 rural lots developed in Trails Filing 2, parts of 12 lots developed in Trails Filing 7, drainage easements for existing South Pond, part of the Oregon Wagon Trail, and part of the Buffalo River Trail roadways. Additionally, there are some existing swales, and culverts that direct flows from the north to south side of Oregon Wagon Trail. More information about the existing conditions can be found in the approved MDDP or amendments. The historic drainage path generally flows southeast and eventually flows towards the Meridian Ranch development through several existing culverts. Runoff from this basin will flow south overland and will be routed south and east to DP14 and then to DP14.1 where the flows are combined with flows from DP13.1. The peak flow rate for the basin at DP14 in the 5 and 100-year storm are 23.3 cfs and 95.6 cfs. Flows from DP14.1 (Q_5=48.3 cfs, Q_{100}=193.8 cfs) represent the total existing flow that is routed to the existing South Pond.

Proposed Drainage Conveyance

In general, developed flows are collected in proposed roadside swales, which convey water to the proposed detention areas. Swales were designed per the typical county rural roadside ditch section. Proposed swale sections were designed to ensure they are stable and have required capacity to satisfy criteria. A swale is considered stable with a velocity of 5 ft/s of less. Where velocities exceed 5 ft/s, swales will be reinforced with the specified SC250 VMax TRM (turf reinforcement mat) product (or approved equivalent) shown in Appendix C. The roadway swale slopes in general follow the roadway slopes and specific locations where the TRM reinforcing is required in swale sections are shown in the Grading and Erosion Control Construction Documents. To ensure capacity, swales will have a minimum of 1 ft. of freeboard over the water surface for flows anticipated in a 100-year storm event. Detailed swale calculations, sections, and TRM specifications are located in Appendix C.

In addition to the swales, a few proposed culverts also convey flows under roadways, maintenance access roads, and future driveways. Culverts under both paved and gravel access roads were sized to not overtop the roadways with flows from a 100-year storm event. For the proposed Filing 9, three culverts are proposed. One for the proposed maintenance road accessing the proposed Pond G1, one for the proposed Buffalo River Trail roadway crossing, and one for the maintenance road accessing the existing south pond. The inlets and outlets of the proposed culverts will be protected with riprap to limit potential erosion. The proposed culverts will be protected with Type L soil riprap. The riprap protection sizing calculations for the proposed culverts are located in Appendix C. The riprap protection sizing calculations for the pond outfalls are located in Appendix D.

Additionally, future driveway culverts were sized based on anticipated flows. A sizing table is provided on the proposed drainage map and a separate driveway culvert exhibit is also provided in Appendix F. The future driveway culverts were allowed to over-top the roadway by a maximum of 6-inches, measured at the roadway shoulder. For the 18" RCP and (3)-36" RCP future driveway culverts, two HY-8 reports are provided based on the maximum flows for those sizes. For the proposed 30" RCP future driveway culverts, the Pond G1 maintenance access HY-8 report is used since the Pond G1 maintenance access shares the Lot 6 driveway. Future engineered site plans will provide final details for the individual lot driveways and will be constructed by others. See Appendix C for the HY-8 reports.

Proposed Sub-basin Drainage

The proposed basin delineation for Latigo Trials Filing 9 as shown in Appendix F is as follows;

Basin OS2 is an approximately 2.12 acre off-site basin and therefore, no work is proposed within that area other than slight modifications where the proposed roadside swale begins. Flow will follow the historic path overland towards DP1 where it will enter Basin A and follow the drainage patterns of that basin as described below towards DP2.1. The peak flow rate for basin at DP1 in the 5 and 100-year storm are 2.1 cfs and 6.9 cfs, respectively. Flows will follow the routed path until they discharge into the existing South Pond.

Basin A is approximately 1.58 acres and the existing conditions were previously described as part of Existing Basin B. In the proposed condition it will be rural 2.5 acre lots, part of the Conestoga Trail South road, and a roadway swale. Runoff from this basin will be collected in a roadside swale and conveyed east to DP2 and then along Conestoga Trail South to DP2.1 where the flows are combined with flows from DP1. The peak flow rate for the basin at DP2 in the 5 and 100-year storm are 1.6 cfs and 5.1 cfs, respectively. Flows from DP2.1 (Q_5=3.5 cfs, Q_{100}=11.5 cfs) continue east in the roadside ditch to DP4.1 and eventually the flow will be routed to the existing South Pond.

Basin OS3 is an approximately 51.16 acre off-site basin and therefore, no work is proposed within that area. Runoff from this basin will flow south overland and enter into Basin B at DP3. The peak flow rate for the basin at DP3 in the 5 and 100-year storm are 27.6 cfs and 105.5 cfs, respectively.

From there they will follow the drainage patterns as described in Basin B towards DP4.1, and eventually be routed to the existing South Pond.

Basin B is approximately 8.71 acres and the existing conditions were previously described as part of Existing Basin C. In the proposed condition it will be rural 2.5 acre lots, part of the Conestoga Trail South road, and a roadway swale. Runoff from this basin will be collected in a roadside swale and conveyed east to DP4 and then along Conestoga Trail South to DP4.1 where the flows are combined with flows from DP2.1. The peak flow rate for the basin at DP4 in the 5 and 100-year storm are 4.8 cfs and 19.0 cfs, respectively. Flows from DP4.1 (Q_5=34.7 cfs, Q_{100}=131.6 cfs) continue east in the roadside ditch to DP6.1 and eventually the flow will be routed to the existing South Pond.

Basin OS4 is an approximately 3.70 acre off-site basin and therefore, no work is proposed within that area. Runoff from this basin will flow south overland and enter into Basin C at DP5. The peak flow rate for the basin at DP5 in the 5 and 100-year storm are 2.0 cfs and 8.2 cfs, respectively. From there they will follow the drainage patterns as described in Basin C towards DP6.1, and eventually be routed to the existing South Pond.

Basin C is approximately 5.43 acres and the existing conditions were previously described as part of Existing Basin C. In the proposed condition it will be rural 2.5 acre lots, part of the Conestoga Trail South road, and a roadway swale. Runoff from this basin will be collected in a roadside swale and conveyed east to DP6 and then along Conestoga Trail South to DP6.1 where the flows are combined with flows from DP4.1. The peak flow rate for the basin at DP6 in the 5 and 100-year storm are 3.1 cfs and 11.8 cfs, respectively. Flows from DP6.1 (Q_5=37.9 cfs, Q_{100}=145.9 cfs) continue east in the roadside ditch to DP8.1 and eventually the flow will be routed to the existing South Pond.

Basin OS5 is an approximately 3.99 acre off-site basin and therefore, no work is proposed within that area. Runoff from this basin will flow south overland and enter into Basin D at DP7. The peak flow rate for the basin at DP7 in the 5 and 100-year storm are 2.2 cfs and 9.3 cfs, respectively. From there they will follow the drainage patterns as described in Basin D towards DP8.1, and eventually be routed to the existing South Pond.

Basin D is approximately 7.22 acres and the existing conditions were previously described as part of Existing Basin D. In the proposed condition it will be rural 2.5 acre lots, part of the Conestoga Trail South road, and a roadway swale. Runoff from this basin will be collected in a roadside swale and conveyed east to DP8 and then along Conestoga Trail South to DP8.1 where the flows are combined with flows from DP6.1. The peak flow rate for the basin at DP8 in the 5 and 100-year storm are 4.2 cfs and 16.1 cfs, respectively. Flows from DP8.1 (Q_5=41.9 cfs, Q_{100}=163.8 cfs) continue east in the roadside ditch to DP10.1 and eventually the flow will be routed to the existing South Pond.

Basin OS6 is an approximately 2.33 acre off-site basin and therefore, no work is proposed within that area. Runoff from this basin will flow south overland and enter into Basin E at DP9. The peak flow rate for the basin at DP9 in the 5 and 100-year storm are 1.2 cfs and 4.9 cfs, respectively. From there

they will follow the drainage patterns as described in Basin E towards DP10.1, and eventually be routed to the existing South Pond.

Basin E is approximately 10.46 acres and the existing conditions were previously described as part of Existing Basin E. In the proposed condition it will be rural 2.5 acre lots, part of the Conestoga Trail South road, and a roadway swale. Runoff from this basin will be collected in a roadside swale and conveyed east to DP10 and then along Conestoga Trail South to DP10.1 where the flows are combined with flows from DP8.1. The peak flow rate for the basin at DP10 in the 5 and 100-year storm are 5.6 cfs and 21.3 cfs, respectively. Flows from DP10.1 (Q_5=46.0 cfs, Q_{100}=182.1 cfs) continue east in the roadside ditch and travel through the proposed dual 29"x45" HERCP to DP12.1 and eventually the flow will be routed to the existing South Pond. The proposed culvert was sized using the peak flow listed and ensured there was enough cover.

Basin OS7 is an approximately 63.10 acre off-site basin and therefore, no work is proposed within that area. Runoff from this basin will flow south and east overland and enter into Basin F near DP11. The peak flow rate for the basin at DP11 in the 5 and 100-year storm are 29.0 cfs and 111.4 cfs, respectively. From there they will follow the drainage patterns as described in Basin F towards DP12.1, and eventually be routed to the existing South Pond.

Basin F is approximately 6.51 acres and the existing conditions were previously described as part of Existing Basin F. In its proposed condition it will be rural 2.5 acre lots, part of the Conestoga Trail South road, part of Buffalo River Trail road, and roadside swales. The proposed flows drain east and uses an existing culvert to cross the existing Buffalo River Trail and conveyed south and east to DP12 and then along Conestoga Trail South to DP12.1 where the flows are combined with flows from DP10.1. The peak flow rate for the basin at DP12 in the 5 and 100-year storm are 4.1 cfs and 14.6 cfs, respectively. Flows from DP12.1 (Q_5=73.3 cfs, Q_{100}=284.7 cfs) continue east in the roadside ditch to DP13.1 and eventually the flow will be routed to the existing South Pond.

Basin G is approximately 2.42 acres and the existing conditions were previously described as part of Existing Basins B-F. In the proposed condition it will be the south-half of the proposed Conestoga Trail South paved road as well as the south roadside swale. The basin will flow to the south and then is conveyed east to DP13.1 where the flows are combined with flows from DP12.1. The peak flow rate for the basin at DP13 in the 5 and 100-year storm are 3.6 cfs and 7.8 cfs, respectively. Flows from DP13.1 (Q_5=76.3 cfs, Q_{100}=291.2 cfs) continue east in the roadside ditch to DP14.1 and eventually the flow will be routed to the existing South Pond.

Basin OS8 is approximately 68.37 acres and its existing condition was described in the section above. Runoff from this basin will flow south overland and will be routed south and east to DP14 and then to DP14.1 where the flows are combined with flows from DP13.1. The peak flow rate for the basin at DP14 in the 5 and 100-year storm are 26.2 cfs and 99.6 cfs. Flows from DP14.1 (Q_5=92.0 cfs, Q_{100}=347.0 cfs) represent the total routed flow that will be routed to the existing South Pond.

Basin OS1 is an approximately 2.01 acre off-site basin and therefore, no work is proposed within that area. Flow will follow the historic path overland from both the north and south towards DP15 where it will enter into Basin H and follow the drainage patterns of that basin as described below. The peak flow rate for the basin at DP15 in the 5 and 100-year storm are 0.6 cfs and 4.1 cfs, respectively. From there they will follow the drainage patterns as described in Basin H towards DP16.1, and eventually be routed to the proposed G1 Pond.

Basin H is approximately 8.65 acres and the existing conditions were previously described as part of Existing Basin B. In the proposed condition it will be rural 2.5 acre lots as well as the part of the south-half of the existing Conestoga Trail South. Runoff from this basin will be collected in roadside swales and conveyed southwest along the proposed Horse Canyon Trail to DP16 and then to DP16.1 where the flows are combined with flows from DP15. The peak flow rate for the basin at DP16 in the 5 and 100-year storm are 5.5 cfs and 20.7 cfs, respectively. Flows from DP16.1 (Q_5=6.0 cfs, Q_{100}=24.5 cfs) continue southwest in the roadside ditch to DP17.1 and eventually the flow will be routed to proposed G1 Pond.

Basin J is approximately 4.56 acres and the existing conditions were previously described as part of Existing Basin B. In the proposed condition it will be rural 2.5 acre lots, roadside swales, proposed Horse Canyon Trail road, as well as contain the proposed G1 Pond. Runoff from this basin will be collected in roadside swales and conveyed southwest along the proposed Horse Canyon Trail to DP17 and then to DP17.1 where the flows are combined with flows from DP16.1. The peak flow rate for the basin at DP17 in the 5 and 100-year storm are 6.1 cfs and 15.9 cfs, respectively. Flows from DP17.1 (Q_5=9.9 cfs, Q_{100}=34.9 cfs) represent the total routed flow that will be routed to the proposed G1 Pond.

Basin K is approximately 3.78 acres and the existing conditions were previously described as part of Existing Basin A. In the proposed condition, Basin K will be rural 2.5 acre lots. Runoff from this basin does not include any roadway flows and therefore follows the historic drainage pattern flowing off-site to the south undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff from this basin enters flows overland towards the existing culvert at DP18. The peak flow rate for the basin at DP18 in the 5 and 100-year storm are 2.3 cfs and 9.7 cfs, respectively. Proposed Basins K, I, and L have a combined area of 6.42 acres and when the flows are directly summed, release Q_5=3.0 cfs, Q_{100}=14.8 cfs (DP18-20). Compared to the existing release rate of Existing Basin A (Q_5=2.0 cfs, Q_{100}=14.4 cfs), the proposed release rate of the combined flow is essentially the same as the historic for the 100-year event.

Basin I is approximately 0.62 acres and the existing conditions were previously described as part of Existing Basin A. In the proposed condition, Basin I will be part of rural 2.5 acre lots. Runoff from this basin does not include any roadway flows and therefore follows the historic drainage pattern flowing off-site to the southwest undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. The peak flow rate for the basin at DP19 in the 5 and 100-year storm are 0.2 cfs and 1.3 cfs, respectively. Proposed Basins K, I, and L have a

combined area of 6.42 acres and when the flows are directly summed, release Q_5=3.0 cfs, Q_{100}=14.8 cfs (DP18-20). Compared to the existing release rate of Existing Basin A (Q_5=2.0 cfs, Q_{100}=14.4 cfs), the proposed release rate of the combined flow is essentially the same as the historic for the 100-year event.

Basin L is approximately 2.02 acres and the existing conditions were previously described as part of Existing Basin A. In the proposed condition, Basin L will be rural 2.5 acre lots. Runoff from this basin does not include any roadway flows and therefore follows the historic drainage pattern flowing off-site to the south undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. The peak flow rate for the basin at DP20 in the 5 and 100-year storm are 0.5 cfs and 3.8 cfs, respectively. Proposed Basins K, I, and L have a combined area of 6.42 acres and when the flows are directly summed, release Q_5=3.0 cfs, Q_{100}=14.8 cfs (DP18-20). Compared to the existing release rate of Existing Basin A (Q_5=2.0 cfs, Q_{100}=14.4 cfs), the proposed release rate of the combined flow is essentially the same as the historic for the 100-year event.

Basin M is approximately 15.65 acres and the existing conditions were previously described as part of Existing Basin B. In the proposed condition, Basin M will be rural 2.5 acre lots. Runoff from this basin does not include any roadway flows and therefore follows the historic drainage pattern flowing off-site to the south undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. The peak flow rate for the basin at DP21 in the 5 and 100-year storm are 7.8 cfs and 33.3 cfs, respectively. Compared to the existing combined release rate of Existing Basin B (Q_5=8.2 cfs, Q_{100}=51.1 cfs), the proposed release rate is less than historic for both the 5 and 100-year events.

Basin N is approximately 10.54 acres and the existing conditions were previously described as part of Existing Basin C. In the proposed condition, Basin N will be rural 2.5 acre lots. Runoff from this basin does not include any roadway flows and therefore follows the historic drainage pattern flowing off-site to the south undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. The peak flow rate for the basin at DP22 in the 5 and 100-year storm are 4.9 cfs and 20.8 cfs, respectively. Compared to the existing combined release rate of Existing Basin C (Q_5=30.8 cfs, Q_{100}=135.7 cfs), the proposed release rate is less than historic for both the 5 and 100-year events.

Basin O is approximately 5.87 acres and the existing conditions were previously described as part of Existing Basin D. In the proposed condition, Basin O will be rural 2.5 acre lots. Runoff from this basin does not include any roadway flows and therefore follows the historic drainage pattern flowing off-site to the south undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. The peak flow rate for the basin at DP23 in the 5 and 100-year storm are 2.9 cfs and 12.4 cfs, respectively. Compared to the existing combined release rate of Existing Basin D (Q_5=4.7 cfs, Q_{100}=28.9 cfs), the proposed release rate is less than historic for both the 5 and 100-year events.

Basin P is approximately 13.14 acres and the existing conditions were previously described as part of Existing Basin E. In the proposed condition, Basin P will be rural 2.5 acre lots. Runoff from this basin does not include any roadway flows and therefore follows the historic drainage pattern flowing off-site to the south undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. The peak flow rate for the basin near DP24 in the 5 and 100-year storm are 6.6 cfs and 28.1 cfs, respectively. Compared to the existing combined release rate of Existing Basin E (Q_5=7.0 cfs, Q_{100}=48.4 cfs), the proposed release rate is less than historic for both the 5 and 100-year events.

A summary of all basin parameters has been presented in Appendix B.

DRAINAGE DESIGN CRITERIA

Development Criteria Reference

Storm drainage analysis and design criteria for the project were taken from the "City of Colorado Spring/El Paso County Drainage Criteria Manual" Volumes 1 and 2 (EPCDCM), dated October 12, 1994, the "Urban Storm Drainage Criteria Manual" Volumes 1 - 3 (USDCM) and Chapter 6 and Section 3.2.1 of Chapter 13 of the "Colorado Springs Drainage Criteria Manual (CCSDCM)", dated May 2014, as adopted by El Paso County, as well as the July 2019 El Paso County Engineering Criteria Manual update.

Hydrologic Criteria

All hydrologic data was obtained from the "El Paso Drainage Criteria Manual" Volumes 1 and 2, and the "Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual" Volumes 1, 2, and 3. Onsite drainage improvements were designed based on the 5-year (minor) storm event and the 100-year (major) storm event. Rainfall intensities for the 5-year and the 100-year storm return frequencies were obtained from Figure 6-5 of the City of Colorado Springs DCM. One hour point rainfall data for the storm events are 1.50 inches for the 5-year and 2.52 inches for the 100-year storm. Rational Method calculations were prepared for sub-basins with areas less than 100 acres, in accordance with EPC DCM Chapter 5.2 for the proposed on-site and off-site drainage basins.

Urban Drainage and Flood Control District's UD-Detention, Version 4.04 workbook was used for pond sizing. Required detention volumes and allowable release rates were designed per USDCM and CCS/EPCDCM. Pond sizing spreadsheets are presented in Appendix D.

Hydraulic Criteria

The Federal Highway Administration's HY-8 program (Volume 7.50) was used to analyze the proposed culverts within the Latigo Trails development. Per Section 6.4.1 of the EPCDCM, culverts under paved and gravel roads were sized as to not overtop the road in the 100-year storm. As shown in the same section, future driveway culverts were sized as to not overtop the road by more than 6-

inches measured from the shoulder in the 100-year storm. Culvert design sheets are presented in Appendix C.

Autodesk Inc.'s Hydraflow Express Extension (Volume 10.5) was used for roadside ditch design. For the purposes of this FDR/MDDP, the maximum roadside ditch size was determined based on peak 100-year flows and minimum swale slopes within each basin. Swales were checked for velocity per the EPC DCM Chapter 10, Table 10-4 based on peak 100-year flows and maximum swale slopes. Swale cross sections with a 100-year velocity greater than 5 ft/s will be lined with the specified SC250 VMax TRM product, or another approved method of stabilization, to limit erosive potential. Swale design sheets are presented in Appendix C.

DRAINAGE FACILITY DESIGN

General Concept-Filing 9

The proposed stormwater conveyance system was designed to convey the developed Latigo Trails Filing 9 flows to one of two full-spectrum EDBs via roadside ditches and local street culverts. Pond G1 is to be fully built and will remain the same in the ultimate condition as no future Latigo Trails developments will contribute additional developed flow. The existing South Pond outlet structure and spillway crest will be modified with the development of Filing 9. EDBs will be designed to release at less than historic rates to minimize adverse impacts downstream. Undeveloped basins are allowed to follow existing drainage patterns.

In accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure, proposed developed basins with large lot single-family sites on it with a maximum of 10% impervious area shall be allowed to release runoff without a downstream water quality feature. In accordance with Section I.7.1.B.7, sites with land disturbance to undeveloped land that will remain undeveloped shall also be excluded from releasing to a downstream water quality feature. See highlighted areas in the drainage maps presented in Appendix F.

Specific Details

Four Step Process to Minimize Adverse Impacts of Urbanization

In accordance with the El Paso County Drainage Criteria Manual, Volume 2 this site has implemented the four step process to minimize adverse impacts of urbanization. The four step process includes reducing runoff volumes; stabilizing drainageways, treating the water quality capture volume (WQCV), and consider the need for Industrial Commercial BMP's.

Step 1, Reducing Runoff Volumes: The development of the project site is proposed as single family residential (2.5 ac. min.) with lawn areas interspersed within the development which helps disconnect impervious areas and reduce runoff volumes. Roadways will utilize roadside ditches to further disconnect impervious areas. These practices will also allow for increased infiltration and reduce runoff volume.

Step 2, Stabilize Drainageways: This site will utilize roadside ditches with culvert crossings throughout the site. These roadside ditches will then direct the on-site development flows to the multiple detention ponds within the project that will be designed to release at or below historic rates. The roadside ditches will be stabilized in reaches with high velocity (>5 fps) by the use of turf reinforcement mats. Based upon the proposed reduction in released flows compared to the pre-developed flows, no impact to downstream drainageways is anticipated.

Step 3, Provide WQCV: Runoff from this development will be treated through capture and slow release of the WQCV in multiple permanent detention basins that will be designed per current El Paso County drainage criteria.

Step 4, Consider the need for Industrial and Commercial BMP's: No industrial or commercial uses are proposed within this development. However, a site specific storm water quality and erosion control plan and narrative will be prepared for each future Filing. Site specific temporary source control BMPs as well as permanent BMP's will be detailed in this plan and narrative to protect receiving waters.

Water Quality

In accordance with Section 13.3.2.1 of the CCS/EPCDCM, full spectrum water quality and detention will be provided for all of the development site not meeting exclusions present in the ECM - Stormwater Quality Policy and Procedures Section I.7.1.B and C. As previously stated, the applicable exclusions fall under Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure for areas with large single-family lots. Any areas of the development site not being included in the site's permeant stormwater management are presented on the proposed Drainage Maps, presented in Appendix F. Outlet structure release rates will be limited to less than historic rates to minimize adverse impacts to downstream stormwater facilities.

<u>Existing South Pond-Proposed</u>

The existing South Pond is located to the southeast of the site. The existing pond consists of an existing riprap pad at the entrance of the pond, a flat pond bottom, and existing outlet structure with a failed orifice plate. The existing South Pond was built about 15 years ago, and the El Paso County standards for a full-spectrum EDB have been modified since that date. Therefore, there will need to be some retrofit design changes that will ensure the EDB meets current criteria. This includes the installation of a low-tailwater riprap basin, concrete trickle channel, concrete micropool, maintenance access, and revised pond grading to ensure that the pond bottom has a minimum of 3% bottom slope.

The existing pond was built with the development of Filing 7, and was sized for the anticipated entire upstream developed area using a total of 163 acres of area with a 20.0% impervious value. In the referenced Filing 7 report, it states that the flows entering the pond are 104 cfs and 247 cfs for the 5- and 100-year storm events, respectively. The existing on-site and off-site drainage areas tributary to the existing South Pond were re-analyzed using the Rational Method for the development of Filing 9.

From the analysis it was determined that on-site basins A-G and off-site basins OS2-8 will contribute flows towards the existing South Pond. These basins total 42.3 acres of on-site developed flow and 194.8 acres of off-site developed flows that contribute to the South Pond with 13.8% impervious for flows of 92 and 347 cfs for the 5- and 100-year storm events, respectively.

The full-spectrum EDB sizing was determined by using Urban Drainage and Flood Control District's UD-Detention, Version 4.04 workbook and the proposed basin conditions. Inputting the basin parameters for the proposed Filing 9 development, it was determined that the pond needed approximately 1.7 Ac-ft. for the WQCV, 1.4 Ac-ft. for the EURV, 7.1 Ac-ft. for the 100-year detention, and 10.3 Ac-ft. for the total detention volume. The modified pond sizing will provide approximately 7.2 Ac-ft. for the 100-year detention and 12.4 Ac-ft. at the top of pond. These sizes satisfy the required volumes and ensures the 100-year volume will be detained within the pond.

As mentioned previously, a retrofit of the existing riprap pad is proposed to dissipate the flows at the entrance to the pond. A low-tailwater basin was designed using an equivalent size from the trapezoidal swale to a rectangular box culvert based on the sizing guidance from MHFD Volume II Figure 9-37 and 9-39 (see Appendix D). The low-tailwater basin was sized based on the tributary, undetained 100-year peak flow rate and trapezoidal swale section. It was assumed that the top width of the water in the trapezoidal section would be the width of the equivalent box culvert rounded to the nearest half foot. Additionally the depth was determined by taking the water depth in the section, adding a foot of freeboard, and then rounding it to the nearest half foot. Based on that sizing method, the trapezoidal swale section is roughly equivalent to a 31.5'W x 2.5'T rectangular box culvert. Figure 9-37 (see Appendix D) was used to determine the standard sizing (D=2.5', W=31.5', and L=45.5'). Then using Figure 9-39 (see Appendix D), it was determined that the low-tailwater basin shall be protected with Type L soil riprap. For additional erosion protection, a turf reinforcing mat (TRM) shall be used from DP13.1 along the swale to the entrance of the low-tailwater basin. To meet the current full-spectrum EBD criteria, a 7-ft. wide concrete trickle channel is also proposed with a slope of 0.5% from the end of the proposed low-tailwater basin to the proposed concrete micropool and outlet structure. Due to the addition of the proposed concrete trickle channel, the bottom of pond at the entrance of the riprap is now higher than it was in the existing condition. Having reduced the existing drop of the riprap pad and providing the low-tailwater basin, this retrofit solution will prevent erosion and ensures flows enter into the proposed trickle channel as designed.

At the end of the concrete trickle channel, a concrete micropool is proposed to meet the minimum 10 ft^2 surface area with the required 2.5-ft. depth. This retrofit application provides the required micropool and also provides a hard surface that shows maintenance the depth to which the sediment should be cleared to. The top of the micropool has an elevation of 7087.26', which allowed for a 4-inch drop through the modified outlet structure to the existing outlet RCBC invert of 7086.93'. Additionally, the proposed outlet structure modifications will be modify the existing 8.33 ft. by 2.92 ft. overflow grate size and elevation. The existing grate will be raised and a second grate of the same size will be added. The new raised elevation of the combined overflow grates is at 7093.16'. Additionally, a new orifice plate was designed to meet the minimum drain times and will be installed

on the modified outlet structure, which will replace the existing failed orifice plate. The proposed pond modifications will ensure the WQVC drains in 40 hours, continuously releases both the 5-year storm and EURV in less than 72 hours, limit the 5-year and 100-year design storms to approximately pre-development/historic rates or less, and drains completely under 120 hours.

The existing approximate spillway is located on the east side of the pond and has an existing approximate elevation of 7095.50'. The UD-Detention spreadsheet for the Filing 9 development shows that the proposed spillway needs to at approximately 7095.16' to detain the 100-year volume. The proposed spillway location is located further south to ensure the emergency overflow path functions adequately and will follow the historic drainage pattern to the east. The emergency spillway was sized for the undetained peak 100-year flow rate (Q=360.0 cfs) and a minimum of 1-ft. of freeboard provided over the spillway flow depth. The UD-Detention spreadsheet shows with a spillway crest width of 120 ft and 4:1 side slopes, the flow depth over the spillway is 0.97 ft. Therefore, the proposed top of pond is at 7097.16' to ensure required freeboard. The spillway and emergency overflow path are protected by Type M soil riprap, sized per the guidance provided by MHFD (see Appendix D).
Additionally, a 12 ft. wide maintenance access trail with a maximum slope of 12% is proposed to meet the current full-spectrum EDB criteria. The proposed maintenance trail shall follow the proposed swale from the end of the proposed Conestoga Trail South into the South Pond and down towards the concrete trickle channel. It is assumed that the 7 ft. wide concrete trickle channel will allow maintenance vehicles to access both the low-tailwater basin and the concrete micropool/outlet structure for required routine maintenance.

The existing South Pond outlet structure is proposed to be revised to provide full-spectrum detention and water quality for the proposed Filing 9 development. The outlet structure will limit release rates from an existing 8'W x 3'T RCBC storm culvert that will outfall to the east and then south along unnamed ephemeral streams flowing offsite onto the Meridian Ranch development to below historic levels. The previous design utilized Type L riprap at the existing outlet structure outfall and the new analysis confirmed that this size riprap will be adequate.

The pond design is summarized below with bullets:

- WQCV: +/- 1.733 acre-ft
- EURV: +/- 3.161 acre-ft
- 100-Year Volume: +/- 7.222 acre-ft
- $Q_{5,in}$: +/- 103.7 cfs
- $Q_{100,in}$: +/- 360.0 cfs
- $Q_{5,out}$: +/- 51.8 cfs
- $Q_{100,out}$: +/- 296.0 cfs
- Spillway: 120 ft to be modified from approx. 7095.50' to 7095.16' elevation, sized for undetained peak. Directs water to the east over the spillway.
- Top of Pond: Set to 7097.16' elevation for 0.98 ft. flow over spillway and minimum 1 ft. of freeboard

- Outlet: 8'W x 3'T RCBC storm sewer released to the east.

See Appendices B, C, and D for applicable calculations and supporting design information.

Pond G1

Currently, proposed G1 Pond is undeveloped land at the southwest corner of the Filing 9 site. On-site basins H, J and off-site basin OS1 will contribute flows towards the proposed full-spectrum G1 Pond. This Filing 9 report analyzed the conditions for the contributing on-site and off-site basins using the Rational Method and calculated a total tributary area of 15.2 acres (13.2 acres on-site, 2.0 acres off-site) with 10 and 35 cfs for the 5- and 100-year storms, respectively. Pond G1 was sized for the development of Filing 9 and designed per current criteria & full-spectrum design methodology based on WQCV, Excess Urban Runoff Volume (EURV), and 100-year detention. The full-spectrum EDB was designed to include a rock chute and basin, concrete trickle channel, maintenance access, and a full-spectrum outlet structure.

The full-spectrum EDB sizing was determined by using Urban Drainage and Flood Control District's UD-Detention, Version 4.04 workbook and the proposed basin conditions. Inputting the basin parameters for the proposed Filing 9 development, it was determined that the pond requires approximately 0.1 Ac-ft. for the WQCV, 0.1 Ac-ft. for the EURV, 0.5 Ac-ft. for the 100-year detention, and 0.7 Ac-ft. for the total detention volume. The proposed pond sizing will provide approximately 0.7 Ac-ft. for the 100-year detention and 1.6 Ac-ft. at the top of pond. These sizes satisfy the required volumes and ensures the 100-year volume will be detained within the pond.

A proposed rock chute was designed to accept the flows from the proposed roadway swale and dissipate energy in a riprap basin before entering into the proposed concrete trickle channel. The proposed 7 ft. wide trickle channel has a slope of 0.5% from the end of the proposed rock chute and riprap basin to the proposed outlet structure. See Appendix D for the supporting design spreadsheet.

Using the UD-Detention spreadsheet, an outlet structure with an overflow grate size of 4 ft. by 4 ft. and an orifice plate are proposed to meet the required drain times. The proposed G1 Pond outlet structure will ensure the WQVC drains in 40 hours, continuously releases both the 5-year storm and EURV in less than 72 hours, limit the 5-year and 100-year design storms to approximately pre-development/historic rates or less, and drains completely under 120 hours.

The UD-Detention spreadsheet for the Filing 9 development shows that the spillway needs to at approximately 7180.00' to detain the 100-year volume. The spillway is located to the southwest of the pond was sized for the undetained peak 100-year flow rate (Q=18.8 cfs) and a minimum of 1-ft. of freeboard provided over the spillway flow depth. The UD-Detention spreadsheet shows with a spillway crest width of 40 ft and 4:1 side slopes, the flow depth over the spillway is 0.28 ft. Therefore, the proposed top of pond is at 7181.50' to ensure required freeboard. The spillway and emergency overflow path are protected by Type VL soil riprap, sized per the guidance provided by

MHFD (see Appendix D). The emergency flows will follow the historic path to the existing 30-inch culvert on the south property line.

Additionally, a 12 ft. wide maintenance access trail with a maximum slope of 12% is proposed to meet the current full-spectrum EDB criteria. The proposed maintenance trail shall start at the end of the proposed Horse Canyon Trial following the proposed swale into the proposed G1 Pond. From there the trail goes down towards the concrete trickle channel. It is assumed that the 7 ft. wide concrete trickle channel will allow maintenance vehicles to access both the riprap basin and the outlet structure for required routine maintenance.

The proposed outlet structure will release flows through a restricted 24-inch RCP, which outfalls near an existing 30-inch culvert located along the south property line. Riprap outfall protection was sized to ensure erosion protection for the outlet structure outfall and it was determined that Type L riprap will be adequate. Flows from the full-spectrum EDB will be released through the proposed full-spectrum outlet structure at below historic rates.

The pond design is summarized below with bullets:

- WQCV: +/- 0.135 acre-ft
- EURV: +/- 0.266 acre-ft
- 100-Year Volume: +/- 0.663 acre-ft
- $Q_{5,in}$: +/- 5.6 cfs
- $Q_{100,in}$: +/- 18.8 cfs
- $Q_{5,out}$: +/- 2.5 cfs
- $Q_{100,out}$: +/- 11.8 cfs
- Spillway: 40 ft at 7180.00’ elevation, sized for undetained peak. Directs water to the southwest over the spillway.
- Top of Pond: Set to 7181.50’ elevation for 0.28 ft. flow over spillway and minimum 1 ft. of freeboard
- Outlet: Restricted 24” RCP storm pipe released to the southwest.

See Appendices B and D for applicable calculations and supporting design information.

Erosion Control Plan

The El Paso County Drainage Criteria Manual specifies an Erosion Control Plan and associated Cost Estimate must be submitted with each Final Drainage Report. The Erosion Control Plan and Cost Estimate shall be submitted prior to obtaining a grading permit.

Operation & Maintenance

In order to ensure the function and effectiveness of the stormwater infrastructure, maintenance activities such as inspection, routine maintenance, restorative maintenance, rehabilitation and repair, are required. All proposed drainage structures within the any platted County ROW (roadside ditches and local road culverts) will be owned and maintained by El Paso County. All proposed drainage

structures within easements or tracts (full-spectrum water quality and detention ponds, drainageway culverts and drainageway improvements) will be owned and maintained by the Latigo Creek Metropolitan District. Inspection access for El Paso County will be provided through a maintenance easement.

Drainage and Bridge Fees

Geich Ranch (CHMS0400) drainage basin is not included in the El Paso County Drainage Basin Fee program therefore; no drainage or bridge fees are due at the time of plat recordation.

Construction Cost Opinion

(For Information Only / Non-Reimbursable)
Cost opinion has been presented in Appendix A.

SUMMARY

The Final Drainage Report for Latigo Trials Filing No. 9 and Addendum to Master Development/ Preliminary Drainage Plan for Latigo Trails analyzed the proposed drainage patterns, determined proposed runoff quantities, sized drainage facilities, presented solutions to on and off-site drainage impacts resulting from this development, safely routed developed storm water runoff to the appropriate outfall facilities as delineated in previous reports, and amended the Master Development/ Preliminary Drainage Plan (MDDP). The proposed Filing 9 site development remains consistent with pre-development drainage conditions with the construction of the recommended drainage improvements as described in the approved MDDP and amended reports. The proposed development will not adversely affect the offsite major drainageways or surrounding development. This report meets the latest El Paso County Drainage Criteria requirements for this site.

REFERENCES:

1. City of Colorado Springs Drainage Criteria Manual Volume 1, City of Colorado Springs, CO, May 2014.

2. Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Latest Revision.

3. Gieck Ranch Drainage Basin Planning Study, Drexel, Barrell & Co., October 2007 and revised in February 2010.

4. Master Development/ Preliminary Drainage Plan Latigo Trails, URC, October 2001.

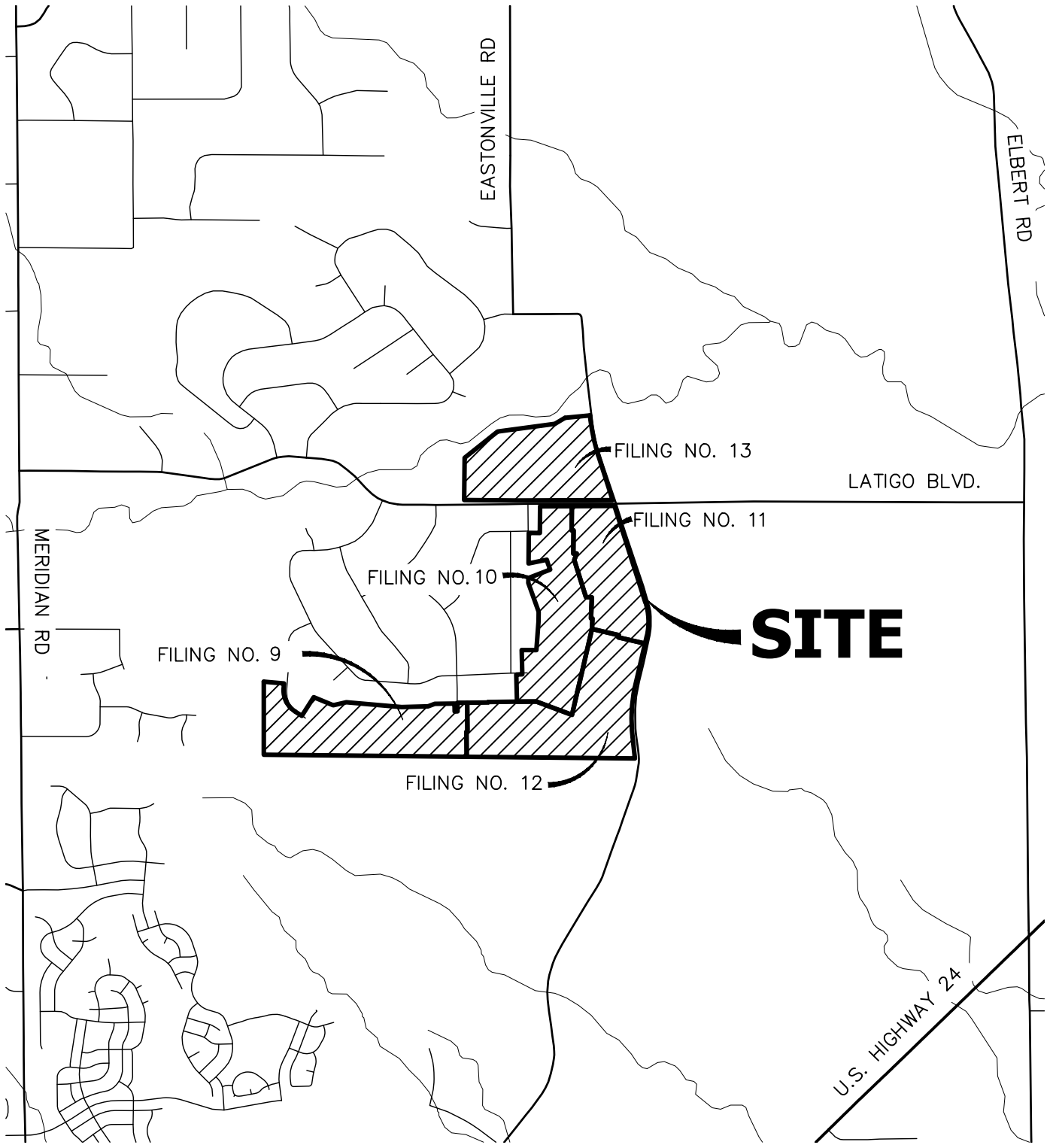
5. Final Drainage Report Addendum No. 1 for The Trails Filing No. 7 Subdivision, URS, February 2007.

6. Final Drainage Report for the Trails Filing No. 8 and Addendum to Master Development/ Preliminary Drainage Plan for Latigo Trails, JR Engineering, January 2007.

7. Final Drainage Report for Latigo Trails Filing No. 10 and Addendum to Master Development/ Preliminary Drainage Plan for Latigo Trails, JR Engineering, September 2021.

APPENDIX A

FIGURES AND EXHIBITS



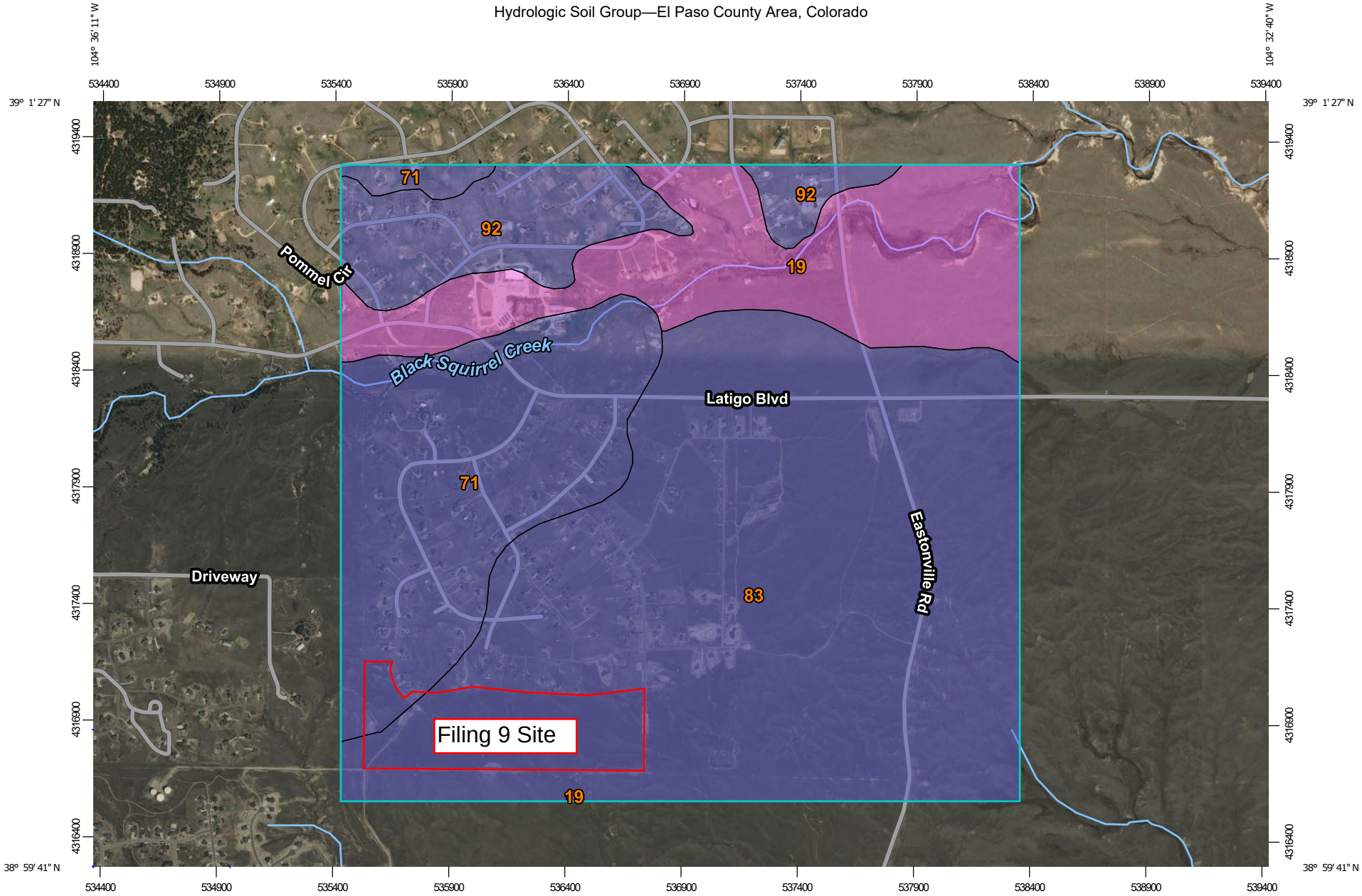
3000 1500 0 3000 6000

ORIGINAL SCALE: 1" = 3000'

VICINITY MAP
LATIGO TRAILS
JOB NO. 25175.01
08/23/21
SHEET 1 OF 1

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com



Map Scale: 1:23,100 if printed on A landscape (11" x 8.5") sheet.

N

0 300 600 1200 1800 Meters

0 1000 2000 4000 6000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	330.2	16.7%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	393.4	19.9%
83	Stapleton sandy loam, 3 to 8 percent slopes	B	1,081.8	54.7%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	172.5	8.7%
Totals for Area of Interest			**1,977.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

NOTES TO USERS

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To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

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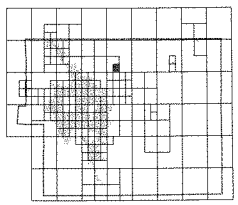
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



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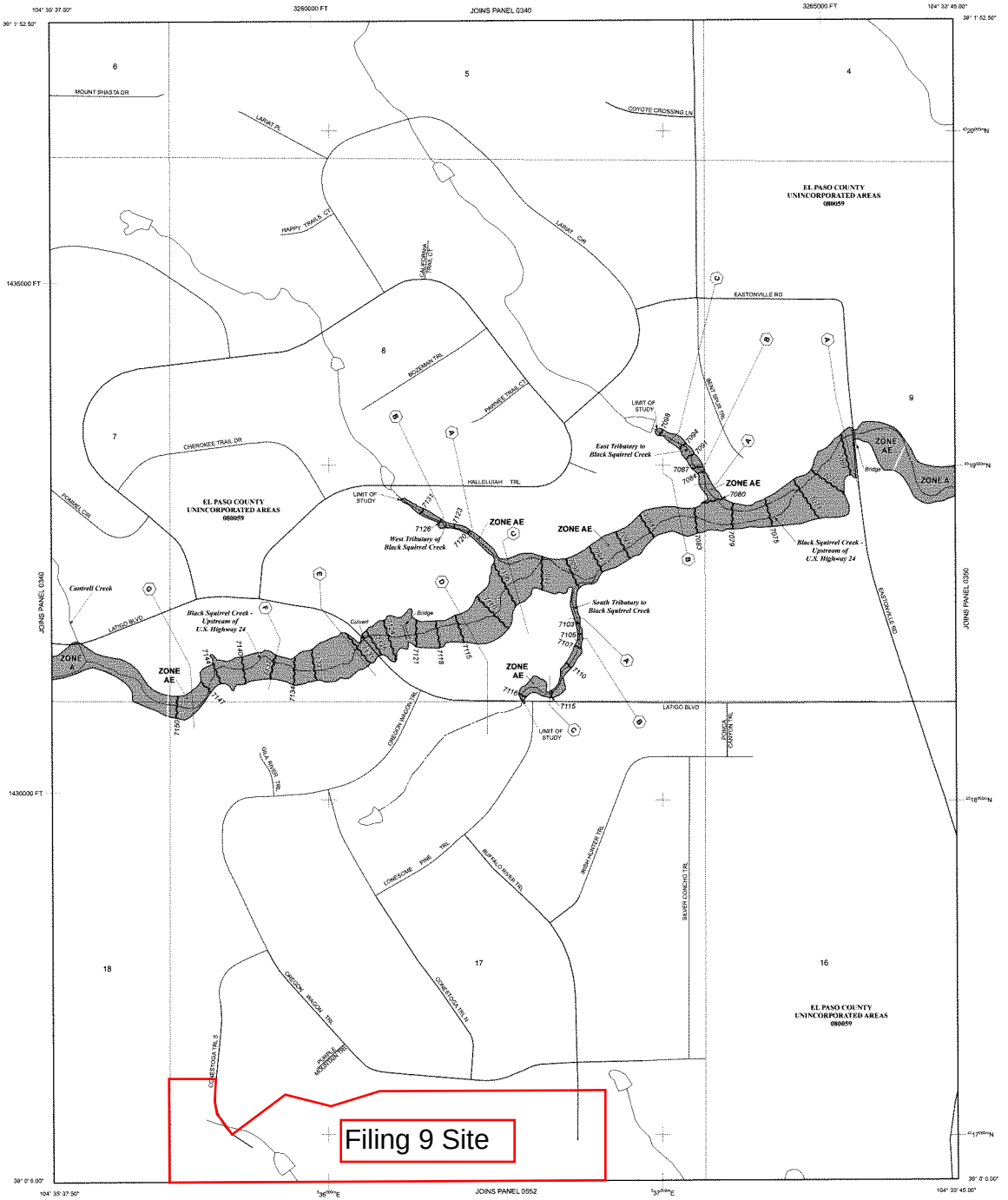
Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 64 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
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ZONE AR Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D Boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A — A — Cross section line
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- 4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
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- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0339G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 339 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0339	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0339G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

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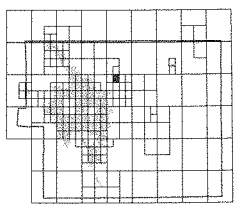

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Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
512 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*
* Referenced to the North American Vertical Datum of 1988 (NAVD 88)
A — A — Cross section line
23 — 23 — Transect line
97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
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MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
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250 0 500 1000 FEET
150 0 150 300 METERS

PANEL 0552G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 552 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0552	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0552G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

APPENDIX B

HYDROLOGIC CALCULATIONS

EXISTING COMPOSITE % IMPERVIOUS/C VALUE CALCULATIONS

Subdivision: Latigo Trails — Filing 9
Location: El Paso County — 25175.02
GAG
3/21/22

Basin ID	Total Area (ac)	Hardscape (100% Impervious)				Lawns (0% Impervious)				Basin Total Weighted C		Basins Total Weighted % Imp.
		C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	
A	7.27	0.90	0.96	0.00	0.0%	0.08	0.35	7.27	0.0%	0.08	0.35	0.0%
B	30.17	0.90	0.96	0.31	1.0%	0.08	0.35	29.86	0.0%	0.09	0.36	1.0%
C	25.25	0.90	0.96	0.00	0.0%	0.08	0.35	25.25	0.0%	0.08	0.35	0.0%
D	13.42	0.90	0.96	0.00	0.0%	0.08	0.35	13.42	0.0%	0.08	0.35	0.0%
E	31.05	0.90	0.96	0.00	0.0%	0.08	0.35	31.05	0.0%	0.08	0.35	0.0%
F	5.74	0.90	0.96	0.23	4.0%	0.08	0.35	5.51	0.0%	0.11	0.37	4.0%
OS1	2.01	0.90	0.96	0.00	0.0%	0.08	0.35	2.01	0.0%	0.08	0.35	0.0%
OS2	2.12	0.90	0.96	0.40	19.0%	0.08	0.35	1.72	0.0%	0.24	0.47	19.0%
OS3	51.16	0.90	0.96	6.86	13.4%	0.08	0.35	44.30	0.0%	0.19	0.43	13.4%
OS4	3.70	0.90	0.96	0.42	11.4%	0.08	0.35	3.28	0.0%	0.17	0.42	11.4%
OS5	3.99	0.90	0.96	0.40	10.0%	0.08	0.35	3.59	0.0%	0.16	0.41	10.0%
OS6	2.33	0.90	0.96	0.23	10.0%	0.08	0.35	2.10	0.0%	0.16	0.41	10.0%
OS7	63.10	0.90	0.96	8.30	13.2%	0.08	0.35	54.80	0.0%	0.19	0.43	13.2%
OS8	68.29	0.90	0.96	7.58	11.1%	0.08	0.35	60.71	0.0%	0.17	0.42	11.1%
TOTAL ON-SITE	112.90											0.5%
TOTAL OFF-SITE	196.70											12.3%
TOTAL SOUTH POND	137.13											11.7%

EXISTING STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Latigo Trails
Location: El Paso County

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 3/21/22

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
A	7.27	B	0%	0.08	0.35	200	8.0%	13.1	715	5.7%	15.0	3.6	3.3	16.4	915.0	31.5	16.4
B	30.17	B	1%	0.09	0.36	200	6.0%	14.3	2420	2.7%	15.0	2.5	16.4	30.7	2620.0	52.7	30.7
C	25.25	B	0%	0.08	0.35	200	3.8%	16.8	1825	2.4%	15.0	2.3	13.1	29.9	2025.0	47.8	29.9
D	13.42	B	0%	0.08	0.35	200	3.5%	17.2	1305	3.0%	15.0	2.6	8.4	25.6	1505.0	40.0	25.6
E	31.05	B	0%	0.08	0.35	200	2.1%	20.4	1500	2.5%	15.0	2.4	10.5	30.9	1700.0	43.6	30.9
F	5.74	B	4%	0.11	0.37	200	2.6%	18.4	750	3.4%	15.0	2.8	4.5	22.9	950.0	32.4	22.9

EXISTING STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Latigo Trails
Location: El Paso County

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 3/21/22

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
OS1	2.01	B	0%	0.08	0.35	200	6.0%	14.4	85	0.8%	15.0	1.4	1.0	15.5	285.0	27.7	15.5
OS2	2.12	B	19%	0.24	0.47	30	2.0%	6.8	555	3.9%	15.0	3.0	3.1	9.9	585.0	26.8	9.9
OS3	51.16	B	13%	0.19	0.43	200	5.8%	13.0	1865	3.9%	15.0	2.9	10.5	23.5	2065.0	38.3	23.5
OS4	3.70	B	11%	0.17	0.42	200	3.7%	15.4	515	2.5%	15.0	2.4	3.6	19.0	715.0	29.2	19.0
OS5	3.99	B	10%	0.16	0.41	200	6.4%	13.0	515	2.8%	15.0	2.5	3.4	16.4	715.0	29.3	16.4
OS6	2.33	B	10%	0.16	0.41	200	4.5%	14.6	770	2.0%	15.0	2.1	6.0	20.7	970.0	33.0	20.7
OS7	63.10	B	13%	0.19	0.43	200	7.6%	11.9	2885	2.9%	15.0	2.6	18.8	30.7	3085.0	49.8	30.7
OS8	68.29	B	11%	0.17	0.42	200	4.4%	14.5	3885	2.6%	15.0	2.4	26.9	41.4	4085.0	62.3	41.4

NOTES:

$$t_c = t_i + t_t$$

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

Equation 6-2

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$

Where:

t_i = overland (initial) flow time (minutes)
C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
L_i = length of overland flow (ft)
S_o = average slope along the overland flow path (ft/ft).

Equation 6-4

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$

Where:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
L_t = length of channelized flow path (ft)
i = imperviousness (expressed as a decimal)
S_t = slope of the channelized flow path (ft/ft).

Equation 6-3

Equation 6-5

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

EXISTING STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 5-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 3/21/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	1	A	7.27	0.08	16.4	0.58	3.38	2.0															Flows overland in the direction of DP1 and flows off-site.
	2	OS1	2.01	0.08	15.5	0.16	3.48	0.6															Flows overland towards DP2 and into Basin B. Flows travel overland towards DP4.1 where they combine.
	3	OS2	2.12	0.24	9.9	0.50	4.14	2.1												518	3.4	2.5	Flows in swale towards DP3 and into Basin B. Flows travel overland towards DP4.1 where they combine.
	4	B	30.17	0.09	30.7	2.67	2.45	6.5															Flows overland in the direction of DP4. Flows combine at DP4.1.
	4.1								30.7	3.33	2.45	8.2											Combination of flows from DP2, DP3, and DP4. Flows continue off-site.
	5	OS3	51.16	0.19	23.5	9.71	2.84	27.6															Flows overland towards DP5 and into Basin C. Flows travel overland towards DP7.1 where they combine.
	6	OS4	3.70	0.17	19.0	0.64	3.17	2.0															Flows overland towards DP6 and into Basin C. Flows travel overland towards DP7.1 where they combine.
	7	C	25.25	0.08	29.9	2.02	2.49	5.0															Flows overland in the direction of DP7. Flows combine at DP7.1.
	7.1								29.9	12.37	2.49	30.8											Combination of flows from DP5, DP6, and DP7. Flows continue off-site.
	8	OS5	3.99	0.16	16.4	0.65	3.38	2.2															Flows overland towards DP8 and into Basin D. Flows travel overland towards DP9.1 where they combine.
	9	D	13.42	0.08	25.6	1.07	2.72	2.9															Flows overland in the direction of DP9. Flows combine at DP9.1.
	9.1								25.6	1.72	2.72	4.7											Combination of flows from DP8 and DP9. Flows continue off-site.

EXISTING STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 5-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 3/21/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	10	OS6	2.33	0.16	20.7	0.38	3.04	1.2															Flows overland towards DP10 and into Basin E. Flows travel overland towards DP11.1 where they combine.
	11	E	31.05	0.08	30.9	2.48	2.44	6.0															Flows overland in the direction of DP11. Flows combine at DP11.1.
	11.1								30.9	2.86	2.44	7.0											Combination of flows from DP10 and DP11. Flows continue off-site.
	12	OS7	63.10	0.19	30.7	11.85	2.44	29.0															Flows overland towards DP12 and into Basin F. Flows travel overland towards DP13.1 where they combine.
	13	F	5.74	0.11	22.9	0.65	2.89	1.9															Flows overland in the direction of DP13. Flows combine at DP13.1.
	13.1								30.7	12.50	2.44	30.6											Combination of flows from DP12 and DP13. Flows combine at DP14.1.
	14	OS8	68.29	0.17	41.4	11.68	2.00	23.3															Flows overland in the direction of DP14. Flows combine at DP14.1.
	14.1								41.4	24.18	2.00	48.3											Represents the flow to the existing South Pond. Combines DP13.1 and DP14 flows. Flows are released at pond outlet.

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

EXISTING STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 100-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 3/21/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C* A (ac)	I (in/hr)	Q (cfs)	tc (min)	C* A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C* A (ac)	Slope (%)	Q_{pipe} (cfs)	C* A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	1	A	7.27	0.35	16.4	2.54	5.68	14.4															Flows overland in the direction of DP1 and flows off-site.
	2	OS1	2.01	0.35	15.5	0.70	5.83	4.1															Flows overland towards DP2 and into Basin B. Flows travel overland towards DP4.1 where they combine.
	3	OS2	2.12	0.47	9.9	0.99	6.96	6.9												518	4.7	1.8	Flows in swale towards DP3 and into Basin B. Flows travel overland towards DP4.1 where they combine.
	4	B	30.17	0.36	30.7	10.75	4.11	44.2															Flows overland in the direction of DP4. Flows combine at DP4.1.
	4.1								30.7	12.44	4.11	51.1											Combination of flows from DP2, DP3, and DP4. Flows continue off-site.
	5	OS3	51.16	0.43	23.5	22.09	4.77	105.5															Flows overland towards DP5 and into Basin C. Flows travel overland towards DP7.1 where they combine.
	6	OS4	3.70	0.42	19.0	1.55	5.32	8.2															Flows overland towards DP6 and into Basin C. Flows travel overland towards DP7.1 where they combine.
	7	C	25.25	0.35	29.9	8.84	4.18	36.9															Flows overland in the direction of DP7. Flows combine at DP7.1.
	7.1								29.9	32.48	4.18	135.6											Combination of flows from DP5, DP6, and DP7. Flows continue off-site.
	8	OS5	3.99	0.41	16.4	1.64	5.68	9.3															Flows overland towards DP8 and into Basin D. Flows travel overland towards DP9.1 where they combine.
	9	D	13.42	0.35	25.6	4.70	4.56	21.5															Flows overland in the direction of DP9. Flows combine at DP9.1.
	9.1								25.6	6.34	4.56	28.9											Combination of flows from DP8 and DP9. Flows continue off-site.

EXISTING STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 100-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 3/21/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	10	OS6	2.33	0.41	20.7	0.96	5.10	4.9															Flows overland towards DP10 and into Basin E. Flows travel overland towards DP11.1 where they combine.
	11	E	31.05	0.35	30.9	10.87	4.09	44.4															Flows overland in the direction of DP11. Flows combine at DP11.1.
	11.1								30.9	11.83	4.09	48.4											Combination of flows from DP10 and DP11. Flows continue off-site.
	12	OS7	63.10	0.43	30.7	27.15	4.10	111.4															Flows overland towards DP12 and into Basin F. Flows travel overland towards DP13.1 where they combine.
	13	F	5.74	0.37	22.9	2.15	4.85	10.4															Flows overland in the direction of DP13. Flows combine at DP13.1.
	13.1								30.7	29.30	4.10	120.2											Combination of flows from DP12 and DP13. Flows combine at DP14.1.
	14	OS8	68.29	0.42	41.4	28.52	3.35	95.6															Flows overland in the direction of DP14. Flows combine at DP14.1.
	14.1								41.4	57.82	3.35	193.8											Represents the flow to the existing South Pond. Combines DP13.1 and DP14 flows. Flows are released

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

PROPOSED COMPOSITE % IMPERVIOUS/C VALUE CALCULATIONS

Subdivision: Latigo Trails
Location: El Paso County

Filing 9
25175.02
GAG

4/6/22

Basin ID	Total Area (ac)	Hardscape (100% Impervious)				Lawns (0% Impervious)				Basin Total Weighted C		Basins Total Weighted % Imp.
		C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	
A	1.58	0.90	0.96	0.35	22.0%	0.08	0.35	1.23	0.0%	0.26	0.48	22.0%
B	8.71	0.90	0.96	1.09	12.5%	0.08	0.35	7.62	0.0%	0.18	0.43	12.5%
C	5.43	0.90	0.96	0.70	12.9%	0.08	0.35	4.73	0.0%	0.19	0.43	12.9%
D	7.22	0.90	0.96	0.95	13.2%	0.08	0.35	6.27	0.0%	0.19	0.43	13.2%
E	10.46	0.90	0.96	1.44	13.7%	0.08	0.35	9.02	0.0%	0.19	0.43	13.7%
F	6.51	0.90	0.96	1.04	16.0%	0.08	0.35	5.47	0.0%	0.21	0.45	16.0%
G	2.42	0.90	0.96	1.32	54.7%	0.08	0.35	1.10	0.0%	0.53	0.68	54.7%
H	8.65	0.90	0.96	1.18	13.6%	0.08	0.35	7.48	0.0%	0.19	0.43	13.6%
I	0.62	0.90	0.96	0.00	0.0%	0.08	0.35	0.62	0.0%	0.08	0.35	0.0%
J	4.56	0.90	0.96	1.53	33.5%	0.08	0.35	3.03	0.0%	0.35	0.55	33.5%
K	3.78	0.90	0.96	0.38	10.0%	0.08	0.35	3.40	0.0%	0.16	0.41	10.0%
L	2.02	0.90	0.96	0.00	0.0%	0.08	0.35	2.02	0.0%	0.08	0.35	0.0%
M	15.65	0.90	0.96	1.57	10.0%	0.08	0.35	14.09	0.0%	0.16	0.41	10.0%
N	10.54	0.90	0.96	1.05	10.0%	0.08	0.35	9.49	0.0%	0.16	0.41	10.0%
O	5.87	0.90	0.96	0.59	10.0%	0.08	0.35	5.28	0.0%	0.16	0.41	10.0%
P	13.14	0.90	0.96	1.31	10.0%	0.08	0.35	11.83	0.0%	0.16	0.41	10.0%
OS1	2.01	0.90	0.96	0.00	0.0%	0.08	0.35	2.01	0.0%	0.08	0.35	0.0%
OS2	2.12	0.90	0.96	0.40	19.0%	0.08	0.35	1.72	0.0%	0.24	0.47	19.0%
OS3	51.16	0.90	0.96	6.86	13.4%	0.08	0.35	44.30	0.0%	0.19	0.43	13.4%
OS4	3.70	0.90	0.96	0.42	11.4%	0.08	0.35	3.28	0.0%	0.17	0.42	11.4%
OS5	3.99	0.90	0.96	0.40	10.0%	0.08	0.35	3.59	0.0%	0.16	0.41	10.0%
OS6	2.33	0.90	0.96	0.23	10.0%	0.08	0.35	2.10	0.0%	0.16	0.41	10.0%
OS7	63.10	0.90	0.96	8.30	13.2%	0.08	0.35	54.80	0.0%	0.19	0.43	13.2%
OS8	68.37	0.90	0.96	9.24	13.5%	0.08	0.35	59.14	0.0%	0.19	0.43	13.5%
TOTAL ON-SITE	107.16											13.5%
TOTAL OFF-SITE	196.78											13.1%
TOTAL SOUTH POND	237.10											13.8%
TOTAL G1 POND	15.22											17.7%

PROPOSED STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Latigo Trails
Location: El Paso County

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
A	1.58	B	22%	0.26	0.48	90	5.0%	8.5	480	4.2%	15.0	3.1	2.6	11.1	570.0	25.5	11.1
B	8.71	B	13%	0.18	0.43	200	3.8%	15.1	830	2.7%	15.0	2.5	5.6	20.7	1030.0	31.7	20.7
C	5.43	B	13%	0.19	0.43	200	2.8%	16.6	585	2.3%	15.0	2.3	4.3	20.9	785.0	29.8	20.9
D	7.22	B	13%	0.19	0.43	200	3.5%	15.4	715	2.9%	15.0	2.5	4.7	20.1	915.0	30.2	20.1
E	10.46	B	14%	0.19	0.43	200	4.5%	14.1	1360	2.2%	15.0	2.2	10.3	24.4	1560.0	37.8	24.4
F	6.51	B	16%	0.21	0.45	200	2.6%	16.5	795	3.5%	15.0	2.8	4.7	21.3	995.0	29.6	21.3
G	2.42	B	55%	0.53	0.68	28	2.0%	4.3	3520	2.2%	20.0	2.9	20.0	24.3	3548.0	40.7	24.3
H	8.65	B	14%	0.19	0.43	200	6.0%	12.9	775	3.4%	15.0	2.8	4.6	17.5	975.0	30.1	17.5
I	0.62	B	0%	0.08	0.35	200	7.1%	13.6	155	7.3%	15.0	4.1	0.6	14.3	355.0	27.1	14.3
J	4.56	B	33%	0.35	0.55	200	7.7%	9.7	650	5.2%	15.0	3.4	3.2	12.9	850.0	23.8	12.9
K	3.78	B	10%	0.16	0.41	200	14.7%	9.9	570	3.9%	15.0	3.0	3.2	13.1	770.0	28.9	13.1
L	2.02	B	0%	0.08	0.35	200	3.0%	18.1	180	3.0%	15.0	2.6	1.2	19.3	380.0	27.9	19.3
M	15.65	B	10%	0.16	0.41	200	6.6%	12.8	995	2.3%	15.0	2.3	7.3	20.1	1195.0	34.8	20.1
N	10.54	B	10%	0.16	0.41	200	3.4%	16.0	1065	2.6%	15.0	2.4	7.3	23.4	1265.0	34.9	23.4
O	5.87	B	10%	0.16	0.41	200	3.0%	16.7	625	3.8%	15.0	2.9	3.6	20.2	825.0	29.5	20.2
P	13.14	B	10%	0.16	0.41	200	7.4%	12.4	1130	2.8%	15.0	2.5	7.5	19.9	1330.0	35.2	19.9

PROPOSED STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Latigo Trails
Location: El Paso County

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
OS1	2.01	B	0%	0.08	0.35	200	6.0%	14.4	85	0.8%	15.0	1.4	1.0	15.5	285.0	27.7	15.5
OS2	2.12	B	19%	0.24	0.47	30	2.0%	6.8	555	3.9%	15.0	3.0	3.1	9.9	585.0	26.8	9.9
OS3	51.16	B	13%	0.19	0.43	200	5.8%	13.0	1865	3.9%	15.0	2.9	10.5	23.5	2065.0	38.3	23.5
OS4	3.70	B	11%	0.17	0.42	200	3.7%	15.4	515	2.5%	15.0	2.4	3.6	19.0	715.0	29.2	19.0
OS5	3.99	B	10%	0.16	0.41	200	6.4%	13.0	515	2.8%	15.0	2.5	3.4	16.4	715.0	29.3	16.4
OS6	2.33	B	10%	0.16	0.41	200	4.5%	14.6	770	2.0%	15.0	2.1	6.0	20.7	970.0	33.0	20.7
OS7	63.10	B	13%	0.19	0.43	200	7.6%	11.9	2885	2.9%	15.0	2.6	18.8	30.7	3085.0	49.8	30.7
OS8	68.37	B	14%	0.19	0.43	200	4.4%	14.2	3885	2.6%	15.0	2.4	26.9	41.1	4085.0	60.7	41.1

NOTES:

$$t_c = t_i + t_t$$

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

Equation 6-2

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$

Where:

t_i = overland (initial) flow time (minutes)
C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
L_i = length of overland flow (ft)
S_o = average slope along the overland flow path (ft/ft).

Equation 6-4

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$

Where:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
L_t = length of channelized flow path (ft)
i = imperviousness (expressed as a decimal)
S_t = slope of the channelized flow path (ft/ft).

Equation 6-3

Equation 6-5

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

PROPOSED STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 5-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	1	OS2	2.12	0.24	9.9	0.50	4.14	2.1												518	3.4	2.5	Flows overland towards DP1 and into A. Flows enter roadside swale and flow towards DP2.1.
	2	A	1.58	0.26	11.1	0.41	3.98	1.6															Flows overland towards roadway swale and then to DP2. Flows combine at DP2.1.
	2.1								12.4	0.91	3.80	3.5								595	4.0	2.5	Combination of flows from DP1 and DP2. Flows along swale to DP4.1.
	3	OS3	51.16	0.19	23.5	9.71	2.84	27.6															Flows overland towards DP3 and into B. Flows combine at DP4.1.
	4	B	8.71	0.18	20.7	1.59	3.04	4.8															Flows overland towards DP4. Flows enter roadway swale and combine at DP4.1
	4.1								23.5	12.21	2.84	34.7								442	4.1	1.8	Combination of flows from DP2.1, DP3, and DP4. Flows along swale to DP6.1.
	5	OS4	3.70	0.17	19.0	0.64	3.17	2.0															Flows overland towards DP5 and into C. Flows combine at DP6.1.
	6	C	5.43	0.19	20.9	1.01	3.02	3.1															Flows overland towards DP6. Flows enter roadway swale and combine at DP6.1
	6.1								25.3	13.86	2.73	37.9								627	6.5	1.6	Combination of flows from DP4.1, DP5, and DP6. Flows along swale to DP8.1.
	7	OS5	3.99	0.16	16.4	0.65	3.38	2.2															Flows overland towards DP7 and into D. Flows combine at DP8.1.
	8	D	7.22	0.19	20.1	1.36	3.08	4.2															Flows overland towards DP8. Flows enter roadway swale and combine at DP8.1
	8.1								27.0	15.87	2.64	41.9								1041	7.4	2.3	Combination of flows from DP6.1, DP7, and DP8. Flows along swale to DP10.1.
	9	OS6	2.33	0.16	20.7	0.38	3.04	1.2															Flows overland towards DP9 and into E. Flows combine at DP10.1.
	10	E	10.46	0.19	24.4	2.01	2.79	5.6															Flows overland towards DP10. Flows enter roadway swale and combine at DP10.1
	10.1								29.3	18.26	2.52	46.0								189	7.7	0.4	Combination of flows from DP8.1, DP9, and DP10. Flows along swale to DP12.1.

PROPOSED STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 5-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	11	OS7	63.10	0.19	30.7	11.85	2.44	29.0												425	2.9	2.4	Flows overland towards DP11 and into F. Flows combine at DP12.1.
	12	F	6.51	0.21	21.3	1.37	3.00	4.1															Flows overland towards DP12. Flows enter roadway swale and combine at DP12.1
	12.1								33.2	31.48	2.33	73.3											Combination of flows from DP10.1, DP11, and DP12. Flows along swale to DP13.1.
	13	G	2.42	0.53	24.3	1.28	2.80	3.6															Flow along south roadway towards DP13. Flows combine at DP13.1
	13.1								33.2	32.76	2.33	76.3											Combination of flows from DP12.1 and DP13. Flows along swale to DP14.1.
	14	OS8	68.37	0.19	41.1	13.04	2.01	26.2															Flows overland towards DP14. Flows enter swale and combine at DP14.1
	14.1								41.1	45.80	2.01	92.0											Combination of flows from DP13.1 and DP14. Flows along swale to South Pond.
	15	OS1	2.01	0.08	15.5	0.16	3.48	0.6															Flows overland towards DP15 and into H. Flows combine at DP16.1.
	16	H	8.65	0.19	17.5	1.66	3.29	5.5															Flows overland towards DP16. Flows combine at DP16.1.
	16.1								17.5	1.82	3.29	6.0								820	2.4	5.7	Combination of flows from DP15 and DP16. Flows along swale to DP17.1.
	17	J	4.56	0.35	12.9	1.62	3.75	6.1															Flows overland towards DP17. Flows along swale to DP17.1.
	17.1								23.2	3.44	2.87	9.9											Combination of flows from DP16.1 and DP17. Total flow into G1 Pond.

PROPOSED STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 5-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	18	K	3.78	0.16	13.1	0.61	3.73	2.3															Flows overland in the direction of DP19 and flows off-site.
	19	I	0.62	0.08	14.3	0.05	3.60	0.2															Flows overland in the direction of DP19 and flows off-site.
	20	L	2.02	0.08	19.3	0.16	3.14	0.5															Flows overland in the direction of DP20 and flows off-site.
	21	M	15.65	0.16	20.1	2.54	3.08	7.8															Flows overland in the direction of DP21 and flows off-site.
	22	N	10.54	0.16	23.4	1.71	2.86	4.9															Flows overland in the direction of DP22 and flows off-site.
	23	O	5.87	0.16	20.2	0.95	3.07	2.9															Flows overland in the direction of DP23 and flows off-site.
	24	P	13.14	0.16	19.9	2.13	3.10	6.6															Flows overland in the direction of DP24 and flows off-site.

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 100-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C* A (ac)	I (in/hr)	Q (cfs)	tc (min)	C* A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C* A (ac)	Slope (%)	Q_{pipe} (cfs)	C* A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	1	OS2	2.12	0.47	9.9	0.99	6.96	6.9												518	4.7	1.8	Flows overland towards DP1 and into A. Flows enter roadside swale and flow towards DP2.1.
	2	A	1.58	0.48	11.1	0.77	6.68	5.1															Flows overland towards roadway swale and then to DP2. Flows combine at DP2.1.
	2.1								11.7	1.76	6.53	11.5								595	5.4	1.8	Combination of flows from DP1 and DP2. Flows along swale to DP4.1.
	3	OS3	51.16	0.43	23.5	22.09	4.77	105.5															Flows overland towards DP3 and into B. Flows combine at DP4.1.
	4	B	8.71	0.43	20.7	3.71	5.10	18.9															Flows overland towards DP4. Flows enter roadway swale and combine at DP4.1
	4.1								23.5	27.56	4.77	131.6								442	5.7	1.3	Combination of flows from DP2.1, DP3, and DP4. Flows along swale to DP6.1.
	5	OS4	3.70	0.42	19.0	1.55	5.32	8.2															Flows overland towards DP5 and into C. Flows combine at DP6.1.
	6	C	5.43	0.43	20.9	2.33	5.07	11.8															Flows overland towards DP6. Flows enter roadway swale and combine at DP6.1
	6.1								24.8	31.44	4.64	145.9								627	9.1	1.1	Combination of flows from DP4.1, DP5, and DP6. Flows along swale to DP8.1.
	7	OS5	3.99	0.41	16.4	1.64	5.68	9.3															Flows overland towards DP7 and into D. Flows combine at DP8.1.
	8	D	7.22	0.43	20.1	3.11	5.18	16.1															Flows overland towards DP8. Flows enter roadway swale and combine at DP8.1
	8.1								26.0	36.19	4.53	163.8								1041	10.4	1.7	Combination of flows from DP6.1, DP7, and DP8. Flows along swale to DP10.1.
	9	OS6	2.33	0.41	20.7	0.96	5.10	4.9															Flows overland towards DP9 and into E. Flows combine at DP10.1.
	10	E	10.46	0.43	24.4	4.54	4.68	21.3															Flows overland towards DP10. Flows enter roadway swale and combine at DP10.1
	10.1								27.7	41.69	4.37	182.1								189	10.9	0.3	Combination of flows from DP8.1, DP9, and DP10. Flows along swale to DP12.1.

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 100-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C* A (ac)	I (in/hr)	Q (cfs)	tc (min)	C* A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C* A (ac)	Slope (%)	Q_{pipe} (cfs)	C* A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	11	OS7	63.10	0.43	30.7	27.15	4.10	111.4												425	4.2	1.7	Flows overland towards DP11 and into F. Flows combine at DP12.1.
	12	F	6.51	0.45	21.3	2.91	5.03	14.6															Flows overland towards DP12. Flows enter roadway swale and combine at DP12.1
	12.1								32.4	71.75	3.97	284.6											Combination of flows from DP10.1, DP11, and DP12. Flows along swale to DP13.1.
	13	G	2.42	0.68	24.3	1.65	4.69	7.7															Flow along south roadway towards DP13. Flows combine at DP13.1
	13.1								32.4	73.40	3.97	291.2											Combination of flows from DP12.1 and DP13. Flows along swale to DP14.1.
	14	OS8	68.37	0.43	41.1	29.56	3.37	99.6															Flows overland towards DP14. Flows enter swale and combine at DP14.1
	14.1								41.1	102.96	3.37	347.0											Combination of flows from DP13.1 and DP14. Flows along swale to South Pond.
	15	OS1	2.01	0.35	15.5	0.70	5.83	4.1															Flows overland towards DP15 and into H. Flows combine at DP16.1.
	16	H	8.65	0.43	17.5	3.74	5.52	20.6															Flows overland towards DP16. Flows combine at DP16.1.
	16.1								17.5	4.44	5.52	24.5								820	3.4	4.0	Combination of flows from DP15 and DP16. Flows along swale to DP17.1.
	17	J	4.56	0.55	12.9	2.53	6.30	15.9															Flows overland towards DP17. Flows along swale to DP17.1.
	17.1								21.5	6.97	5.00	34.9											Combination of flows from DP16.1 and DP17. Total flow into G1 Pond.

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 100-Year

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	18	K	3.78	0.41	13.1	1.55	6.26	9.7															Flows overland in the direction of DP18 and flows off-site.
	19	I	0.62	0.35	14.3	0.22	6.04	1.3															Flows overland in the direction of DP19 and flows off-site.
	20	L	2.02	0.35	19.3	0.71	5.28	3.7															Flows overland in the direction of DP20 and flows off-site.
	21	M	15.65	0.41	20.1	6.43	5.17	33.3															Flows overland in the direction of DP21 and flows off-site.
	22	N	10.54	0.41	23.4	4.33	4.79	20.8															Flows overland in the direction of DP22 and flows off-site.
	23	O	5.87	0.41	20.2	2.41	5.16	12.4															Flows overland in the direction of DP23 and flows off-site.
	24	P	13.14	0.41	19.9	5.40	5.20	28.1															Flows overland in the direction of DP24 and flows off-site.

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

ULTIMATE COMPOSITE % IMPERVIOUS/C VALUE CALCULATIONS

Subdivision: Latigo Trails
Location: El Paso County

Filing 9-Ultimate
25175.02
GAG

4/7/22

Basin ID	Total Area (ac)	Hardscape (100% Impervious)				Lawns (0% Impervious)				Basin Total Weighted C		Basins Total Weighted % Imp.
		C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	
A	1.58	0.90	0.96	0.35	22.0%	0.08	0.35	1.23	0.0%	0.26	0.48	22.0%
B	8.71	0.90	0.96	1.09	12.5%	0.08	0.35	7.62	0.0%	0.18	0.43	12.5%
C	5.43	0.90	0.96	0.70	12.9%	0.08	0.35	4.73	0.0%	0.19	0.43	12.9%
D	7.22	0.90	0.96	0.95	13.2%	0.08	0.35	6.27	0.0%	0.19	0.43	13.2%
E	10.46	0.90	0.96	1.44	13.7%	0.08	0.35	9.02	0.0%	0.19	0.43	13.7%
F	6.51	0.90	0.96	1.04	16.0%	0.08	0.35	5.47	0.0%	0.21	0.45	16.0%
G	2.42	0.90	0.96	1.32	54.7%	0.08	0.35	1.10	0.0%	0.53	0.68	54.7%
H	8.65	0.90	0.96	1.18	13.6%	0.08	0.35	7.48	0.0%	0.19	0.43	13.6%
I	0.62	0.90	0.96	0.00	0.0%	0.08	0.35	0.62	0.0%	0.08	0.35	0.0%
J	4.56	0.90	0.96	1.53	33.5%	0.08	0.35	3.03	0.0%	0.35	0.55	33.5%
K	3.78	0.90	0.96	0.38	10.0%	0.08	0.35	3.40	0.0%	0.16	0.41	10.0%
L	2.02	0.90	0.96	0.00	0.0%	0.08	0.35	2.02	0.0%	0.08	0.35	0.0%
M	15.65	0.90	0.96	1.57	10.0%	0.08	0.35	14.09	0.0%	0.16	0.41	10.0%
N	10.54	0.90	0.96	1.05	10.0%	0.08	0.35	9.49	0.0%	0.16	0.41	10.0%
O	5.87	0.90	0.96	0.59	10.0%	0.08	0.35	5.28	0.0%	0.16	0.41	10.0%
P	13.14	0.90	0.96	1.31	10.0%	0.08	0.35	11.83	0.0%	0.16	0.41	10.0%
OS1	2.01	0.90	0.96	0.00	0.0%	0.08	0.35	2.01	0.0%	0.08	0.35	0.0%
OS2	2.12	0.90	0.96	0.40	19.0%	0.08	0.35	1.72	0.0%	0.24	0.47	19.0%
OS3	51.16	0.90	0.96	6.86	13.4%	0.08	0.35	44.30	0.0%	0.19	0.43	13.4%
OS4	3.70	0.90	0.96	0.42	11.4%	0.08	0.35	3.28	0.0%	0.17	0.42	11.4%
OS5	3.99	0.90	0.96	0.40	10.0%	0.08	0.35	3.59	0.0%	0.16	0.41	10.0%
OS6	2.33	0.90	0.96	0.23	10.0%	0.08	0.35	2.10	0.0%	0.16	0.41	10.0%
OS7	63.10	0.90	0.96	8.30	13.2%	0.08	0.35	54.80	0.0%	0.19	0.43	13.2%
OS8	68.37	0.90	0.96	12.20	17.8%	0.08	0.35	56.17	0.0%	0.23	0.46	17.8%
TOTAL ON-SITE	107.16											13.5%
TOTAL OFF-SITE	196.78											14.6%
TOTAL SOUTH POND	237.10											15.1%
TOTAL G1 POND	15.22											17.7%

ULTIMATE STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Latigo Trails
Location: El Paso County

Project Name: Filing 9-Ultimate
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/7/22

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
A	1.58	B	22%	0.26	0.48	90	5.0%	8.5	480	4.2%	15.0	3.1	2.6	11.1	570.0	25.5	11.1
B	8.71	B	13%	0.18	0.43	200	3.8%	15.1	830	2.7%	15.0	2.5	5.6	20.7	1030.0	31.7	20.7
C	5.43	B	13%	0.19	0.43	200	2.8%	16.6	585	2.3%	15.0	2.3	4.3	20.9	785.0	29.8	20.9
D	7.22	B	13%	0.19	0.43	200	3.5%	15.4	715	2.9%	15.0	2.5	4.7	20.1	915.0	30.2	20.1
E	10.46	B	14%	0.19	0.43	200	4.5%	14.1	1360	2.2%	15.0	2.2	10.3	24.4	1560.0	37.8	24.4
F	6.51	B	16%	0.21	0.45	200	2.6%	16.5	795	3.5%	15.0	2.8	4.7	21.3	995.0	29.6	21.3
G	2.42	B	55%	0.53	0.68	28	2.0%	4.3	3520	2.2%	20.0	2.9	20.0	24.3	3548.0	40.7	24.3
H	8.65	B	14%	0.19	0.43	200	6.0%	12.9	775	3.4%	15.0	2.8	4.6	17.5	975.0	30.1	17.5
I	0.62	B	0%	0.08	0.35	200	7.1%	13.6	155	7.3%	15.0	4.1	0.6	14.3	355.0	27.1	14.3
J	4.56	B	33%	0.35	0.55	200	7.7%	9.7	650	5.2%	15.0	3.4	3.2	12.9	850.0	23.8	12.9
K	3.78	B	10%	0.16	0.41	200	14.7%	9.9	570	3.9%	15.0	3.0	3.2	13.1	770.0	28.9	13.1
L	2.02	B	0%	0.08	0.35	200	3.0%	18.1	180	3.0%	15.0	2.6	1.2	19.3	380.0	27.9	19.3
M	15.65	B	10%	0.16	0.41	200	6.6%	12.8	995	2.3%	15.0	2.3	7.3	20.1	1195.0	34.8	20.1
N	10.54	B	10%	0.16	0.41	200	3.4%	16.0	1065	2.6%	15.0	2.4	7.3	23.4	1265.0	34.9	23.4
O	5.87	B	10%	0.16	0.41	200	3.0%	16.7	625	3.8%	15.0	2.9	3.6	20.2	825.0	29.5	20.2
P	13.14	B	10%	0.16	0.41	200	7.4%	12.4	1130	2.8%	15.0	2.5	7.5	19.9	1330.0	35.2	19.9

ULTIMATE STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Latigo Trails
Location: El Paso County

Project Name: Filing 9-Ultimate
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/7/22

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
OS1	2.01	B	0%	0.08	0.35	200	6.0%	14.4	85	0.8%	15.0	1.4	1.0	15.5	285.0	27.7	15.5
OS2	2.12	B	19%	0.24	0.47	30	2.0%	6.8	555	3.9%	15.0	3.0	3.1	9.9	585.0	26.8	9.9
OS3	51.16	B	13%	0.19	0.43	200	5.8%	13.0	1865	3.9%	15.0	2.9	10.5	23.5	2065.0	38.3	23.5
OS4	3.70	B	11%	0.17	0.42	200	3.7%	15.4	515	2.5%	15.0	2.4	3.6	19.0	715.0	29.2	19.0
OS5	3.99	B	10%	0.16	0.41	200	6.4%	13.0	515	2.8%	15.0	2.5	3.4	16.4	715.0	29.3	16.4
OS6	2.33	B	10%	0.16	0.41	200	4.5%	14.6	770	2.0%	15.0	2.1	6.0	20.7	970.0	33.0	20.7
OS7	63.10	B	13%	0.19	0.43	200	7.6%	11.9	2885	2.9%	15.0	2.6	18.8	30.7	3085.0	49.8	30.7
OS8	68.37	B	18%	0.23	0.46	200	4.4%	13.7	3885	2.6%	15.0	2.4	26.9	40.6	4085.0	58.0	40.6

NOTES:

$$t_c = t_i + t_t$$

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

Equation 6-2

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$

Where:

t_i = overland (initial) flow time (minutes)
C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
L_i = length of overland flow (ft)
S_o = average slope along the overland flow path (ft/ft).

Equation 6-4

$$t_c = (26 - 17\bar{i}) + \frac{L_t}{60(14\bar{i} + 9)\sqrt{S_t}}$$

Where:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
L_t = length of channelized flow path (ft)
$\bar{i}$ = imperviousness (expressed as a decimal)
S_t = slope of the channelized flow path (ft/ft).

Equation 6-3

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Equation 6-5

ULTIMATE STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 5-Year

Project Name: Filing 9-Ultimate
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/7/22

		DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			
STREET	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	1	OS2	2.12	0.24	9.9	0.50	4.14	2.1												518	3.4	2.5	Flows overland towards DP1 and into A. Flows enter roadside swale and flow towards DP2.1.
	2	A	1.58	0.26	11.1	0.41	3.98	1.6															Flows overland towards roadway swale and then to DP2. Flows combine at DP2.1.
	2.1								12.4	0.91	3.80	3.5								595	4.0	2.5	Combination of flows from DP1 and DP2. Flows along swale to DP4.1.
	3	OS3	51.16	0.19	23.5	9.71	2.84	27.6															Flows overland towards DP3 and into B. Flows combine at DP4.1.
	4	B	8.71	0.18	20.7	1.59	3.04	4.8															Flows overland towards DP4. Flows enter roadway swale and combine at DP4.1
	4.1								23.5	12.21	2.84	34.7								442	4.1	1.8	Combination of flows from DP2.1, DP3, and DP4. Flows along swale to DP6.1.
	5	OS4	3.70	0.17	19.0	0.64	3.17	2.0															Flows overland towards DP5 and into C. Flows combine at DP6.1.
	6	C	5.43	0.19	20.9	1.01	3.02	3.1															Flows overland towards DP6. Flows enter roadway swale and combine at DP6.1
	6.1								25.3	13.86	2.73	37.9								627	6.5	1.6	Combination of flows from DP4.1, DP5, and DP6. Flows along swale to DP8.1.
	7	OS5	3.99	0.16	16.4	0.65	3.38	2.2															Flows overland towards DP7 and into D. Flows combine at DP8.1.
	8	D	7.22	0.19	20.1	1.36	3.08	4.2															Flows overland towards DP8. Flows enter roadway swale and combine at DP8.1
	8.1								27.0	15.87	2.64	41.9								1041	7.4	2.3	Combination of flows from DP6.1, DP7, and DP8. Flows along swale to DP10.1.
	9	OS6	2.33	0.16	20.7	0.38	3.04	1.2															Flows overland towards DP9 and into E. Flows combine at DP10.1.
	10	E	10.46	0.19	24.4	2.01	2.79	5.6															Flows overland towards DP10. Flows enter roadway swale and combine at DP10.1
	10.1								29.3	18.26	2.52	46.0								189	7.7	0.4	Combination of flows from DP8.1, DP9, and DP10. Flows along swale to DP12.1.

ULTIMATE STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 5-Year

Project Name: Filing 9-Ultimate
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/7/22

		DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			
STREET	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	11	OS7	63.10	0.19	30.7	11.85	2.44	29.0												425	2.9	2.4	Flows overland towards DP11 and into F. Flows combine at DP12.1.
	12	F	6.51	0.21	21.3	1.37	3.00	4.1															Flows overland towards DP12. Flows enter roadway swale and combine at DP12.1
	12.1								33.2	31.48	2.33	73.3											Combination of flows from DP10.1, DP11, and DP12. Flows along swale to DP13.1.
	13	G	2.42	0.53	24.3	1.28	2.80	3.6															Flow along south roadway towards DP13. Flows combine at DP13.1
	13.1								33.2	32.76	2.33	76.3											Combination of flows from DP12.1 and DP13. Flows along swale to DP14.1.
	14	OS8	68.37	0.23	40.6	15.47	2.03	31.4															Flows overland towards DP14. Flows enter swale and combine at DP14.1
	14.1								40.6	48.23	2.03	97.9											Combination of flows from DP13.1 and DP14. Flows along swale to South Pond.
	15	OS1	2.01	0.08	15.5	0.16	3.48	0.6															Flows overland towards DP15 and into H. Flows combine at DP16.1.
	16	H	8.65	0.19	17.5	1.66	3.29	5.5															Flows overland towards DP16. Flows combine at DP16.1.
	16.1								17.5	1.82	3.29	6.0								820	2.4	5.7	Combination of flows from DP15 and DP16. Flows along swale to DP17.1.
	17	J	4.56	0.35	12.9	1.62	3.75	6.1															Flows overland towards DP17. Flows along swale to DP17.1.
	17.1								23.2	3.44	2.87	9.9											Combination of flows from DP16.1 and DP17. Total flow into G1 Pond.

ULTIMATE STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 5-Year

Project Name: Filing 9-Ultimate
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/7/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	18	K	3.78	0.16	13.1	0.61	3.73	2.3															Flows overland in the direction of DP18 and flows off-site.
	19	I	0.62	0.08	14.3	0.05	3.60	0.2															Flows overland in the direction of DP19 and flows off-site.
	20	L	2.02	0.08	19.3	0.16	3.14	0.5															Flows overland in the direction of DP20 and flows off-site.
	21	M	15.65	0.16	20.1	2.54	3.08	7.8															Flows overland in the direction of DP21 and flows off-site.
	22	N	10.54	0.16	23.4	1.71	2.86	4.9															Flows overland in the direction of DP22 and flows off-site.
	23	O	5.87	0.16	20.2	0.95	3.07	2.9															Flows overland in the direction of DP23 and flows off-site.
	24	P	13.14	0.16	19.9	2.13	3.10	6.6															Flows overland in the direction of DP24 and flows off-site.

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

ULTIMATE STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 100-Year

Project Name: Filing 9-Ultimate
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/7/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C* A (ac)	I (in/hr)	Q (cfs)	tc (min)	C* A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C* A (ac)	Slope (%)	Q_{pipe} (cfs)	C* A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	1	OS2	2.12	0.47	9.9	0.99	6.96	6.9												518	4.7	1.8	Flows overland towards DP1 and into A. Flows enter roadside swale and flow towards DP2.1.
	2	A	1.58	0.48	11.1	0.77	6.68	5.1															Flows overland towards roadway swale and then to DP2. Flows combine at DP2.1.
	2.1								11.7	1.76	6.53	11.5								595	5.4	1.8	Combination of flows from DP1 and DP2. Flows along swale to DP4.1.
	3	OS3	51.16	0.43	23.5	22.09	4.77	105.5															Flows overland towards DP3 and into B. Flows combine at DP4.1.
	4	B	8.71	0.43	20.7	3.71	5.10	18.9															Flows overland towards DP4. Flows enter roadway swale and combine at DP4.1
	4.1								23.5	27.56	4.77	131.6								442	5.7	1.3	Combination of flows from DP2.1, DP3, and DP4. Flows along swale to DP6.1.
	5	OS4	3.70	0.42	19.0	1.55	5.32	8.2															Flows overland towards DP5 and into C. Flows combine at DP6.1.
	6	C	5.43	0.43	20.9	2.33	5.07	11.8															Flows overland towards DP6. Flows enter roadway swale and combine at DP6.1
	6.1								24.8	31.44	4.64	145.9								627	9.1	1.1	Combination of flows from DP4.1, DP5, and DP6. Flows along swale to DP8.1.
	7	OS5	3.99	0.41	16.4	1.64	5.68	9.3															Flows overland towards DP7 and into D. Flows combine at DP8.1.
	8	D	7.22	0.43	20.1	3.11	5.18	16.1															Flows overland towards DP8. Flows enter roadway swale and combine at DP8.1
	8.1								26.0	36.19	4.53	163.8								1041	10.4	1.7	Combination of flows from DP6.1, DP7, and DP8. Flows along swale to DP10.1.
	9	OS6	2.33	0.41	20.7	0.96	5.10	4.9															Flows overland towards DP9 and into E. Flows combine at DP10.1.
	10	E	10.46	0.43	24.4	4.54	4.68	21.3															Flows overland towards DP10. Flows enter roadway swale and combine at DP10.1
	10.1								27.7	41.69	4.37	182.1								189	10.9	0.3	Combination of flows from DP8.1, DP9, and DP10. Flows along swale to DP12.1.

ULTIMATE STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 100-Year

Project Name: Filing 9-Ultimate
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/7/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C* A (ac)	I (in/hr)	Q (cfs)	tc (min)	C* A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C* A (ac)	Slope (%)	Q_{pipe} (cfs)	C* A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	11	OS7	63.10	0.43	30.7	27.15	4.10	111.4												425	4.2	1.7	Flows overland towards DP11 and into F. Flows combine at DP12.1.
	12	F	6.51	0.45	21.3	2.91	5.03	14.6															Flows overland towards DP12. Flows enter roadway swale and combine at DP12.1
	12.1								32.4	71.75	3.97	284.6											Combination of flows from DP10.1, DP11, and DP12. Flows along swale to DP13.1.
	13	G	2.42	0.68	24.3	1.65	4.69	7.7															Flow along south roadway towards DP13. Flows combine at DP13.1
	13.1								32.4	73.40	3.97	291.2											Combination of flows from DP12.1 and DP13. Flows along swale to DP14.1.
	14	OS8	68.37	0.46	40.6	31.37	3.40	106.8															Flows overland towards DP14. Flows enter swale and combine at DP14.1
	14.1								40.6	104.77	3.40	356.7											Combination of flows from DP13.1 and DP14. Flows along swale to South Pond.
	15	OS1	2.01	0.35	15.5	0.70	5.83	4.1															Flows overland towards DP15 and into H. Flows combine at DP16.1.
	16	H	8.65	0.43	17.5	3.74	5.52	20.6															Flows overland towards DP16. Flows combine at DP16.1.
	16.1								17.5	4.44	5.52	24.5								820	3.4	4.0	Combination of flows from DP15 and DP16. Flows along swale to DP17.1.
	17	J	4.56	0.55	12.9	2.53	6.30	15.9															Flows overland towards DP17. Flows along swale to DP17.1.
	17.1								21.5	6.97	5.00	34.9											Combination of flows from DP16.1 and DP17. Total flow into G1 Pond.

ULTIMATE STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Latigo Trails
Location: El Paso County
Design Storm: 100-Year

Project Name: Filing 9-Ultimate
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/7/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	18	K	3.78	0.41	13.1	1.55	6.26	9.7															Flows overland in the direction of DP18 and flows off-site.
	19	I	0.62	0.35	14.3	0.22	6.04	1.3															Flows overland in the direction of DP19 and flows off-site.
	20	L	2.02	0.35	19.3	0.71	5.28	3.7															Flows overland in the direction of DP20 and flows off-site.
	21	M	15.65	0.41	20.1	6.43	5.17	33.3															Flows overland in the direction of DP21 and flows off-site.
	22	N	10.54	0.41	23.4	4.33	4.79	20.8															Flows overland in the direction of DP22 and flows off-site.
	23	O	5.87	0.41	20.2	2.41	5.16	12.4															Flows overland in the direction of DP23 and flows off-site.
	24	P	13.14	0.41	19.9	5.40	5.20	28.1															Flows overland in the direction of DP24 and flows off-site.

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

APPENDIX C

HYDRAULIC CALCULATIONS

Channel Report

5: DP1 to DP2.1

Triangular

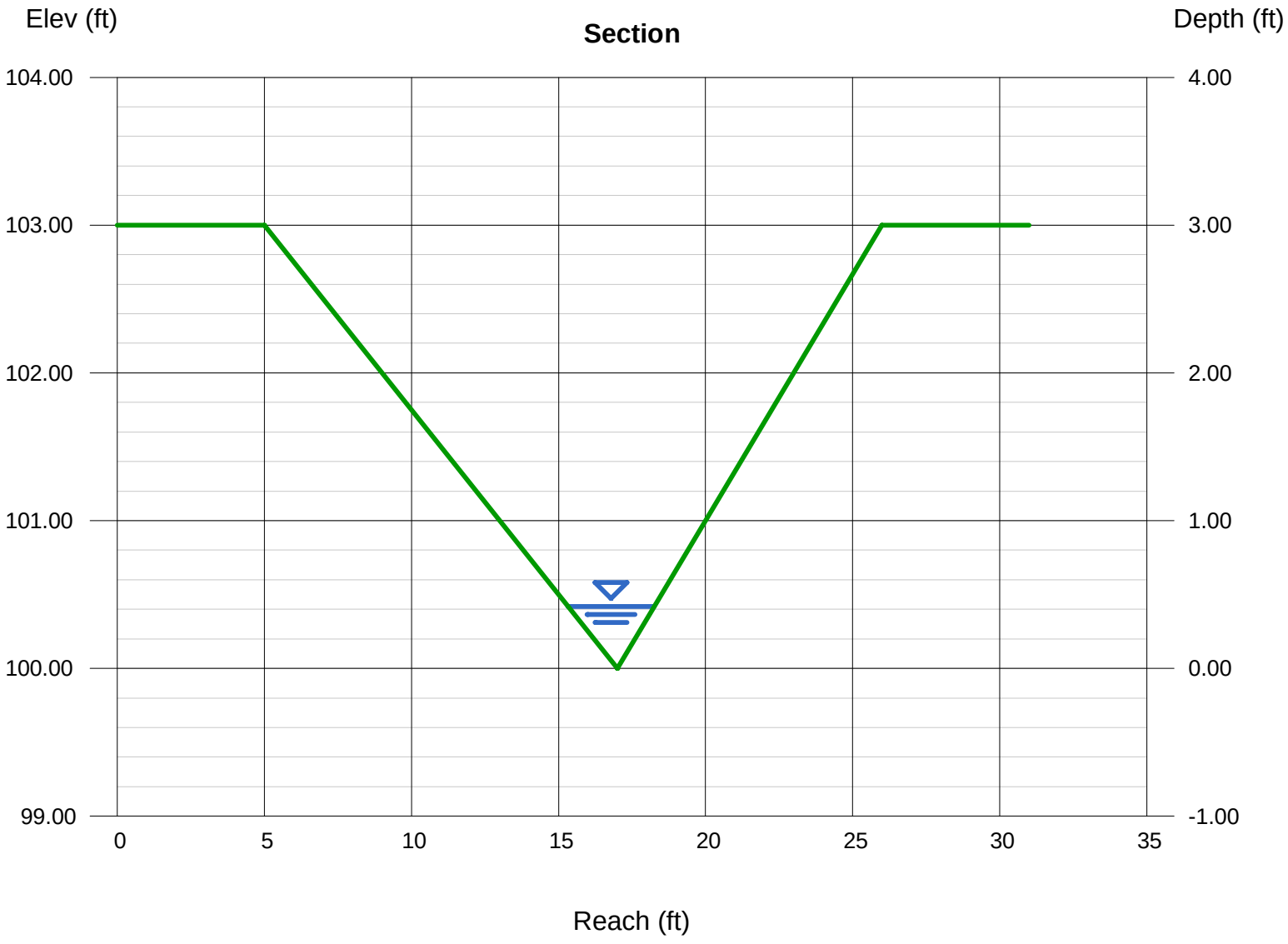
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 4.21
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 2.10

Highlighted

Depth (ft)	= 0.42
Q (cfs)	= 2.100
Area (sqft)	= 0.62
Velocity (ft/s)	= 3.40
Wetted Perim (ft)	= 3.06
Crit Depth, Yc (ft)	= 0.47
Top Width (ft)	= 2.94
EGL (ft)	= 0.60



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 16 2021

100: DP1 to DP2.1

Triangular

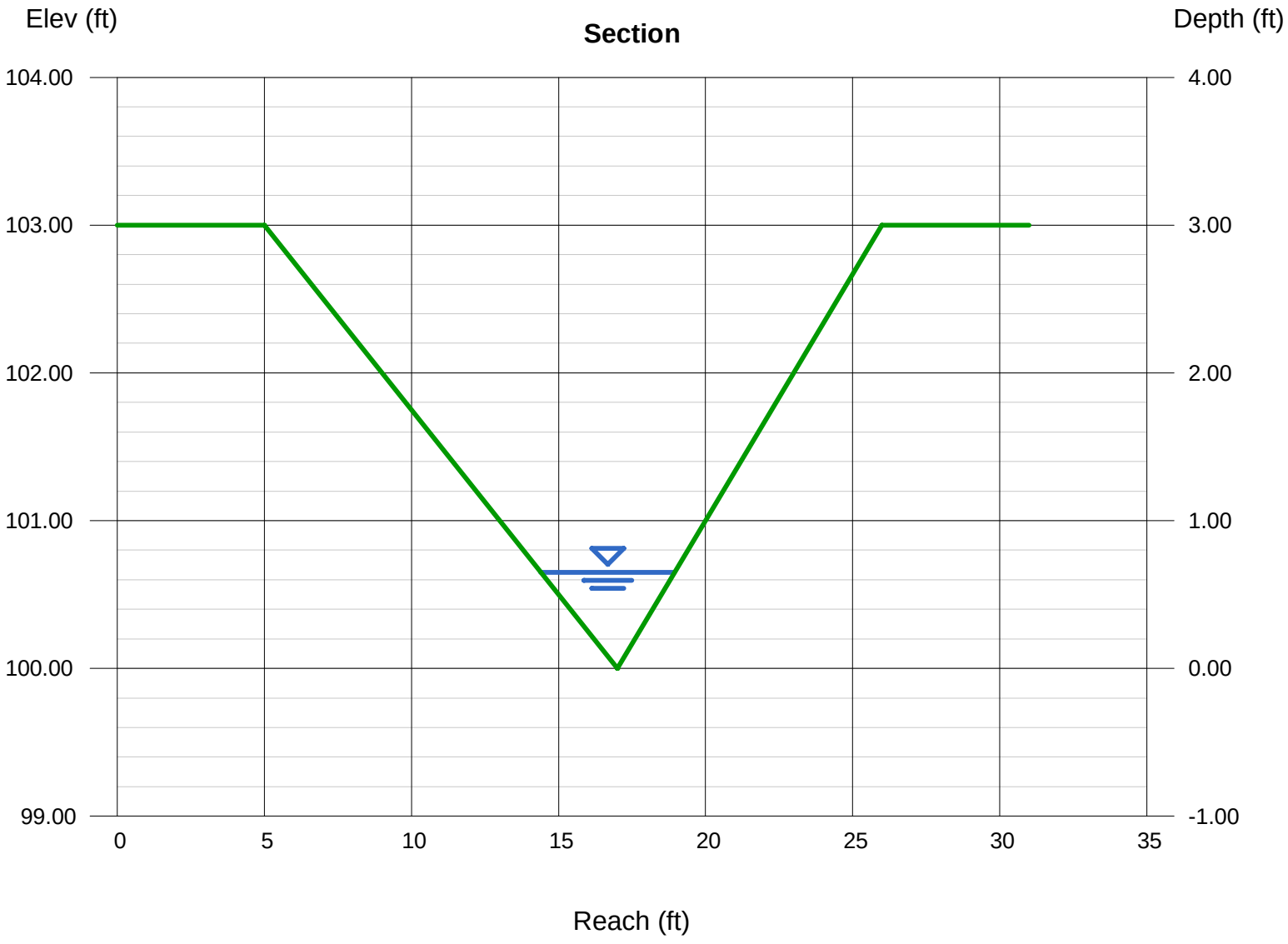
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 4.21
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 6.90

Highlighted

Depth (ft)	= 0.65
Q (cfs)	= 6.900
Area (sqft)	= 1.48
Velocity (ft/s)	= 4.67
Wetted Perim (ft)	= 4.74
Crit Depth, Yc (ft)	= 0.76
Top Width (ft)	= 4.55
EGL (ft)	= 0.99



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 16 2021

100: DP1 to DP2.1- Capacity

Triangular

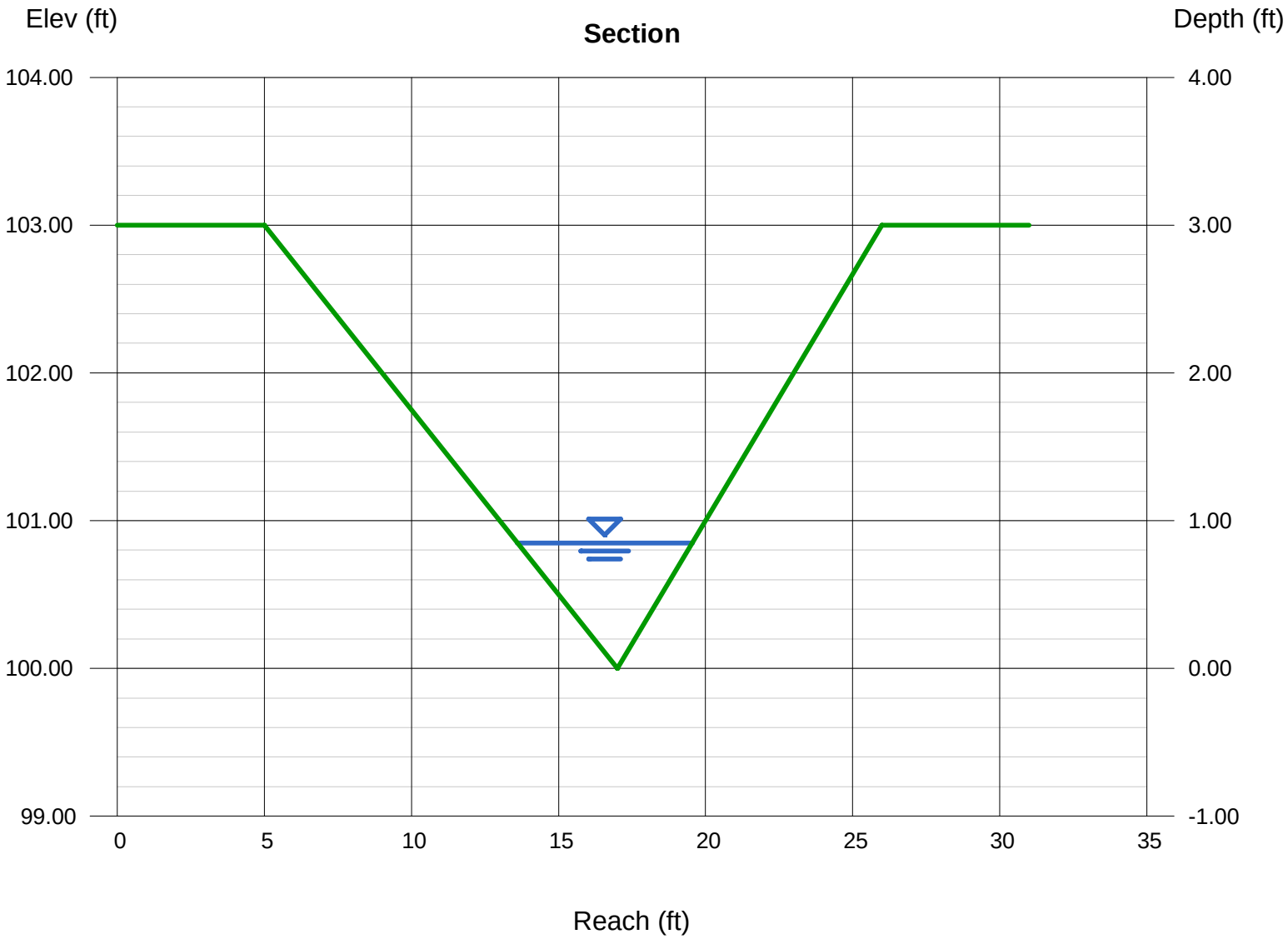
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.06
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 6.90

Highlighted

Depth (ft)	= 0.85
Q (cfs)	= 6.900
Area (sqft)	= 2.53
Velocity (ft/s)	= 2.73
Wetted Perim (ft)	= 6.19
Crit Depth, Yc (ft)	= 0.76
Top Width (ft)	= 5.95
EGL (ft)	= 0.97



Channel Report

5: DP2.1 to DP4.1

Triangular

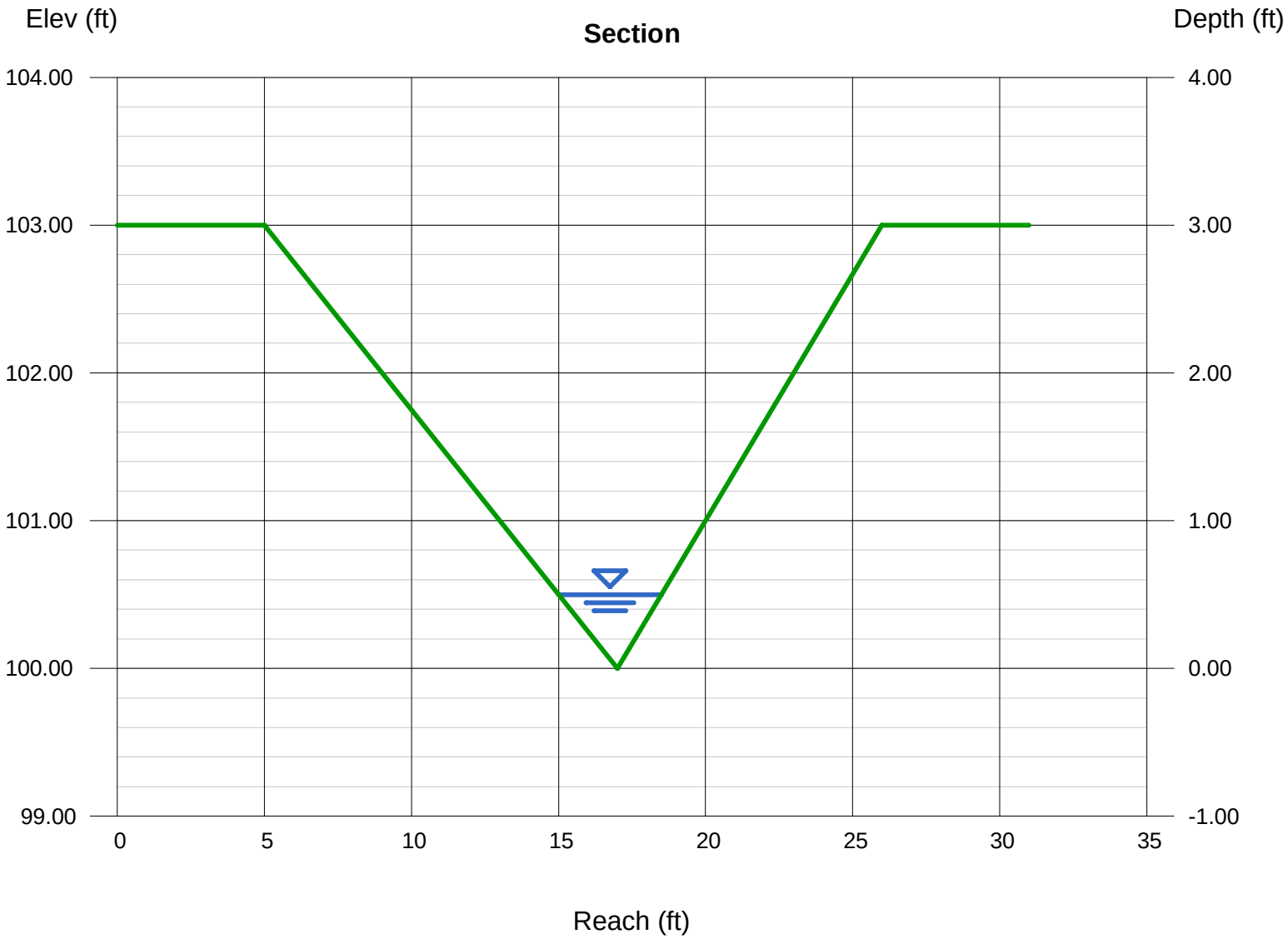
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 4.59
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3.50

Highlighted

Depth (ft)	= 0.50
Q (cfs)	= 3.500
Area (sqft)	= 0.87
Velocity (ft/s)	= 4.00
Wetted Perim (ft)	= 3.64
Crit Depth, Yc (ft)	= 0.58
Top Width (ft)	= 3.50
EGL (ft)	= 0.75



Channel Report

100: DP2.1 to DP4.1

Triangular

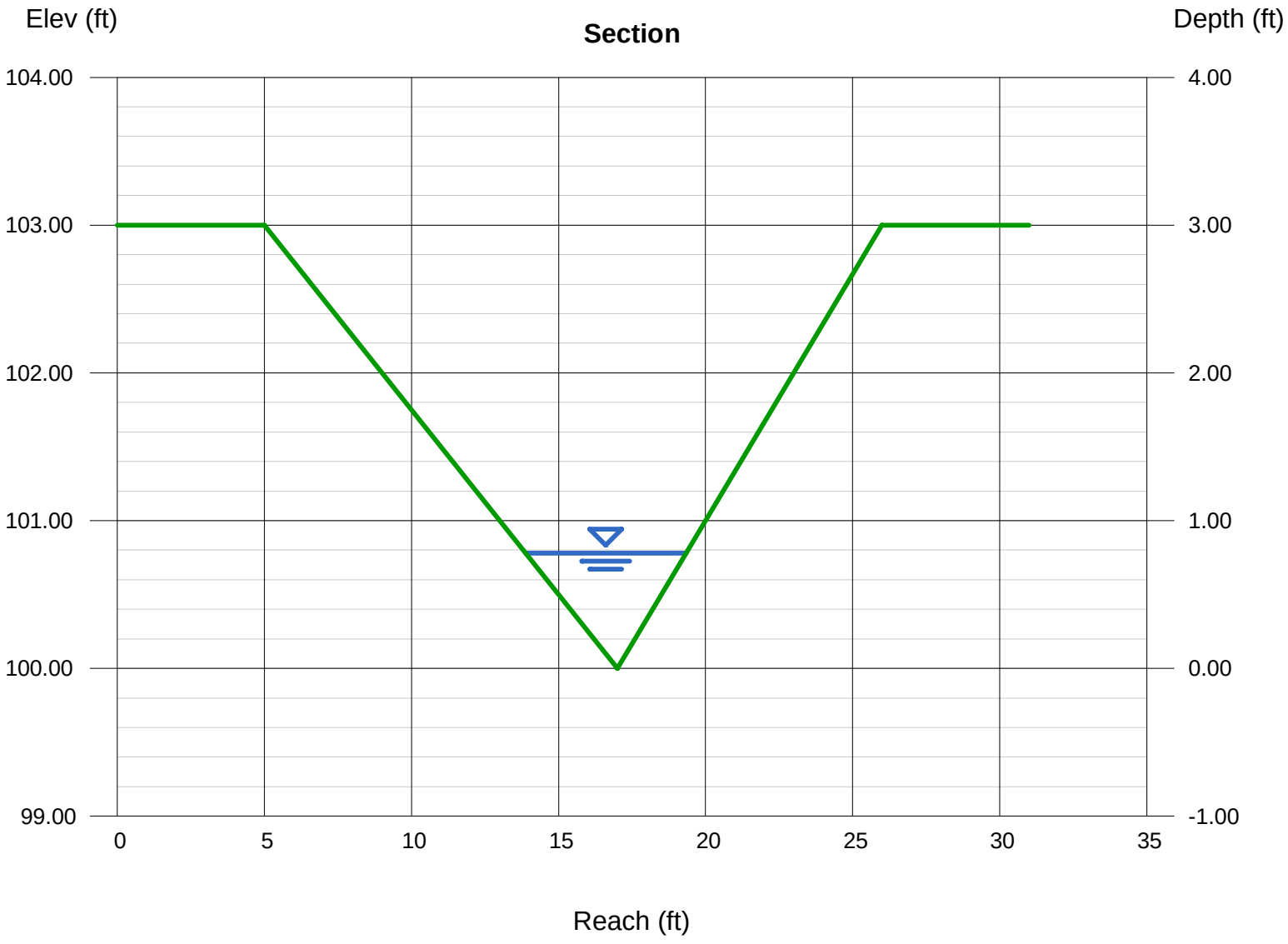
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 4.59
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 11.50

Highlighted

Depth (ft)	= 0.78
Q (cfs)	= 11.50
Area (sqft)	= 2.13
Velocity (ft/s)	= 5.40
Wetted Perim (ft)	= 5.68
Crit Depth, Yc (ft)	= 0.93
Top Width (ft)	= 5.46
EGL (ft)	= 1.23



Channel Report

100: DP2.1 to DP4.1-Capacity

Triangular

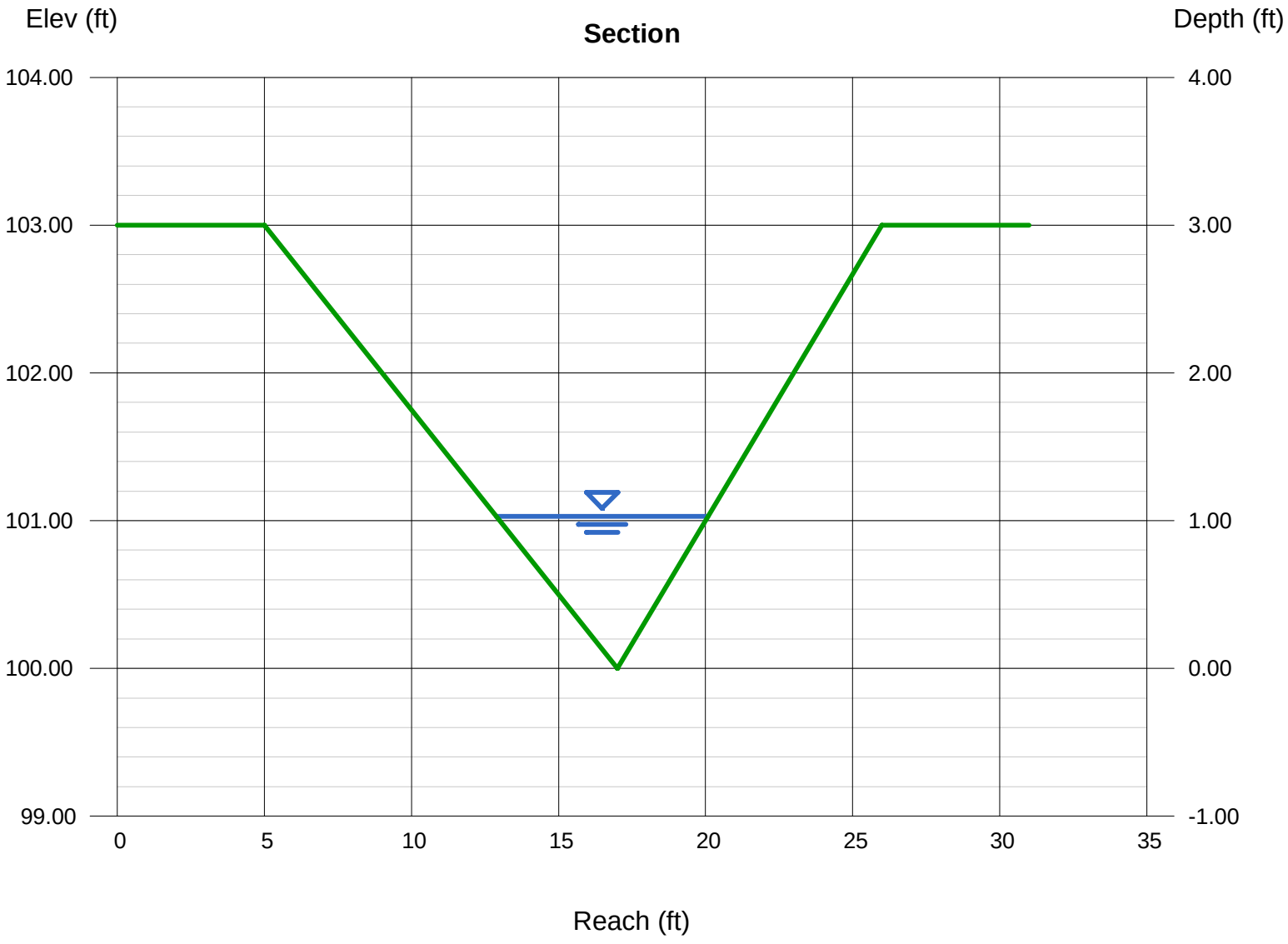
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 11.50

Highlighted

Depth (ft)	= 1.03
Q (cfs)	= 11.50
Area (sqft)	= 3.71
Velocity (ft/s)	= 3.10
Wetted Perim (ft)	= 7.50
Crit Depth, Yc (ft)	= 0.93
Top Width (ft)	= 7.21
EGL (ft)	= 1.18



Channel Report

5: DP4.1 to DP6.1

Triangular

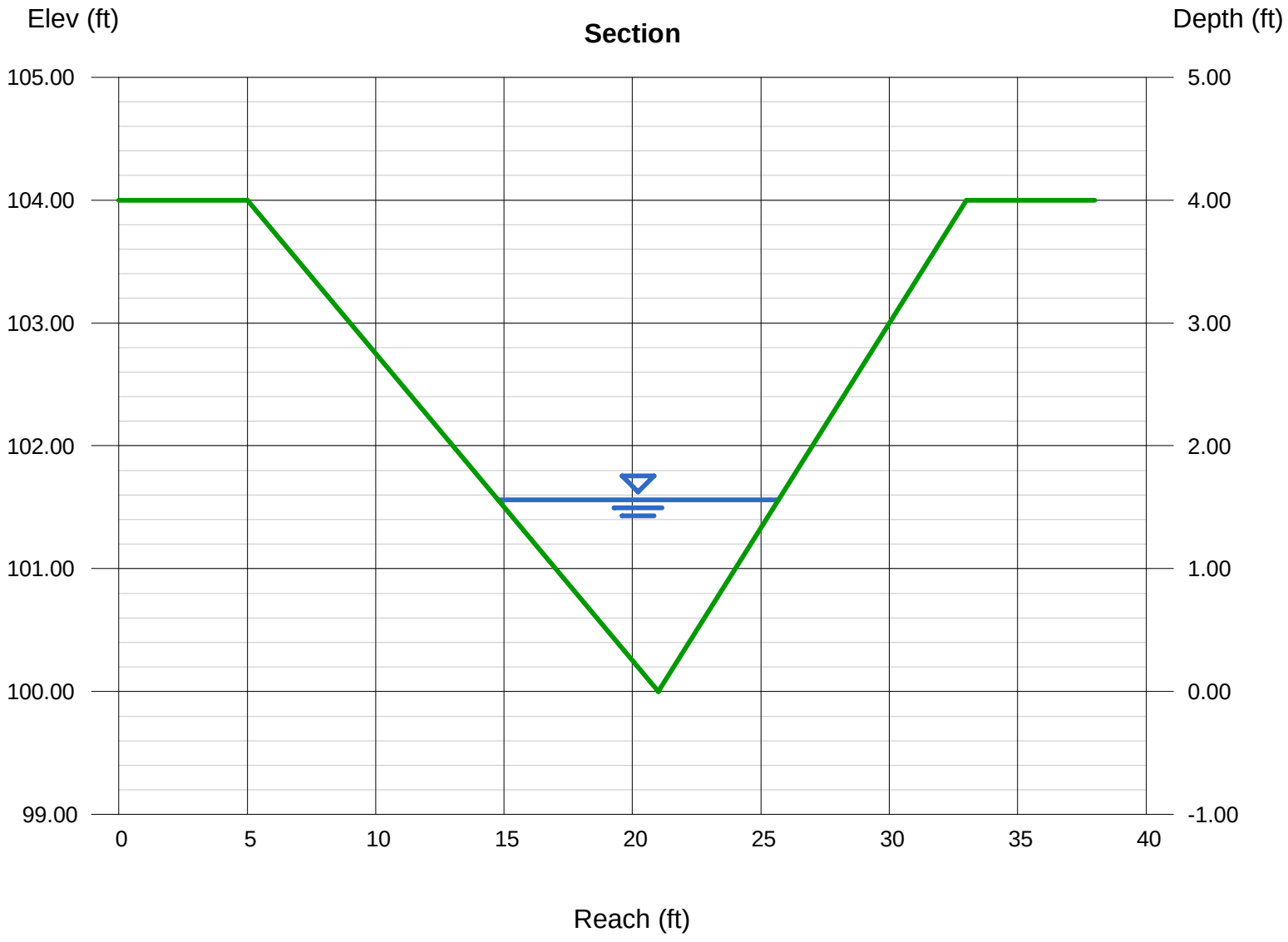
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 34.70

Highlighted

Depth (ft)	= 1.56
Q (cfs)	= 34.70
Area (sqft)	= 8.52
Velocity (ft/s)	= 4.07
Wetted Perim (ft)	= 11.37
Crit Depth, Yc (ft)	= 1.44
Top Width (ft)	= 10.92
EGL (ft)	= 1.82



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 16 2021

100: DP4.1 to DP6.1

Triangular

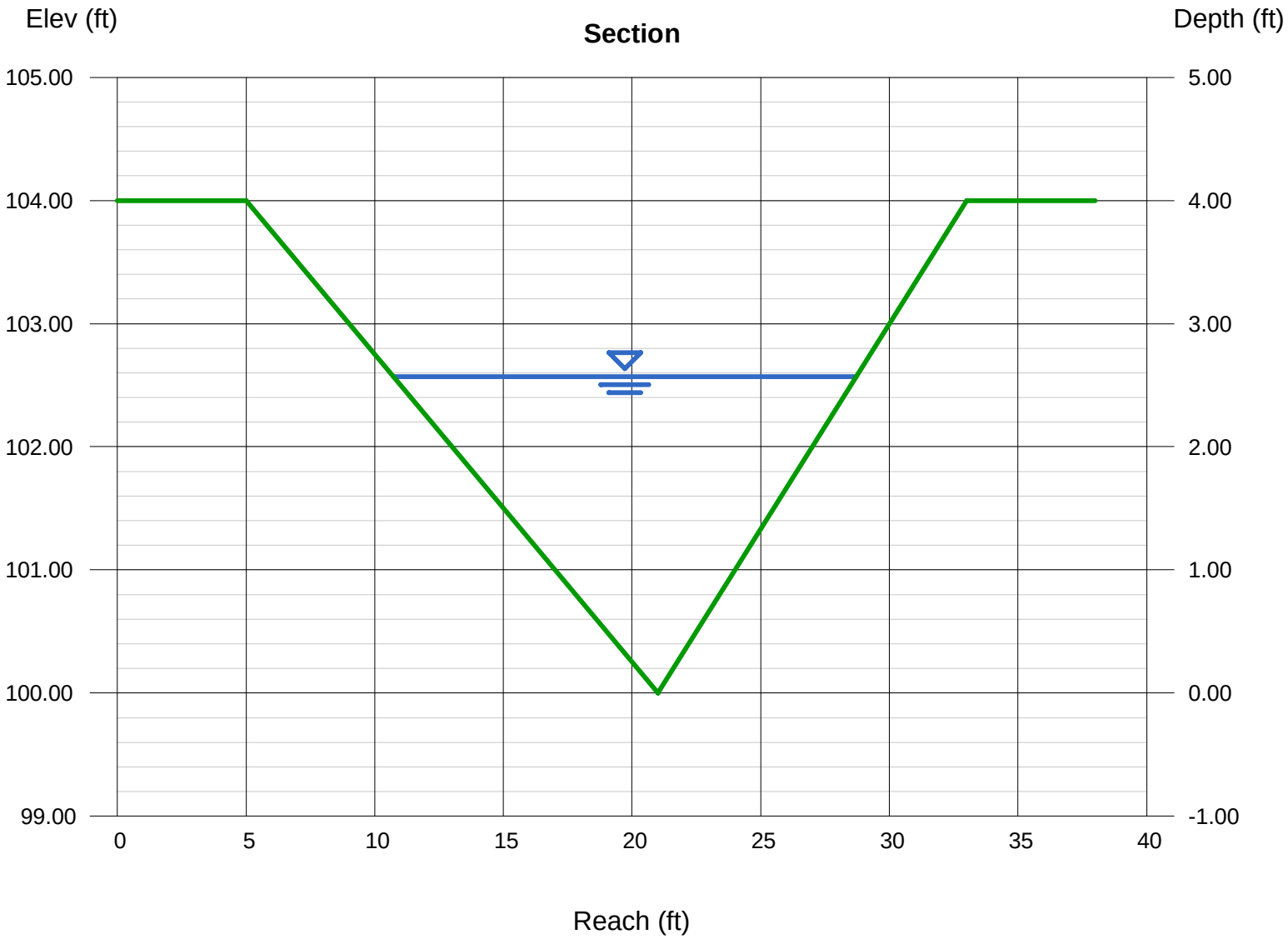
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 131.60

Highlighted

Depth (ft)	= 2.57
Q (cfs)	= 131.60
Area (sqft)	= 23.12
Velocity (ft/s)	= 5.69
Wetted Perim (ft)	= 18.72
Crit Depth, Yc (ft)	= 2.45
Top Width (ft)	= 17.99
EGL (ft)	= 3.07



Channel Report

100: DP4.1 to DP6.1-Capacity

Triangular

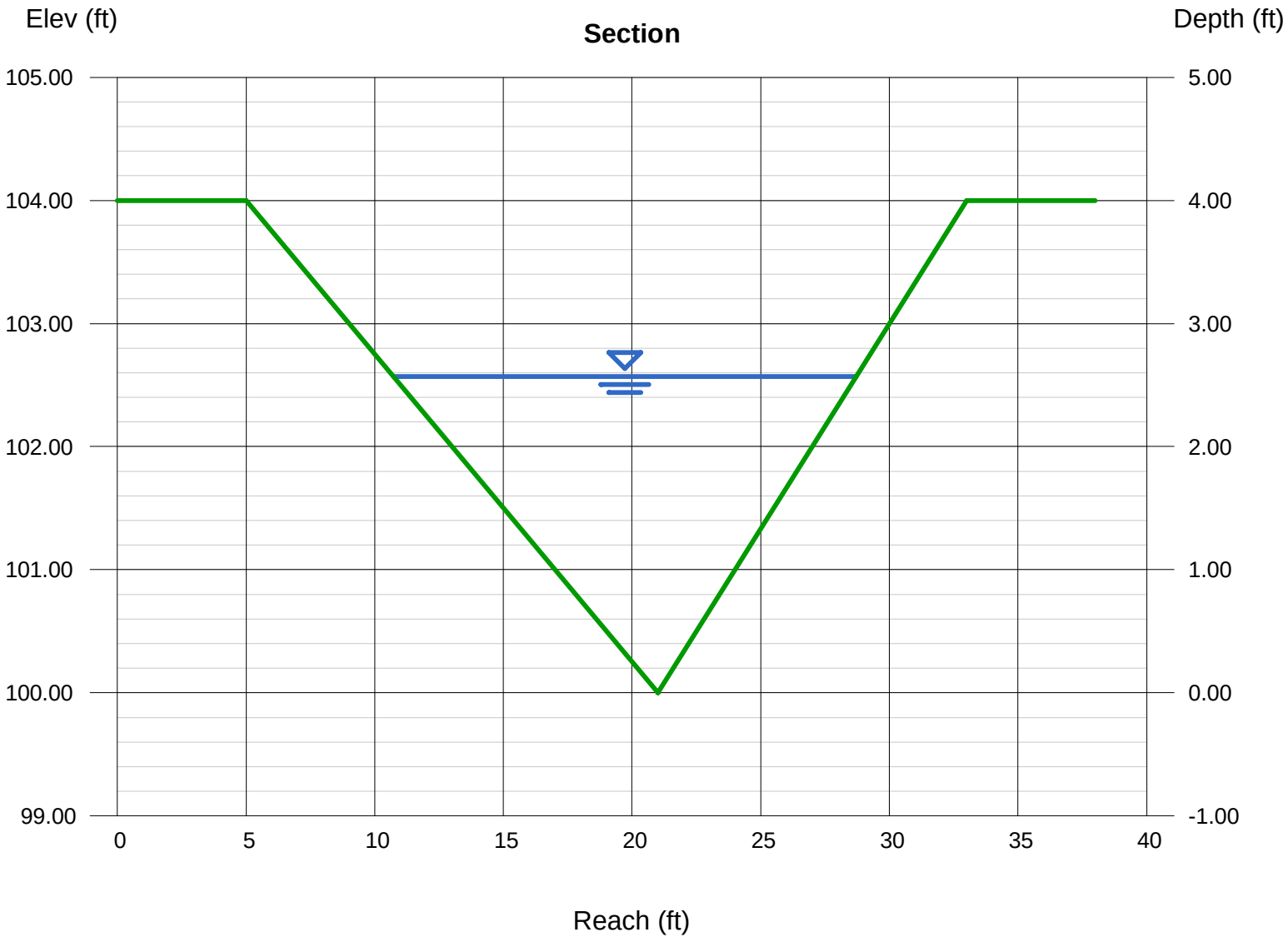
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 131.60

Highlighted

Depth (ft)	= 2.57
Q (cfs)	= 131.60
Area (sqft)	= 23.12
Velocity (ft/s)	= 5.69
Wetted Perim (ft)	= 18.72
Crit Depth, Yc (ft)	= 2.45
Top Width (ft)	= 17.99
EGL (ft)	= 3.07



Channel Report

5: DP6.1 to DP8.1

Triangular

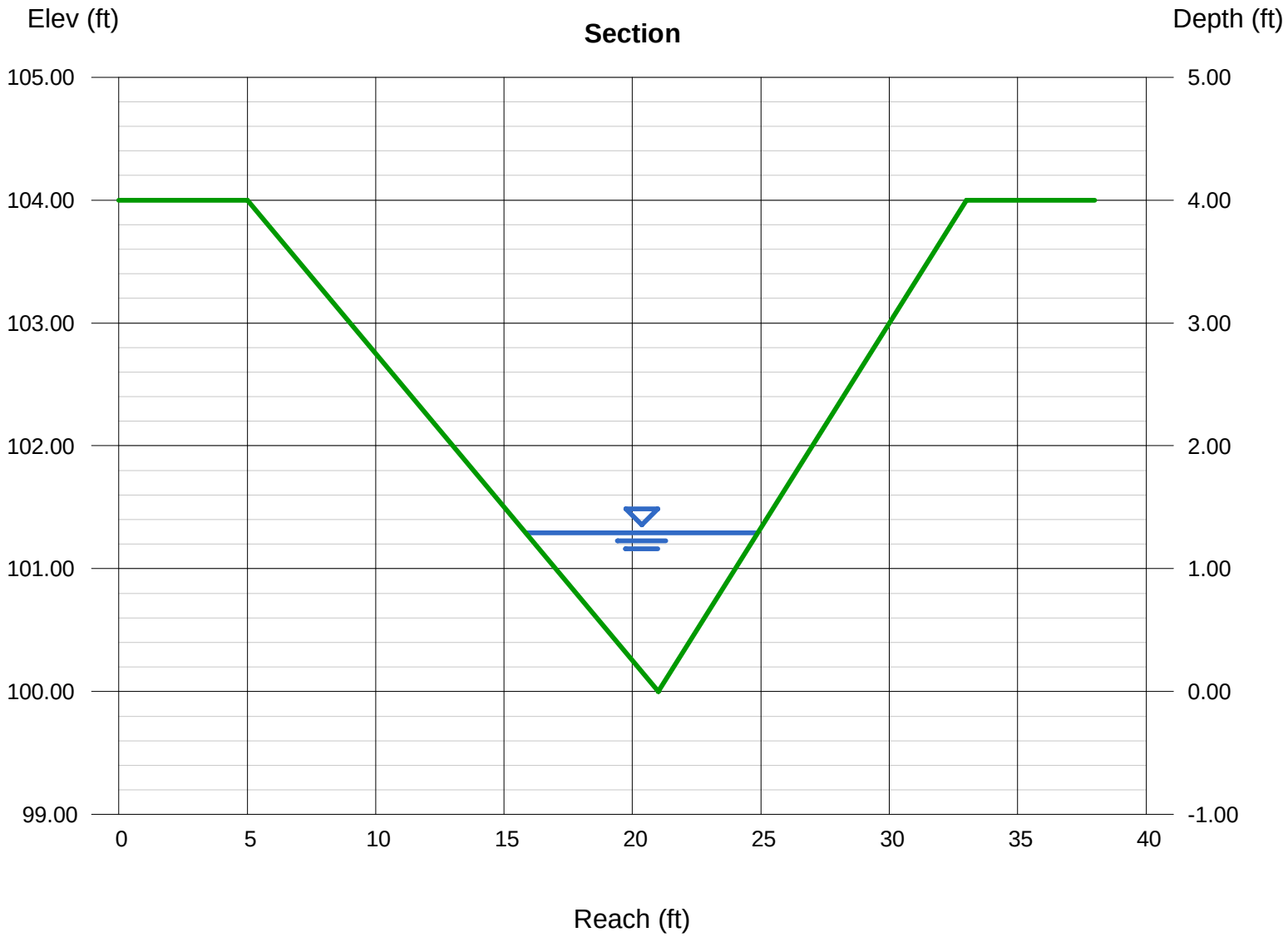
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 3.32
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 37.90

Highlighted

Depth (ft)	= 1.29
Q (cfs)	= 37.90
Area (sqft)	= 5.82
Velocity (ft/s)	= 6.51
Wetted Perim (ft)	= 9.40
Crit Depth, Yc (ft)	= 1.49
Top Width (ft)	= 9.03
EGL (ft)	= 1.95



Channel Report

100: DP6.1 to DP8.1

Triangular

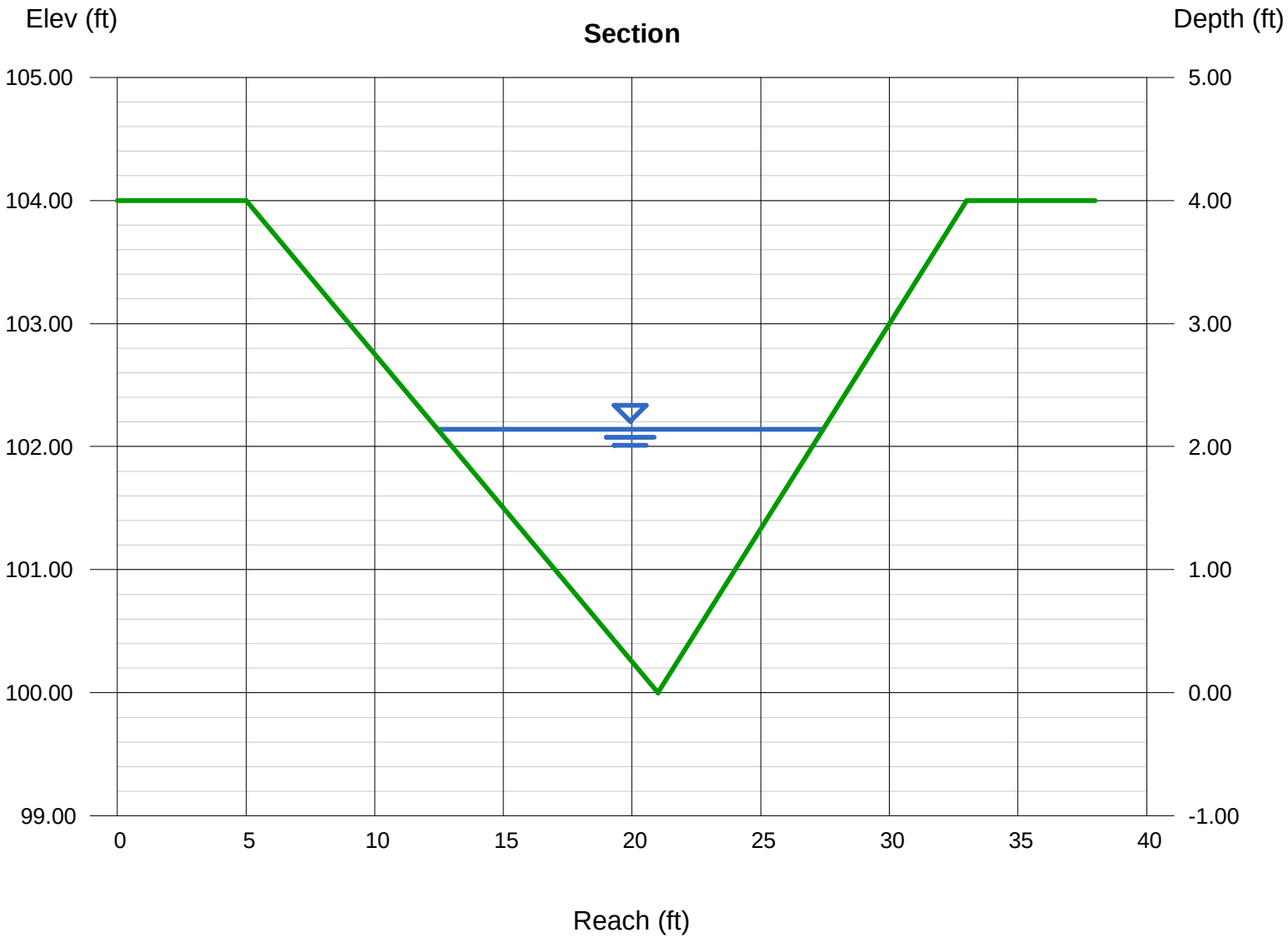
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 3.32
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 145.90

Highlighted

Depth (ft)	= 2.14
Q (cfs)	= 145.90
Area (sqft)	= 16.03
Velocity (ft/s)	= 9.10
Wetted Perim (ft)	= 15.59
Crit Depth, Yc (ft)	= 2.56
Top Width (ft)	= 14.98
EGL (ft)	= 3.43



Channel Report

100: DP6.1 to DP8.1-Capacity

Triangular

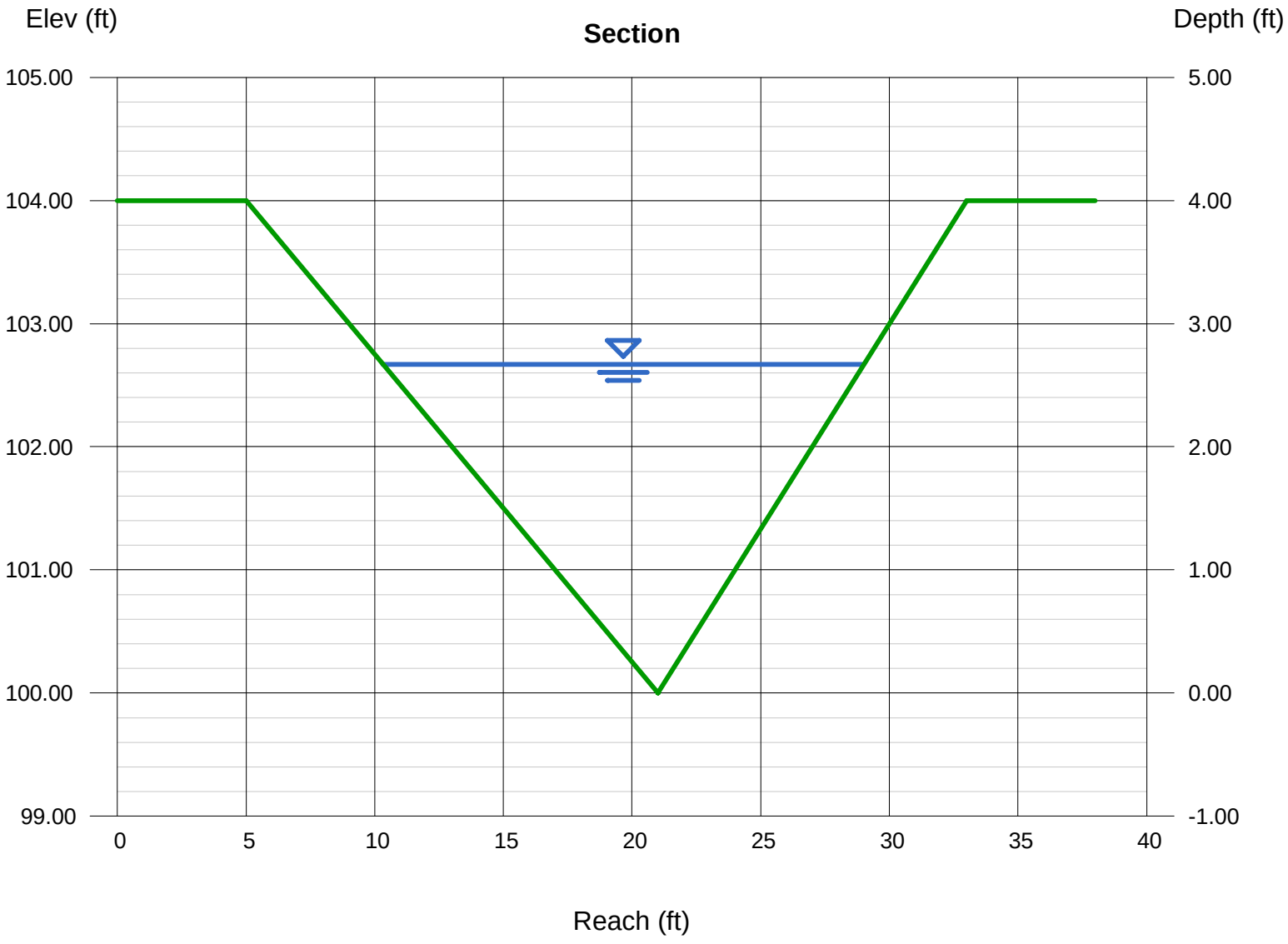
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 145.90

Highlighted

Depth (ft)	= 2.67
Q (cfs)	= 145.90
Area (sqft)	= 24.95
Velocity (ft/s)	= 5.85
Wetted Perim (ft)	= 19.45
Crit Depth, Yc (ft)	= 2.56
Top Width (ft)	= 18.69
EGL (ft)	= 3.20



Channel Report

5: DP8.1 to DP10.1

Triangular

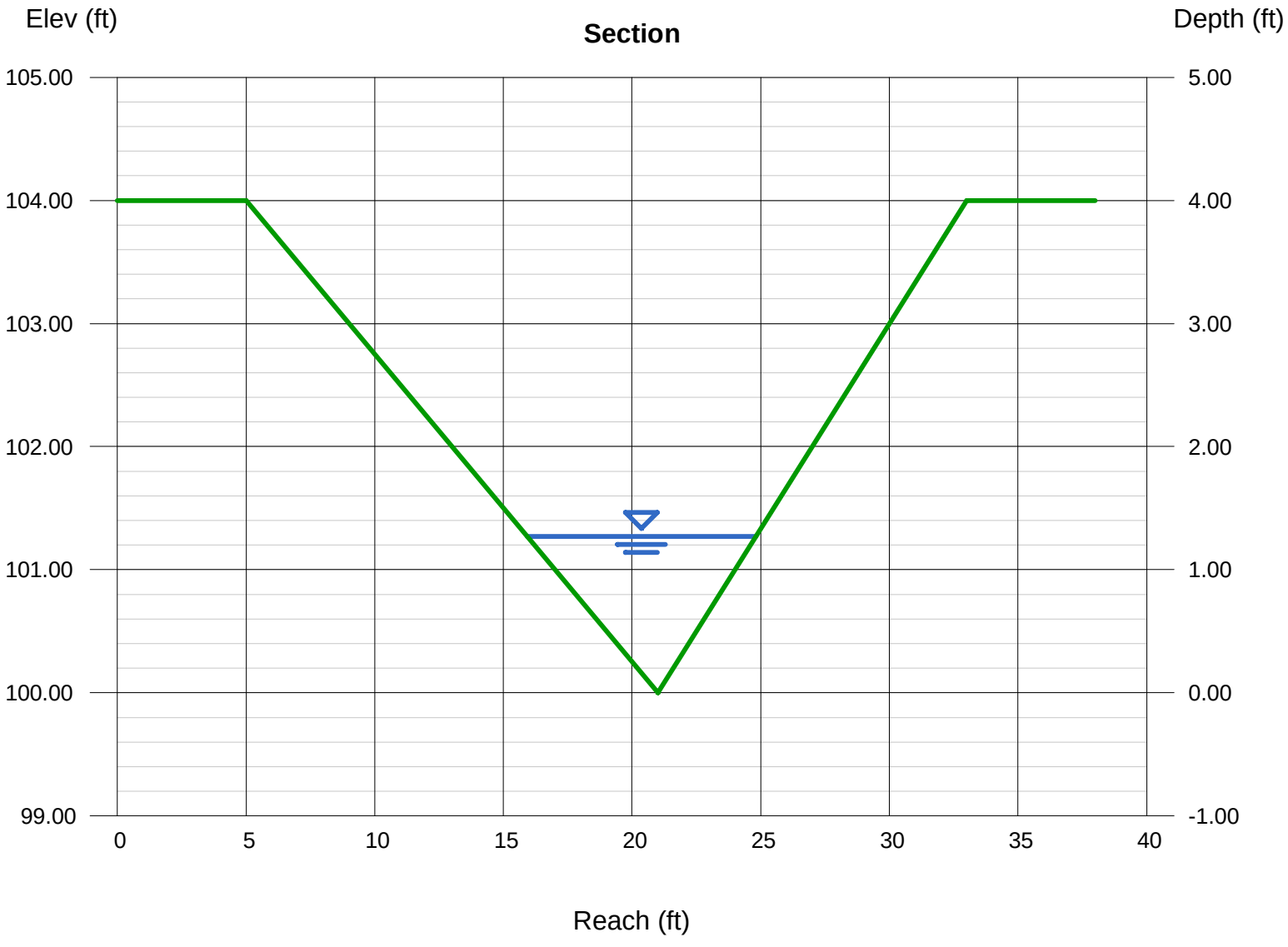
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 4.35
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 41.90

Highlighted

Depth (ft)	= 1.27
Q (cfs)	= 41.90
Area (sqft)	= 5.65
Velocity (ft/s)	= 7.42
Wetted Perim (ft)	= 9.25
Crit Depth, Yc (ft)	= 1.55
Top Width (ft)	= 8.89
EGL (ft)	= 2.13



Channel Report

100: DP8.1 to DP10.1

Triangular

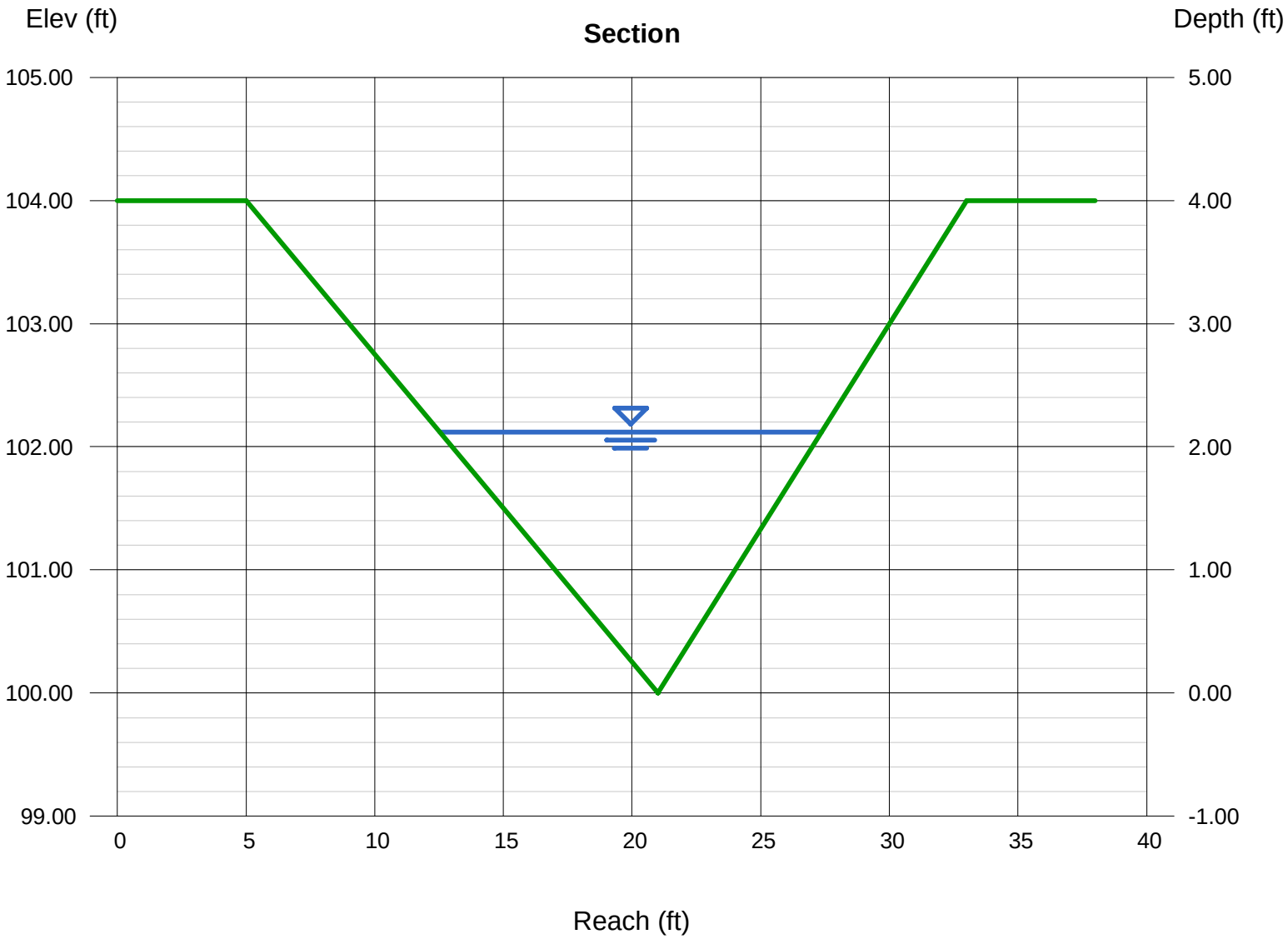
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 4.35
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 163.80

Highlighted

Depth (ft)	= 2.12
Q (cfs)	= 163.80
Area (sqft)	= 15.73
Velocity (ft/s)	= 10.41
Wetted Perim (ft)	= 15.45
Crit Depth, Yc (ft)	= 2.68
Top Width (ft)	= 14.84
EGL (ft)	= 3.81



Channel Report

100: DP8.1 to DP10.1-Capacity

Triangular

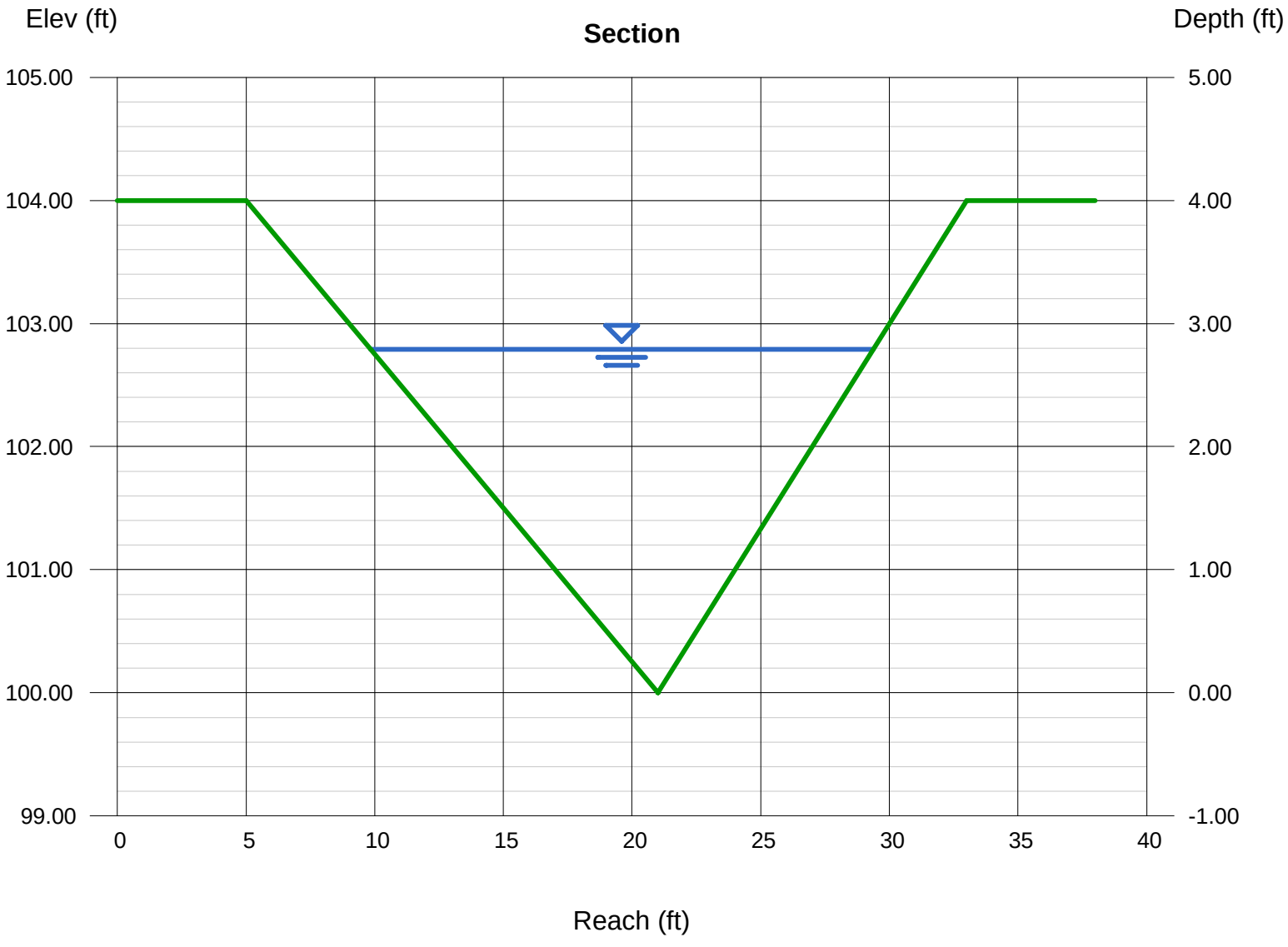
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 163.80

Highlighted

Depth (ft)	= 2.79
Q (cfs)	= 163.80
Area (sqft)	= 27.24
Velocity (ft/s)	= 6.01
Wetted Perim (ft)	= 20.33
Crit Depth, Yc (ft)	= 2.68
Top Width (ft)	= 19.53
EGL (ft)	= 3.35



HY-8 Culvert Analysis Report: Buffalo River Trail Culvert

Crossing Discharge Data

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

Minimum Flow: 0.00 cfs

Design Flow: 182.10 cfs

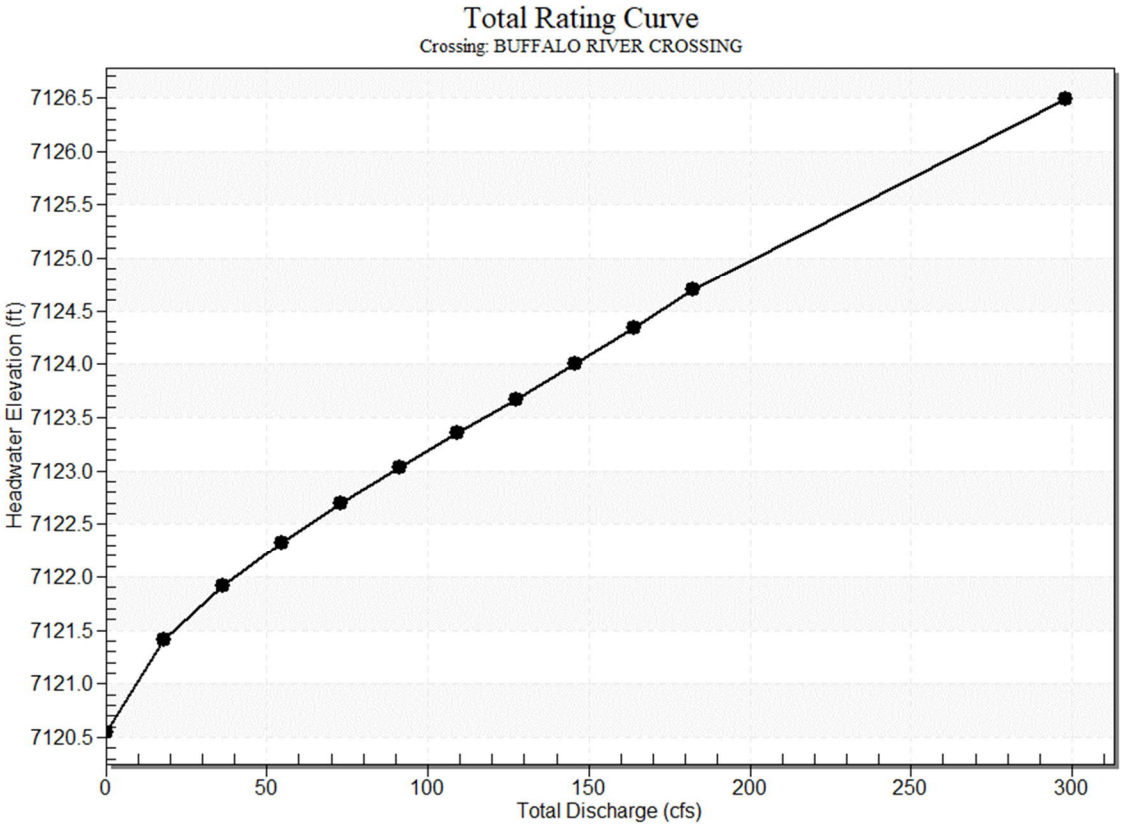
Maximum Flow: 182.10 cfs

Table 1 - Summary of Culvert Flows at Crossing: BUFFALO RIVER CROSSING

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7120.55	0.00	0.00	0.00	1
7121.41	18.21	18.21	0.00	1
7121.91	36.42	36.42	0.00	1
7122.33	54.63	54.63	0.00	1
7122.69	72.84	72.84	0.00	1
7123.03	91.05	91.05	0.00	1
7123.35	109.26	109.26	0.00	1
7123.67	127.47	127.47	0.00	1
7124.00	145.68	145.68	0.00	1
7124.34	163.89	163.89	0.00	1
7124.70	182.10	182.10	0.00	1
7125.97	236.50	236.50	0.00	Overtopping

Hw/D = 4.15/3 = 1.38

Rating Curve Plot for Crossing: BUFFALO RIVER CROSSING



Culvert Data: Culvert

Table 2 - Culvert Summary Table: Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7120.55	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
18.21	18.21	7121.41	0.86	0.265	1-S2n	0.42	0.50	0.42	0.55	4.81	2.94
36.42	36.42	7121.91	1.36	0.561	1-S2n	0.65	0.80	0.66	0.81	6.15	3.66
54.63	54.63	7122.33	1.78	0.854	1-S2n	0.84	1.05	0.86	1.01	7.03	4.13
72.84	72.84	7122.69	2.14	1.159	1-S2n	1.01	1.27	1.05	1.18	7.70	4.50
91.05	91.05	7123.03	2.48	1.470	1-S2n	1.16	1.47	1.23	1.33	8.24	4.79
109.26	109.26	7123.35	2.80	1.792	1-S2n	1.31	1.66	1.39	1.46	8.71	5.05
127.47	127.47	7123.67	3.12	2.127	5-S2n	1.45	1.84	1.55	1.58	9.12	5.27
145.68	145.68	7124.00	3.45	2.478	5-S2n	1.59	2.01	1.71	1.69	9.48	5.47
163.89	163.89	7124.34	3.79	2.846	5-S2n	1.72	2.18	1.86	1.79	9.82	5.65
182.10	182.10	7124.70	4.15	3.565	5-S2n	1.84	2.33	2.00	1.89	10.12	5.82

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

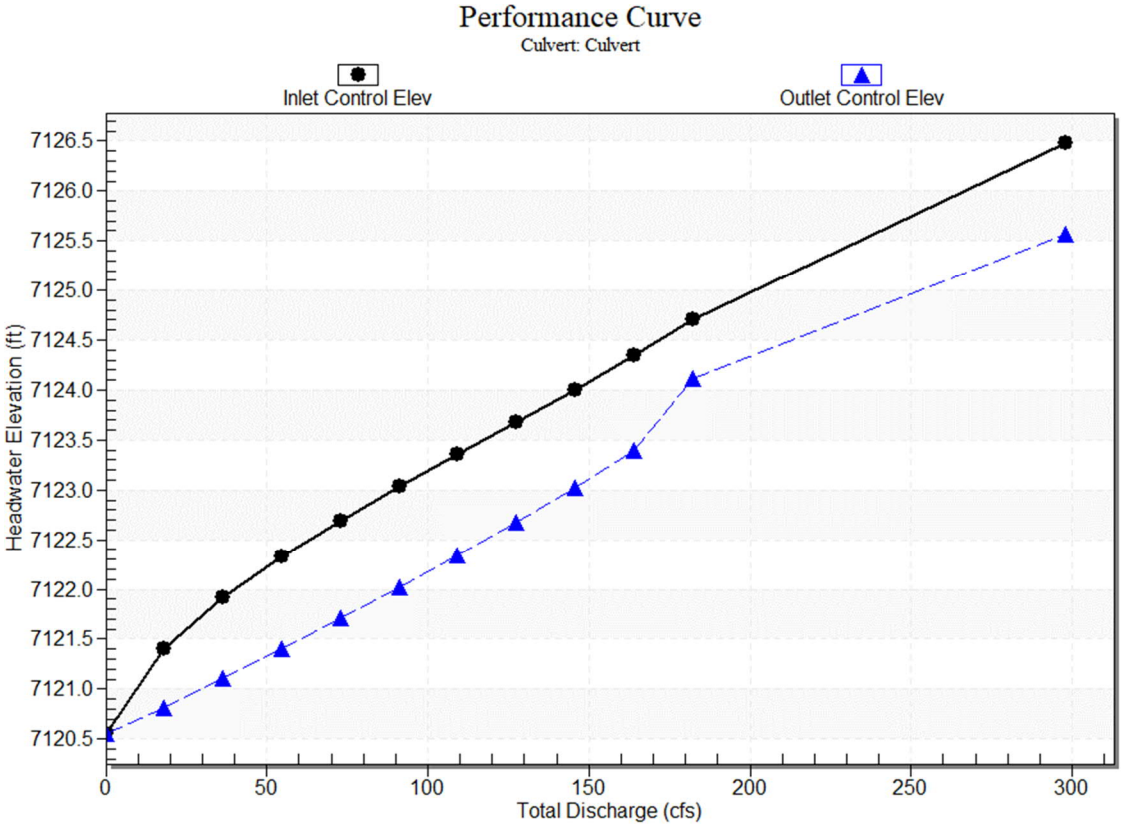
Inlet Elevation (invert): 7120.55 ft,

Outlet Elevation (invert): 7120.25 ft

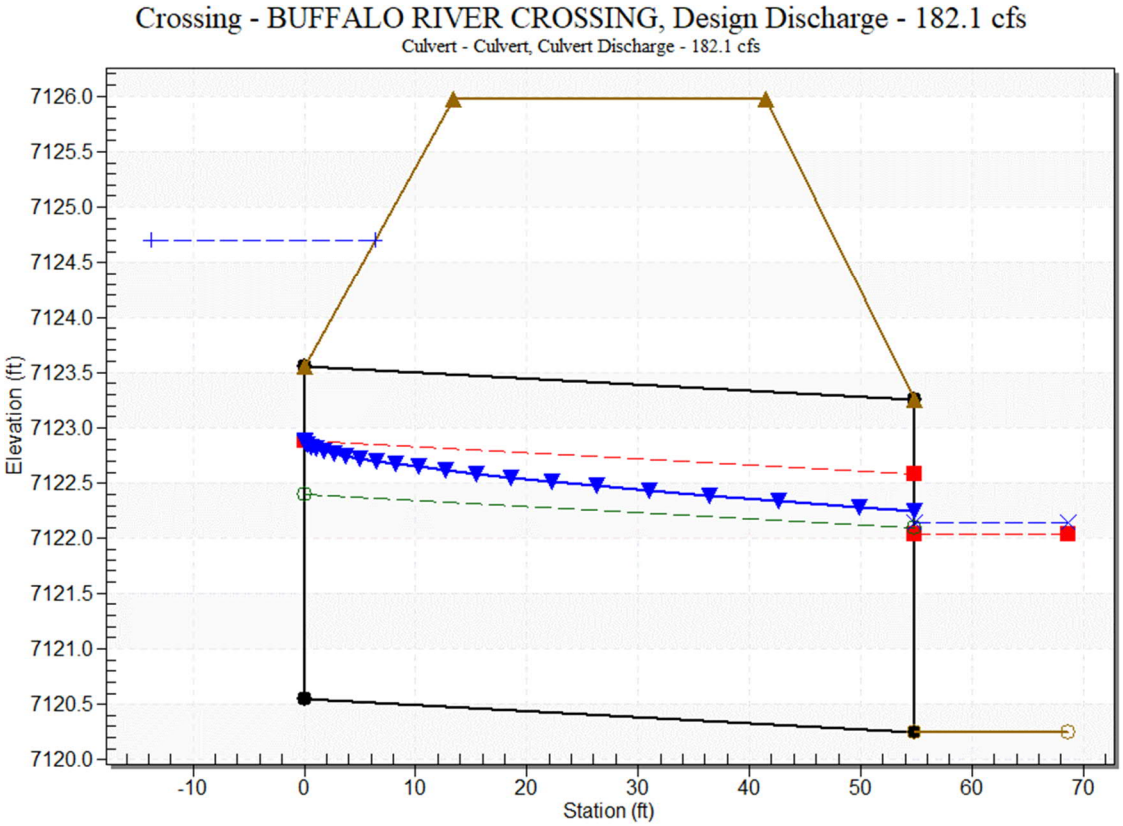
Culvert Length: 54.90 ft,

Culvert Slope: 0.0055

Culvert Performance Curve Plot: Culvert



Water Surface Profile Plot for Culvert: Culvert



Site Data - Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7120.55 ft

Outlet Station: 54.90 ft

Outlet Elevation: 7120.25 ft

Number of Barrels: 1

Culvert Data Summary - Culvert

Barrel Shape: Concrete Box

Barrel Span: 9.00 ft

Barrel Rise: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: BUFFALO RIVER CROSSING

Table 3 - Downstream Channel Rating Curve (Crossing: BUFFALO RIVER CROSSING)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	7120.25	0.00	0.00	0.00	0.00
18.21	7120.80	0.55	2.94	0.34	0.76
36.42	7121.06	0.81	3.66	0.51	0.80
54.63	7121.26	1.01	4.13	0.63	0.83
72.84	7121.43	1.18	4.50	0.74	0.85
91.05	7121.58	1.33	4.79	0.83	0.86
109.26	7121.71	1.46	5.05	0.91	0.87
127.47	7121.83	1.58	5.27	0.99	0.88
145.68	7121.94	1.69	5.47	1.05	0.89
163.89	7122.04	1.79	5.65	1.12	0.89
182.10	7122.14	1.89	5.82	1.18	0.90

Tailwater Channel Data - BUFFALO RIVER CROSSING

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 9.00 ft

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

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 7120.25 ft

Roadway Data for Crossing: BUFFALO RIVER CROSSING

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 38.00 ft

Crest Elevation: 7125.97 ft

Roadway Surface: Paved

Roadway Top Width: 28.00 ft

Channel Report

100: DP13

Triangular

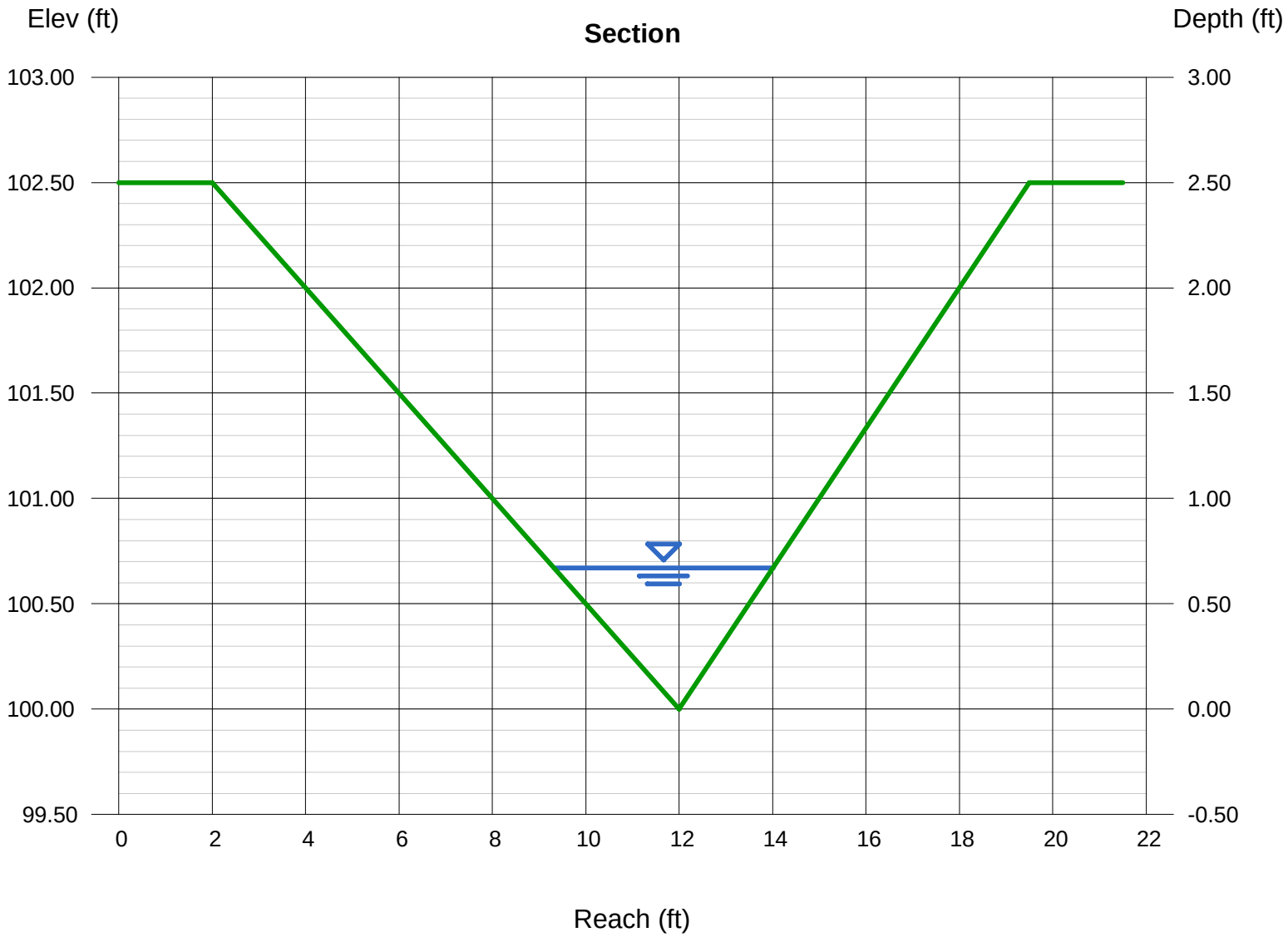
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 4.59
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 7.70

Highlighted

Depth (ft)	= 0.67
Q (cfs)	= 7.700
Area (sqft)	= 1.57
Velocity (ft/s)	= 4.90
Wetted Perim (ft)	= 4.88
Crit Depth, Yc (ft)	= 0.79
Top Width (ft)	= 4.69
EGL (ft)	= 1.04



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 16 2021

100: DP13-Capacity

Triangular

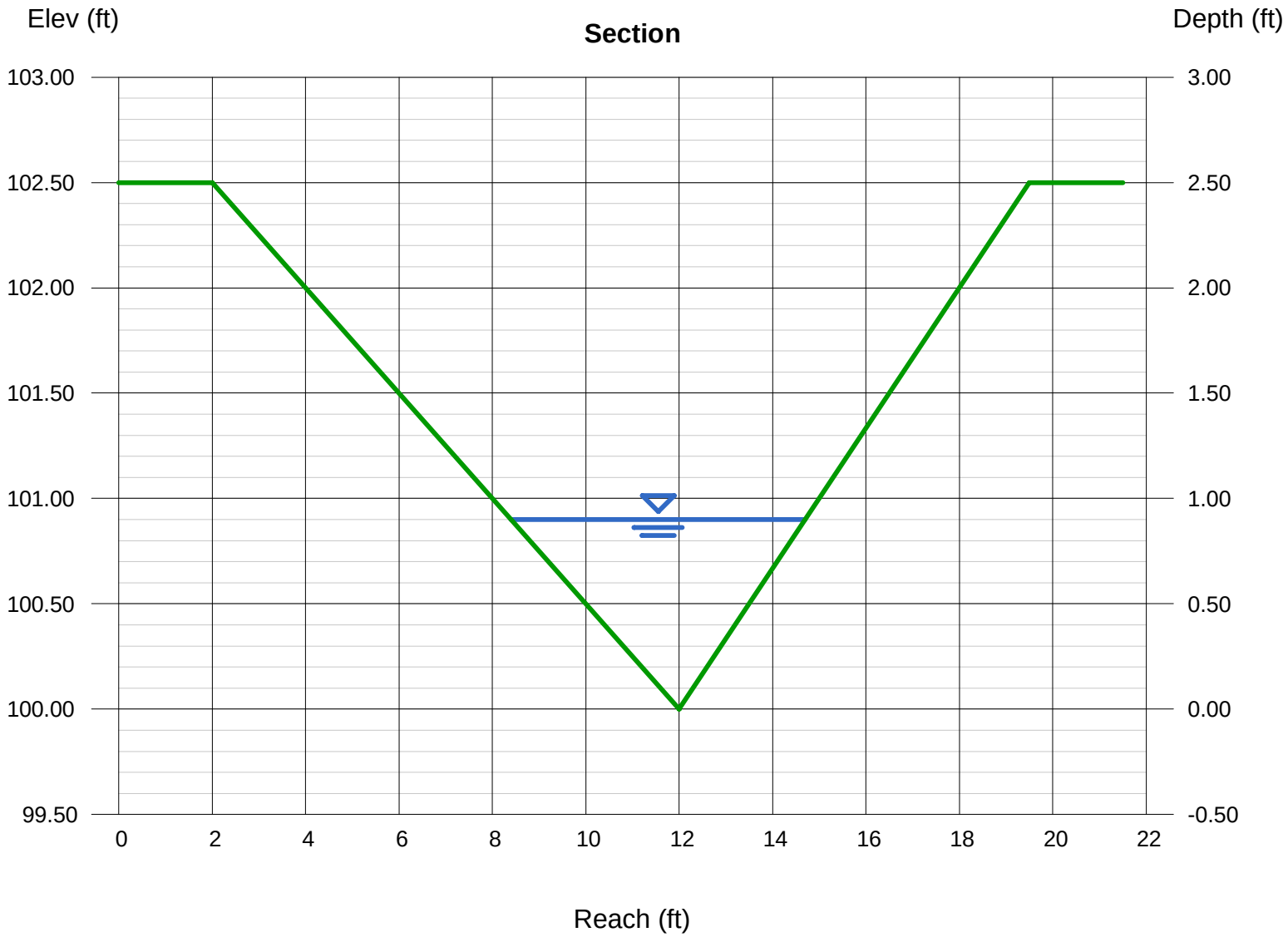
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.95
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 7.70

Highlighted

Depth (ft)	= 0.90
Q (cfs)	= 7.700
Area (sqft)	= 2.83
Velocity (ft/s)	= 2.72
Wetted Perim (ft)	= 6.56
Crit Depth, Yc (ft)	= 0.79
Top Width (ft)	= 6.30
EGL (ft)	= 1.01



HY-8 Culvert Analysis Report

South Pond Maint. Trail Culvert

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 7.8 cfs

Maximum Flow: 7.8 cfs

Table 1 - Summary of Culvert Flows at Crossing: South Pond Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7115.77	0.00	0.00	0.00	1
7116.20	0.78	0.78	0.00	1
7116.39	1.56	1.56	0.00	1
7116.55	2.34	2.34	0.00	1
7116.70	3.12	3.12	0.00	1
7116.83	3.90	3.90	0.00	1
7116.95	4.68	4.68	0.00	1
7117.06	5.46	5.46	0.00	1
7117.17	6.24	6.24	0.00	1
7117.28	7.02	7.02	0.00	1
7117.40	7.80	7.80	0.00	1
7118.14	11.60	11.60	0.00	Overtopping

Rating Curve Plot for Crossing: South Pond Culvert

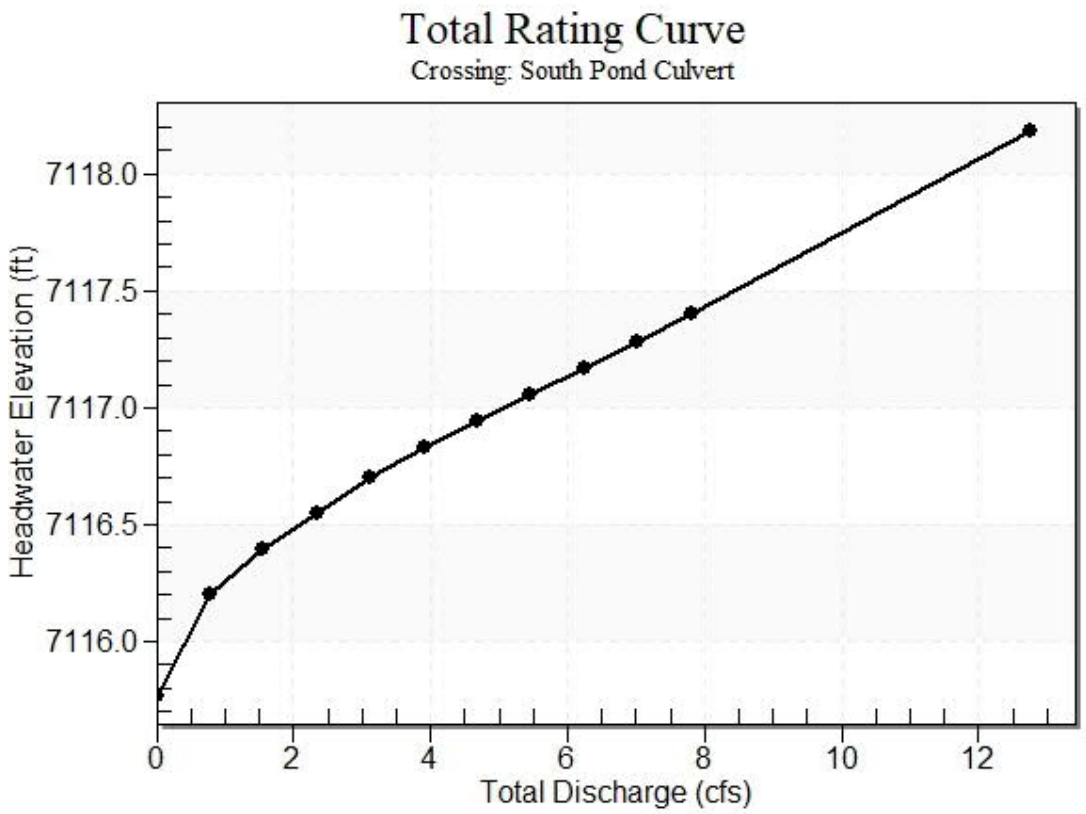


Table 2 - Culvert Summary Table: Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7115.77	0.000	0.000	0-NF	0.000	0.000	1.500	0.000	0.000	0.000
0.78	0.78	7116.20	0.434	0.318	1-JS1f	0.200	0.328	1.500	0.313	0.441	2.278
1.56	1.56	7116.39	0.624	0.429	1-JS1f	0.280	0.469	1.500	0.406	0.883	2.709
2.34	2.34	7116.55	0.779	0.525	1-JS1f	0.343	0.578	1.500	0.472	1.324	2.998
3.12	3.12	7116.70	0.928	0.620	1-JS1f	0.396	0.672	1.500	0.526	1.766	3.221
3.90	3.90	7116.83	1.057	0.719	1-JS1f	0.444	0.755	1.500	0.572	2.207	3.406
4.68	4.68	7116.95	1.176	0.825	1-JS1f	0.488	0.831	1.500	0.612	2.648	3.565
5.46	5.46	7117.06	1.288	0.939	1-JS1f	0.530	0.901	1.500	0.649	3.090	3.705
6.24	6.24	7117.17	1.398	1.061	1-JS1f	0.569	0.965	1.500	0.682	3.531	3.831
7.02	7.02	7117.28	1.512	1.193	5-JS1f	0.607	1.026	1.500	0.713	3.973	3.945
7.80	7.80	7117.40	1.632	1.334	5-JS1f	0.643	1.082	1.500	0.742	4.414	4.051

****

Straight Culvert

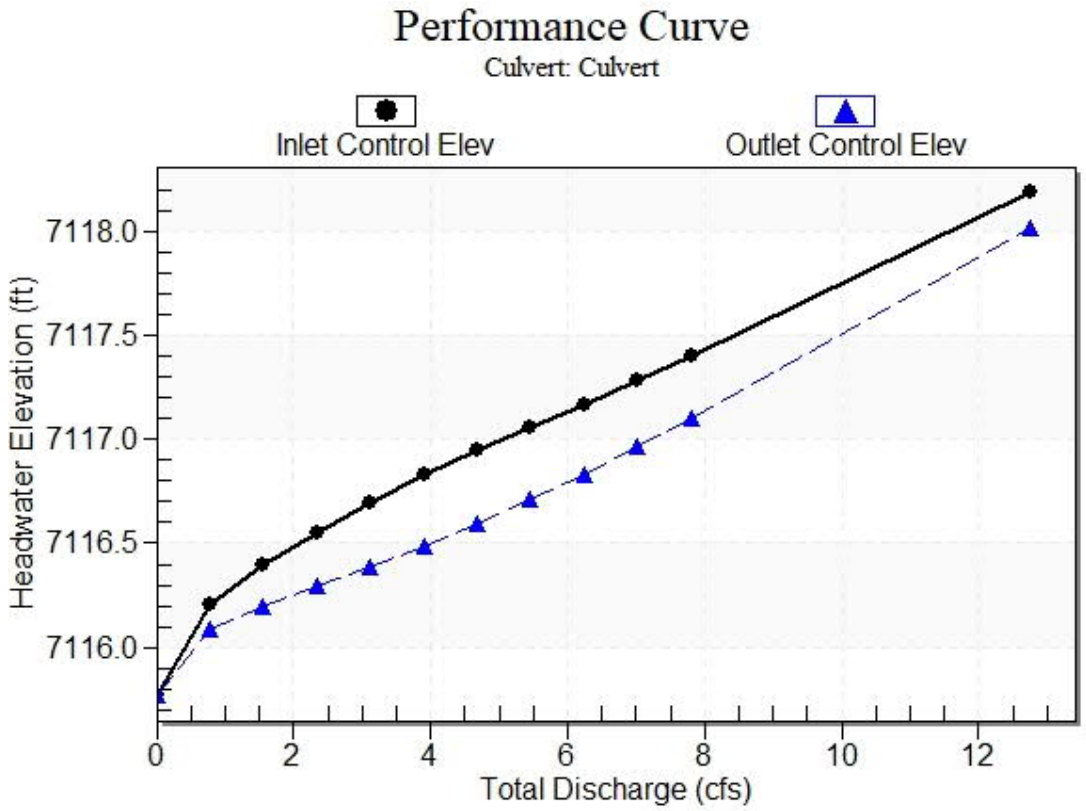
Inlet Elevation (invert): 7115.77 ft, Outlet Elevation (invert): 7114.19 ft

Culvert Length: 49.32 ft, Culvert Slope: 0.0321

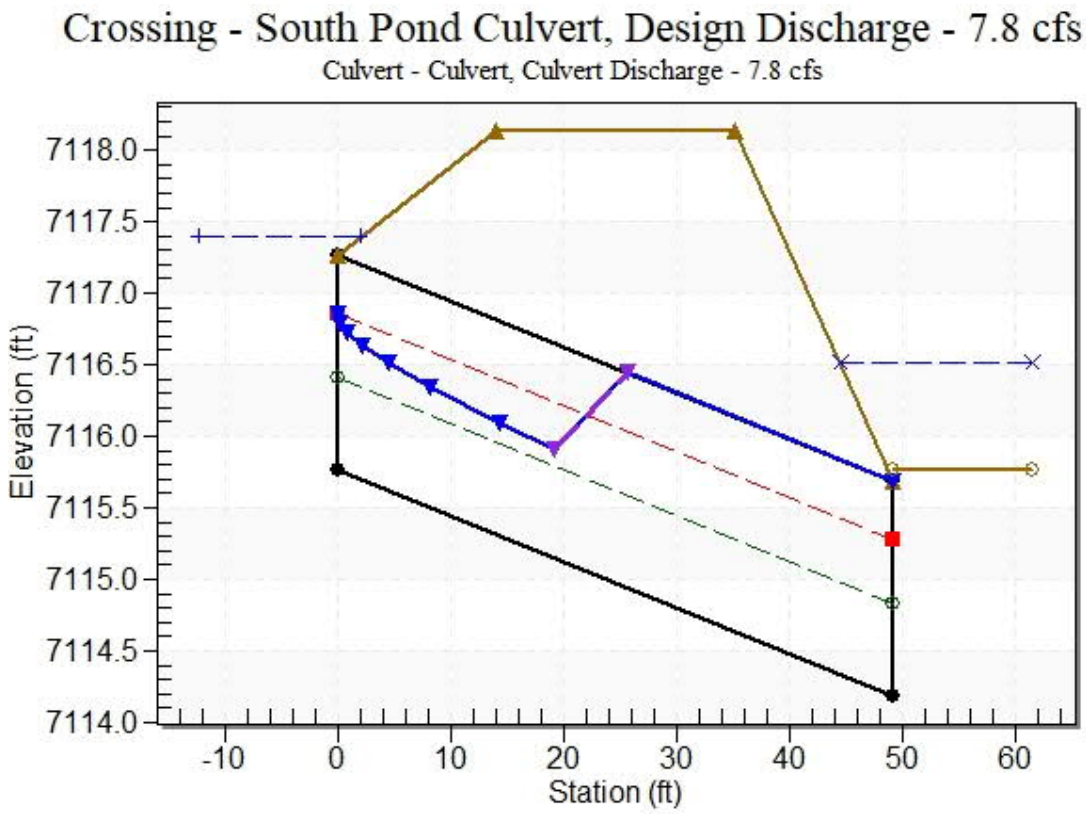
****

Hw/D = 1.63/1.5 = 1.09

Culvert Performance Curve Plot: Culvert



Water Surface Profile Plot for Culvert: Culvert



Site Data - Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7115.77 ft

Outlet Station: 49.29 ft

Outlet Elevation: 7114.19 ft

Number of Barrels: 1

Culvert Data Summary - Culvert

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: South Pond Culvert)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7115.77	0.00	0.00	0.00	0.00
0.78	7116.08	0.31	2.28	0.62	1.02
1.56	7116.18	0.41	2.71	0.81	1.06
2.34	7116.24	0.47	3.00	0.94	1.09
3.12	7116.30	0.53	3.22	1.05	1.11
3.90	7116.34	0.57	3.41	1.14	1.12
4.68	7116.38	0.61	3.57	1.22	1.14
5.46	7116.42	0.65	3.71	1.30	1.15
6.24	7116.45	0.68	3.83	1.36	1.16
7.02	7116.48	0.71	3.95	1.42	1.16
7.80	7116.51	0.74	4.05	1.48	1.17

Tailwater Channel Data - South Pond Culvert

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.50 (_:1)

Channel Slope: 0.0320

Channel Manning's n: 0.0330

Channel Invert Elevation: 7115.77 ft

Roadway Data for Crossing: South Pond Culvert

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 35.00 ft

Crest Elevation: 7118.14 ft

Roadway Surface: Gravel

Roadway Top Width: 21.00 ft

Channel Report

100: 13.1 to DP14.1

Triangular

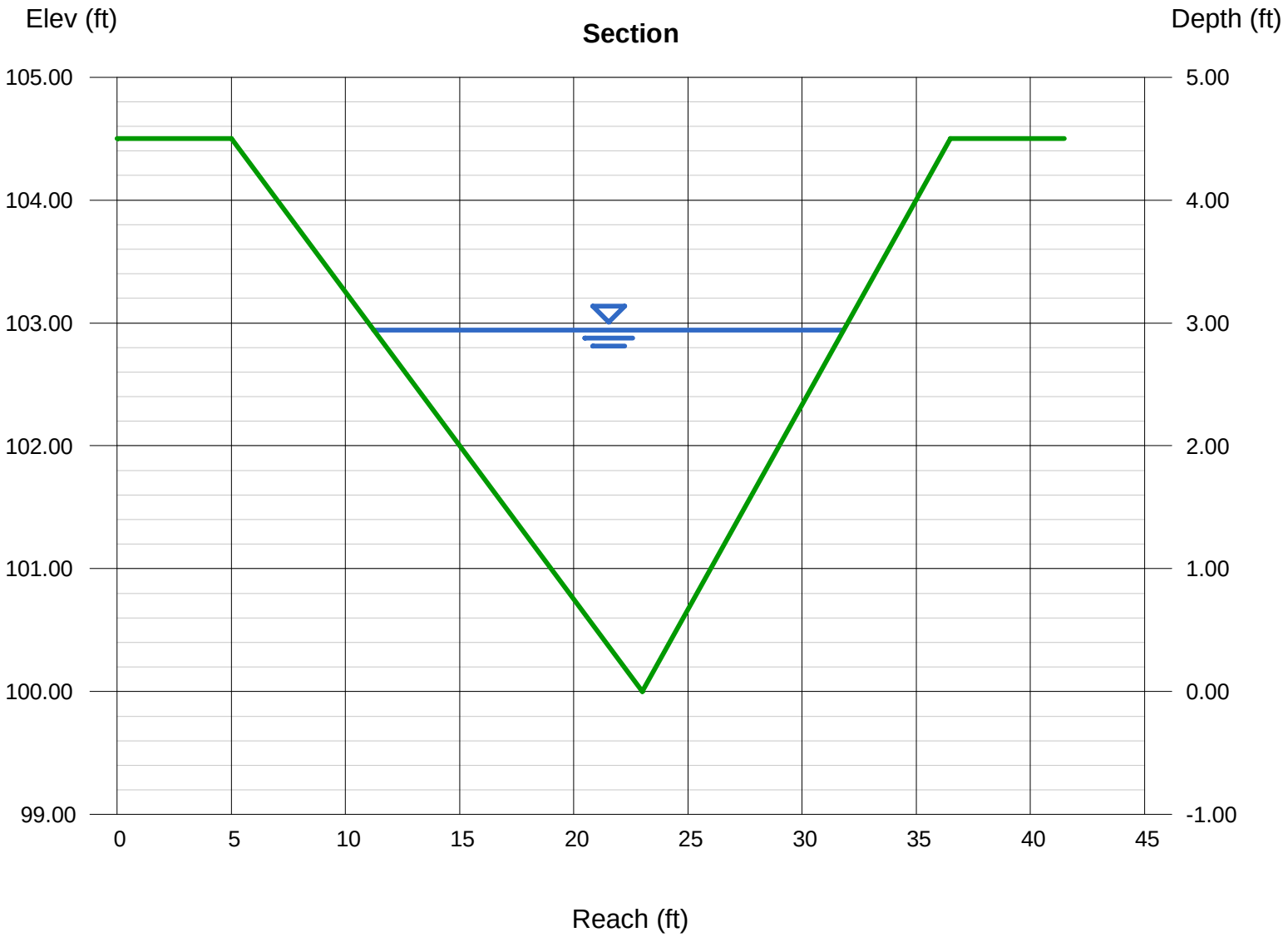
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 4.50
Invert Elev (ft)	= 100.00
Slope (%)	= 2.42
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 291.20

Highlighted

Depth (ft)	= 2.94
Q (cfs)	= 291.20
Area (sqft)	= 30.25
Velocity (ft/s)	= 9.63
Wetted Perim (ft)	= 21.42
Crit Depth, Yc (ft)	= 3.37
Top Width (ft)	= 20.58
EGL (ft)	= 4.38



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 7 2022

100: DP14.1 to Low-Tailwater Basin

User-defined

Invert Elev (ft)	= 7091.66
Slope (%)	= 6.87
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 347.00

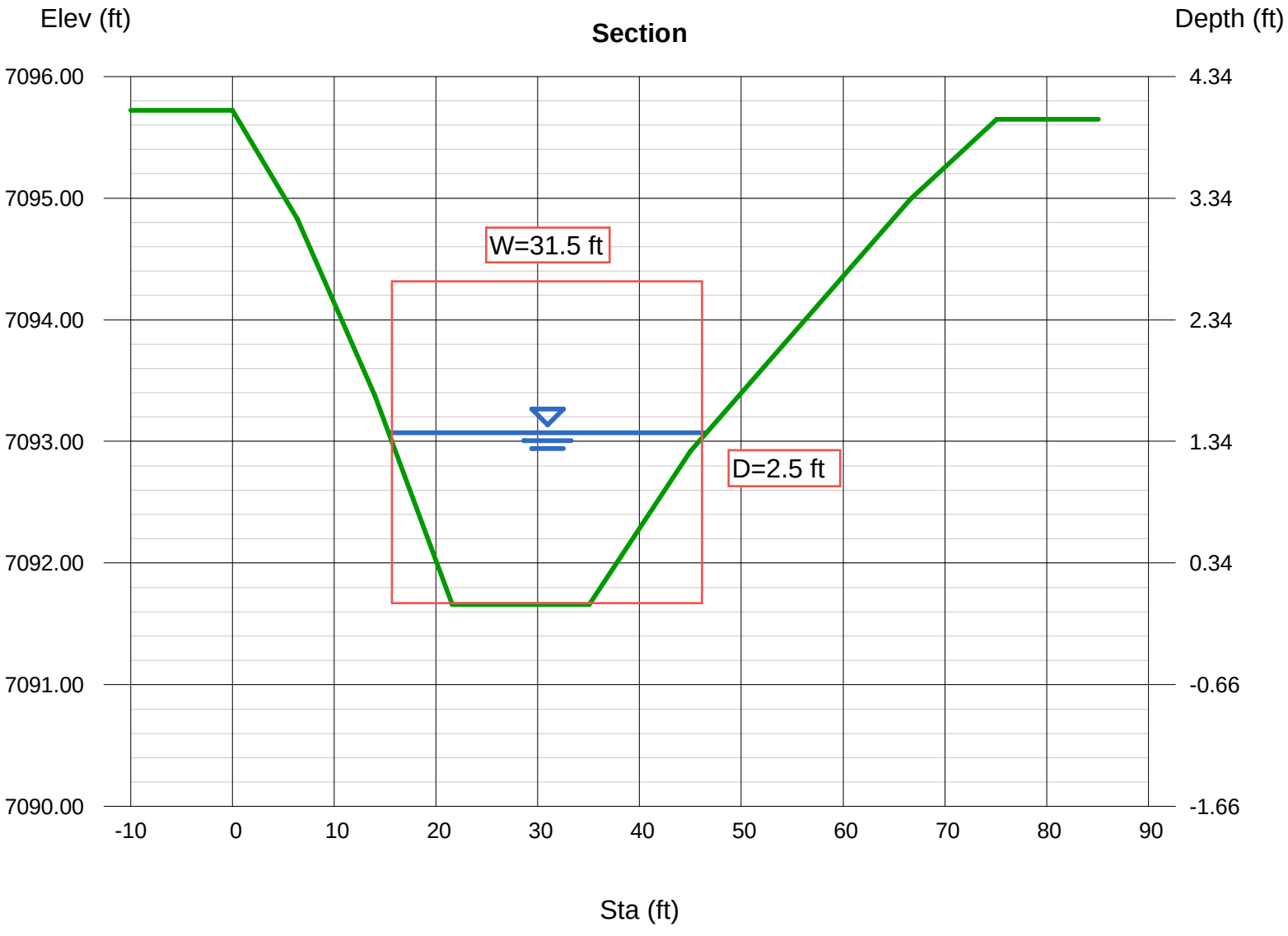
Highlighted

Depth (ft)	= 1.41
Q (cfs)	= 347.00
Area (sqft)	= 31.29
Velocity (ft/s)	= 11.09
Wetted Perim (ft)	= 31.47
Crit Depth, Yc (ft)	= 2.03
Top Width (ft)	= 31.23
EGL (ft)	= 3.32

(Sta, El, n)-(Sta, El, n)...

(0.00, 7095.72) -(6.34, 7094.83, 0.035) -(13.96, 7093.38, 0.035) -(21.58, 7091.66, 0.035) -(35.08, 7091.66, 0.035) -(44.99, 7092.92, 0.035) -(66.58, 7094.99, 0.035) -(75.09, 7095.65, 0.035)

Proposed swale is trapezoidal section to the low-tailwater basin. Top width of water rounded to nearest half foot is 31.5 feet. Water depth with freeboard rounded to the nearest half foot is 2.5 feet. See low-tailwater basin standard sizing based on an equivalent shape.



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Mar 31 2022

5: DP16.1 to DP17.1

Triangular

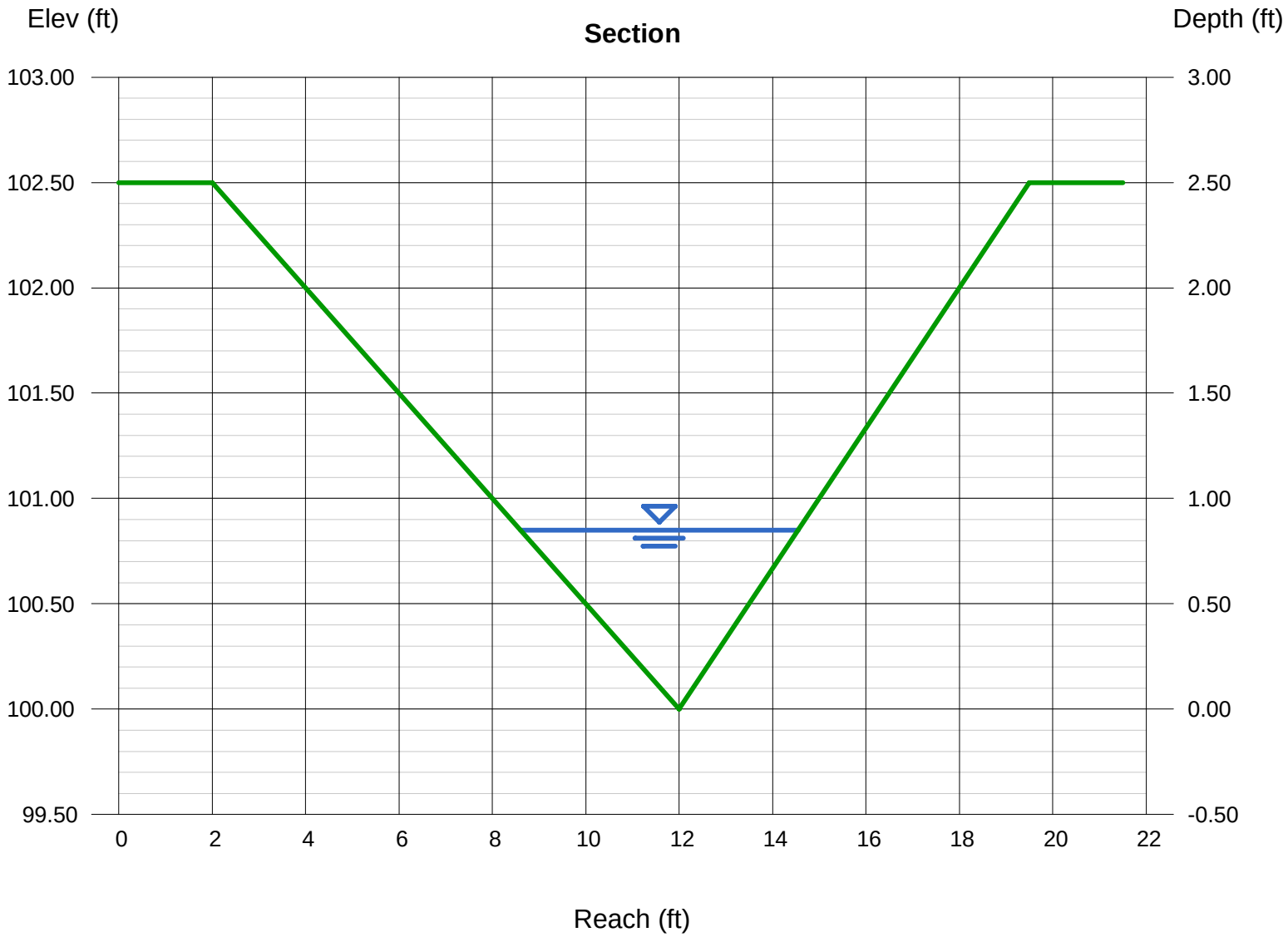
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 6.00

Highlighted

Depth (ft)	= 0.85
Q (cfs)	= 6.000
Area (sqft)	= 2.53
Velocity (ft/s)	= 2.37
Wetted Perim (ft)	= 6.19
Crit Depth, Yc (ft)	= 0.72
Top Width (ft)	= 5.95
EGL (ft)	= 0.94



Channel Report

100: DP16.1 to DP17.1

Triangular

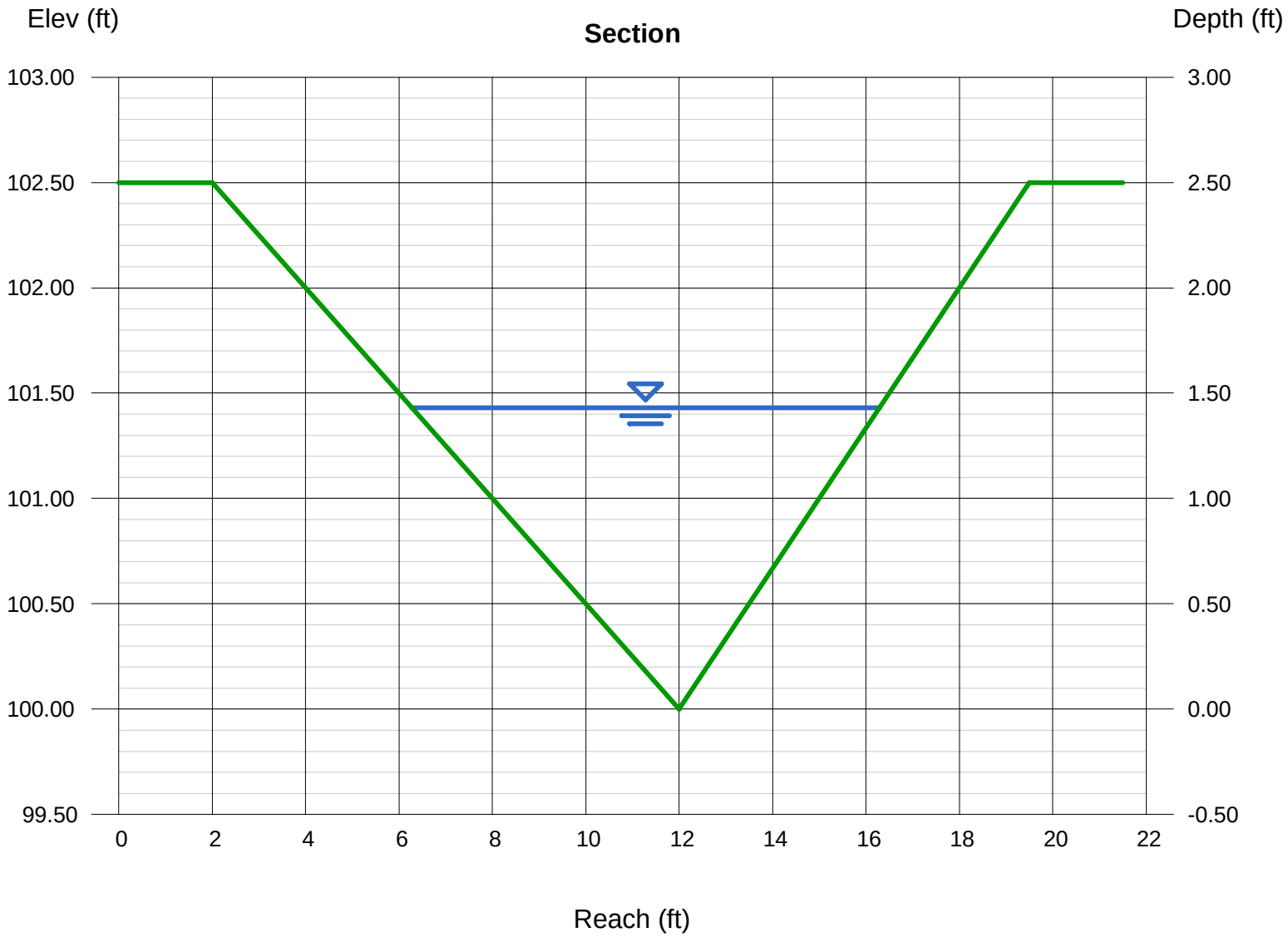
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 24.50

Highlighted

Depth (ft)	= 1.43
Q (cfs)	= 24.50
Area (sqft)	= 7.16
Velocity (ft/s)	= 3.42
Wetted Perim (ft)	= 10.42
Crit Depth, Yc (ft)	= 1.25
Top Width (ft)	= 10.01
EGL (ft)	= 1.61



Channel Report

100: DP16.1 to DP17.1-Capacity

Triangular

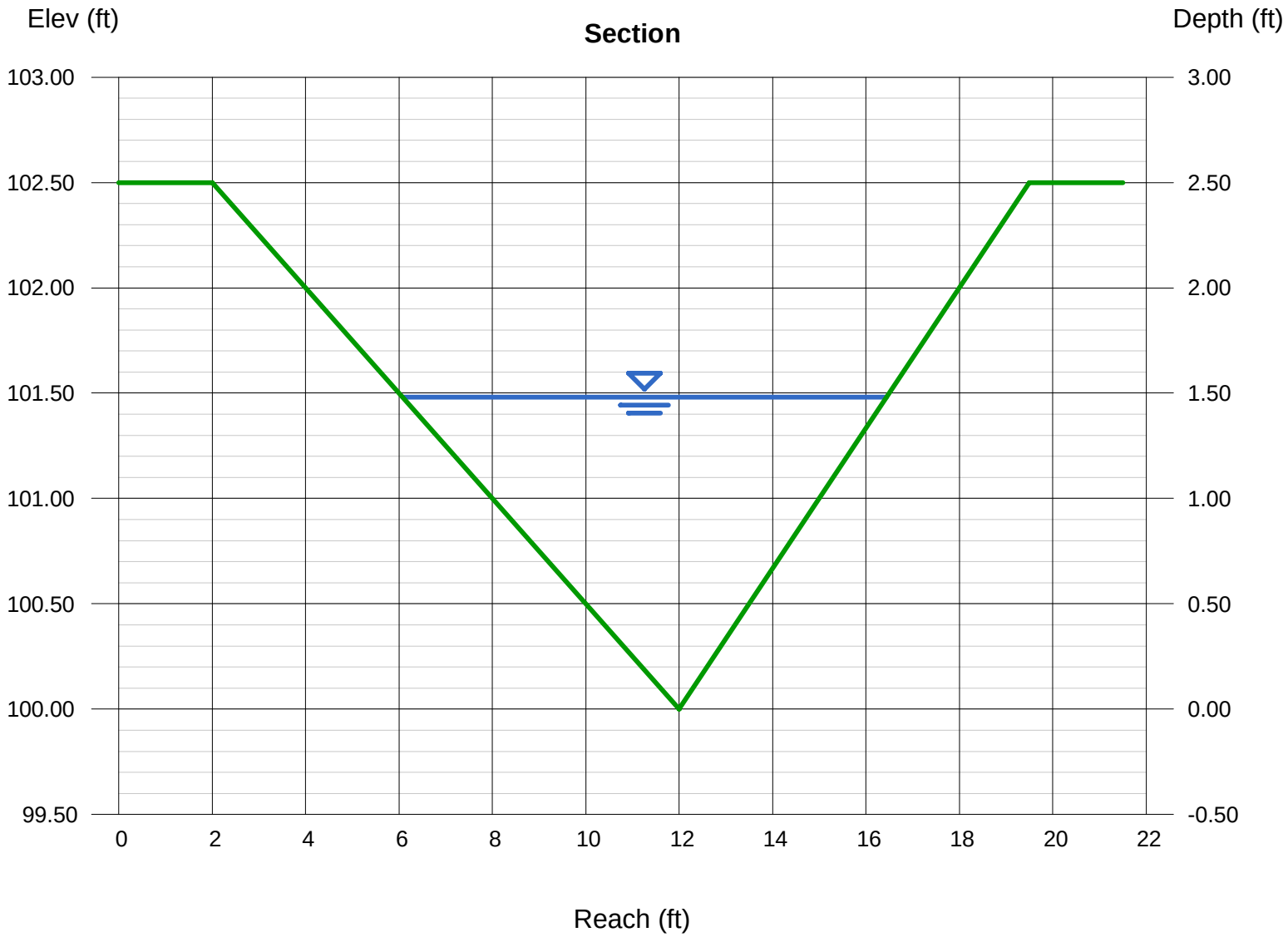
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.68
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 24.50

Highlighted

Depth (ft)	= 1.48
Q (cfs)	= 24.50
Area (sqft)	= 7.67
Velocity (ft/s)	= 3.20
Wetted Perim (ft)	= 10.78
Crit Depth, Yc (ft)	= 1.25
Top Width (ft)	= 10.36
EGL (ft)	= 1.64



HY-8 Culvert Analysis Report: Pond G1 Culvert

Crossing Discharge Data

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

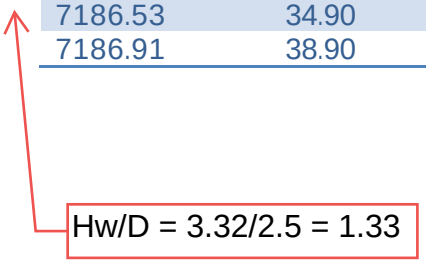
Minimum Flow: 0.00 cfs

Design Flow: 34.90 cfs

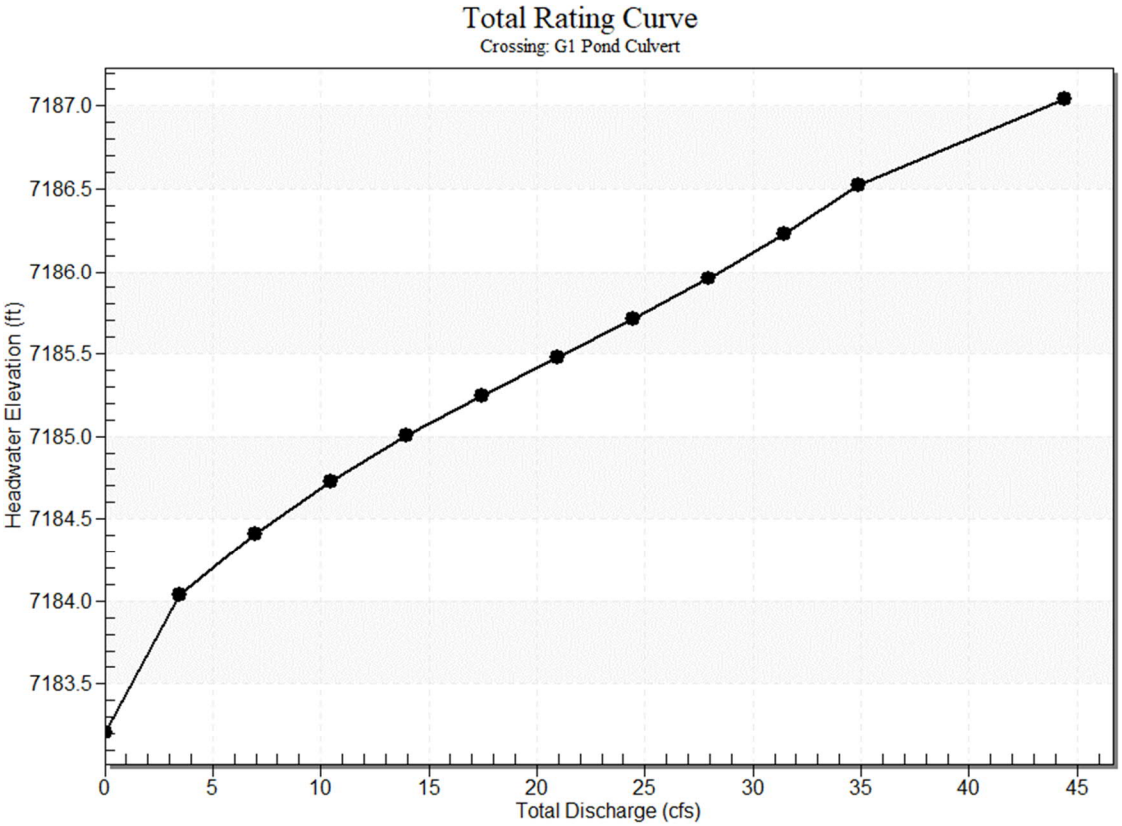
Maximum Flow: 34.90 cfs

Table 1 - Summary of Culvert Flows at Crossing: G1 Pond Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7183.21	0.00	0.00	0.00	1
7184.04	3.49	3.49	0.00	1
7184.41	6.98	6.98	0.00	1
7184.73	10.47	10.47	0.00	1
7185.00	13.96	13.96	0.00	1
7185.25	17.45	17.45	0.00	1
7185.48	20.94	20.94	0.00	1
7185.71	24.43	24.43	0.00	1
7185.96	27.92	27.92	0.00	1
7186.23	31.41	31.41	0.00	1
7186.53	34.90	34.90	0.00	1
7186.91	38.90	38.90	0.00	Overtopping



Rating Curve Plot for Crossing: G1 Pond Culvert



Culvert Data: Culvert

Table 2 - Culvert Summary Table: Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7183.21	0.00	0.000	0-NF	0.00	0.00	0.31	0.00	0.00	0.00
3.49	3.49	7184.04	0.83	0.486	1-JS1t	0.52	0.61	0.78	0.47	2.65	4.44
6.98	6.98 cfs	7184.41	1.20	0.663	1-S2n	0.74	0.88	0.75	0.61	5.67	5.28
10.47	10.47	7184.73	1.52	0.881	1-S2n	0.91	1.08	0.93	0.72	6.30	5.85
13.96	13.96	7185.00	1.79	1.142	1-S2n	1.06	1.26	1.09	0.80	6.79	6.28
17.45	17.45	7185.25	2.04	1.408	1-S2n	1.21	1.41	1.24	0.87	7.19	6.64
20.94	20.94	7185.48	2.27	1.683	1-S2n	1.35	1.55	1.38	0.93	7.54	6.95
24.43	24.43	7185.71	2.50	1.970	5-S2n	1.48	1.68	1.52	0.98	7.85	7.23
27.92	27.92	7185.96	2.75	2.271	5-S2n	1.62	1.80	1.65	1.03	8.12	7.47
31.41	31.41	7186.23	3.02	2.881	5-S2n	1.77	1.91	1.79	1.08	8.36	7.70
34.90	34.90	7186.53	3.32	3.161	5-S2n	1.93	2.01	1.94	1.12	8.54	7.90

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

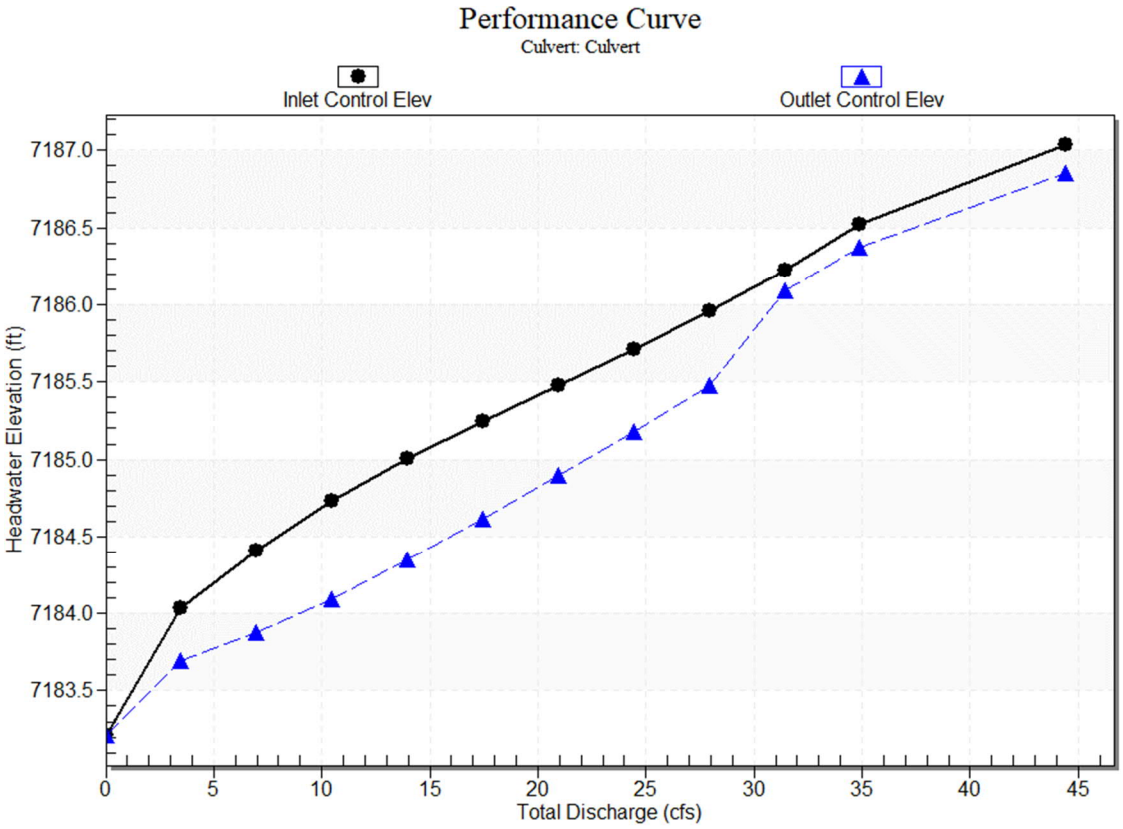
Inlet Elevation (invert): 7183.21 ft,

Outlet Elevation (invert): 7182.90 ft

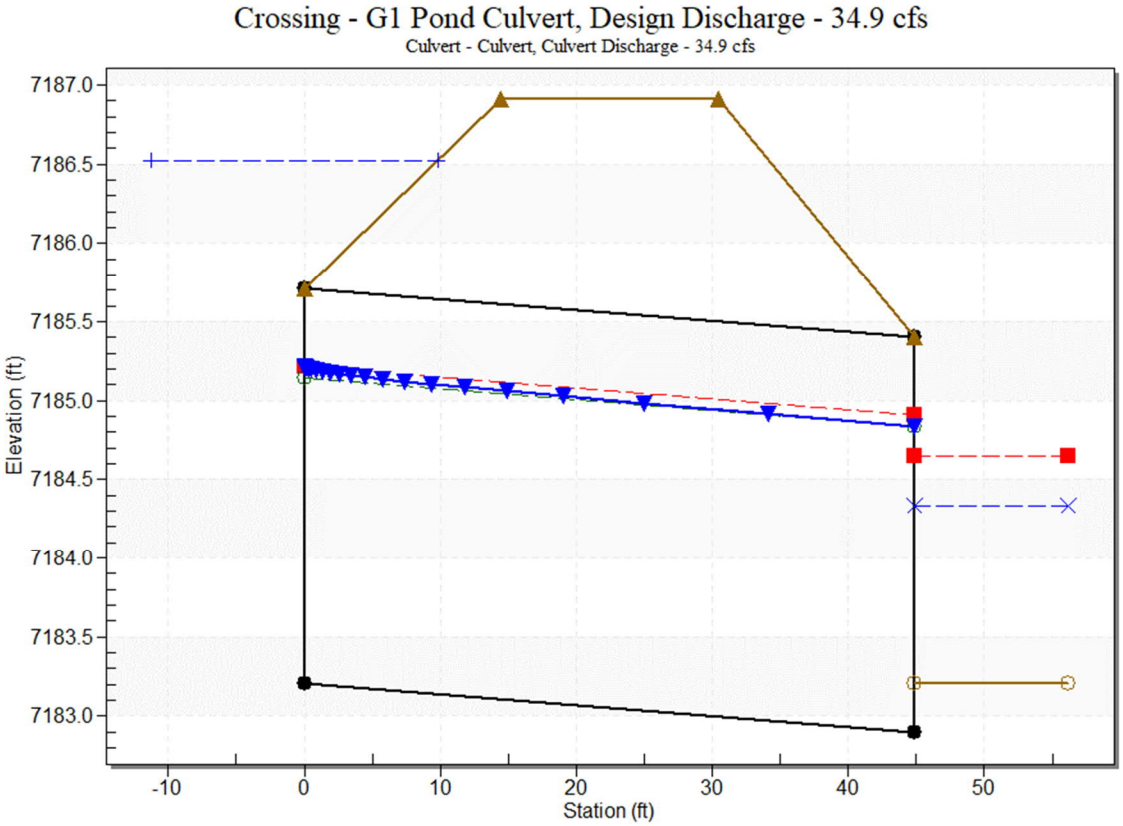
Culvert Length: 44.92 ft,

Culvert Slope: 0.0069

Culvert Performance Curve Plot: Culvert



Water Surface Profile Plot for Culvert: Culvert



Site Data - Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7183.21 ft

Outlet Station: 44.92 ft

Outlet Elevation: 7182.90 ft

Number of Barrels: 1

Culvert Data Summary - Culvert

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Tailwater Data for Crossing: G1 Pond Culvert

Table 3 - Downstream Channel Rating Curve (Crossing: G1 Pond Culvert)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	7183.21	0.00	0.00	0.00	0.00
3.49	7183.68	0.47	4.44	2.07	1.61
6.98	7183.82	0.61	5.28	2.68	1.68
10.47	7183.93	0.72	5.85	3.12	1.72
13.96	7184.01	0.80	6.28	3.48	1.75
17.45	7184.08	0.87	6.64	3.78	1.78
20.94	7184.14	0.93	6.95	4.05	1.80
24.43	7184.19	0.98	7.23	4.29	1.82
27.92	7184.24	1.03	7.47	4.51	1.83
31.41	7184.29	1.08	7.70	4.72	1.85
34.90	7184.33	1.12	7.90	4.91	1.86

Tailwater Channel Data - G1 Pond Culvert

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.50 (_:1)

Channel Slope: 0.0700

Channel Manning's n: 0.0330

Channel Invert Elevation: 7183.21 ft

Roadway Data for Crossing: G1 Pond Culvert

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 35.00 ft

Crest Elevation: 7186.91 ft

Roadway Surface: Gravel

Roadway Top Width: 16.02 ft

VMax® TRMs

ROLLMAX™
ROLLED EROSION CONTROL

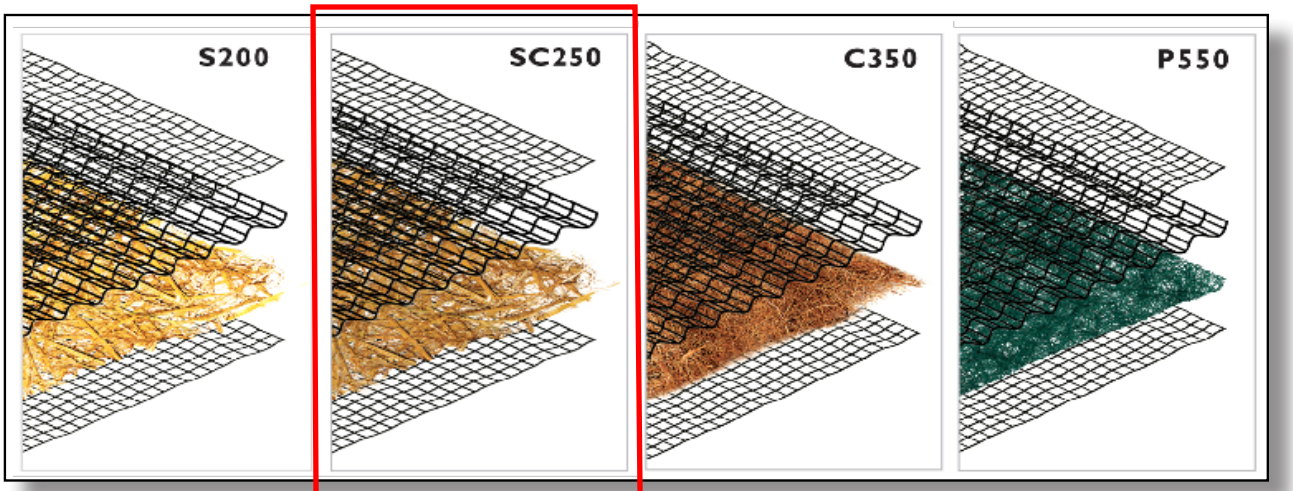
A Permanent Turf Reinforcement Mat Solution for Every Design

The VMax system of permanent TRMs are ideal for high-flow channels, streambanks, shorelines, and other areas needing permanent vegetation reinforcement and protection from water and wind. Our VMax TRMs combine a three-dimensional matting and a fiber matrix material for all-out erosion protection, vegetation establishment and reinforcement. The VMax TRMs are available with various performance capabilities and support reinforced vegetative lining development from germination to maturity.

VMax® Unique Three-Dimensional Design

North American Green VMax TRMs are each designed to maximize performance through all development phases of a reinforced vegetative lining. The corrugated matting structure lends a true reinforcement zone for vegetation entanglement, especially compared to flat net mats. The unique design of the corrugated matting also helps to create a shear plane that deflects flowing water away from the soil surface. And the incorporation of a fiber matrix supplements the 3-D structure by creating a ground cover that blocks soil movement and aids in vegetation establishment.

Four VMax Turf Reinforcement Mats Designed for Every Level of Performance



	S200	SC250	C350	P550
Matrix Fiber	100% Straw	70% Straw / 30% Coconut	100% Coconut	100% Polypropylene
Netting Types	Top and Bottom light-weight UV-stabilized PP, Crimped PP center net	Top and Bottom UV-stabilized PP, Crimped PP center net	Top and Bottom heavy-weight UV-stabilized PP, Crimped PP center net	Top and Bottom ultra heavy-weight UV-stabilized PP, Crimped PP center net
Typical Slope Applications (H:V)	1:1 and greater	1:1 and greater	1:1 and greater	1:1 and greater
Channel Shear Stress Threshold	Unvegetated: 2.3 psf Vegetated: 10.0 psf	Unvegetated: 3.0 psf Vegetated: 10.0 psf	Unvegetated: 3.2 psf Vegetated: 12.0 psf	Unvegetated: 4.0 psf Vegetated: 14.0 psf
Channel Velocity Threshold	Unvegetated: 8.5 fps Vegetated: 18 fps	Unvegetated: 9.5 fps Vegetated: 15 fps	Unvegetated: 10.5 fps Vegetated: 20 fps	Unvegetated: 12.5 fps Vegetated: 25 fps

NORTH AMERICAN GREEN®

Selected product that will work for all swales above 5 ft/s. Has maximum of 15 ft/s.

North American Green, LLC.
4609 E. Boonville-New Harmony Rd., Evansville, IN
(800) 772-2040 | www.nagreen.com

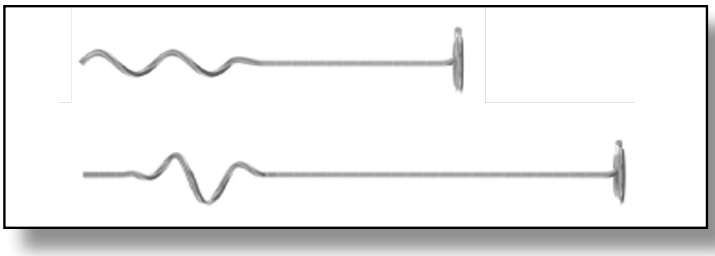
VMax® TRMs cont.

Selecting the Right VMax TRM

Choosing the right VMax TRM can be made easy by utilizing our Erosion Control Materials Design Software (www.ecmds.com), which allows users to input project specific parameters for channels, slopes, spillways, and more and ensures proper evaluation, design, and product selection in return. Our four VMax TRMs offer varying performance values, fiber matrix longevities, and price points, to help you meet your project specific goals.

Twist Pin + VMax TRM - an Ideal Installation

Utilizing the VMax TRMs in conjunction with Twist Pin fastener technology can result in an installed system that pushes TRM performance with increased factors of safety. The combined system has been shown to have superior pullout strength performance up to 200 lbs when compared to installation with traditional wire staples and pins. This is up to 10x the pullout resistance of wire staples and pins. Additionally, the use of the twist pins provides intimate contact between the TRM and the soil, and have been shown to be effective in a wide range of soil types. With a quick and easy installation using an electric drill and custom chuck, the TRM+Twist Pin system can eliminate time and labor costs from day 1 through project release.



VMax turf reinforcement mat being installed on a channel application (top right), twist pins installed with TRMs can have increased system performance and pullout resistance (middle right), twist pins are available in 8" and 12" lengths and two coil configurations designed for hard or soft soil types (lower right).

Comparison of common TRM fasteners based on pullout performance and typical application (below).

Fastener	Pullout Resistance (lb)	Comment
6" Round Top Pin	14	Best for hardened soils where other fasteners are damaged during installation.
6" Regular U-staple	42	Standard fastener that develops additional pullout as legs may deflect and add friction during installation.
12" Pin with Washer	35	Standard fastener good for soils where staples can be bent frequently and are too difficult to install.
18" Pin with Washer	27	Standard fastener good for soils where staples are frequently bent and 12" straight pins fail to provide sufficient pullout because surface soil is wet or loose.
Twist Pin	170	Upgraded fastener that provides high pullout and ideal for loose or soft soils.

NORTH AMERICAN GREEN®

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PIPE OUTFALL RIPRAP SIZING CALCULATIONS

Subdivision: Latigo Trails
Location: El Paso County

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

	STORM DRAIN SYSTEM			Notes
	South Maint. Trail	G1 Maint. Trail	Buffalo River	
Q_{100} (cfs):	7.8	34.9	182.1	Flows are the greater of proposed vs. future
Conduit	Pipe	Pipe	Box Culvert	
D_c, Pipe Diameter (in):	18	30	N/A	
W, Box Width (ft):	N/A	N/A	9	
H, Box Height (ft):	N/A	N/A	3	
Y_t, Tailwater Depth (ft):	0.60	1.00	1.80	If unknown, use Y_t/D_c (or H)=0.4
Y_t/Dc or Y_t/H	0.40	0.40	0.60	
$Q/D^{2.5}$ or $Q/(WH^{3/2})$	2.83	3.53	3.89	
Supercritical?	No	Yes	No	
Y_n, Normal Depth (ft) [Supercritical]:		1.93		
D_a, H_a (in) [Supercritical]:	N/A	2.22	N/A	$D_a=(D_c+Y_n)/2$
Riprap d_{50} (in) [Supercritical]:	N/A	7.59	N/A	
Riprap d_{50} (in) [Subcritical]:	3.52	N/A	3.27	
Required Riprap Size:	L	L	L	Fig. 9-38 or Fig. 9-36
d_{50} (in):	9	9	9	
Expansion Factor, $1/(2\tan\theta)$:	4.70	3.00	6.40	Read from Fig. 9-35 or 9-36
θ:	0.11	0.17	0.08	
Erosive Soils?	No	No	No	
Area of Flow, A_t (ft^2):	1.11	4.99	26.01	$A_t=Q/V$
Length of Protection, L_p (ft):	1.7	7.5	34.9	$L=(1/(2\tan\theta))(At/Yt - D)$
Min Length (ft)	4.5	7.5	27.0	Min L=3D or 3H
Max Length (ft)	15.0	25.0	30.0	Max L=10D or 10H
Min Bottom Width, T (ft):	1.9	5.0	8.4	$T=2*(L_p*\tan\theta)+W$
Design Length (ft)	4.5	7.5	30.0	
Design Width (ft)	1.9	5.0	8.4	
Riprap Depth (in)	18	18	18	Depth=2(d_{50})
Type II Bedding Depth (in)*	6	6	6	*Not used if Soil Riprap
Cutoff Wall	No	No	No	
Cutoff Wall Depth (ft)				Depth of Riprap and Base
Cutoff Wall Width (ft)				

Note: No Type II Base to be used if Soil Riprap is specified within the plans

* For use when the flow in the culvert is supercritical (and less than full).

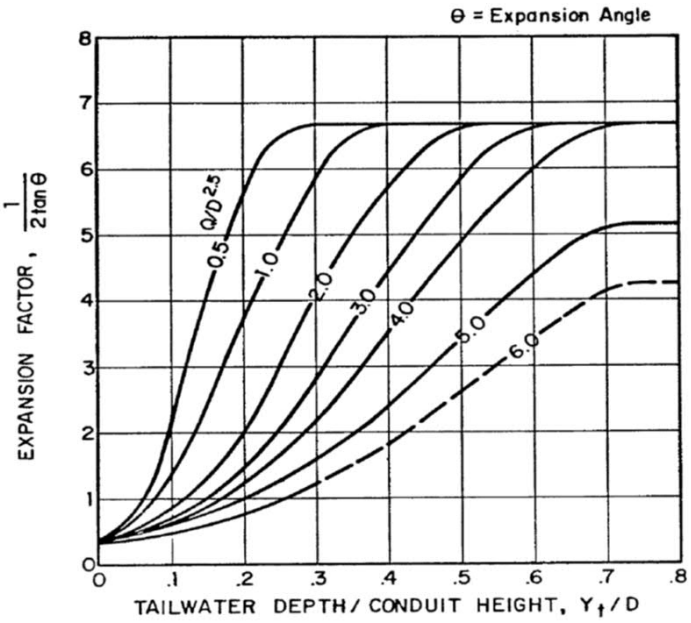

Figure 9-35. Expansion factor for circular conduits

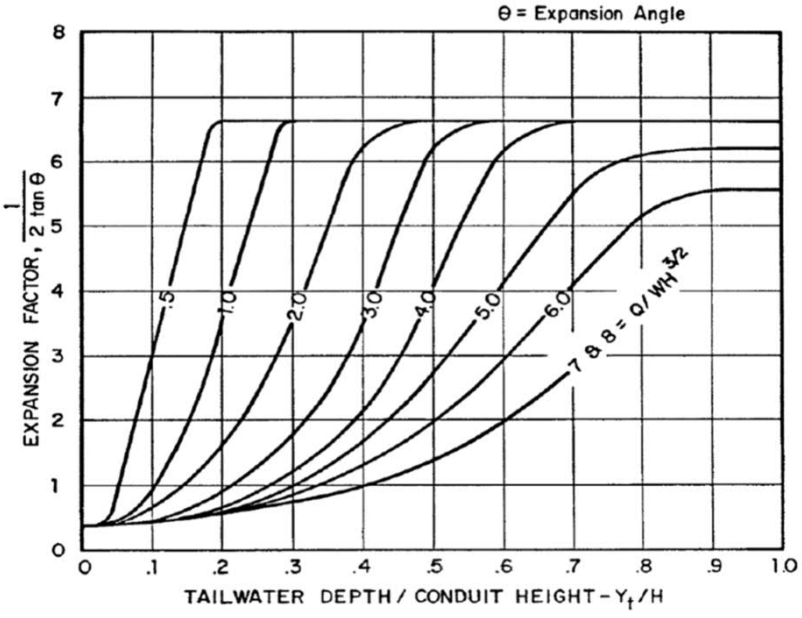

Figure 9-36. Expansion factor for rectangular conduits

Future Driveway Culvert Analysis- 18" RCP
HY-8 Culvert Analysis Report

The sizing of this future driveway analyzed Lots 1-4 and it was determined that an 18” RCP culvert will be sufficient. Additionally, Lots 7-5 and 39 will also use an 18” RCP culvert for future driveways. Future engineered site plans will provide final details for the individual lot driveways and will be constructed by others.

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 24.51 cfs

Maximum Flow: 24.51 cfs

Table 1 - Summary of Culvert Flows at Crossing: Lots 1-4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7196.48	0.00	0.00	0.00	1
7197.38	2.45	2.45	0.00	1
7197.81	4.90	4.90	0.00	1
7198.30	7.35	7.35	0.00	1
7198.65	9.80	8.67	1.10	15
7198.78	12.26	9.11	3.11	8
7198.86	14.71	9.40	5.27	6
7198.93	17.16	9.62	7.49	5
7198.99	19.61	9.80	9.78	5
7199.04	22.06	9.96	12.05	4
7199.08	24.51	10.08	14.39	3
7199.05	7.75	7.75	0.00	Overtopping

Rating Curve Plot for Crossing: Lots 1-4

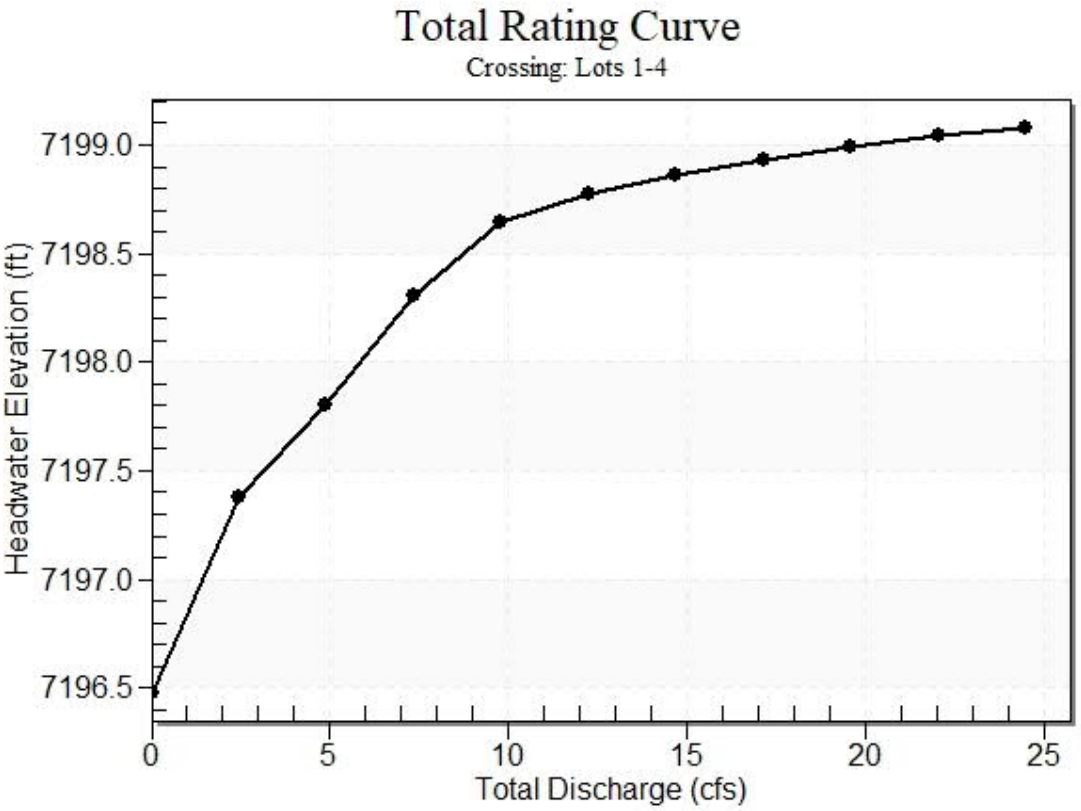

Table 2 - Culvert Summary Table: Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7196.48	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
2.45	2.45	7197.38	0.897	0.0*	1-S2n	0.339	0.593	0.353	0.465	7.716	3.238
4.90	4.90	7197.81	1.327	0.0*	1-S2n	0.482	0.851	0.522	0.603	8.953	3.851
7.35	7.35	7198.30	1.823	0.460	5-S2n	0.599	1.050	0.666	0.702	9.709	4.262
9.80	8.67	7198.65	2.168	0.961	5-S2n	0.656	1.140	0.737	0.782	10.037	4.580
12.26	9.11	7198.78	2.294	1.058	5-S2n	0.674	1.167	0.761	0.850	10.123	4.842
14.71	9.40	7198.86	2.382	1.125	5-S2n	0.686	1.184	0.776	0.911	10.184	5.068
17.16	9.62	7198.93	2.452	1.178	5-S2n	0.696	1.197	0.788	0.965	10.234	5.267
19.61	9.80	7198.99	2.511	1.223	5-S2n	0.703	1.208	0.797	1.014	10.275	5.446
22.06	9.96	7199.04	2.561	1.260	5-S2n	0.710	1.216	0.805	1.060	10.310	5.609
24.51	10.08	7199.08	2.602	1.291	5-S2n	0.715	1.223	0.811	1.103	10.338	5.759

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 7196.48 ft, Outlet Elevation (invert): 7195.30 ft

Culvert Length: 32.02 ft, Culvert Slope: 0.0369

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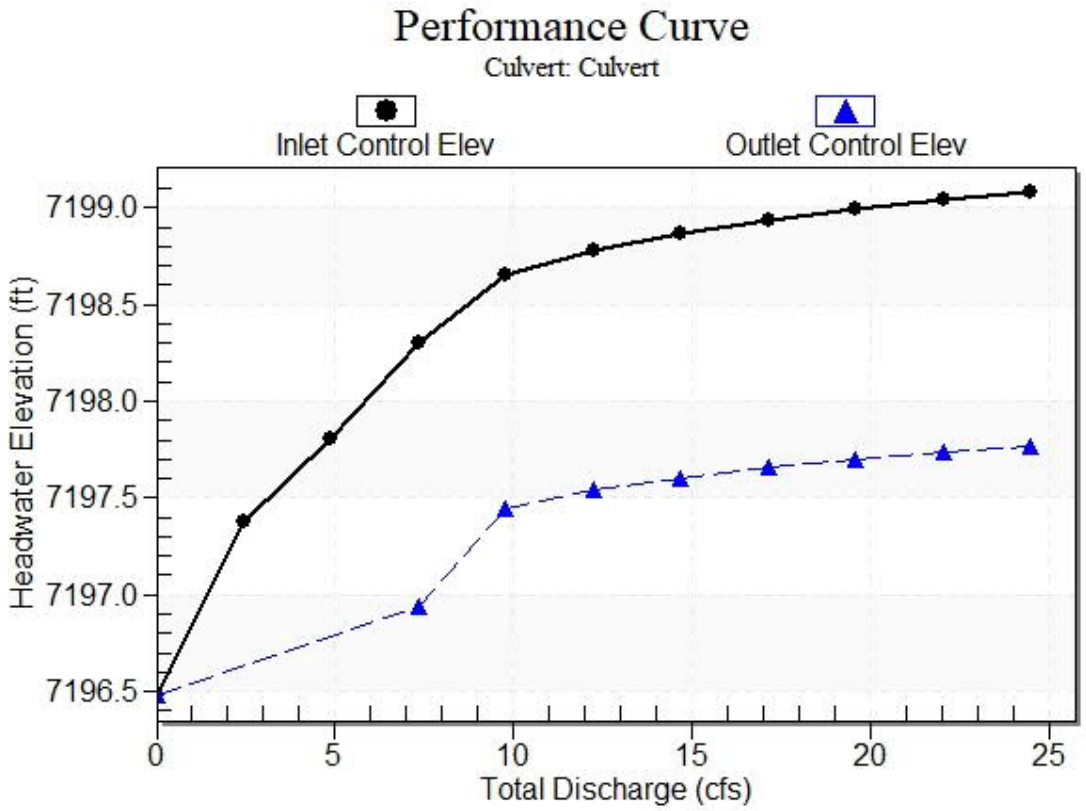
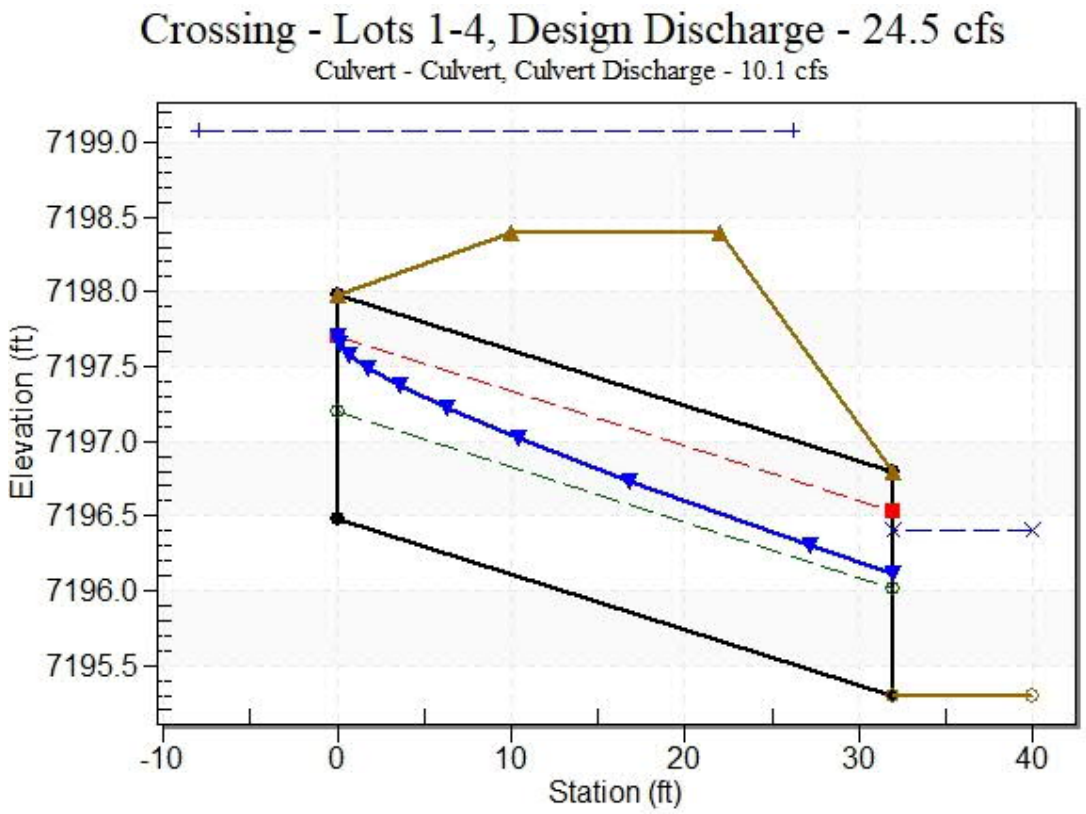
The maximum headwater elevation is 7199.08’. The elevation at the shoulder is 7199.05’. Therefore, the maximum overtopping does not exceed the elevation at the shoulder of the roadway by more than 6 inches.

Culvert Performance Curve Plot: Culvert



Water Surface Profile Plot for Culvert: Culvert



Site Data - Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7196.48 ft

Outlet Station: 32.00 ft

Outlet Elevation: 7195.30 ft

Number of Barrels: 1

Culvert Data Summary - Culvert

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Lots 1-4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7195.30	0.00	0.00	0.00	0.00
2.45	7195.77	0.47	3.24	0.91	1.18
4.90	7195.90	0.60	3.85	1.19	1.24
7.35	7196.00	0.70	4.26	1.38	1.27
9.80	7196.08	0.78	4.58	1.54	1.29
12.26	7196.15	0.85	4.84	1.67	1.31
14.71	7196.21	0.91	5.07	1.79	1.32
17.16	7196.26	0.96	5.27	1.90	1.34
19.61	7196.31	1.01	5.45	1.99	1.35
22.06	7196.36	1.06	5.61	2.08	1.36
24.51	7196.40	1.10	5.76	2.17	1.37

Tailwater Channel Data - Lots 1-4

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.50 (_:1)

Channel Slope: 0.0315

Channel Manning's n: 0.0300

Channel Invert Elevation: 7195.30 ft

Roadway Data for Crossing: Lots 1-4

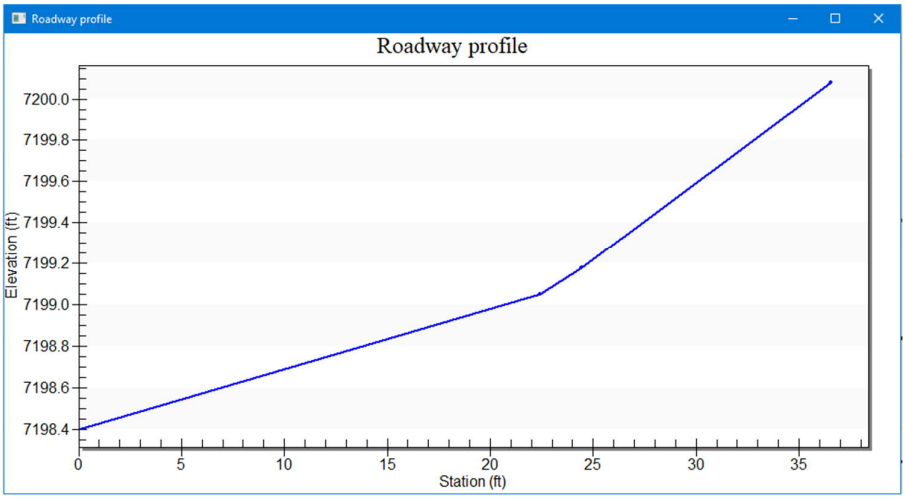
Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	0.00	7198.40
1	22.42	7199.05
2	24.42	7199.18
3	36.53	7200.08

Roadway Surface: Paved

Roadway Top Width: 12.00 ft



Future Driveway Culvert Analysis- (3) 36" RCP
HY-8 Culvert Analysis Report

The sizing of this future driveway analyzed Lots 26-31 and it was determined that three 36” RCP culverts are required. Additionally, Lots 32-38 will also use three 36” RCP culverts for future driveways. Future engineered site plans will provide final details for the individual lot driveways and will be constructed by others.

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 182.13 cfs

Maximum Flow: 182.13 cfs

Table 1 - Summary of Culvert Flows at Crossing: Lots 26-31

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7117.53	0.00	0.00	0.00	1
7118.69	18.21	18.21	0.00	1
7119.21	36.43	36.43	0.00	1
7119.62	54.64	54.64	0.00	1
7119.97	72.85	72.16	0.67	5
7120.27	91.06	86.75	4.27	5
7120.52	109.28	98.37	10.82	6
7120.74	127.49	107.74	19.64	8
7120.93	145.70	115.25	30.31	9
7121.07	163.92	120.72	43.02	7
7121.19	182.13	124.84	57.14	6
7119.70	58.53	58.53	0.00	Overtopping

Rating Curve Plot for Crossing: Lots 26-31

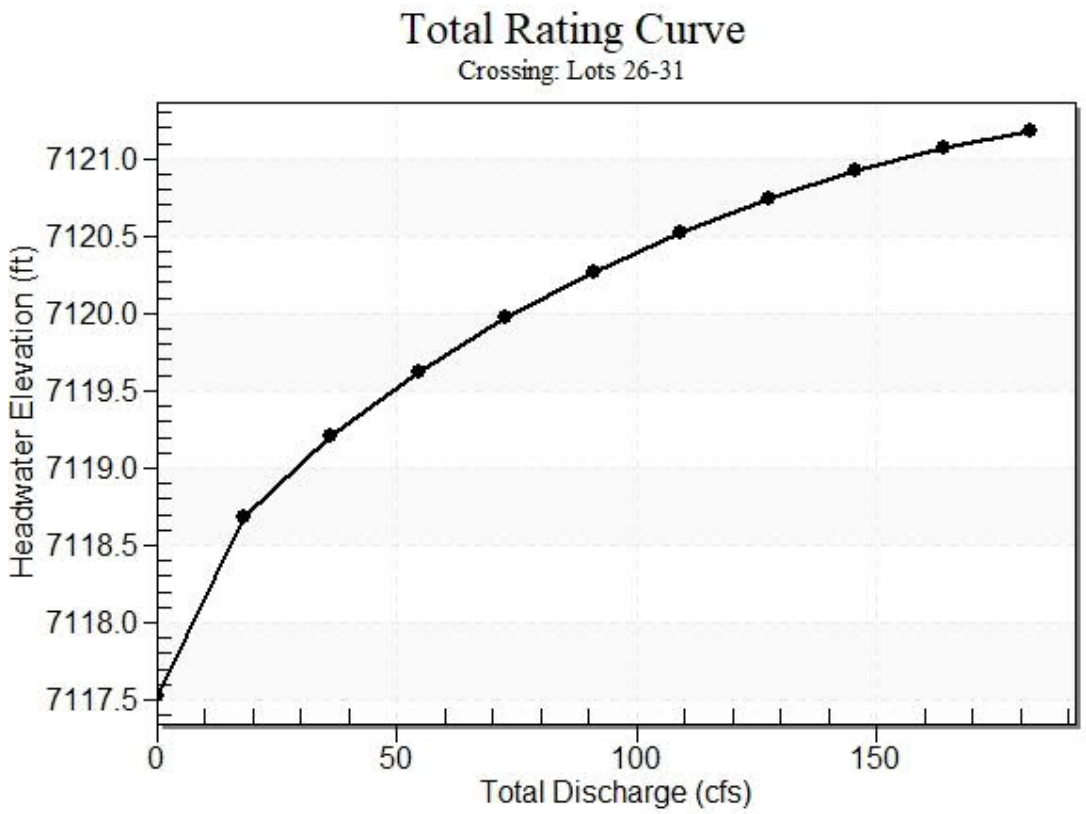


Table 2 - Culvert Summary Table: Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7117.53	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
18.21	18.21	7118.69	1.158	0.0*	1-S2n	0.413	0.773	0.444	0.391	9.297	3.489
36.43	36.43	7119.21	1.680	0.0*	1-S2n	0.580	1.106	0.656	0.584	10.622	4.441
54.64	54.64	7119.62	2.090	0.064	1-S2n	0.710	1.366	0.833	0.737	11.368	5.087
72.85	72.16	7119.97	2.442	0.426	1-S2n	0.818	1.580	0.980	0.867	11.987	5.586
91.06	86.75	7120.27	2.738	0.740	1-S2n	0.899	1.740	1.096	0.983	12.378	5.999
109.28	98.37	7120.52	2.990	1.000	1-S2n	0.960	1.858	1.184	1.088	12.648	6.352
127.49	107.74	7120.74	3.209	1.218	5-S2n	1.007	1.948	1.249	1.185	12.894	6.663
145.70	115.25	7120.93	3.398	1.398	5-S2n	1.043	2.017	1.303	1.275	13.044	6.941
163.92	120.72	7121.07	3.543	1.532	5-S2n	1.069	2.065	1.341	1.360	13.161	7.193
182.13	124.84	7121.19	3.657	1.635	5-S2n	1.089	2.101	1.368	1.440	13.254	7.424

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 7117.53 ft, Outlet Elevation (invert): 7116.03 ft

Culvert Length: 36.03 ft, Culvert Slope: 0.0417

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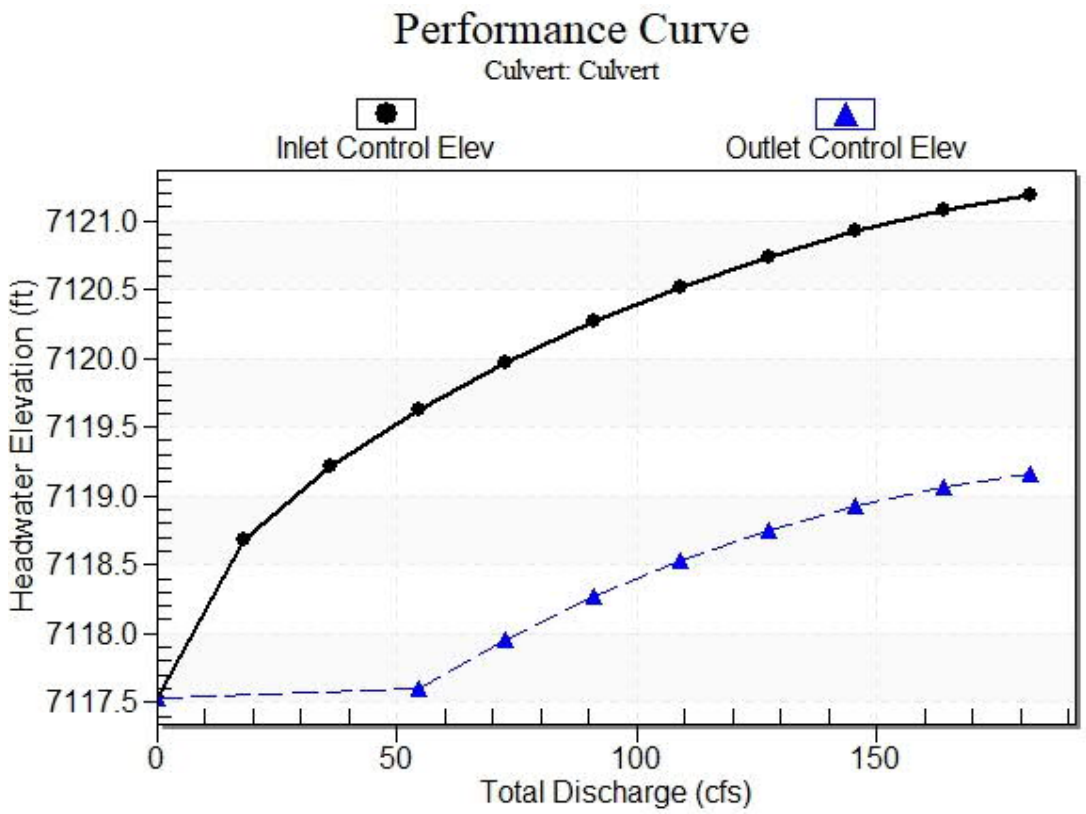
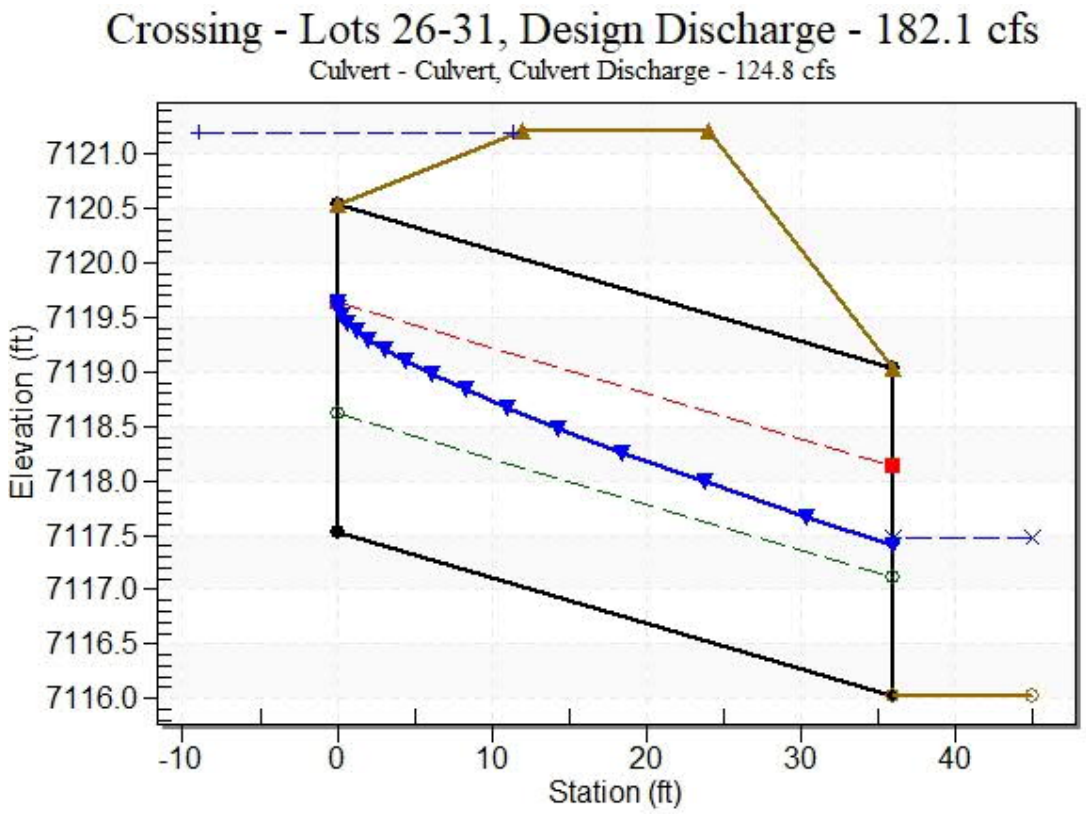
The maximum headwater elevation is 7121.19’. The elevation at the shoulder is 7120.82’. Therefore, the maximum overtopping does not exceed the elevation at the shoulder of the roadway by more than 6 inches.

Culvert Performance Curve Plot: Culvert



Water Surface Profile Plot for Culvert: Culvert



Site Data - Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7117.53 ft

Outlet Station: 36.00 ft

Outlet Elevation: 7116.03 ft

Number of Barrels: 3

Culvert Data Summary - Culvert

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Lots 26-31)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7116.03	0.00	0.00	0.00	0.00
18.21	7116.42	0.39	3.49	0.49	1.03
36.43	7116.61	0.58	4.44	0.73	1.10
54.64	7116.77	0.74	5.09	0.92	1.13
72.85	7116.90	0.87	5.59	1.08	1.16
91.06	7117.01	0.98	6.00	1.23	1.18
109.28	7117.12	1.09	6.35	1.36	1.20
127.49	7117.21	1.18	6.66	1.48	1.21
145.70	7117.31	1.28	6.94	1.59	1.22
163.92	7117.39	1.36	7.19	1.70	1.23
182.13	7117.47	1.44	7.42	1.80	1.24

Tailwater Channel Data - Lots 26-31

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 3.50 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 7116.03 ft

Roadway Data for Crossing: Lots 26-31

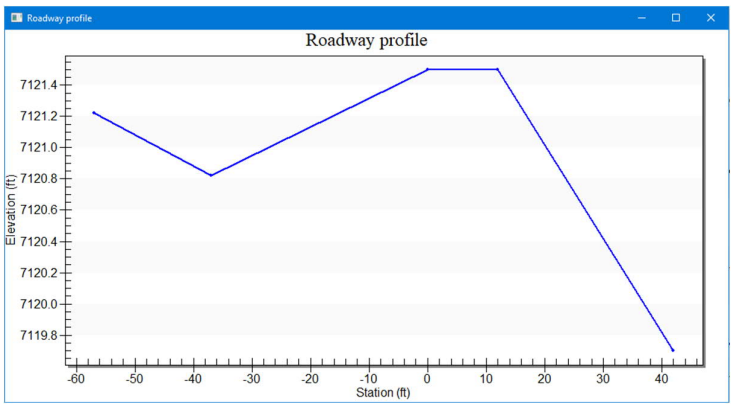
Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	-57.00	7121.22
1	-37.00	7120.82
2	0.00	7121.50
3	12.00	7121.50
4	42.00	7119.70

Roadway Surface: Paved

Roadway Top Width: 12.00 ft

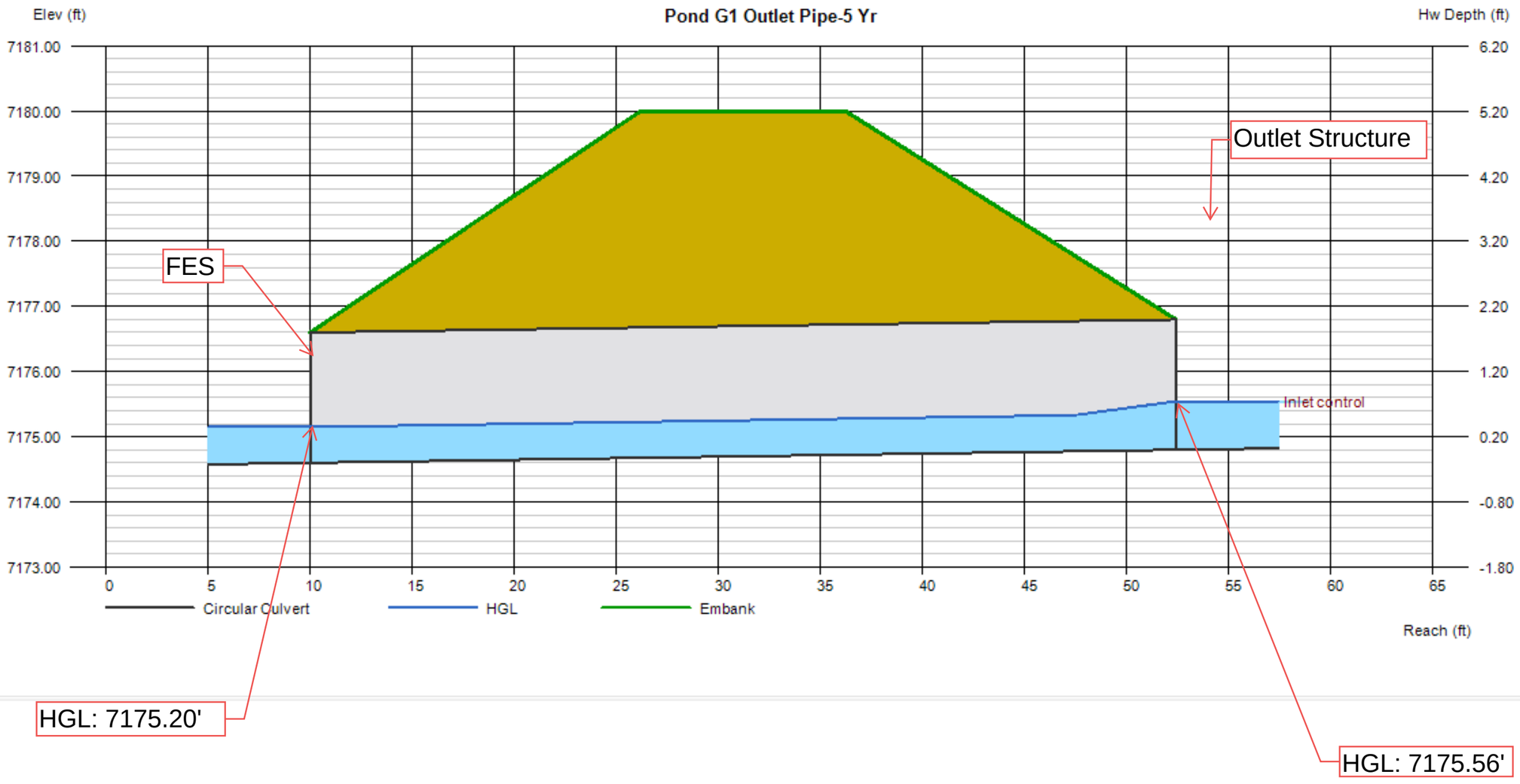


Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Jun 14 2022

Pond G1 Outlet Pipe-5 Yr

Invert Elev Dn (ft)	= 7174.60	**Calculations**	
Pipe Length (ft)	= 42.41	Qmin (cfs)	= 2.50
Slope (%)	= 0.47	Qmax (cfs)	= 2.50
Invert Elev Up (ft)	= 7174.80	Tailwater Elev (ft)	= Normal
Rise (in)	= 24.0		
Shape	= Circular	**Highlighted**	
Span (in)	= 24.0	Qtotal (cfs)	= 2.50
No. Barrels	= 1	Qpipe (cfs)	= 2.50
n-Value	= 0.013	Qovertop (cfs)	= 0.00
Culvert Type	= Circular Concrete	Veloc Dn (ft/s)	= 3.56
Culvert Entrance	= Groove end projecting (C)	Veloc Up (ft/s)	= 3.52
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.2	HGL Dn (ft)	= 7175.15
		HGL Up (ft)	= 7175.35
Embankment		Hw Elev (ft)	= 7175.55
Top Elevation (ft)	= 7180.00	Hw/D (ft)	= 0.37
Top Width (ft)	= 10.00	Flow Regime	= Inlet Control
Crest Width (ft)	= 40.00		



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Jun 14 2022

Pond G1 Outlet Pipe-100 Yr

Invert Elev Dn (ft)	=	7174.60
Pipe Length (ft)	=	42.41
Slope (%)	=	0.47
Invert Elev Up (ft)	=	7174.80
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

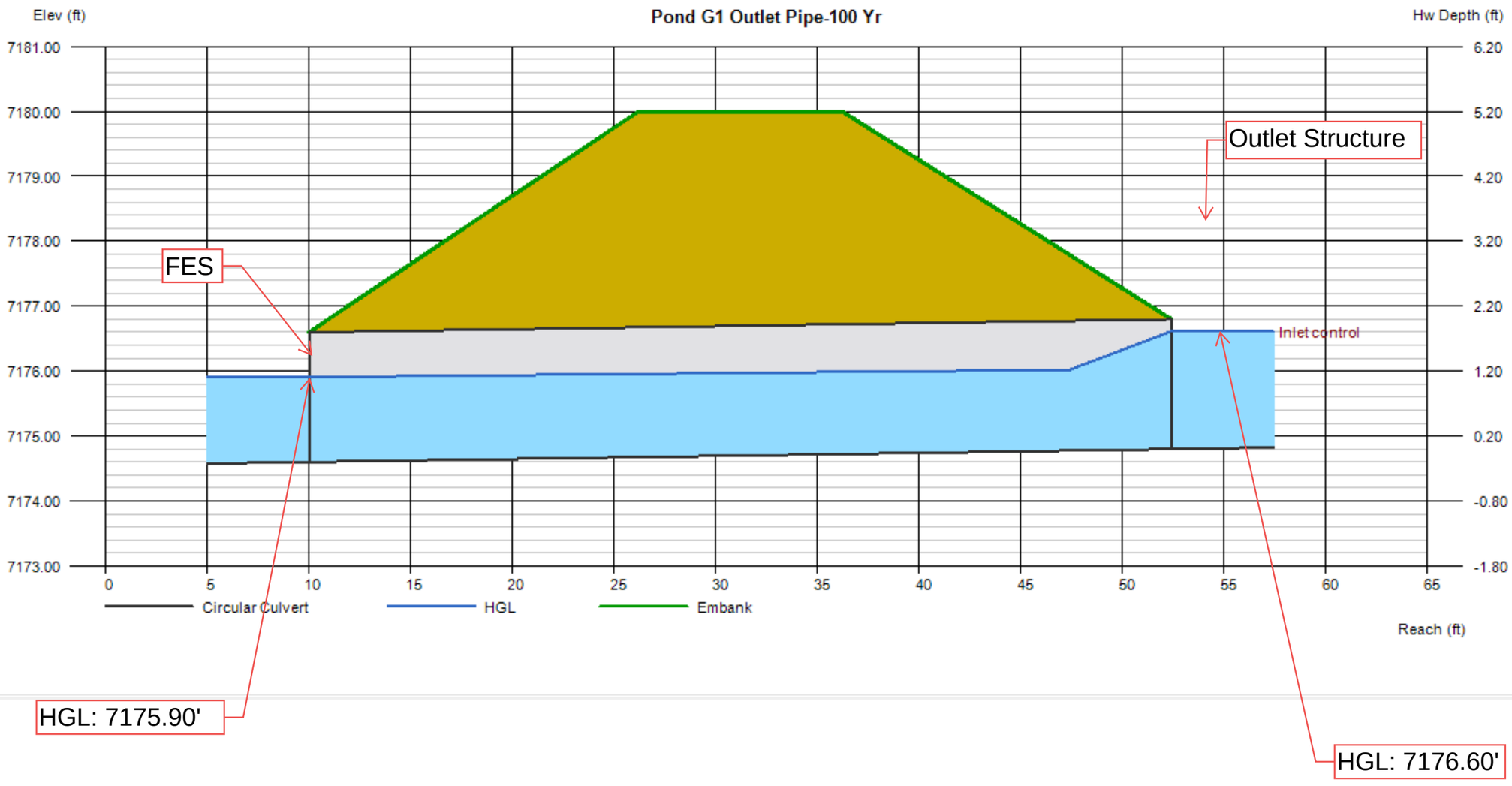
Top Elevation (ft)	=	7180.00
Top Width (ft)	=	10.00
Crest Width (ft)	=	40.00

Calculations

Qmin (cfs)	=	11.80
Qmax (cfs)	=	11.80
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	11.80
Qpipe (cfs)	=	11.80
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.42
Veloc Up (ft/s)	=	5.78
HGL Dn (ft)	=	7175.91
HGL Up (ft)	=	7176.04
Hw Elev (ft)	=	7176.62
Hw/D (ft)	=	0.91
Flow Regime	=	Inlet Control

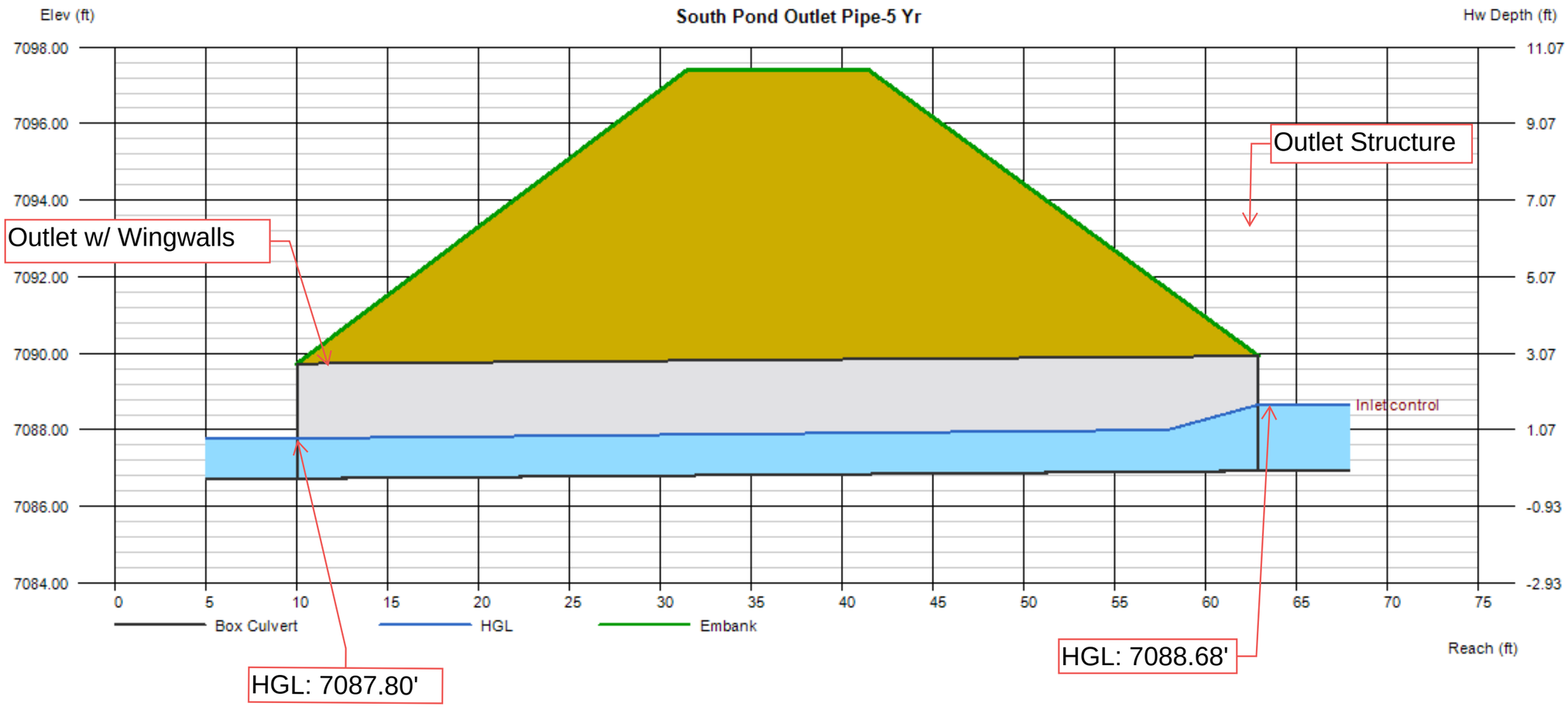


Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Jun 14 2022

South Pond Outlet Pipe-5 Yr

Invert Elev Dn (ft)	= 7086.73	**Calculations**		
Pipe Length (ft)	= 52.90	Qmin (cfs)	= 51.80	
Slope (%)	= 0.38	Qmax (cfs)	= 51.80	
Invert Elev Up (ft)	= 7086.93	Tailwater Elev (ft)	= Normal	
Rise (in)	= 36.0			
Shape	= Box	**Highlighted**		
Span (in)	= 96.0	Qtotal (cfs)	= 51.80	
No. Barrels	= 1	Qpipe (cfs)	= 51.80	
n-Value	= 0.013	Qovertop (cfs)	= 0.00	
Culvert Type	= Flared Wingwalls	Veloc Dn (ft/s)	= 6.17	
Culvert Entrance	= 30D to 75D wingwall flares	Veloc Up (ft/s)	= 5.92	
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4	HGL Dn (ft)	= 7087.78	
		HGL Up (ft)	= 7088.02	
Embankment		Hw Elev (ft)	= 7088.66	
Top Elevation (ft)	= 7097.40	Hw/D (ft)	= 0.58	
Top Width (ft)	= 10.00	Flow Regime	= Inlet Control	
Crest Width (ft)	= 40.00			



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Jun 14 2022

South Pond Outlet Pipe-100 Yr

Invert Elev Dn (ft)	=	7086.73
Pipe Length (ft)	=	52.90
Slope (%)	=	0.38
Invert Elev Up (ft)	=	7086.93
Rise (in)	=	36.0
Shape	=	Box
Span (in)	=	96.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

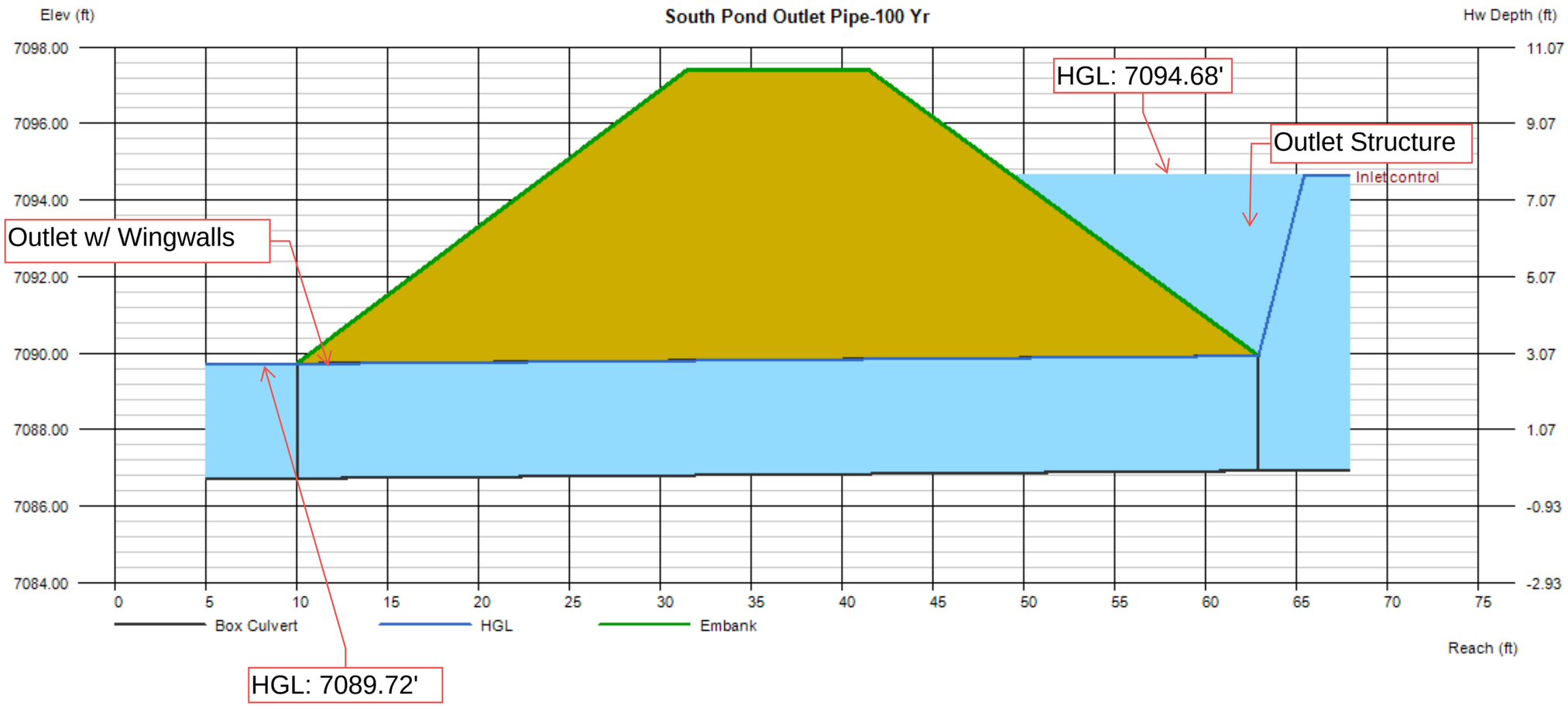
Top Elevation (ft)	=	7097.40
Top Width (ft)	=	10.00
Crest Width (ft)	=	40.00

Calculations

Qmin (cfs)	=	296.00
Qmax (cfs)	=	296.00
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	296.00
Qpipe (cfs)	=	296.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	12.37
Veloc Up (ft/s)	=	12.33
HGL Dn (ft)	=	7089.72
HGL Up (ft)	=	7089.93
Hw Elev (ft)	=	7094.63
Hw/D (ft)	=	2.57
Flow Regime	=	Inlet Control



APPENDIX D

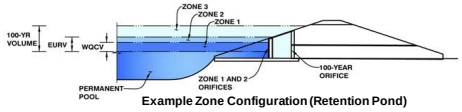
WATER QUALITY AND DETENTION CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Latigo Trails Filing 9

Basin ID: South Pond



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	237.10	acres
Watershed Length =	4,610	ft
Watershed Length to Centroid =	1,845	ft
Watershed Slope =	0.035	ft/ft
Watershed Imperviousness =	13.80%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.726	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	3.156	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	3.918	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	7.929	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	11.853	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	18.594	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	23.283	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	29.934	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3 in.) =	39.350	acre-feet	3.00	inches
Approximate 2-yr Detention Volume =	2.083	acre-feet		
Approximate 5-yr Detention Volume =	3.181	acre-feet		
Approximate 10-yr Detention Volume =	5.803	acre-feet		
Approximate 25-yr Detention Volume =	7.671	acre-feet		
Approximate 50-yr Detention Volume =	8.080	acre-feet		
Approximate 100-yr Detention Volume =	10.228	acre-feet		

Define Zones and Basin Geometry

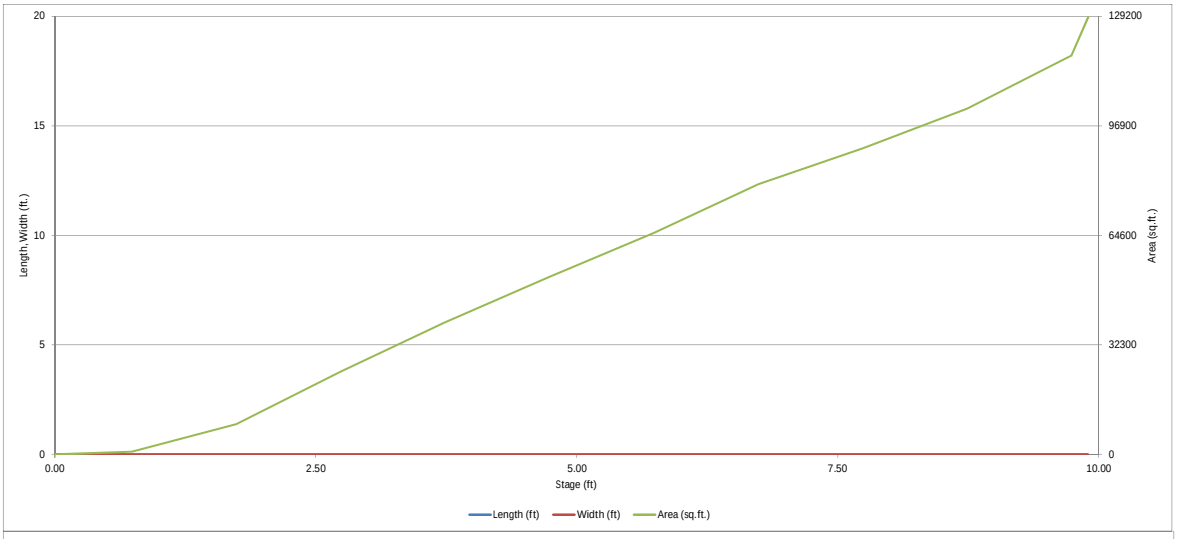
Zone 1 Volume (WQCV) =	1.726	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.429	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	7.073	acre-feet
Total Detention Basin Volume =	10.228	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

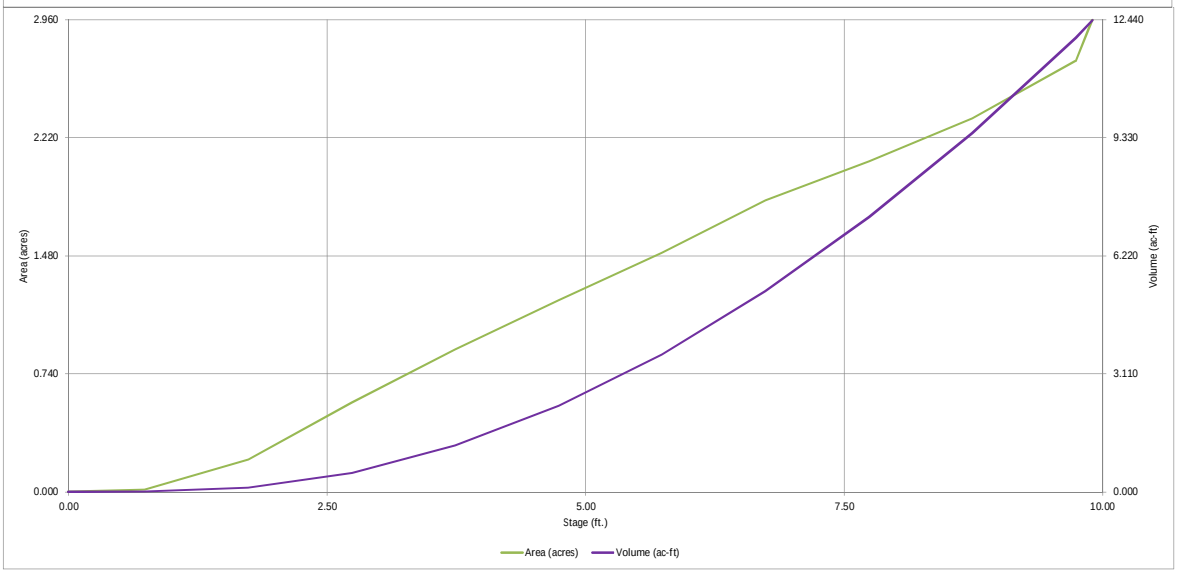
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
7088	--	0.74	--	--	--	757	0.017	280	0.006
7089	--	1.74	--	--	--	8,862	0.203	5,089	0.117
7090	--	2.74	--	--	--	24,382	0.560	21,711	0.498
7091	--	3.74	--	--	--	39,017	0.896	53,411	1.226
7092	--	4.74	--	--	--	52,356	1.202	99,097	2.275
7093	--	5.74	--	--	--	65,385	1.501	157,968	3.626
7094	--	6.74	--	--	--	79,696	1.830	230,508	5.292
7095	--	7.74	--	--	--	90,272	2.072	315,492	7.243
7096	--	8.74	--	--	--	102,009	2.342	411,633	9.450
7097	--	9.74	--	--	--	117,693	2.702	521,484	11.972
7097.16	--	9.90	--	--	--	128,850	2.958	541,207	12.424

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



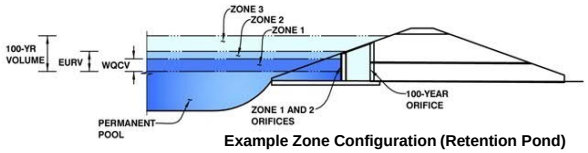


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: Latigo Trails Filing 9

Basin ID: South Pond



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.26	1.726	Orifice Plate
Zone 2 (EURV)	5.42	1.429	Rectangular Orifice
Zone 3 (100-year)	9.07	7.073	Weir&Pipe (Rect.)
Total (all zones)		10.228	

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

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

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	4.26	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.00	0.00	0.50	0.50	0.50	1.00	1.00
Orifice Area (sq. inches)	1.11	1.11	1.11	1.00	1.00	1.00	1.00	1.00

	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)	1.00							
Orifice Area (sq. inches)	1.00							

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected			Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	3.98	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	10.42	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	5.42	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.63	N/A	feet
Vertical Orifice Height =	15.00	N/A	inches				
Vertical Orifice Width =	100.00		inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.90	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.90	N/A	feet
Overflow Weir Front Edge Length =	8.33	N/A	feet	Overflow Weir Slope Length =	5.84	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	1.41	N/A	
Horiz. Length of Weir Sides =	5.84	N/A	feet	Overflow Grate Open Area w/o Debris =	33.86	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	33.86	N/A	ft^2
Debris Clogging % =	0%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Rectangular	Not Selected			Zone 3 Rectangular	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	24.00	N/A	ft^2
Rectangular Orifice Width =	96.00	N/A	inches	Outlet Orifice Centroid =	1.50	N/A	feet
Rectangular Orifice Height =	36.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.90	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.97	feet
Spillway Crest Length =	120.00	feet	Stage at Top of Freeboard =	9.87	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	2.91	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	12.34	acre-ft

Calculated Parameters for Spillway

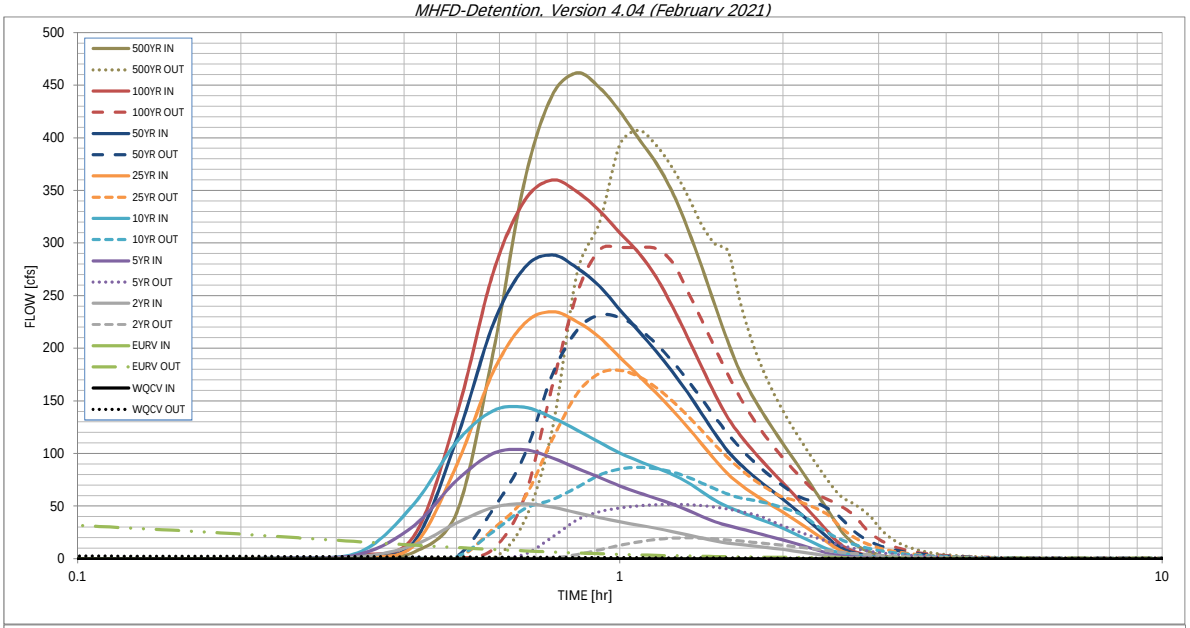
Routed Hydrograph Results

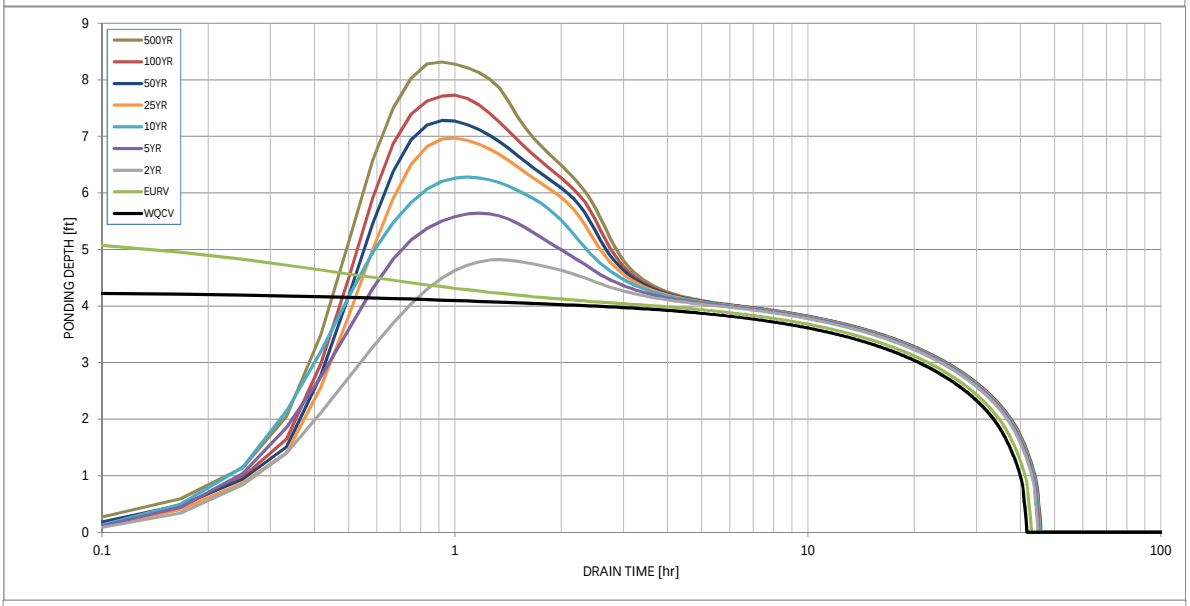
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

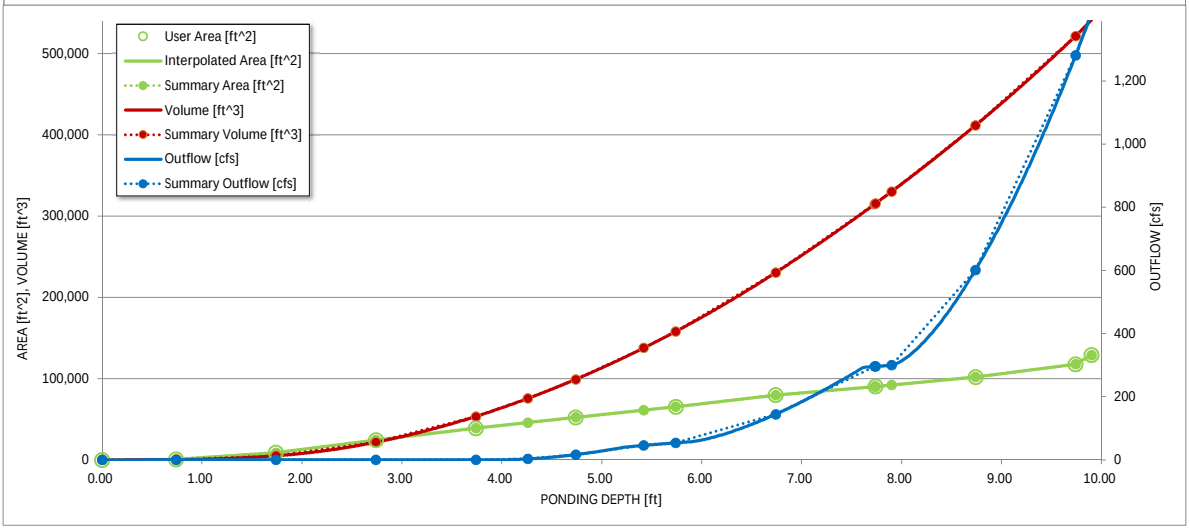
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
CUHP Runoff Volume (acre-ft) =	1.726	3.156	3.918	7.929	11.853	18.594	23.283	29.934	39.350
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.918	7.929	11.853	18.594	23.283	29.934	39.350
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	26.9	76.5	116.4	206.4	259.5	328.3	428.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.11	0.32	0.49	0.87	1.09	1.38	1.81
Peak Inflow Q (cfs) =	N/A	N/A	52.3	103.7	144.0	234.8	288.8	360.0	461.8
Peak Outflow Q (cfs) =	3.0	42.8	20.0	51.8	86.9	179.1	231.7	295.9	407.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.7	0.9	0.9	0.9	1.0
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.6	3.0	4.4	6.1	6.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	38	39	35	32	27	24	19	13
Time to Drain 99% of Inflow Volume (hours) =	40	41	42	41	39	37	36	34	31
Maximum Ponding Depth (ft) =	4.26	5.42	4.82	5.64	6.28	6.97	7.28	7.73	8.32
Area at Maximum Ponding Depth (acres) =	1.05	1.41	1.23	1.47	1.68	1.89	1.96	2.07	2.23
Maximum Volume Stored (acre-ft) =	1.733	3.161	2.372	3.478	4.468	5.719	6.315	7.201	8.468

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.13
	0:15:00	0.00	0.00	0.46	0.75	0.93	0.62	0.83	0.77	1.14
	0:20:00	0.00	0.00	2.04	4.76	7.12	2.16	2.58	3.43	6.28
	0:25:00	0.00	0.00	12.94	31.39	51.97	12.57	15.84	21.48	43.77
	0:30:00	0.00	0.00	34.10	74.62	111.11	89.16	113.91	136.95	195.01
	0:35:00	0.00	0.00	48.79	100.07	140.66	177.27	222.56	271.44	358.61
	0:40:00	0.00	0.00	52.32	103.67	144.00	223.52	276.51	340.26	440.40
	0:45:00	0.00	0.00	49.14	95.96	134.27	234.82	288.78	359.95	461.81
	0:50:00	0.00	0.00	43.74	86.04	122.30	225.33	276.46	348.93	447.84
	0:55:00	0.00	0.00	39.20	77.44	110.81	210.59	259.12	330.82	425.17
	1:00:00	0.00	0.00	35.15	69.27	100.58	191.38	236.63	309.72	399.16
	1:05:00	0.00	0.00	31.99	62.76	92.83	173.99	216.41	290.73	376.18
	1:10:00	0.00	0.00	29.04	57.37	86.44	157.54	197.20	267.71	348.19
	1:15:00	0.00	0.00	25.89	51.96	80.21	141.30	177.88	239.57	313.96
	1:20:00	0.00	0.00	22.75	46.16	72.66	125.07	157.94	210.42	277.09
	1:25:00	0.00	0.00	19.66	40.28	63.68	109.01	137.77	181.82	239.77
	1:30:00	0.00	0.00	16.94	35.15	55.44	93.60	118.36	155.55	205.61
	1:35:00	0.00	0.00	14.94	31.55	49.35	80.44	101.98	133.68	177.40
	1:40:00	0.00	0.00	13.57	28.67	44.64	70.77	89.98	117.48	156.24
	1:45:00	0.00	0.00	12.40	25.81	40.48	62.94	80.17	104.24	138.77
	1:50:00	0.00	0.00	11.30	23.07	36.66	56.13	71.57	92.51	123.27
	1:55:00	0.00	0.00	10.14	20.44	32.91	49.94	63.76	81.85	109.18
	2:00:00	0.00	0.00	8.95	17.92	28.95	44.18	56.48	71.93	96.04
	2:05:00	0.00	0.00	7.70	15.34	24.77	38.35	49.06	62.24	83.09
	2:10:00	0.00	0.00	6.42	12.72	20.57	32.50	41.58	52.85	70.45
	2:15:00	0.00	0.00	5.17	10.16	16.54	26.76	34.26	43.79	58.26
	2:20:00	0.00	0.00	3.95	7.69	12.72	21.13	27.12	34.84	46.33
	2:25:00	0.00	0.00	2.79	5.35	9.18	15.63	20.18	26.07	34.73
	2:30:00	0.00	0.00	1.83	3.54	6.59	10.41	13.59	17.74	24.05
	2:35:00	0.00	0.00	1.25	2.54	5.06	6.79	9.13	11.93	16.66
	2:40:00	0.00	0.00	0.95	1.99	4.03	4.61	6.40	8.26	11.85
	2:45:00	0.00	0.00	0.75	1.59	3.21	3.22	4.58	5.71	8.40
	2:50:00	0.00	0.00	0.60	1.27	2.56	2.25	3.27	3.86	5.84
	2:55:00	0.00	0.00	0.48	1.01	2.01	1.60	2.36	2.54	3.96
	3:00:00	0.00	0.00	0.37	0.79	1.56	1.15	1.70	1.59	2.59
	3:05:00	0.00	0.00	0.30	0.61	1.18	0.82	1.22	0.99	1.68
	3:10:00	0.00	0.00	0.24	0.46	0.88	0.61	0.91	0.72	1.21
	3:15:00	0.00	0.00	0.20	0.35	0.65	0.47	0.69	0.57	0.93
	3:20:00	0.00	0.00	0.15	0.26	0.49	0.36	0.53	0.45	0.73
	3:25:00	0.00	0.00	0.12	0.18	0.37	0.27	0.41	0.35	0.57
	3:30:00	0.00	0.00	0.09	0.12	0.27	0.20	0.31	0.27	0.43
	3:35:00	0.00	0.00	0.06	0.08	0.19	0.15	0.22	0.19	0.32
	3:40:00	0.00	0.00	0.04	0.05	0.12	0.10	0.15	0.13	0.21
	3:45:00	0.00	0.00	0.02	0.03	0.07	0.06	0.10	0.08	0.13
	3:50:00	0.00	0.00	0.01	0.02	0.03	0.03	0.05	0.04	0.07
	3:55:00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
Top of Micropool-7087.26	0.00	0	0.000	0	0.000	0.00
7088.00	0.74	757	0.017	280	0.006	0.14
7089.00	1.74	8,862	0.203	5,089	0.117	0.34
7090.00	2.74	24,382	0.560	21,711	0.498	0.47
7091.00	3.74	39,017	0.896	53,411	1.226	0.56
WQCV WSEL-7091.52	4.26	45,953	1.055	75,503	1.733	3.25
7092.00	4.74	52,356	1.202	99,097	2.275	16.75
EURV WSEL-7092.68	5.42	61,216	1.405	137,712	3.161	45.97
7093.00	5.74	65,385	1.501	157,968	3.626	54.15
7094.00	6.74	79,696	1.830	230,508	5.292	144.36
100 Yr WSEL-7094.99	7.73	90,166	2.070	314,590	7.222	295.98
7095.00	7.74	90,272	2.072	315,492	7.243	296.20
Spillway Crest-7095.16	7.90	92,150	2.115	330,086	7.578	299.79
7096.00	8.74	102,009	2.342	411,633	9.450	601.31
7097.00	9.74	117,693	2.702	521,484	11.972	1,280.91
Top of Pond-7097.16	9.90	128,850	2.958	541,207	12.424	1,413.98

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

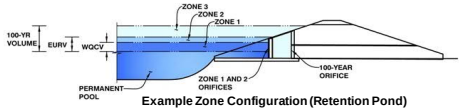
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Latigo Trails Filing 9

Basin ID: Pond G1



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	15.22	acres
Watershed Length =	1,775	ft
Watershed Length to Centroid =	785	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	17.70%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.134	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.265	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.302	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.570	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.828	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	1.255	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.557	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.981	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3 in.) =	2.587	acre-feet	3.00 inches
Approximate 2-yr Detention Volume =	0.179	acre-feet	
Approximate 5-yr Detention Volume =	0.268	acre-feet	
Approximate 10-yr Detention Volume =	0.450	acre-feet	
Approximate 25-yr Detention Volume =	0.569	acre-feet	
Approximate 50-yr Detention Volume =	0.601	acre-feet	
Approximate 100-yr Detention Volume =	0.747	acre-feet	

Define Zones and Basin Geometry

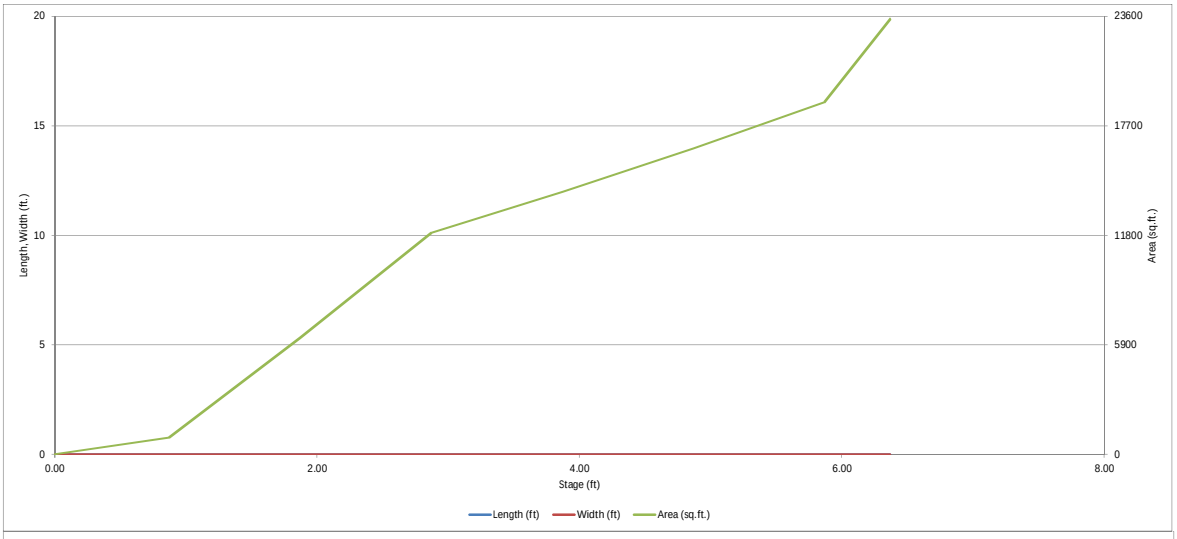
Zone 1 Volume (WQCV) =	0.134	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.131	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.482	acre-feet
Total Detention Basin Volume =	0.747	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

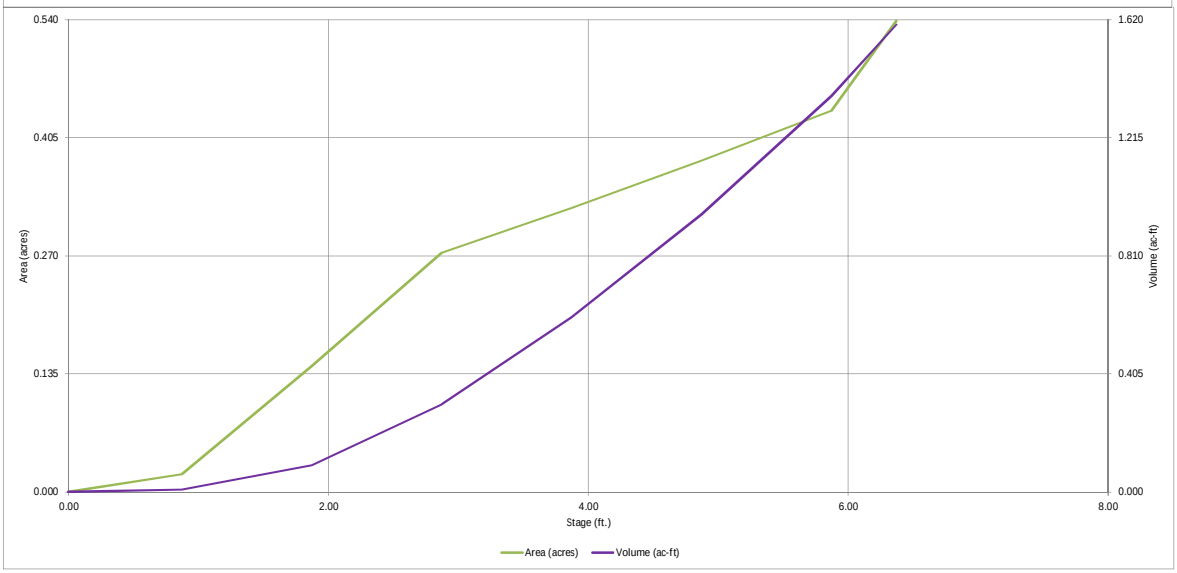
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
7176	--	0.87	--	--	--	897	0.021	395	0.009
7177	--	1.87	--	--	--	6,282	0.144	3,984	0.091
7178	--	2.87	--	--	--	11,930	0.274	13,090	0.301
7179	--	3.87	--	--	--	14,157	0.325	26,133	0.600
7180	--	4.87	--	--	--	16,502	0.379	41,463	0.952
7181	--	5.87	--	--	--	18,983	0.436	59,205	1.359
7181.5	--	6.37	--	--	--	23,460	0.539	69,816	1.603

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



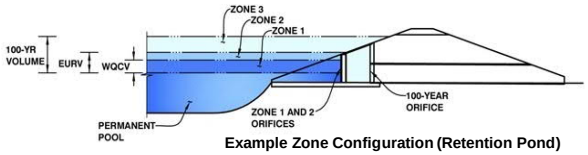


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: Latigo Trails Filing 9

Basin ID: Pond G1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.14	0.134	Orifice Plate
Zone 2 (EURV)	2.74	0.131	Orifice Plate
Zone 3 (100-year)	4.31	0.482	Weir&Pipe (Restrict)
Total (all zones)		0.747	

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

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

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.45	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.20	2.25					
Orifice Area (sq. inches)	0.72	0.58	0.55					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.00	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.99	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	11.14	N/A	ft^2
Debris Clogging % =	0%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.24	N/A	ft^2
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	0.48	N/A	feet
Restrictor Plate Height Above Pipe Invert =	10.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.40	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.87	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.28	feet
Spillway Crest Length =	40.00	feet	Stage at Top of Freeboard =	6.15	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.49	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.49	acre-ft

Calculated Parameters for Spillway

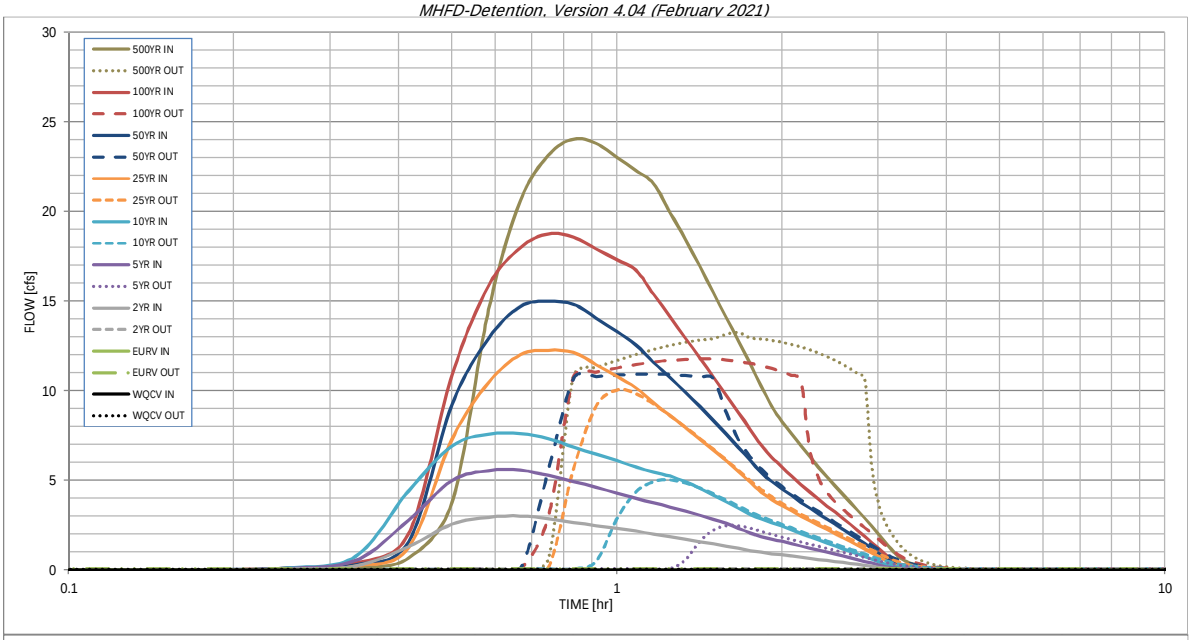
Routed Hydrograph Results

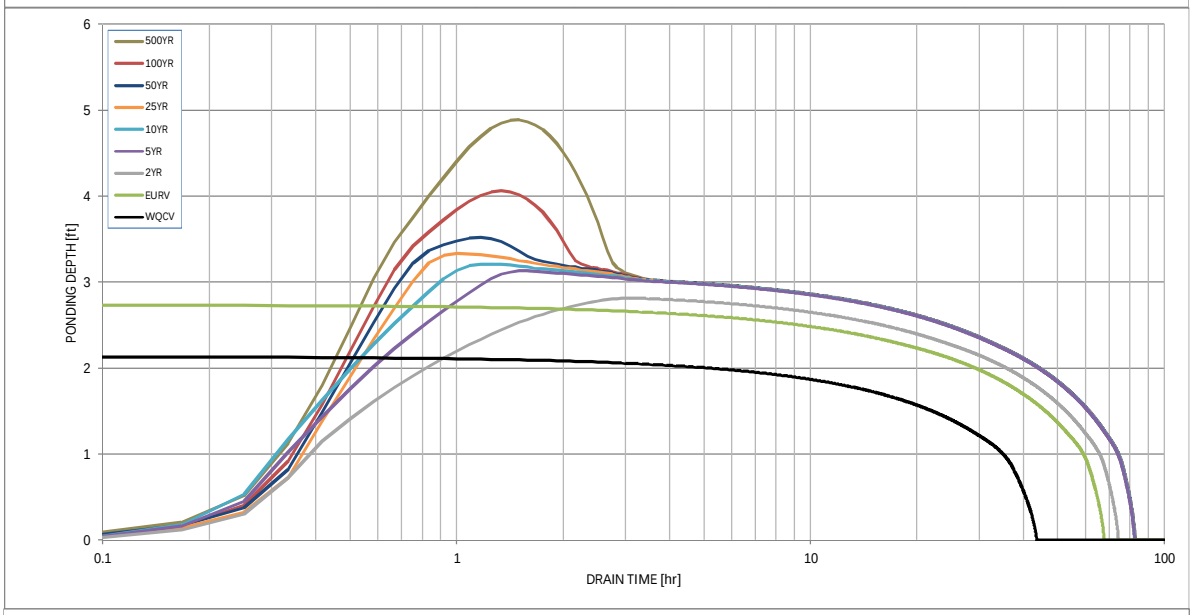
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

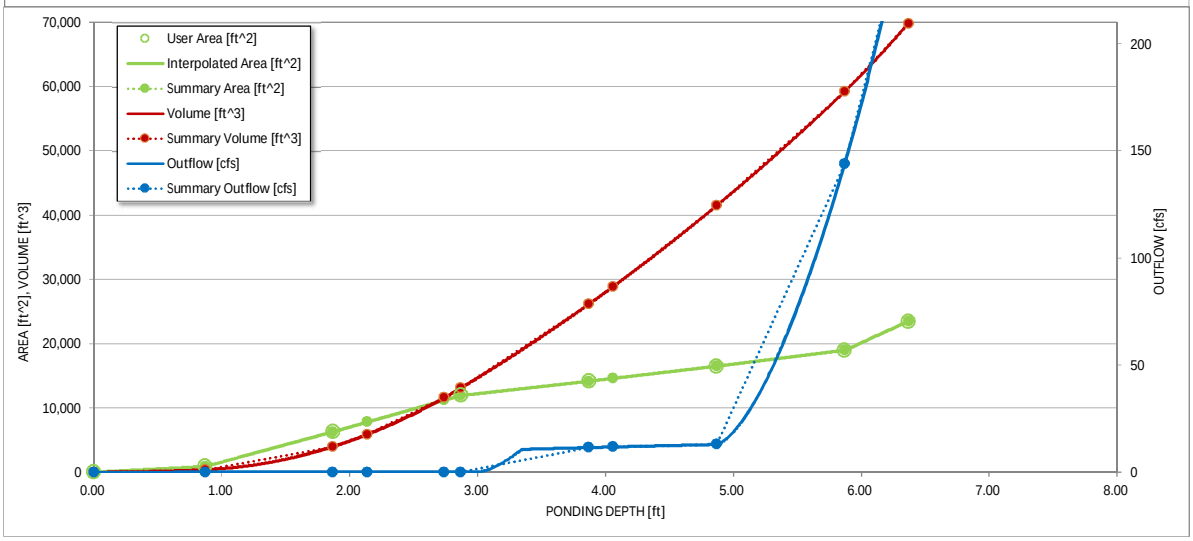
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
CUHP Runoff Volume (acre-ft) =	0.134	0.265	0.302	0.570	0.828	1.255	1.557	1.981	2.587
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.302	0.570	0.828	1.255	1.557	1.981	2.587
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.3	3.7	5.6	10.2	12.8	16.4	21.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.09	0.24	0.37	0.67	0.84	1.08	1.41
Peak Inflow Q (cfs) =	N/A	N/A	3.0	5.6	7.6	12.3	15.0	18.8	24.1
Peak Outflow Q (cfs) =	0.1	0.1	0.1	2.5	5.0	10.1	10.9	11.8	13.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.9	1.0	0.9	0.7	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.2	0.4	0.9	1.0	1.0	1.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	62	68	72	69	64	61	58	53
Time to Drain 99% of Inflow Volume (hours) =	42	65	71	78	77	74	73	71	68
Maximum Ponding Depth (ft) =	2.14	2.74	2.81	3.13	3.21	3.33	3.52	4.06	4.89
Area at Maximum Ponding Depth (acres) =	0.18	0.26	0.27	0.29	0.29	0.30	0.31	0.34	0.38
Maximum Volume Stored (acre-ft) =	0.135	0.266	0.284	0.371	0.394	0.432	0.486	0.663	0.956

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
	0:15:00	0.00	0.00	0.06	0.11	0.13	0.09	0.11	0.11	0.15
	0:20:00	0.00	0.00	0.24	0.54	0.77	0.24	0.31	0.41	0.68
	0:25:00	0.00	0.00	1.32	2.79	4.42	1.28	1.59	2.02	3.78
	0:30:00	0.00	0.00	2.57	5.01	6.94	7.30	9.22	10.86	14.54
	0:35:00	0.00	0.00	2.96	5.56	7.59	10.47	12.93	15.88	20.61
	0:40:00	0.00	0.00	3.03	5.58	7.63	12.02	14.72	17.99	23.15
	0:45:00	0.00	0.00	2.87	5.29	7.34	12.27	15.01	18.77	24.06
	0:50:00	0.00	0.00	2.67	4.95	6.87	12.15	14.84	18.58	23.81
	0:55:00	0.00	0.00	2.49	4.62	6.47	11.47	14.06	17.93	23.02
	1:00:00	0.00	0.00	2.34	4.31	6.11	10.81	13.30	17.33	22.29
	1:05:00	0.00	0.00	2.19	4.01	5.75	10.17	12.57	16.74	21.57
	1:10:00	0.00	0.00	2.02	3.76	5.47	9.34	11.59	15.38	19.95
	1:15:00	0.00	0.00	1.87	3.53	5.26	8.63	10.75	14.15	18.48
	1:20:00	0.00	0.00	1.73	3.29	4.94	7.95	9.92	12.96	16.95
	1:25:00	0.00	0.00	1.60	3.07	4.57	7.33	9.14	11.83	15.48
	1:30:00	0.00	0.00	1.47	2.84	4.20	6.70	8.36	10.78	14.11
	1:35:00	0.00	0.00	1.35	2.61	3.82	6.09	7.60	9.78	12.79
	1:40:00	0.00	0.00	1.22	2.35	3.46	5.49	6.86	8.80	11.52
	1:45:00	0.00	0.00	1.10	2.09	3.12	4.91	6.13	7.86	10.29
	1:50:00	0.00	0.00	1.00	1.88	2.86	4.35	5.45	6.97	9.16
	1:55:00	0.00	0.00	0.92	1.73	2.66	3.94	4.94	6.30	8.30
	2:00:00	0.00	0.00	0.86	1.61	2.46	3.61	4.55	5.77	7.61
	2:05:00	0.00	0.00	0.79	1.48	2.26	3.31	4.16	5.26	6.94
	2:10:00	0.00	0.00	0.72	1.35	2.06	3.02	3.80	4.79	6.32
	2:15:00	0.00	0.00	0.66	1.23	1.87	2.76	3.47	4.36	5.75
	2:20:00	0.00	0.00	0.60	1.12	1.69	2.51	3.15	3.96	5.21
	2:25:00	0.00	0.00	0.54	1.00	1.52	2.27	2.85	3.58	4.71
	2:30:00	0.00	0.00	0.48	0.90	1.35	2.05	2.56	3.23	4.24
	2:35:00	0.00	0.00	0.43	0.79	1.20	1.83	2.29	2.89	3.79
	2:40:00	0.00	0.00	0.37	0.69	1.04	1.61	2.02	2.55	3.34
	2:45:00	0.00	0.00	0.32	0.59	0.90	1.40	1.75	2.22	2.90
	2:50:00	0.00	0.00	0.27	0.49	0.75	1.19	1.49	1.88	2.46
	2:55:00	0.00	0.00	0.22	0.39	0.61	0.98	1.22	1.55	2.03
	3:00:00	0.00	0.00	0.17	0.30	0.47	0.77	0.96	1.22	1.60
	3:05:00	0.00	0.00	0.12	0.21	0.34	0.56	0.71	0.90	1.17
	3:10:00	0.00	0.00	0.08	0.15	0.26	0.37	0.47	0.60	0.80
	3:15:00	0.00	0.00	0.06	0.11	0.20	0.25	0.33	0.42	0.57
	3:20:00	0.00	0.00	0.05	0.09	0.17	0.18	0.24	0.30	0.41
	3:25:00	0.00	0.00	0.04	0.08	0.14	0.13	0.18	0.21	0.30
	3:30:00	0.00	0.00	0.03	0.06	0.11	0.10	0.13	0.15	0.21
	3:35:00	0.00	0.00	0.03	0.05	0.09	0.07	0.10	0.10	0.15
	3:40:00	0.00	0.00	0.02	0.04	0.07	0.06	0.08	0.07	0.10
	3:45:00	0.00	0.00	0.02	0.03	0.06	0.04	0.06	0.05	0.07
	3:50:00	0.00	0.00	0.01	0.02	0.04	0.03	0.04	0.04	0.06
	3:55:00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.04
	4:00:00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.02	0.03
	4:05:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.03
	4:10:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.02
	4:15:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	4:20:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

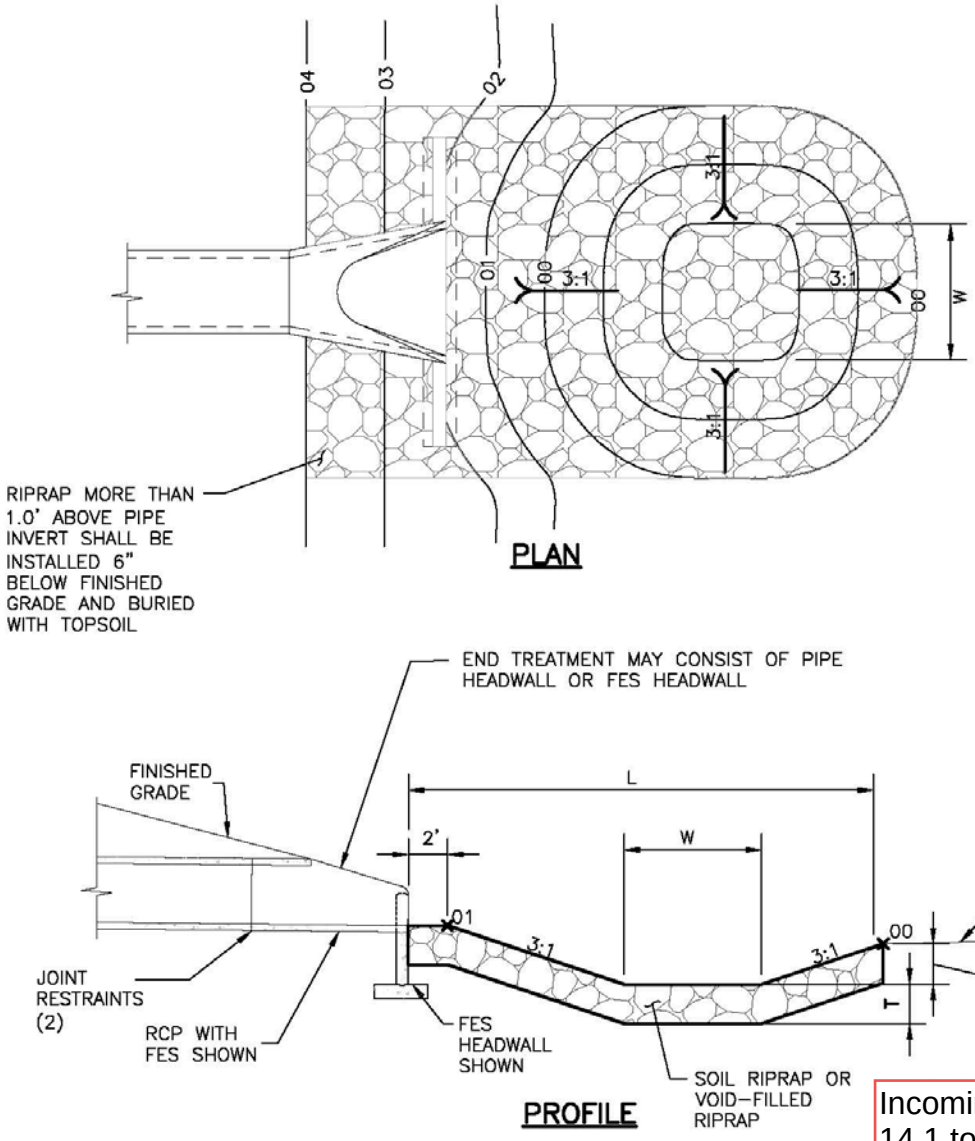
Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
Top of Micropool-7175.13	0.00	10	0.000	0	0.000	0.00
7176.00	0.87	897	0.021	395	0.009	0.02
7177.00	1.87	6,282	0.144	3,984	0.091	0.05
WQVC WSEL-7177.27	2.14	7,807	0.179	5,886	0.135	0.05
EURV WSEL-7177.87	2.74	11,196	0.257	11,587	0.266	0.08
7178.00	2.87	11,930	0.274	13,090	0.301	0.08
7179.00	3.87	14,157	0.325	26,133	0.600	11.50
100-Yr WSEL-7179.19	4.06	14,603	0.335	28,866	0.663	11.79
Spillway Crest-7180.00	4.87	16,502	0.379	41,463	0.952	12.96
7181.00	5.87	18,983	0.436	59,205	1.359	143.86
Top of Pond-7181.50	6.37	23,460	0.539	69,816	1.603	261.78

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).



PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

Figure 9-37. Low tailwater riprap basin

Incoming swale is trapezoidal section 14.1 to the low-tailwater basin.

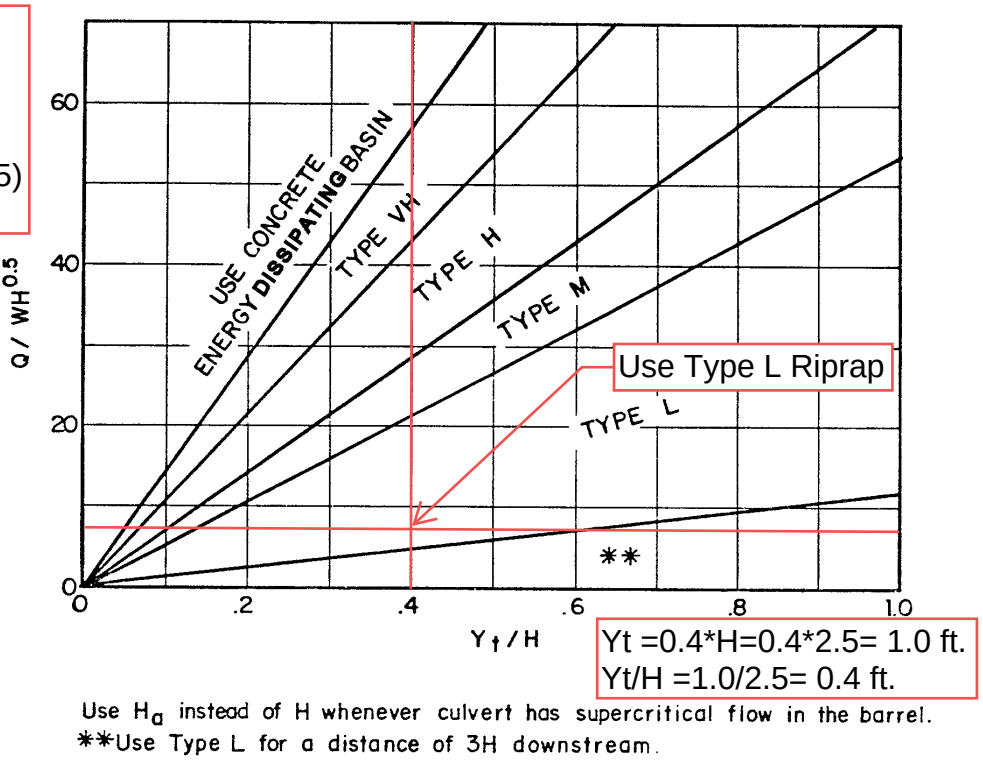
Top width of water rounded to nearest half foot is 31.5 feet. Water depth with freeboard rounded to the nearest half foot is 2.5 feet.
For design purpose, an equivalent rectangular shape w/ width=31.5 ft. and height=2.5 ft. used. Based on the std. sizing criteria for that box height, the depth (D) of the low-tailwater basin is 1.5 ft. Width req. (W) is 31.5 ft. based on the equiv. box size. Total length (L) is 45.5 ft.

Q/WH^1.5 </= 8.0 for this sizing chart to be valid.
Q=356.7 cfs, W=31.5 ft., & H=2.5ft.

(356.7)/((31.5)(2.5)^1.5) = 2.9
Therefore this chart can be used.

Q=356.7 cfs
W=31.5 ft., H=2.5ft.

Q/WH^0.5 =
= (356.7)/(31.5)(2.5)^0.5)
= 7.2



Yt =0.4*H=0.4*2.5= 1.0 ft.
Yt/H =1.0/2.5= 0.4 ft.

Use H_a instead of H whenever culvert has supercritical flow in the barrel.
**Use Type L for a distance of 3H downstream.

Figure 9-39. Riprap erosion protection at rectangular conduit outlet (valid for Q/WH1.5 ≤ 8.0)

3.2.4 Outfalls and Rundowns

A grouted boulder outfall or "rundown" dissipates energy and provides erosion control protection. Grouted boulder outfalls are most commonly used in large rivers like the South Platte. Figure 9-40 provides a plan view and cross section for a standard grouted boulder rundown. See the grouted boulder drop profiles (A1, A2, and A3) in Figure 9-12 for site specific profile options, (i.e., depressed or free-draining basin for use with a stable downstream channel or with no basin for use in channels subject to degradation). Figure 9-41 provides a plan view of the same structure for use when the structure is in-line with the channel. Evaluate the following when designing a grouted boulder outfall or rundown:

- Minimize disturbance to channel bank
- Determine water surface elevation in receiving channel for base flow and design storm(s)
- Determine flow rate, velocity, depth, etc. of flow exiting the outfall pipe for the design storm(s)
- Evaluate permitting procedures and requirements for construction adjacent to large river system.

Rock Chute Design Data

(Version 4.01 - 04/23/03, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Latigo F9-Pond G1 Rundown **County:** El Paso
Designer: GAG **Checked by:**
Date: 9/1/2022 **Date:**

Input Channel Geometry

→ Inlet Channel	→ Chute	→ Outlet Channel
Bw = 0.1 ft.	Bw = 2.0 ft.	Bw = 7.0 ft.
Side slopes = 3.0 (m:1)	Factor of safety = 1.20 (F_s)	Side slopes = 0.1 (m:1)
n-value = 0.035	Side slopes = 3.0 (m:1) → 2.0:1 max.	n-value = 0.013
Bed slope = 0.0068 ft./ft.	Bed slope (4:1) = 0.250 ft./ft. → 2.5:1 max.	Bed slope = 0.0050 ft./ft.
Freeboard = 1.0 ft.	Outlet apron depth, d = 1.5 ft.	Base flow = 0.0 cfs

Design Storm Data (Table 2, NHCP, NRCS Grade Stabilization Structure No. 410)

Drainage area = 15.2 acres Rainfall = ◉ 0 - 3 in. ○ 3 - 5 in. ○ 5+ in.

Apron elev. --- Inlet = 7181.5 ft. --- Outlet = 7176.3 ft. --- (H_{drop} = 3.7 ft.)

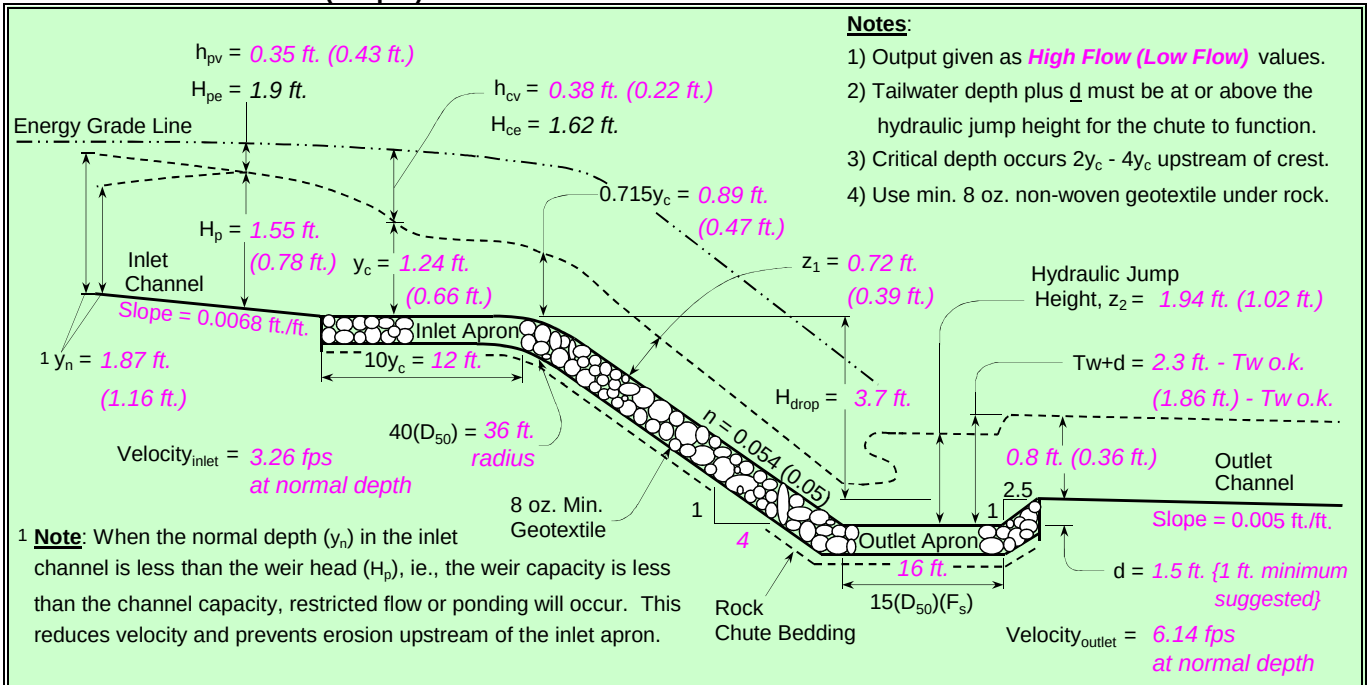
Chute capacity = Q5-year
Total capacity = Q10-year
Minimum capacity (based on a 5-year, 24-hour storm with a 0 - 3 inch rainfall)

Q_{high} = 34.9 cfs High flow storm through chute → Tw (ft.) = Program 0.25

Q_{low} = 9.9 cfs Low flow storm through chute → Tw (ft.) = Program

***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*
***Input tailwater (Tw)**:*

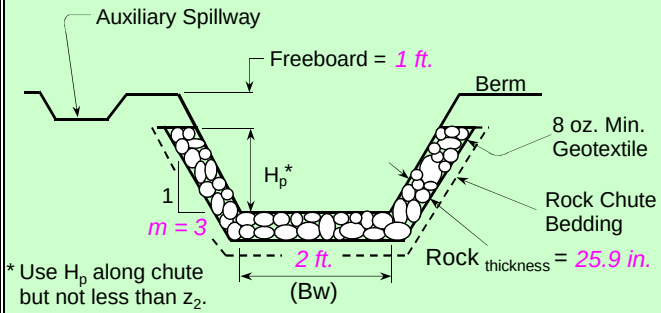
Profile and Cross Section (Output)



Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.
4) Use min. 8 oz. non-woven geotextile under rock.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute



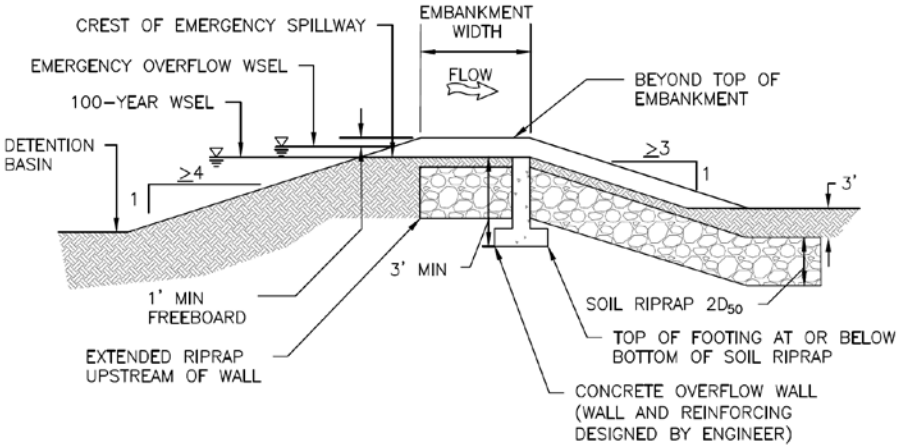
* Use H_p along chute but not less than z_2.

Typical Cross Section

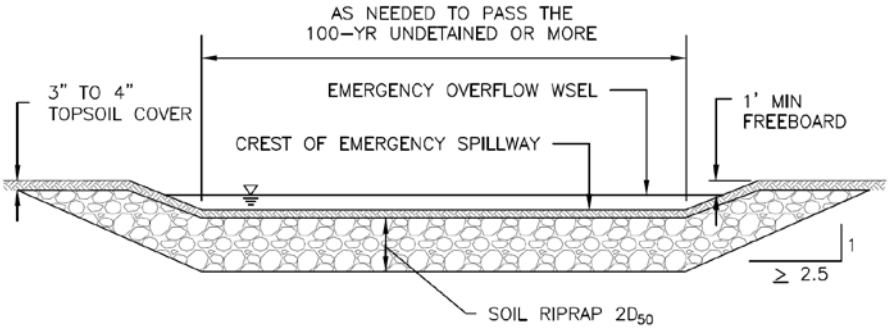
q_t =	7.84 cfs/ft.	Equivalent unit discharge
F_S =	1.20	Factor of safety (multiplier)
z_1 =	0.72 ft.	Normal depth in chute
n-value =	0.054	Manning's roughness coefficient
$D_{50}(F_s)$ =	12.9 in. (157 lbs. - 50% round / 50% angular)	
2(D_{50})(F_s) =	25.9 in.	Rock chute thickness
Tw + d =	2.3 ft.	Tailwater above outlet apron
z_2 =	1.94 ft.	Hydraulic jump height
*** ***The outlet***	***will***	***function adequately***

High Flow Storm Information

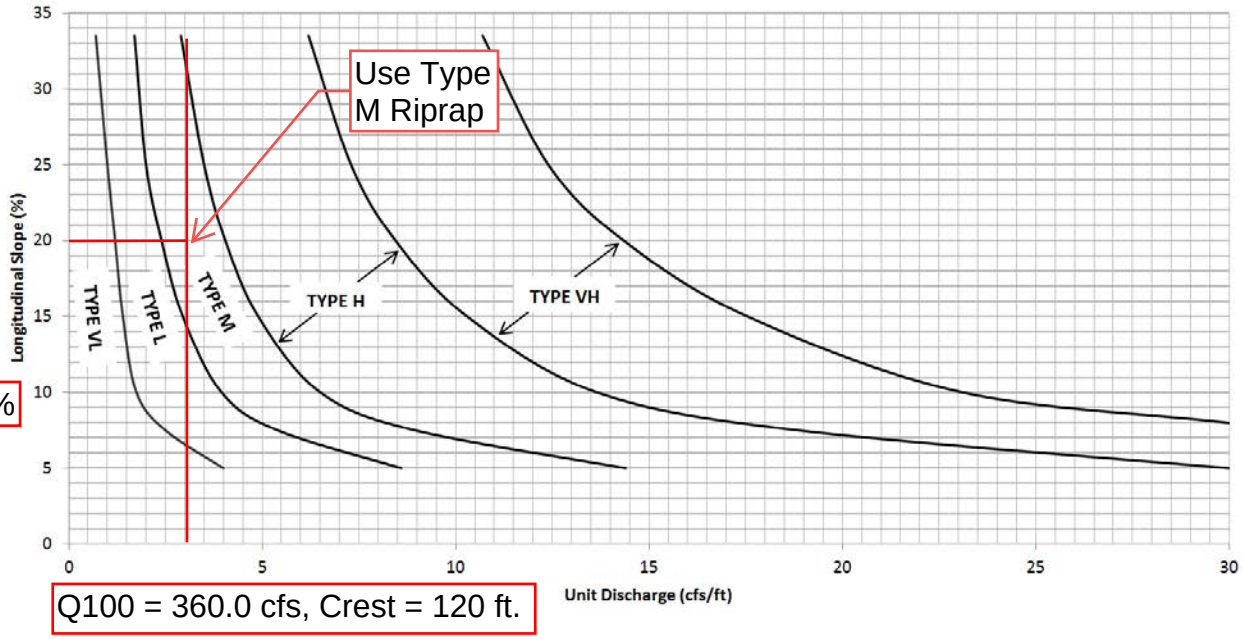
SOUTH POND SPILLWAY RIPRAP CALCULATION



EMERGENCY SPILLWAY PROFILE



EMERGENCY SPILLWAY SECTION AND SPILLWAY CHANNEL



Slope=20%

Q100 = 360.0 cfs, Crest = 120 ft.

Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Apr 7 2022

South Pond TC Capacity

Rectangular

Bottom Width (ft)	= 7.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.50
N-Value	= 0.013

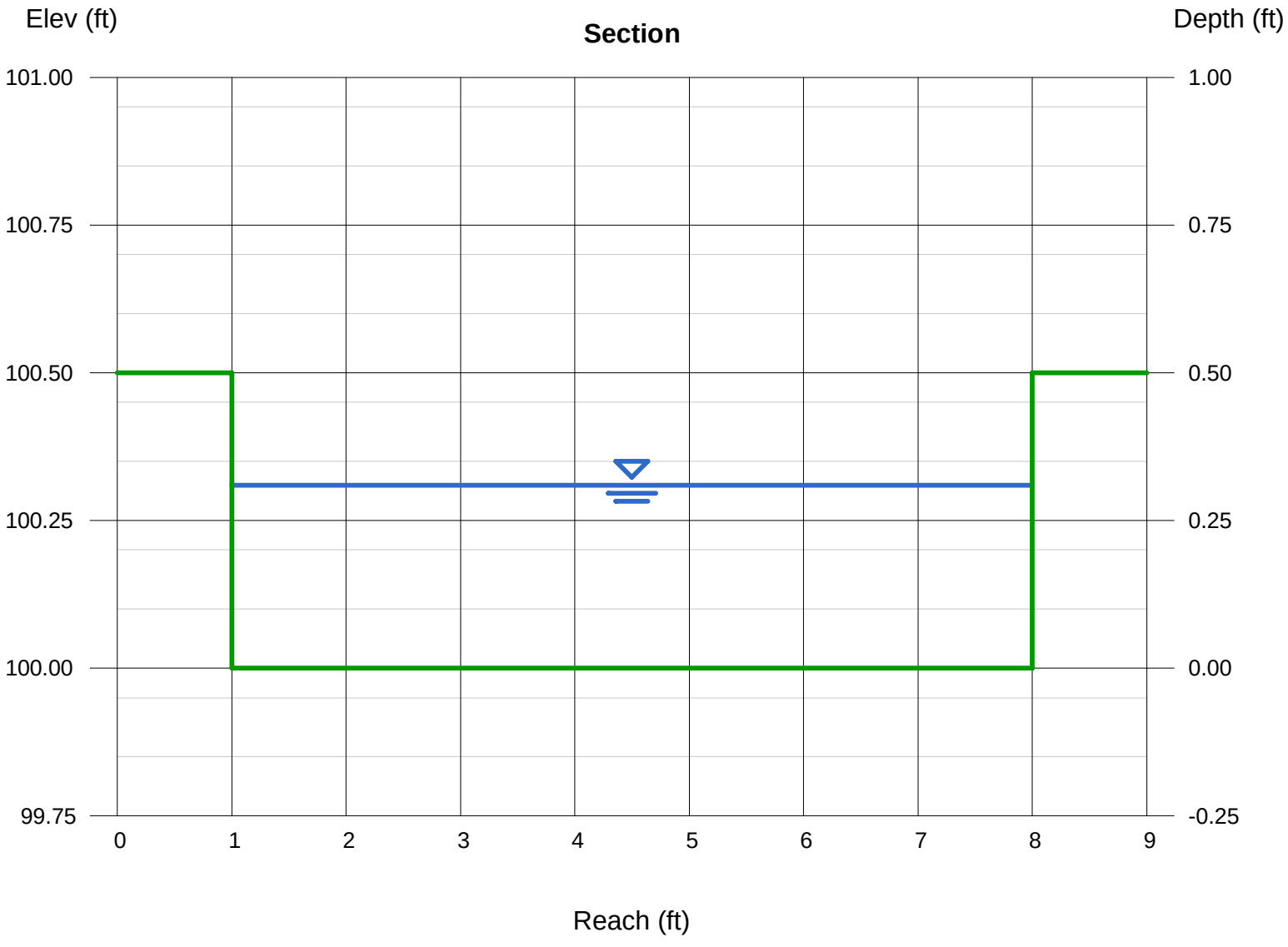
Calculations

Compute by:	Known Q
Known Q (cfs)	= 7.20

Q100=360 cfs, 2%=7.2 cfs

Highlighted

Depth (ft)	= 0.31
Q (cfs)	= 7.200
Area (sqft)	= 2.17
Velocity (ft/s)	= 3.32
Wetted Perim (ft)	= 7.62
Crit Depth, Yc (ft)	= 0.33
Top Width (ft)	= 7.00
EGL (ft)	= 0.48



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Apr 7 2022

G1 Pond TC Capacity

Rectangular

Bottom Width (ft)	= 7.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.50
N-Value	= 0.013

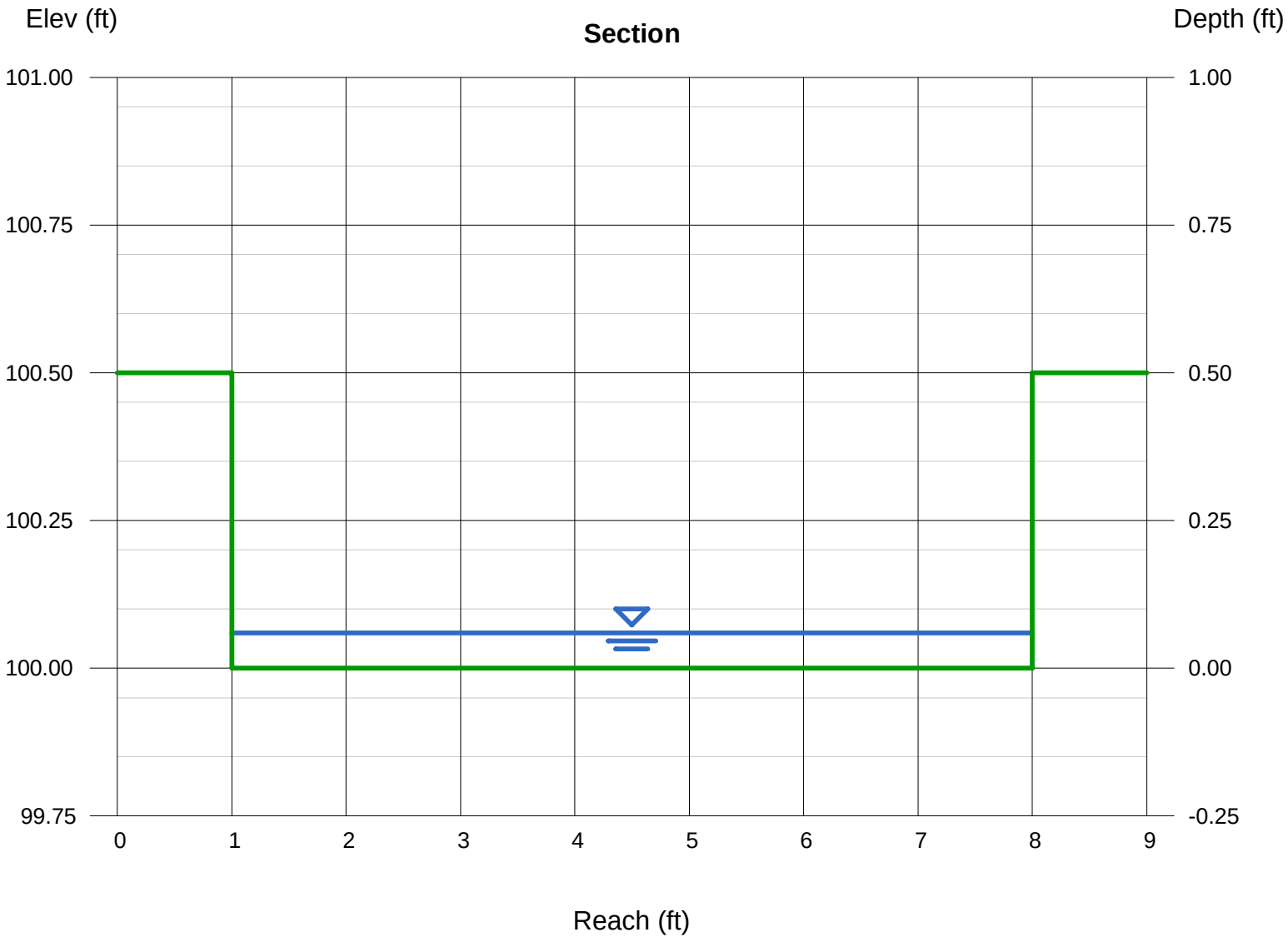
Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.38

Q100=18.8 cfs, 2%=0.38 cfs

Highlighted

Depth (ft)	= 0.06
Q (cfs)	= 0.380
Area (sqft)	= 0.42
Velocity (ft/s)	= 0.90
Wetted Perim (ft)	= 7.12
Crit Depth, Yc (ft)	= 0.05
Top Width (ft)	= 7.00
EGL (ft)	= 0.07



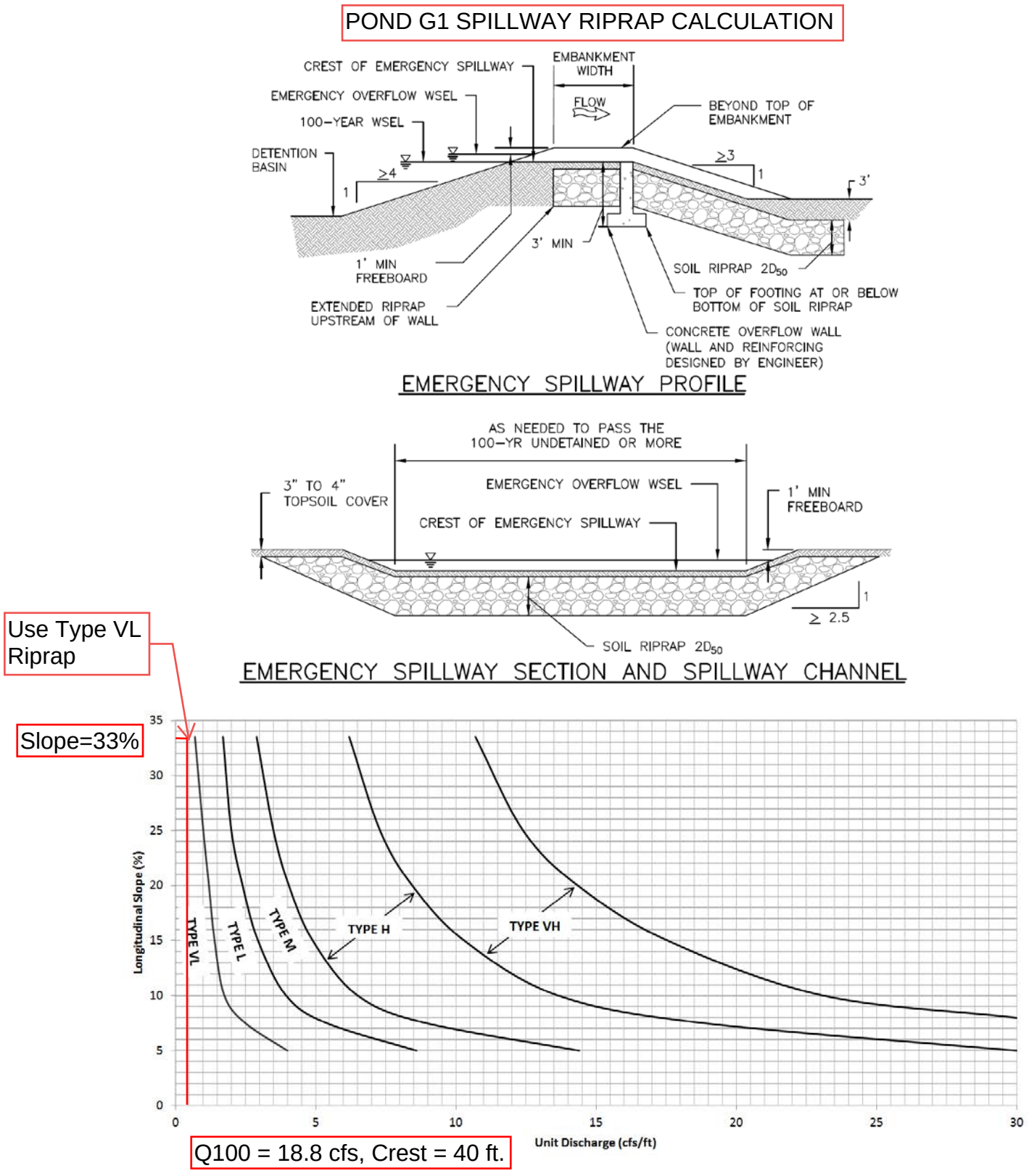


Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

PIPE OUTFALL RIPRAP SIZING CALCULATIONS

Subdivision: Latigo Trails
Location: El Paso County

Project Name: Filing 9
Project No.: 25175.02
Calculated By: GAG
Checked By:
Date: 4/6/22

G1 Pond 100-yr Release Flow

South Pond 100-yr Release Flow

	STORM DRAIN SYSTEM			
	DESIGN POINT	DESIGN POINT	DESIGN POINT	Notes
Q_{100} (cfs):	296.0	11.8		Flows are the greater of proposed vs. future
Conduit	Box Culvert	Pipe		
D_c, Pipe Diameter (in):	N/A	24		
W, Box Width (ft):	8	N/A		
H, Box Height (ft):	3	N/A		
Y_t, Tailwater Depth (ft):	1.20	0.80		If unknown, use Y_t/D_c (or H)=0.4
Y_t/Dc or Y_t/H	0.40	0.40		
$Q/D^{2.5}$ or $Q/(WH^{3/2})$	7.12	2.09		
Supercritical?	No	No		
Y_n, Normal Depth (ft) [Supercritical]:	0.00			
D_a, H_a (in) [Supercritical]:	N/A	N/A		$D_a=(D_c+Y_n)/2$
Riprap d_{50} (in) [Supercritical]:	N/A	N/A		
Riprap d_{50} (in) [Subcritical]:	8.97	3.46		
Required Riprap Size:	L	L		Fig. 9-38 or Fig. 9-36
d_{50} (in):	9	9		
Expansion Factor, $1/(2\tan\theta)$:	1.00	4.90		Read from Fig. 9-35 or 9-36
θ:	0.46	0.10		
Erosive Soils?	No	No		
Area of Flow, A_t (ft^2):	42.29	1.69		$A_t=Q/V$
Length of Protection, L_p (ft):	27.2	0.5		L=(1/(2 tan θ))(At/Yt - D)
Min Length (ft)	24.0	6.0		Min L=3D or 3H
Max Length (ft)	30.0	20.0		Max L=10D or 10H
Min Bottom Width, T (ft):	28.3	2.1		$T=2*(L_p*\tan\theta)+W$
Design Length (ft)	28.0	6.0		
Design Width (ft)	28.3	2.1		
Riprap Depth (in)	18	18		Depth=2(d_{50})
Type II Bedding Depth (in)*	6	6		*Not used if Soil Riprap
Cutoff Wall	No	No		
Cutoff Wall Depth (ft)				Depth of Riprap and Base
Cutoff Wall Width (ft)				

Note: No Type II Base to be used if Soil Riprap is specified within the plans

* For use when the flow in the culvert is supercritical (and less than full).

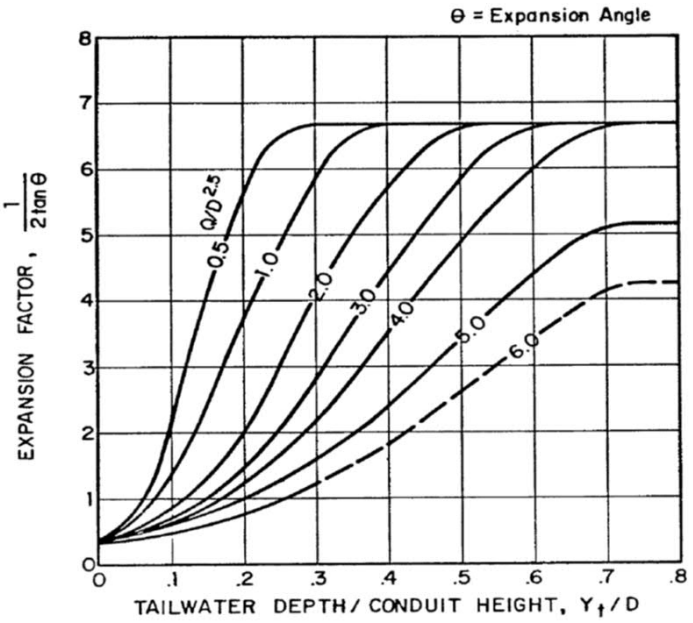


Figure 9-35. Expansion factor for circular conduits

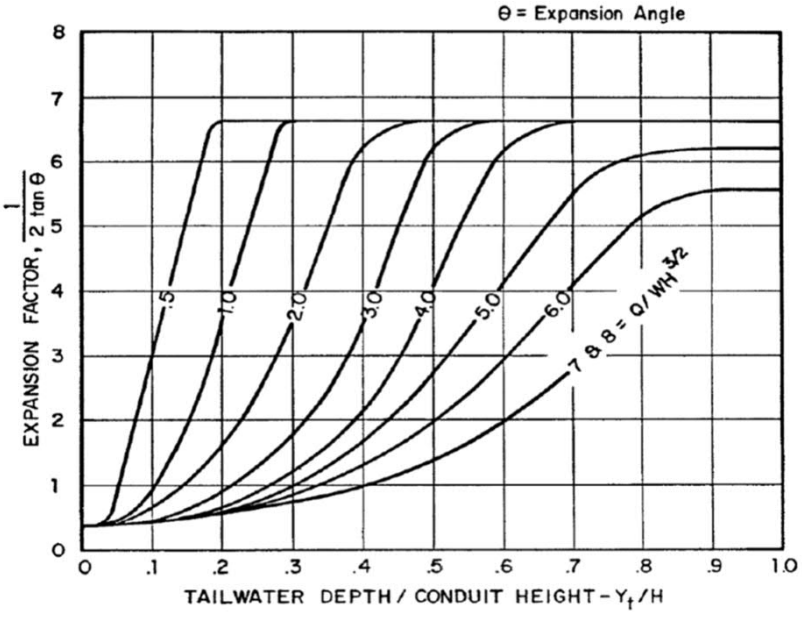


Figure 9-36. Expansion factor for rectangular conduits

APPENDIX E

REFERENCE MATERIALS

MASTER DEVELOPMENT / PRELIMINARY DRAINAGE PLAN LATIGO TRAILS EL PASO COUNTY, COLORADO

October 4, 2001

Prepared for:

RMBG, LLC #2
5170 Mark Dabling Blvd.
COLORADO SPRINGS, CO 80918

PREPARED BY:

URS

9960 Federal Drive, Suite 300
Colorado Springs, CO 80921

URS PROJECT NO. 67-00042443

Four sub-basins, varying from 3 to 53 acres, lie north of Latigo Blvd, draining mainly to the east, with excess runoff ponding at Eastonville Road and eventually overtopping it. One of these basins (9.71) drains directly to Upper Black Squirrel Creek. There is a Zone-A, unstudied FEMA floodplain to the north of the proposed development, in the open space / Upper Black Squirrel Creek area.

Gieck Ranch Basin

The Gieck Ranch Basin covers the southern half of the subject area. Runoff is generally southeasterly, draining to Meridian Ranch to the south, and crossing Eastonville Road at three points to the east. As with the Upper Black Squirrel Creek Basin, many of the existing drainageways (mainly to the south) are not clearly defined.

The major drainage course begins at the west-central portion of the site, traversing the Gieck Ranch Basin to design point G11 to the southeast. Six sub-basins, varying from 19 to 39 acres, contribute to this drainage course, which collects approximately 65% of the runoff generated within the Gieck Basin in Latigo Trails. To the west of this, eight sub-basins drain to five design points along the Meridian Ranch boundary, two of which (G5 and G6) combine shortly after entering Meridian Ranch, at G6b.

There are eight small sub-basins east of the major drainage course, varying from 2 to 41 acres. All but one drain at their own design point, either crossing Eastonville Road or onto Meridian Ranch. The three culverts crossing Eastonville Road include an 18" CMP, a 30" CMP, and a 42"x28" Arch CMP. The 30" CMP has the capacity for 31 cfs, which is inadequate for existing flows. The other two pipes are adequate for existing and developed flows. The drainageways entering Meridian Ranch are not very well defined.

Four stock ponds exist on the site, but are assumed to be full at the beginning of a storm as part of this analysis. If the ponds were empty, flows at G2 may be reduced by about 30 cfs, flows at G10 and G11 may be reduced by about 34 cfs, flows at G13 may be reduced by about 23 cfs, and flows at B1, B2 and B3 may be reduced by about 45 cfs (for flows up to 100-year storm estimates).

See Tables 3 and 4 for flow calculations at specific design points and further comments.

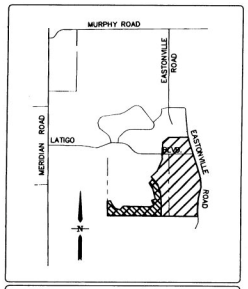
Table 4 - Design Points

THE TRAILS MDDP
HYDROLOGY OUTPUT: DESIGN POINTS
URS Job No. 6742443

DESIGN FLOWS (cfs)											
DESIGN POINT			EXISTING		DEVELOPED-BASE			DEVELOPED-DETN			
DP		Basin	5-YR	100-YR	Method	5-YR**	100-YR	Area*	5-YR	100-YR	
GIECK RANCH BASIN			TRMEGxxx.OUT			TRMDGxxx.OUT					
G1	B	3.12	15	38	rat	21	48	20.3			
G2	B	+	22	55		21	50	25.3			
V1	D	2.62			scs	20	34	12.6			
V2	D	2.72			scs	5	11	4.8			
V3	D	3.22			rat	8	19	8.6			
G3	E	2.61	12	34							
G4/V4	B	+	24	95		57	121	61.8	48	108	
V5	D	2.52			scs	4	11	4.3			
V6	D	5.12			scs	8	15	8.6			
G5	B	+	24	107		68	156	81.1	58	137	
V7	D	5.22			rat	11	25	11.8			
G6	B	+	4	20		17	35	18.2			
G6b	B	+	28	122		83	191	99.3	75	145	
V10	D	2.12			scs	12	29	13.3			
V9N	D	+				43	92	44.1			
V9	D	+				50	103	48.4			
G7	E	2.21	8	44							
V11	D	2.34				4	11	4.9			
V12	B	+	7	34		20	41	17.9	20	35	
G8/V14	B	+	17	75		63	134	72.1			
V15	D	6.42			scs	6	12	5.7			
V15b						25	52	23.5	10	45	
V16	D	6.44			scs	2	4	2.1			
V17	D	6.46			scs	2	4	2.0			
DA5						84	182	107.9	80	170	
DA6						107	240	117.9	90	165	
G10/V19	B	+	38	184		123	282	140.9	107	207	
G11a	B	+	43	208		123	282	147.4	107	207	
V20	D	6.62				6	13	6.7			
G11b						17	33	13.3			
V13	D	6.22			rat	11	26	12.3			
G12	B	6.24	18	44	rat	18	43	19.9			
V21	D	4.32			rat	11	26	12.5	5	15	
G13	B	+	10	24		13	31	15.5	7	20	
V22	D	4.42			rat	4	9	3.7			
V23	D	4.52			rat	9	22	10.3			
V24	D	+				17	39	18.8	15	25	
G14a			6	15		7	17	7.5			
G14b	B	+	13	31		18	42	20.5	16	28	
G15	B	+	29	70		40	92	48.5	38	78	
G16	B	4.82	2	5	rat	3	6	2.4			
G17a	D	4.94				1	3	0.9			
G17b	B	+	3	6		3	7	2.3			
V25	D	4.64				3	7	2.9			
V26	D	4.62			rat	5	12	5.2			
G18	B	+	18	42		21	49	24.6	18	40	
V27	D	4.72				26	60	21.0			
G19	B	+	28	67		37	86	37.2	28	65	

*Area in acres
**If SCS, multiplied by 1.67 (Average correlation SCS/Rational calculation) (5-year flows only)

LATIGO TRAILS
PRELIMINARY DRAINAGE PLAN
IN SECTIONS 8, 9, 16 & 17, T12S, R64W OF THE 6TH P.M.
EL PASO COUNTY, COLORADO



VICINITY MAP
NO SCALE

NOTES:

1) EASEMENTS
All lot lines and boundaries will be platted with easements for utility, drainage and equestrian purposes (not shown). The Homeowners' [illegible] ponds and drainage easements.

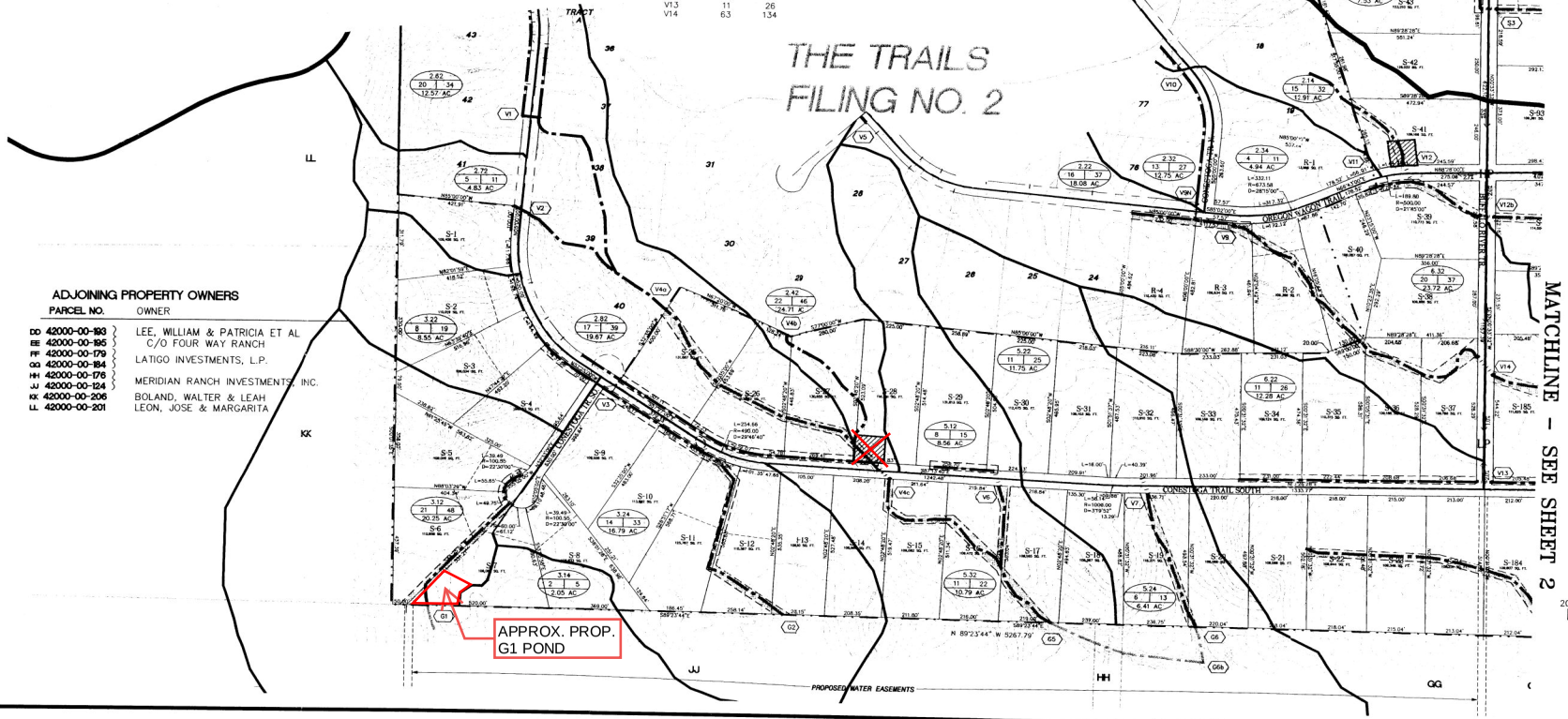
2) CHANNEL DESIGN
All channels will be grass-lined, with 4:1 sides. Natural channels will be utilized, undisturbed, where possible. See Drainage Report Table 8 for specific channel design details.

3) CULVERT DESIGN
Culverts shall be HDPE or RCP, depending on location and size. See Drainage Report Table 7 for preliminary sizes.

Design Point	Q_5 (CFS)	Q_{100} (CFS)
V1	20	34
V2	5	11
V3	8	19
V4b	22	51
V4c	57	121
V5	4	11
V6	8	15
V7	11	25
V9N	43	92
V9	50	103
V10	12	29
V11	4	11
V12	20	41
V12b	20	41
V13	11	26
V14	63	134

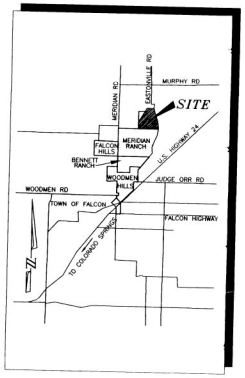
Design Point	Q_5 (CFS)	Q_{100} (CFS)
S1	8	18
S2	14	30
S2b	23	49
S3	27	63

Design Point	Q_5 (CFS)	Q_{100} (CFS)
G1	21	48
G2	21	50
G5	68	156
G6	17	35
G6b	83	191



ADJOINING PROPERTY OWNERS

PARCEL NO.	OWNER
DD 42000-00-193	LEE, WILLIAM & PATRICIA ET AL C/O FOUR WAY RANCH
EE 42000-00-195	
FF 42000-00-179	LATIGO INVESTMENTS, L.P.
GG 42000-00-184	
HH 42000-00-176	MERIDIAN RANCH INVESTMENTS, INC.
JJ 42000-00-124	
KK 42000-00-206	BOLAND, WALTER & LEAH
LL 42000-00-201	LEON, JOSE & MARGARITA



VICINITY MAP
N.T.S.

LEGEND

SUB-BASIN Q5 Q100 AREA	SUB-BASIN DATA
G19	DESIGN POINT
HP	ROAD HIGH POINT
LP	ROAD LOW POINT
1.0%	ROAD GRADE
	SUB-BASIN LINE
	PR./EX. CHANNEL
	DRAINAGE EASEMENT
	CULVERT
	POSSIBLE DETENTION AREA

N

SCALE: 1"=200'

200 0 200 400

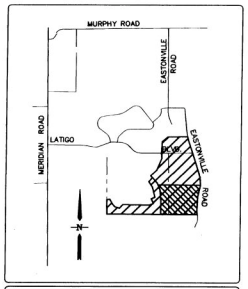
URS
9960 FEDERAL DRIVE, SUITE 300
COLORADO SPRINGS, COLO. 80921
PHONE: (719) 531-0001

DATE: 10/04/01

SHEET 1 OF 4

FIGURE 8

LATIGO TRAILS
PRELIMINARY DRAINAGE PLAN
IN SECTIONS 8, 9, 16 & 17, T12S, R64W OF THE 6TH P.M.
EL PASO COUNTY, COLORADO



VICINITY MAP
NO SCALE

Design Point	Q_5 (CFS)	Q_{100} (CFS)
V15	6	12
V15b	25	52
V16	2	4
V17	2	4
V18	107	240
V20	6	13
V21	11	26
V22	4	9
V23	9	22
V24	17	39
V25	3	7
V26	5	12
V27	26	60

Design Point	Q_5 (CFS)	Q_{100} (CFS)
S14	9	19
S15	1	3

Design Point	Q_5 (CFS)	Q_{100} (CFS)
G10	123	282
G11a	123	282
G11b	17	33
G12	18	43
G13	13	31
G14a	7	17
G14b	18	42
G15	40	92
G17a	1	3
G17b	3	7
G18	21	49
G19	37	86

MATCHLINE – SEE SHEET 3

MATCHLINE – SEE SHEET 1

APPROX. FUTURE G19 POND

30" CMP

APPROX. FUTURE G18 POND

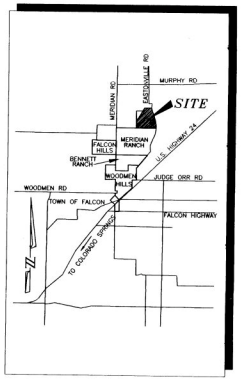
42"x28" ARCH CMP

18" CMP

APPROX. EX. SOUTH POND

A35 AGRICULTURAL

A35 AGRICULTURAL



VICINITY MAP
N.T.S.

LEGEND
- SUB-BASIN DATA (SUB-BASIN | Q5 | Q100 | AREA)
- DESIGN POINT (G19)
- HP ROAD HIGH POINT
- LP ROAD LOW POINT
- ROAD GRADE (1.0%)
- SUB-BASIN LINE
- PR./EX. CHANNEL
- DRAINAGE EASEMENT
- CULVERT
- POSSIBLE DETENTION AREA

N

SCALE: 1"=200'

200 0 200 400

URS
9960 FEDERAL DRIVE, SUITE 300
COLORADO SPRINGS, COLO. 80921
PHONE: (719) 531-0001

DATE: 9/25/01

SHEET 2 OF 4

FIGURE 8

SF-04-005

Final Drainage Report
Addendum No. 1
for
The Trails Filing No. 7 Subdivision
El Paso County, Colorado

Prepared for:

RMBG, LLC #1
5170 Mark Dabling Blvd.
Colorado Springs, CO 80918

Prepared by:

URS
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
URS Job No. 21711264

February 2007

Addendum Description

Latigo Trails Filing No. 7 was designed with minimal grading on site, to allow drainage patterns to remain near existing conditions. Existing drainage swales were to be maintained and easements were put around these swales. However, on Lots 5, 6, 7 and 8, these easements run through the lots, limiting the area available to construct a house. Therefore, new drainage easements have been dedicated along the northern property lines for these lots. New swales were designed for lots 5, 7 and 8 (See Figure 3: Developed Drainage Plan). Due to changes in the field and a more accurate model, some items have been altered to more accurately determine the flows for Filing 7. One revision was to refine the runoff coefficients used for the developed conditions. The Filing 7 FDR document that the coefficients to be used for the rational method calculations are C_5=0.20, C_{10}=0.30 and C_{100}=0.40. However, the coefficients used in the rational method calculation sheets were C_5=0.25, C_{10}=0.35 and C_{100}=0.44. For this addendum, the coefficients used for the rational calculations were those prescribed by the El Paso County DCM (Table 5-1, Recommended Average Runoff Coefficients and Percent Impervious) for 1 acre lots (C_{10}=0.30 and C_{100}=0.40). The C_{10} value was used for the 5-year coefficient. Using these values provides conservative runoff values since the developed lot size for The Trails Filing 7 is about 2.5 acres.

New swales were installed along roads to convey flow (See Figure 3: Developed Drainage Plan). Culverts were installed as needed to transport flows under the proposed roadways. Based on the analysis of the existing and proposed drainage during construction, the culvert at approximately Sta 21+40, just south of the Buffalo River Trail and Oregon Wagon Trail intersection, was removed (DP V12b from Filing 7 FDR). The flow from Design Point V12, which originally flowed to this culvert, was forced to continue along the existing drainage path to the proposed culvert at Design Point V14. With the addition of this flow, a 36" RCP is needed next to the existing 68" X 43" elliptical RCP in order to pass the 100-year flow without overtopping the road. Finally, due to the removal of the culvert at STA 21+40, an additional drainage easement has been created where the natural drainage channel crosses Lot 2 of Filing 7. This easement will connect to the revised drainage easement in Lot 1 of Filing 7 that terminates at DP V14.

Developed Drainage Analysis

The new swales will be located on the north property lines for Lots 5, 7 and 8. Each of these swales will tie into the proposed roadside ditch along Buffalo River Trail. From there, the flow will continue to Design Point S2b, where it will enter a 36" RCP underneath Buffalo River Trail. The flow at this design point has changed from 76 cfs in the approved Final Drainage Report to 72 cfs in this analysis.

Each of the lots will have a 2-foot high V-ditch swale with 5 (H):1(V) side slopes (See Figure 2: Channel Detail). The flow depths range from 0.71 feet to 1.11 feet. The velocities in the swale range from 3.2 to 3.5 feet per second (fps). The construction of these new swales does not affect

the overall drainage pattern of the site, but does allow a larger area for the construction of a house.

Since the culvert at STA 21+40 was not built, the flow originally going to DP V12b now continues down the natural drainage channel to DP V14 and the 68" X 43" elliptical culvert. The 5- and 100-year flows now directed to Design Point V14 are 67 and 159 cfs, respectively. This additional flow requires that a second culvert be placed at DP V14. The proposed additional RCP will be a 36" circular pipe set at the same slope with the same inlet/outlet elevations. The elliptical pipe will pass 106 cfs during the 100-year storm and the circular pipe will pass the remaining 53 cfs during the same storm. The outlet velocities of the culverts are 9.07 fps for the elliptical and 8.85fps for the circular pipe. The headwater elevation has changed from 7124.71 to 7123.93 ft. The decrease in headwater elevation, with an increase of flow, is due to the addition of the roadway "weir" in the culvert analysis. With this additional culvert, the 100-year flows will now pass without overtopping Buffalo River Trail.

From Design Point V14, the flow will continue through an existing channel to the south detention pond at Design Point G10. Revised flows entering the pond are 104 and 247 cfs, respectively, for the 5- and 100-year storm events. The original flows calculated entering the pond were 89 and 336 cfs. However, the original 100-year flow is significantly higher due to an error in the HEC-1 model, which allowed 2 basins to contribute flow to the pond even though they do not and cannot flow to the pond. This lower inflow to the pond will also lower the release rates from the pond.

The Trails Filing No. 7 Addendum 1 Developed Conditions
(RATIONAL METHOD Q=CIA)

BASIN	TOTAL FLOWS					AREA TOTAL	WEIGHTED			OVERLAND				CHANNEL				Tc TOTAL	INTENSITY			COMMENTS
	Q_5	Q_{10}	Q_{100}	CA(equiv.)			C_5	C_{10}	C_{100}	C_5	Length	Slope	Tco	Length	Slope	Velocity	Tcc		I_5	I_{10}	I_{100}	
	(c.f.s.)	(c.f.s.)	(c.f.s.)	5 YR	100 YR	(Ac)					(ft)	(ft)	(min)	(ft)	(%)	(fps)	(min)	(min)	(in/hr)	(in/hr)	(in/hr)	
7.12a	7.8	9.1	18.4	2.56	3.41	8.53	0.30	0.30	0.40	0.30	300	4.7%	15.5	1,095	2.5%	4.3	4.2	19.8	3.0	3.5	5.4	
7.12b	8.4	9.8	20.0	2.82	3.76	9.39	0.30	0.30	0.40	0.30	300	4.7%	15.5	1,202	2.4%	4.2	4.7	20.3	3.0	3.5	5.3	
7.13a	5.4	6.3	12.8	1.61	2.15	5.38	0.30	0.30	0.40	0.30	200	4.5%	12.9	929	2.8%	4.6	3.4	16.3	3.3	3.9	5.9	
7.13b	3.8	4.4	9.0	1.18	1.57	3.92	0.30	0.30	0.40	0.30	291	4.8%	15.2	580	2.6%	4.4	2.2	17.4	3.2	3.8	5.7	
7.14a	3.4	3.9	8.0	0.98	1.30	3.25	0.30	0.30	0.40	0.30	205	4.9%	12.7	766	3.4%	5.0	2.5	15.2	3.4	4.0	6.1	
7.14b	4.6	5.3	10.8	1.28	1.71	4.28	0.30	0.30	0.40	0.30	237	6.8%	12.2	540	2.9%	4.7	1.9	14.2	3.6	4.1	6.3	
2.14	12.2	14.2	28.9	3.74	4.98	12.45	0.30	0.30	0.40	0.30	88	2.3%	10.7	1,837	3.0%	4.7	6.5	17.1	3.3	3.8	5.8	
2.34	6.0	7.0	14.2	1.49	1.99	4.98	0.30	0.30	0.40	0.30	46	5.4%	5.8	1,089	1.9%	3.8	4.8	10.6	4.0	4.7	7.1	
6.32a	7.5	8.8	17.9	2.18	2.91	7.28	0.30	0.30	0.40	0.30	160	3.8%	12.2	852	3.1%	4.8	2.9	15.1	3.4	4.0	6.1	
6.32b	16.4	19.2	39.0	4.92	6.56	16.39	0.30	0.30	0.40	0.30	81	6.2%	7.4	2,520	3.0%	4.7	8.9	16.2	3.3	3.9	5.9	
2.12	13.7	15.9	32.4	3.90	5.20	13.00	0.30	0.30	0.40	0.30	209	11.0%	9.8	1,641	4.3%	5.7	4.8	14.6	3.5	4.1	6.2	
2.22	15.3	17.8	36.2	5.15	6.87	17.18	0.30	0.30	0.40	0.30	300	6.3%	14.1	2,191	4.1%	5.5	6.6	20.7	3.0	3.5	5.3	
2.32	13.6	15.9	32.4	4.17	5.56	13.91	0.30	0.30	0.40	0.30	300	12.0%	11.4	1,816	4.0%	5.5	5.5	16.9	3.3	3.8	5.8	
2.52	5.0	5.9	12.0	1.29	1.72	4.30	0.30	0.30	0.40	0.30	68	2.9%	8.7	1,036	5.7%	6.5	2.6	11.3	3.9	4.6	7.0	
6.22	12.8	14.9	30.3	3.68	4.91	12.28	0.30	0.30	0.40	0.30	140	7.9%	8.9	1,587	2.6%	4.4	6.0	14.9	3.5	4.0	6.2	
6.47a	6.1	7.1	14.5	1.95	2.60	6.51	0.30	0.30	0.40	0.30	300	4.0%	16.4	531	2.4%	4.2	2.1	18.5	3.1	3.7	5.6	
6.34	7.3	8.5	17.2	2.46	3.28	8.21	0.30	0.30	0.40	0.30	300	4.3%	16.0	1,295	2.6%	4.4	4.9	20.9	2.9	3.4	5.2	
6.42a	5.2	6.1	12.4	1.34	1.78	4.45	0.30	0.30	0.40	0.30	78	3.8%	8.5	602	1.8%	3.7	2.7	11.2	3.9	4.6	7.0	
6.47	4.2	4.9	9.9	1.11	1.48	3.69	0.30	0.30	0.40	0.30	163	6.7%	10.2	681	3.5%	5.1	2.2	12.4	3.8	4.4	6.7	
6.48	22.8	26.6	54.1	7.24	9.66	24.14	0.30	0.30	0.40	0.30	241	6.3%	12.7	1,675	3.2%	4.9	5.7	18.4	3.1	3.7	5.6	
POND	5.5	6.4	13.0	1.48	1.97	4.92	0.30	0.30	0.40	0.30	140	5.0%	10.4	656	2.7%	4.5	2.4	12.8	3.7	4.3	6.6	
	*7	*7	*7										*1			*2	*3	Tco+Tcc	*4	*5	*6	
																20			1.5	1.75	2.67	

Total South Pond Area: 153.69 Acres

1: Tco = 1.87(1.1-C5)*(L^0.5)*((S*100)^-0.33) (DCM page 5-11)
*2: Vc = Manning's Equation, n=0.040, Side Slopes 5:1, Assumed 1' depth equal to bankfull (DCM p. 5-11 Provided no ditch section is specified)
*3: Tcc = 1/V*L/60
*4: I_5 = (26.65*1.50)/(10+Tc)^0.76 (City Letter of 1/7/2003)
*5: I_{10} = (26.65*1.75)/(10+Tc)^0.76 (City Letter of 1/7/2003)
*6: I_{100} =(26.65*2.67)/(10+Tc)^0.76 (City Letter of 1/7/2003)
*7: Q=CiA

DESIGN POINT	CONTRIBUTING BASINS	CA(equivalent)		Tc	INTENSITY		TOTAL FLOWS	
		CA(5)	CA(100)	(min.)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
V15	6.42a	1.34	1.78	11.2	3.9	7.0	5	12
				TRAVEL TIME				
		1.34	1.78	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				Channel	607	2.7	3.8	15.0
V15b	6.47a	1.95	2.60	18.5	3.1	5.6	10	24
	V15	1.34	1.78	TRAVEL TIME				
		3.29	4.38	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				Channel	370	3.4	1.8	20.3
V16	V15b	3.29	4.38	20.3	3.0	5.3	13	31
	6.47	1.11	1.48	TRAVEL TIME				
		4.40	5.86	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				Channel	523	2.5	3.5	23.8
G10				32.2	2.3	4.1	104	246
	6.34	2.46	3.28					
	6.48	7.24	9.66					
	V13	3.68	4.91					
	V14	26.85	35.80					
	V16	4.40	5.86	TRAVEL TIME				
		44.63	59.51	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				Channel	433	4.3	1.7	33.9
G11a	G10	44.63	59.51	33.9	2.3	4.0	104	247
	Pond	1.48	1.97	TRAVEL TIME				
		46.11	61.48	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				Channel				

Table 1: Channels Revised

Location by Design Point / Lot	Road side/ Cross-Lot	Q_{100} Flow (cfs)	Min. Slope	Max. Slope	Bottom Width (ft)	Max. Flow Depth (ft)	Design Depth (ft)	Max. Velocity (fps)	Max. Top Width / Easement*	Channel Erosion Control Protection***
S1-S6a	R	21	1.8%	2.0%	6	0.72	2.00	3.4-4.2	12.0' / 16'*	None
Lot 9-Lot 7	R	34	1.8%	1.8%	6	0.93	2.25	3.8-4.6	13.5' / 22'*	Temporary, 550'x24'
Lot 6-S3	R	56-72	0.5%	0.5%	6	1.90	3.25	3.0	21.5' / 24'*	None
S3-S5a	C	72-104	1.7%	1.7%	6	1.65	3.00	4.6-5.7	19.5' / 40'	Permanent, 785'x30'
S5a-**S12**	C	104-118	0.8%	1.8%	6	1.97	varies	4.35**	37.0' / unplatted	As necessary
V12-V12b	C	40	1.7%	1.7%	2	1.44	2.75	4.1-5.1	13.5' / varies	Permanent, 190'x24'
V12b-Pond	C	40	2.0%	2.0%	2	1.37	2.75	4.4-5.5	13.0' / 30'	Permanent, 180'x24'
V15-Pond	C	12	3.2%	3.2%	2	0.94	2.25	3.8-4.2	8.0' / 20'	Temporary, 70'x20'
Pond-**G10**	C	52-77	1.6%	3.8%	>6	1.44	2.75	4.97**	27.5' / 100'	As necessary
V14a-V14	C	159	1.7%	6.0%	6	1.81	varies	8.73**	22.5' / unplatted	As necessary
V14-**G10**	C	159	1.0%	5.3%	7	1.62	varies	8.56**	40.0' / unplatted	As necessary
G10-G11a	C	246	1.1%	2.0%	6	2.10	varies	5.37**	56.5' / unplatted	As necessary

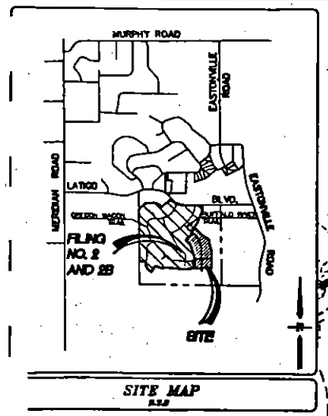
Note: Proposed detention ponds at design points **S12** ("North Pond") and **G11a** ("South Pond").
See complete calculations in Appendix D.

* - 8 feet of ditch section is within ROW; 10 foot utility easement (interior lot side) is not included here.

** - Developer to monitor these natural channels and repair as necessary. (See next section for requirements.)

*** - "Temporary" (photodegradable or biodegradable) soil retention blanket per CDOT Spec. Section 216, with a minimum permissible shear stress of 1.75 lbs/ft^2 and 24 month minimum longevity.
- "Permanent" soil retention blanket per CDOT Spec. Section 216, with a minimum permissible shear stress of 3.00 lbs/ft^2 and "permanent" longevity (non-degradable).
- "As necessary" requires "Permanent" soil retention blanket (or riprap) upon evidence of erosion (natural channels).
- See Construction Drawings for extents of soil retention blanket ("SRB" or "ECB")

THE TRAILS FILING NO. 7 FINAL DRAINAGE PLAN
DEVELOPED CONDITIONS



SITE MAP
N.T.S.

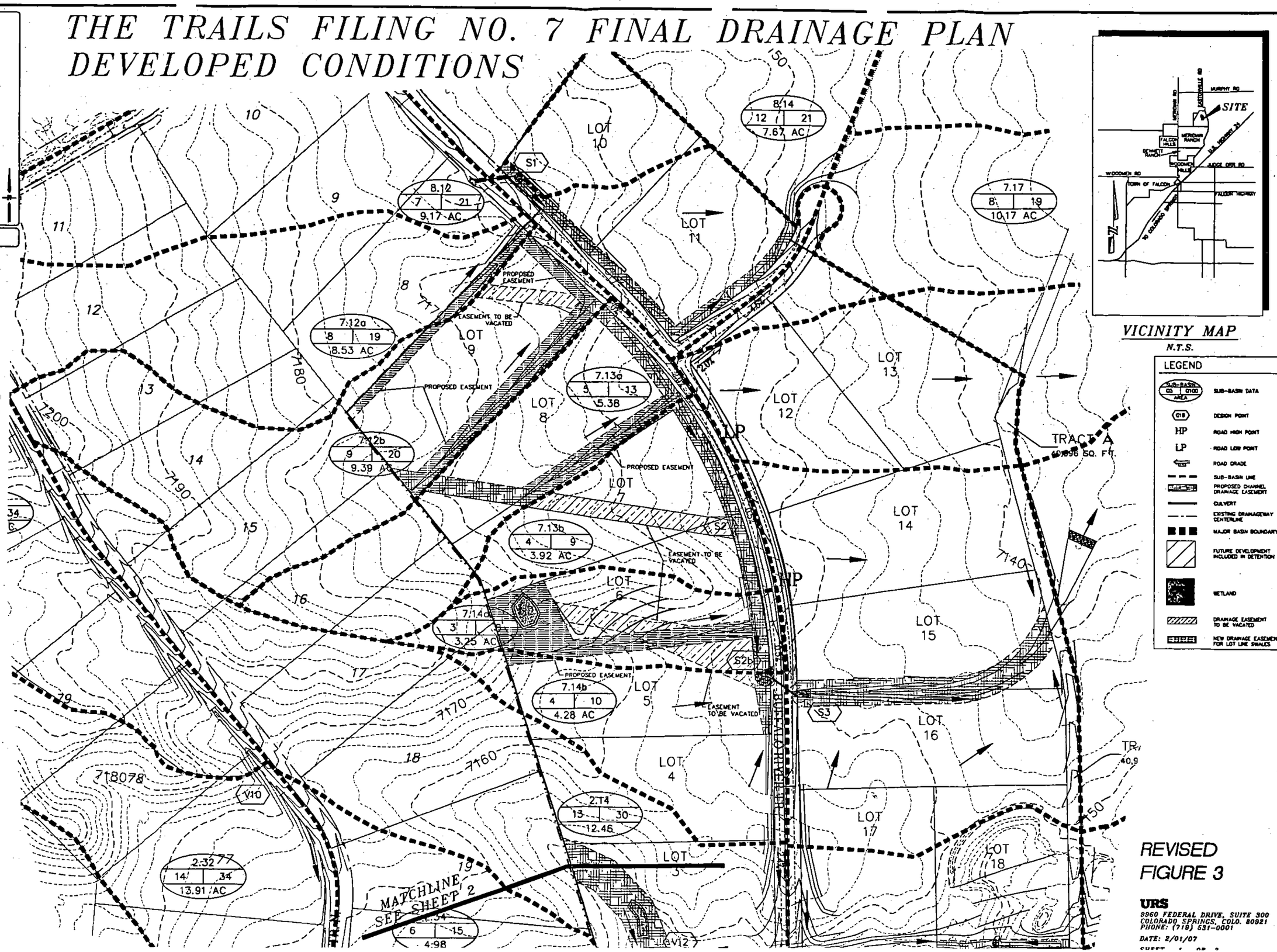
NOTES:

EASEMENTS
Per Final Plat, lot lines and boundaries will be platted with easements for utility, drainage and equestrian purposes (not shown). The Homeowners' Association shall be responsible for maintenance of detention ponds and drainage easements.

CHANNEL DESIGN
All channels will be grass-lined. Natural channels will be utilized, undisturbed, where possible. See Drainage Report for specific channel design details.

CULVERT DESIGN
Culverts shall be RCP. Installation shall be per County requirements.

Design Point	Q_5 (CFS)	Q_{100} (CFS)
S1	7	21
S2	24	58
S2b	30	72
S3	30	72



VICINITY MAP
N.T.S.

LEGEND

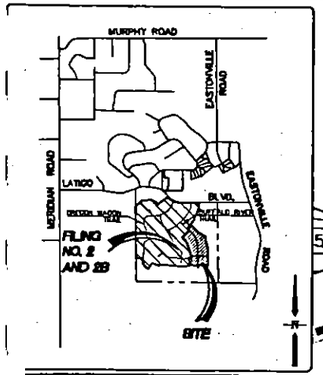
- SUB-BASIN DATA (SUB-BASIN ID, Q_5, Q_{100}, AREA)
- DESIGN POINT (D18)
- HP — ROAD HIGH POINT
- LP — ROAD LOW POINT
- ROAD GRADE
- SUB-BASIN LINE
- PROPOSED CHANNEL DRAINAGE EASEMENT
- CULVERT
- EXISTING DRAINAGEWAY CENTERLINE
- MAJOR BASIN BOUNDARY
- FUTURE DEVELOPMENT INCLUDED IN DETENTION
- WETLAND
- DRAINAGE EASEMENT TO BE VACATED
- NEW DRAINAGE EASEMENTS FOR LOT LINE SWALES

REVISED
FIGURE 3

URS
9960 FEDERAL DRIVE, SUITE 300
COLORADO SPRINGS, COLO. 80921
PHONE: (719) 531-0001

DATE: 2/01/07

THE TRAILS FILING NO. 7 FINAL DRAINAGE PLAN
DEVELOPED CONDITIONS



SITE MAP
N.T.S.

NOTES:

EASEMENTS
Per Final Plat, lot lines and boundaries will be platted with easements for utility, drainage and equestrian purposes not shown). The Homeowners' Association shall be responsible for maintenance of detention ponds and drainage easements.

CHANNEL DESIGN
All channels will be grass-lined. Natural channels will be utilized, undisturbed, where possible. See Drainage Report for specific channel design details.

CULVERT DESIGN
Culverts shall be RCP. Installation shall be per County requirements.

Design Point	Qs (CFS)	Q100 (CFS)
V11	5	14
V12	17	40
V14	67	159
V13	13	30
G10	104	246
G11	104	247

MATCHLINE SEE SHEET 1

OREGON WAGON TRAIL

CONESTOGA TRAIL SOUTH

LOT 2

LOT 1

EASEMENT TO BE VACATED

PROPOSED DRAINAGE EASEMENT

607,672 SQ. FT.

127,619 SQ. FT.

TRACT B
16,925 SQ. FT.

6.32A
18 | 7
7.28 AC

6.32B
18 | 42
16.38 AC

6.47
4 | 10
3.69 AC

6.48
24 | 57
24.14 AC

6.22
13 | 32
12.28 AC

6.34
8 | 18
8.21

6.24
18 | 43
19.92 AC

6.62
6 | 14
6.72 AC

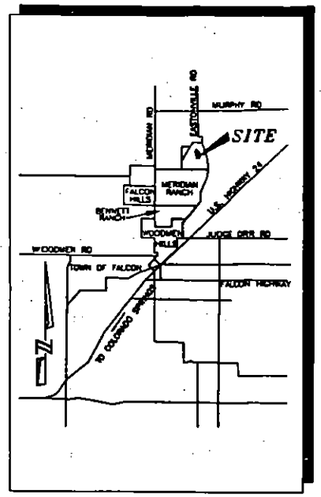
POND
5.6 | 13.3
4.92 AC

6.64
12 | 27
13.18 AC

V11 V12 V13 V14 V15 V16 G10 G11a

7140 7130 7120 7110 7150 7160 7170 7180

EXISTING SOUTH POND



VICINITY MAP
N.T.S.

LEGEND

- SUB-BASIN DATA (Q5 | Q100 | AREA)
- G18 — DESIGN POINT
- HP — ROAD HIGH POINT
- LP — ROAD LOW POINT
- ROAD GRADE
- SUB-BASIN LINE
- PROPOSED CHANNEL DRAINAGE EASEMENT
- CULVERT
- EXISTING DRAINAGEWAY CENTERLINE
- MAJOR BASIN BOUNDARY
- FUTURE DEVELOPMENT INCLUDED IN DETENTION
- WETLAND
- DRAINAGE EASEMENT TO BE VACATED
- NEW DRAINAGE EASEMENTS FOR LOT LINE SWALES

REVISED
FIGURE 3

URS
9960 FEDERAL DRIVE, SUITE 300
COLORADO SPRINGS, COLO. 80921
PHONE: (719) 531-0001

DATE: 2/01/07
SHEET _ OF _

IV. DRAINAGE FACILITY DESIGN

A. General Concept

Existing condition and developed condition rational basin delineation are shown in Figures 5 and 6 respectively. Peak discharges for each basin are summarized in Appendix C.

Historic flows in the Upper Black Squirrel Creek Basin are conveyed through several small existing drainageways to design points, B1a, B1b, B1c, and B7a. Historic flows in the Gieck Ranch Basin are conveyed to design points G10a and G10b (see Figure 5). Design point G8 is an offsite flow taken from the Latigo Trails MDDP/PDP.

Developed flows in the Upper Black Squirrel Creek Basin are conveyed through a network of roadside ditches, culverts and channels to design points S5a, S5b, and S6a (see Figure 6). Developed flows in the Gieck Ranch Basin are conveyed to design points at V14b and V15b (see Figure 6). Design points S1 and V14a are offsite flows taken from the Latigo Trails MDDP/PDP.

B. Roadside Ditches

Roadside ditches will be constructed at the locations listed in Table 1, below, and are designed to meet El Paso County criteria for slope and velocity. Roadside ditches will have a 6' bottom width, with 4:1 side slopes, and a slope which varies between 0.5% and 2.0%.

C. Constructed Channels

Cross-lot channels will be constructed/improved at several locations, and are designed to meet El Paso County criteria for slope and velocity. These channels will have a 2' to 6' bottom width, with 4:1 side slopes, and a slope which varies between 1.7% and 2.0%. The locations of these channels are in Table 1, below. Temporary or permanent erosion control blankets (soil retention blankets), are called out for areas where channel velocities could be erosive before or after vegetation stabilization. In the cases where erosive velocities may exist for 100-year flows in localized sections of existing channels (off-site, within the developer's unplatted property), erosion control blankets, riprap, and/or grade control structures will be installed as necessary, if required by observation before the land is platted. There are four such locations listed in Table 1, where 100-year storm velocities could exceed 5 feet per second.

D. Detention

Two detention ponds have been designed for their respective entire upstream developed areas, with release rates at or below historic levels, in accordance with the MDDP/PDP. The upstream basins also include potential future developed area that may utilize the ponds temporarily or permanently. A berm is provided to direct applicable flows into the north detention pond, while an existing diversion will be graded out and re-channelized to allow applicable flows into the south detention pond. Pond designs are based on the HEC-1 model, included in Appendix D, with spreadsheet calculations of stage/storage/discharge volume relationships. The ponds are sized for water quality, 5-year detention and 100-year detention. Incidental storage at upstream culverts and the existing stock pond, originally intended for use in the MDDP/PDP, were neglected.

The south detention pond will receive flows of Q_5=89 cfs and Q_{100}=336 cfs and release at Q_5=20 cfs and Q_{100}=159 cfs, with a maximum storage volume of 7.8 Ac-ft at elevation 7094.2 and capacity for 11.2 Ac-ft at elevation 7096.13. The north detention pond will receive flows of Q_5=68 cfs and Q_{100}=257 cfs and release at Q_5=14 cfs and Q_{100}=73 cfs, with a maximum storage volume of 7.7 Ac-ft at elevation 7104.3 and capacity for 13.2 Ac-ft at elevation 7107.0.

The Trails Filing 7 — South Pond — C2

Elevation ft	Area ft2		Incr Volume ft3	Total Volume ft3	Total Outflow cfs	elevation ft		Total Volum AC-FT
7088.00		24934	0	0	0.00	7088.00		0.00
7088.50		32991	1629	14481	0.59	7088.50		0.33
7089.00		41048	2032	32991	0.94	7089.00		0.76
7089.50		49104	2435	55529	2.77	7089.50	WQCV	1.27
7090.00		57161	2838	82095	9.66	7090.00		1.88
7090.50		59085	2949	111156	19.38	7090.50		2.55
7091.00		61008	3046	141180	31.25	7091.00		3.24
7091.50		62932	3142	172164	42.21	7091.50	V5	3.95
7092.00		64855	3238	204111	49.74	7092.00		4.69
7092.50		64835	3242	236534	80.92	7092.50		5.43
7093.00		64816	3241	268946	114.75	7093.00		6.17
7093.50		64796	3240	301349	131.91	7093.50		6.92
7094.00		64776	3239	333742	146.82	7094.00		7.66
7094.25		66820	1668	350192	153.53	7094.25		8.04
7094.50		68864	1719	367152	160.23	7094.50	V100	8.43
7094.75		70908	1770	384624	166.38	7094.75		8.83
7095.00		72952	1821	402606	172.53	7095.00		9.24
7095.38		75077	2811	430361	178.25	7095.38		9.88
7095.75		77202	2891	458914	183.97	7095.75		10.54
7096.13		79326	2971	488263	189.34	7096.13	V~~100~~ CAP	11.21

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: Jeffrey D. Rice, PE
Company: URS
Date: October 11, 2004
Project: The Trails Filing No. 7
Location: South Pond - G11a

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio (i = I_a / 100)	I_a = 20.00 % i = 0.20
B) Contributing Watershed Area (Area)	Area = 163.00 acres
C) Water Quality Capture Volume (WQCV) (WQCV =1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I))	WQCV = 0.12 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area * 1.2	Vol = 1.886 acre-feet
2. Outlet Works	
A) Outlet Type (Check One)	X Orifice Plate Perforated Riser Pipe Other:
B) Depth at Outlet Above Lowest Perforation (H)	H = 1.00 feet
C) Required Maximum Outlet Area per Row, (A_o)	A_o = 11.81 square inches
D) Perforation Dimensions **(enter one only)**: i) Circular Perforation Diameter **OR** ii) 2" Height Rectangular Perforation Width	D = 2.070 inches, **OR** W = inches
NOTE: 2 inches is the maximum recommended diameter for cell L35.	
E) Number of Columns (nc, See Table 6a-1 For Maximum)	nc = 3 number
F) Actual Design Outlet Area per Row (A_o)	A_o = 10.10 square inches
G) Number of Rows (nr)	nr = 3 number
H) Total Outlet Area (A_{ot})	A_{ot} = 30.29 square inches
3. Trash Rack	
A) Needed Open Area: A_t = 0.5 * (Figure 7 Value) * A_{ot}	A_t = 902 square inches
B) Type of Outlet Opening (Check One)	X ≤ 2" Diameter **Round** 2" High **Rectangular** Other:
C) For 2", or Smaller, **Round Opening** (Ref.: Figure 6a):	
i) Width of Trash Rack and Concrete Opening (W_{conc}) from Table 6a-1	W_{conc} = 45 inches
ii) Height of Trash Rack Screen (H_{TR})	H_{TR} = 42 inches

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: Jeffrey D. Rice, PE
Company: URS
Date: October 11, 2004
Project: The Trails Filing No. 7
Location: South Pond - G11a

iii) Type of Screen (Based on Depth H), Describe if "Other"	X S.S. #93 VEE Wire (US Filter) ____ Other: ____
iv) Screen Opening Slot Dimension, Describe if "Other"	X 0.139" (US Filter) ____ Other: ____
v) Spacing of Support Rod (O.C.) Type and Size of Support Rod (Ref.: Table 6a-2)	1.00 inches
vi) Type and Size of Holding Frame (Ref.: Table 6a-2)	
D) For 2" High **Rectangular Opening** (Refer to Figure 6b):	
I) Width of Rectangular Opening (W)	W = ____ inches
ii) Width of Perforated Plate Opening (W_{conc} = W + 12")	W_{conc} = ____ inches
iii) Width of Trashrack Opening ($W_{opening}$) from Table 6b-1	$W_{opening}$ = ____ inches
iv) Height of Trash Rack Screen (H_{TR})	H_{TR} = ____ inches
v) Type of Screen (based on depth H) (Describe if "Other")	____ Klemp'™ KPP Series Aluminum ____ Other: ____
vi) Cross-bar Spacing (Based on Table 6b-1, Klemp'™ KPP Grating). Describe if "Other"	____ inches ____ Other: ____
vii) Minimum Bearing Bar Size (Klemp'™ Series, Table 6b-2) (Based on depth of WQCV surcharge)	
4. Detention Basin length to width ratio	2.50 (L/W)
5 Pre-sedimentation Forebay Basin - Enter design values	
A) Volume (no less than 5% of Design Volume from 1D)	____ acre-feet
B) Surface Area	____ acres
C) Connector Pipe Diameter (Size to drain this volume in 5-minutes under inlet control)	____ inches
D) Paved/Hard Bottom and Sides	____ yes/no

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

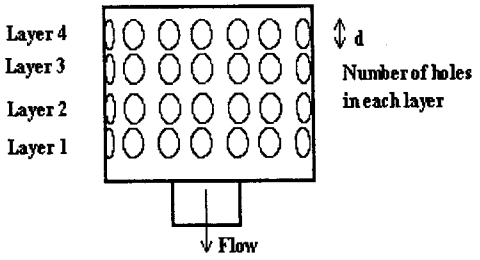
Designer: Jeffrey D. Rice, PE
Company: URS
Date: October 11, 2004
Project: The Trails Filing No. 7
Location: South Pond - G11a

6. Two-Stage Design - See Figure EDB-1	
A) Top Stage (Depth D_{WQ} = 2' Minimum)	D_{WQ} = _____ feet Storage= _____ acre-feet
B) Bottom Stage Depth (D_{BS} = 1.0' Minimum, 2.0' Maximum) Bottom Stage Storage (no less than 3% of Design Volume (0.05656752 acre-feet.)	D_{BS} = _____ feet Storage= _____ acre-feet Surf. Area= _____ acres
C) Micro Pool (Minimum Depth = the Larger of 0.5 * Top Stage Depth or 2.5 Feet)	Depth= _____ feet Storage= _____ acre-feet Surf. Area= _____ acres
D) Total Volume: Vol_{tot} = Storage from 5A + 6A + 6B (Must be > Design Volume in 1D, or 1.885584 acre-feet.)	Vol_{tot} = _____ acre-feet
7. Basin Side Slopes (Z, horizontal distance per unit vertical) Minimum Z = 4, Flatter Preferred	Z = 4.00 (horizontal/vertical)
8. Dam Embankment Side Slopes (Z, horizontal distance) per unit vertical) Minimum Z = 3, Flatter Preferred	Z = 3.00 (horizontal/vertical)
9. Vegetation (Check the method or describe "Other")	X Native Grass _____ Irrigated Turf Grass _____ Other: _____

Notes: _____

Flow Capacity of a Riser (Inlet Control)

Project: The Trails Filing No. 7
Basin ID: To Large Pond G11A



Design Information (Input):

Diameter of holes	d =	2.050 in.
Number of holes per layer	n =	3
Number of layers	N_L =	3
Vertical distance between layers	h =	4.00 in.
Orifice discharge coefficient	C_o =	0.60
Total opening area at each layer	A_o =	9.9019 sq in
	A_o =	0.0688 sq ft

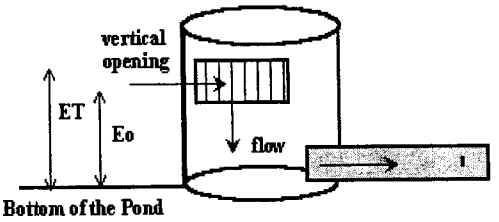
Calculation of Collection Capacity :

The starting water surface elevation must be ≥ the central elevation of the first layer.
Enter water surface elevations in ascending order.

	Water Surface Elevation ft (input)	Central Elevations of Layers of Holes in feet: Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Flow Rate cfs
		7087.75	7088.08	7088.42								
		Collection Capacity for Each Layer of Holes in cfs										
start	7087.50	0.00	0.00	0.00								**0.00**
	7088.50	0.29	0.21	0.09								**0.59**
	7089.00	0.37	0.32	0.25								**0.94**
	7089.50	0.44	0.39	0.34								**1.18**
	7090.00	0.50	0.46	0.42								**1.37**
	7090.50	0.55	0.52	0.48								**1.54**
	7091.00	0.60	0.57	0.53								**1.69**
	7091.50	0.64	0.61	0.58								**1.83**
	7092.00	0.68	0.66	0.63								**1.96**
	7092.50	0.72	0.70	0.67								**2.09**
	7093.00	0.76	0.73	0.71								**2.20**
	7093.50	0.79	0.77	0.75								**2.31**
	7094.00	0.83	0.81	0.78								**2.42**
	7094.50	0.86	0.84	0.82								**2.52**
	7095.00	0.89	0.87	0.85								**2.61**
	7095.50	0.92	0.90	0.88								**2.70**
	7096.00	0.95	0.93	0.91								**2.79**
		0.00	0.00	0.00								**0.00**

Collection Capacity of Vertical Orifice (Inlet Control)

Project: The Trails Filing No. 7
Basin ID: To Large Pond G11A



Design Information (Input):

Circular Opening: Diameter Dia. = _____ ft.

OR

Rectangular Opening: Width W = 5.00 ft.
Height H = 2.00 ft.

Percentage of Open Area After Trash Rack Reduction % open = 75.00 %
Orifice Coefficient C_o = 0.60
Top Elevation of Orifice Opening E_t = 7091.25 ft

Calculation of Collection Capacity:

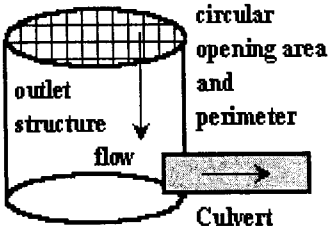
Net Opening Area (After Trash Rack Reduction) A_o = 7.50 sq ft
Center Elevation of Orifice Opening E_o = 7090.25 ft

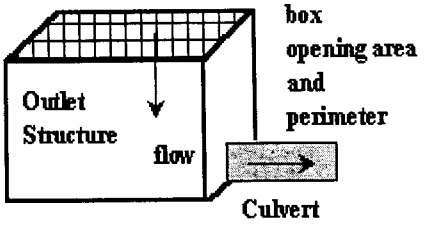
Enter water surface elevations in ascending order.

	Water Surface Elevation ft (input)	Collection Capacity cfs (output)
start	7087.50	0.00
	7088.50	0.00
	7089.00	0.00
	7089.50	1.60
	7090.00	8.29
	7090.50	17.84
	7091.00	29.56
	7091.50	40.37
	7092.00	47.77
	7092.50	54.17
	7093.00	59.89
	7093.50	65.10
	7094.00	69.93
	7094.50	74.45
	7095.00	78.70
	7095.50	82.74
	7096.00	86.59

Collection Capacity of Horizontal Orifice (Inlet Control)

Project: The Trails Filing No. 7
Basin ID: To Large Pond G11A





Design Information (Input):

Circular Opening: Diameter Dia. = _____ ft.

OR

Rectangular Opening: Width W = 8.33 ft.
Height H = 2.92 ft.

Percentage of Open Area After Trash Rack Reduction % open = 45.00 %
Orifice Coefficient C_o = 0.60
Weir Coefficient C_w = 3.10
Orifice Elevation E_o = 7092.00 ft.

Calculation of Collection Capacity:

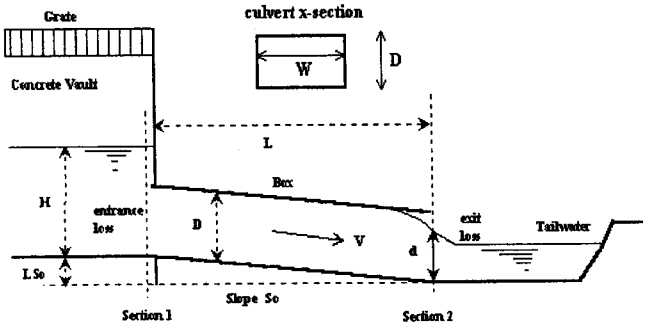
Net Opening Area (after Trash Rack Reduction) A_o = 10.94 sq. ft.
Perimeter as Weir Length L_w = 22.50 ft.

Enter water surface elevations in ascending order.

	Water Surface Elevation ft (input)	Weir Flow cfs (output)	Orifice Flow cfs (output)	Collection Capacity cfs (output)
start	7087.50	0.00	0.00	0.00
	7088.50	0.00	0.00	0.00
	7089.00	0.00	0.00	0.00
	7089.50	0.00	0.00	0.00
	7090.00	0.00	0.00	0.00
	7090.50	0.00	0.00	0.00
	7091.00	0.00	0.00	0.00
	7091.50	0.00	0.00	0.00
	7092.00	0.00	0.00	0.00
	7092.50	24.66	37.24	24.66
	7093.00	69.75	52.66	52.66
	7093.50	128.14	64.50	64.50
	7094.00	197.28	74.48	74.48
	7094.50	275.71	83.27	83.27
	7095.00	362.43	91.22	91.22
	7095.50	456.72	98.52	98.52
	7096.00	558.00	105.33	105.33

Capacity of Box Culverts (Inlet vs. Outlet Control with Tailwater Effects)

Project: The Trails Filing No. 7
Basin ID: To Large Pond G11A



Design Information (Input):

Number of Barrels	No =	1	
Barrel Rise in Feet	Rise =	2.00	ft.
Barrel Width in Feet	Width =	8.00	ft.
Inlet Edge Type (choose from pull-down list)		1.5 : 1 Bevel w/ 90 Deg. Headwall	
Inlet Elevation at Pipe Invert	I_{elev} =	7087.75	ft. elev.
Outlet Elevation at Pipe Invert	O_{elev} =	7087.49	ft. elev.
Box Length in Feet	L =	52.00	ft.
Manning's Roughness	n =	0.0140	
Bend Loss Coefficient	K_b =	0.00	
Exit Loss Coefficient	K_x =	1.00	

← ORIFICE PLATE OVER TOP 12" OF 8'W x 3'T RCBC

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.74
Sum of All Loss Coefficients	K_s =	1.94
Orifice Inlet Condition Coefficient	C_d =	1.03
Minimum Energy Condition Coefficient	KE_{low} =	0.0232

Calculations of Culvert Capacity (output):

Water Surface Elevation From Sheet 'Riser' (ft., input)	Tailwater Surface Elevation ft (input if known)	Culvert Inlet-Control Flowrate cfs (output)	Culvert Outlet-Control Flowrate cfs (output)	Flowrate Into Culvert From Sheet 'Riser' (cfs, output)	Controlling Culvert Flowrate cfs (output)	Inlet equation used:
7088.00	7088.00	1.60	0.00	0.00	0.00	minimum energy equa
7088.50	7088.50	14.30	0.00	0.17	0.00	minimum energy equa
7089.00	7088.50	33.57	26.70	0.59	0.59	regression equation
7089.50	7088.50	55.37	49.50	0.94	0.94	regression equation
7090.00	7088.50	79.97	67.50	1.18	1.18	regression equation
7090.50	7088.50	103.97	83.30	1.37	1.37	regression equation
7091.00	7088.50	125.37	96.40	1.54	1.54	regression equation
7091.50	7088.50	144.17	108.20	1.69	1.69	regression equation
7092.00	7088.50	160.97	119.00	1.83	1.83	regression equation
7092.50	7088.50	176.07	129.40	1.96	1.96	regression equation
7093.00	7088.50	189.97	139.80	2.09	2.09	regression equation
7093.50	7088.50	202.87	149.50	2.20	2.20	regression equation
7094.00	7088.50	214.18	158.60	2.31	2.31	orifice equation
7094.50	7088.50	224.18	167.20	2.42	2.42	orifice equation
7095.00	7088.50	233.68	175.40	2.52	2.52	orifice equation
7095.50	7088.50	242.88	183.20	2.61	2.61	orifice equation
7096.00	7088.50	251.68	190.70	2.70	2.70	orifice equation
				0.00		

Plunge Pool Design

South Detention Pond

220.00 Q (cfs)

16.12 Tailwater (in)

Box Culvert

36 Height (in)

96 Width (in)

Circular

Diameter (in)

Box Culvert

28.46 Normal Depth (in)

N/A	Q/D^(2.5)	Rounded	N/A
N/A	TW/D	Rounded	N/A
N/A	Yo/D		N/A

28.46 Brink Depth (in)

0.57 TW/yo **LOW TAILWATER DEPTH**

2732 Brink Area (sq in)

11.60 Brink Velocity (fps)

28.46 Equivalent Brink Depth (in)

1.33 Froude

Rip Rap Sizing

Type	d50 (in)	dmax (in)	d50/Ye	Hs/Ye	Hs (in)	Hs/d50	2<Hs/d50<4
VL	6	12	0.21	0.89	25.33	4.22	**BAD**
L	9	15	0.32	0.63	18.05	2.01	**OK**
M	12	21	0.42	0.37	10.59	0.88	**BAD**
H	18	30	0.63	0.03	0.88	0.05	**BAD**
VH	24	42	0.84	N/A	#VALUE!	#VALUE!	**#VALUE!**

Rip Rap

Type	d50 (in)	dmax (in)	Hs (in)
L	**9**	**15**	**18.05**

Dissapator Length			**Apron Length**			**Thickness of Approach**			**Thickness of Basin**		
15.04	10*hs (ft)	Max (ft)	7.52	5*hs (ft)	Max (ft)	2.25	3*d50 (ft)	Max (ft)	1.50	2*d50 (ft)	Max (ft)
24.00	3*Wo (ft)	**24.00**	8.00	Wo (ft)	**8.00**	2.50	2*dmax (ft)	**2.50**	1.88	1.5*dmax (ft)	**1.88**

Riprap Quantities

Hs (ft)	1.50	
W (ft)	8.00	
thickness approach (ft)	2.50	
thickness basin (ft)	1.88	
dissapator length (ft)	24.00	
apron length (ft)	8.00	
channel bottom (ft)	44.00	Channel Bottom must be larger than W
tailwater (ft)	1.34	

Areas	(ft^3)	(ft^2)	length (ft)	width (ft)	depth (ft)
A	67.71	27.08	3.01	9.00	2.50
B	669.22	356.92	20.99	17.00	1.88
C	510.00	272.00	8.00	34.00	1.88
D	411.82	164.73	7.70	10.70	2.50
E	518.93	276.76	17.98	7.70	1.88
F	441.85	235.65	11.01	10.70	1.88

Total (cy) **97** **Riprap D50= 9**
Total (sy) **148** **Geotextile (Erosion Control) (Class A)**

APPENDIX F

DRAINAGE MAPS

LATIGO TRAILS FILING NO. 9

EL PASO COUNTY, COLORADO

EXISTING DRAINAGE MAP

LAYER LINETYPE LEGEND

	EXISTING	PROPOSED
BOUNDARY LINE		
PROPERTY LINE		
EASEMENT LINE		
RIGHT OF WAY		
CENTERLINE		
STORM SEWER		
SWALE/WATERWAY FLOWLINE		
INDEX CONTOUR	6100	6100
INTERMEDIATE CONTOUR		
CURB & GUTTER		

SUB-BASIN DRAINAGE AREA

BASIN TAG — BASIN ID: # / AREA [AC]: #.##

1 DESIGN POINT DESIGNATION

FLOW DIRECTION (PROPOSED)

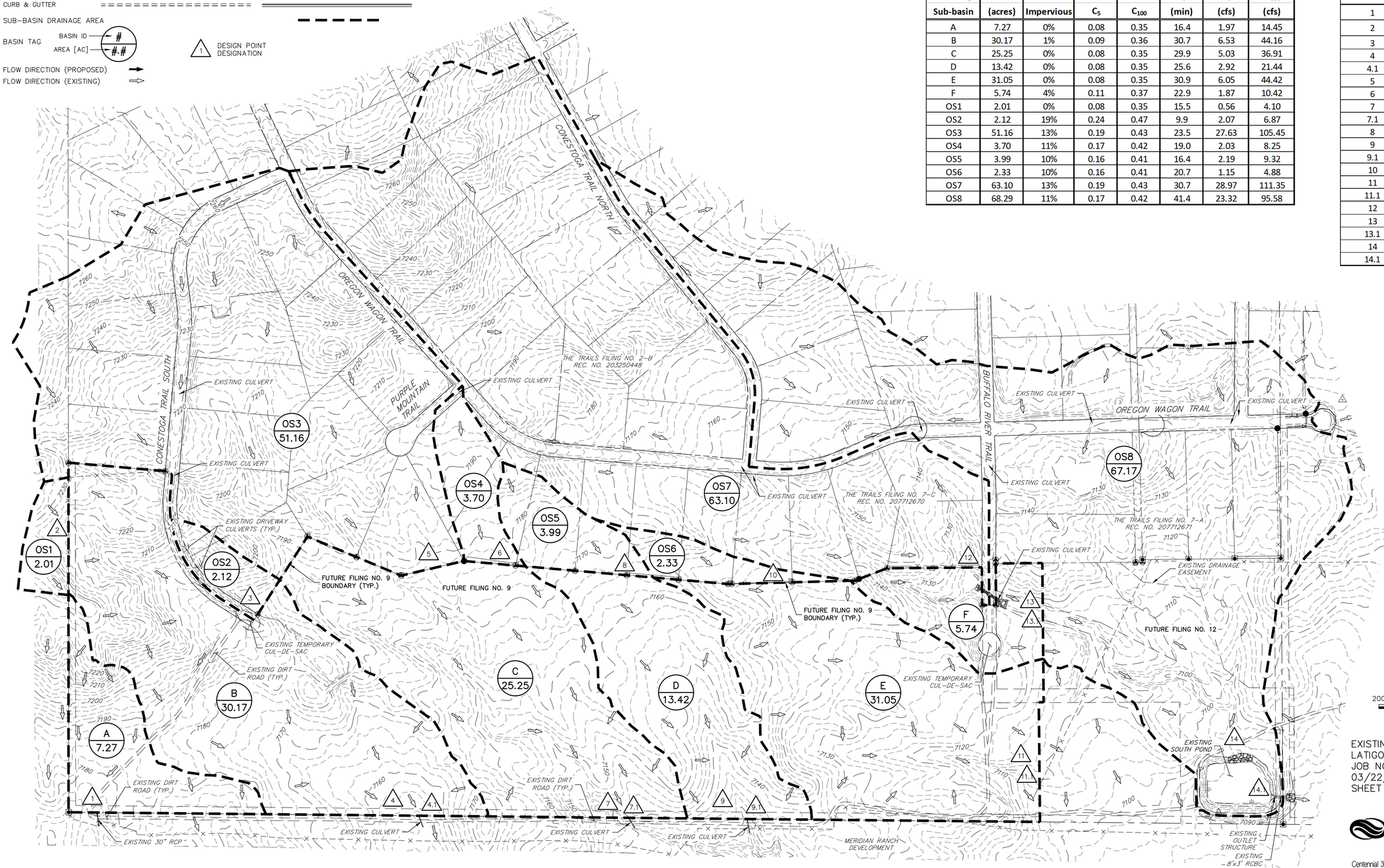
FLOW DIRECTION (EXISTING)

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
A	7.27	0%	0.08	0.35	16.4	1.97	14.45
B	30.17	1%	0.09	0.36	30.7	6.53	44.16
C	25.25	0%	0.08	0.35	29.9	5.03	36.91
D	13.42	0%	0.08	0.35	25.6	2.92	21.44
E	31.05	0%	0.08	0.35	30.9	6.05	44.42
F	5.74	4%	0.11	0.37	22.9	1.87	10.42
OS1	2.01	0%	0.08	0.35	15.5	0.56	4.10
OS2	2.12	19%	0.24	0.47	9.9	2.07	6.87
OS3	51.16	13%	0.19	0.43	23.5	27.63	105.45
OS4	3.70	11%	0.17	0.42	19.0	2.03	8.25
OS5	3.99	10%	0.16	0.41	16.4	2.19	9.32
OS6	2.33	10%	0.16	0.41	20.7	1.15	4.88
OS7	63.10	13%	0.19	0.43	30.7	28.97	111.35
OS8	68.29	11%	0.17	0.42	41.4	23.32	95.58

DESIGN POINT SUMMARY TABLE

DP#	Q_5	Q_{100}
1	1.96	14.43
2	0.56	4.08
3	2.07	6.89
4	6.54	44.17
4.1	8.15	51.11
5	27.62	105.46
6	2.03	8.24
7	5.03	36.92
7.1	30.78	135.65
8	2.20	9.32
9	2.91	21.45
9.1	4.68	28.94
10	1.15	4.90
11	6.04	44.43
11.1	6.97	48.35
12	28.96	111.36
13	1.88	10.42
13.1	30.55	120.18
14	23.33	95.57
14.1	48.29	193.75



200 100 0 200 400

ORIGINAL SCALE: 1" = 200'

EXISTING DRAINAGE MAP
LATIGO TRAILS FILING NO. 9
JOB NO. 25175.02
03/22/2022
SHEET 1 OF 1

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LATIGO TRAILS FILING NO. 9

EL PASO COUNTY, COLORADO

PROPOSED DRAINAGE MAP

LAYER LINETYPE LEGEND

	EXISTING	PROPOSED
BOUNDARY LINE		
PROPERTY LINE		
EASEMENT LINE		
RIGHT OF WAY		
CENTERLINE		
STORM SEWER		
SWALE/WATERWAY FLOWLINE		
INDEX CONTOUR	6100	6100
INTERMEDIATE CONTOUR		
CURB & GUTTER		

SUB-BASIN DRAINAGE AREA

BASIN TAG — BASIN ID: # / AREA [AC]: #.#

DESIGN POINT DESIGNATION

FLOW DIRECTION (EXISTING)

FLOW DIRECTION (PROPOSED)

LARGE-LOT SINGLE FAMILY DEVELOPMENT UNDETAINED AREA

PBMP Summary Table		
Basins	PBMP Tributary Area (Acres)	PBMP
A-G, OS2-OS8	237.10	South Pond
H, J, OS1	15.22	G1 Pond
I, K- P	51.63	Excluded*

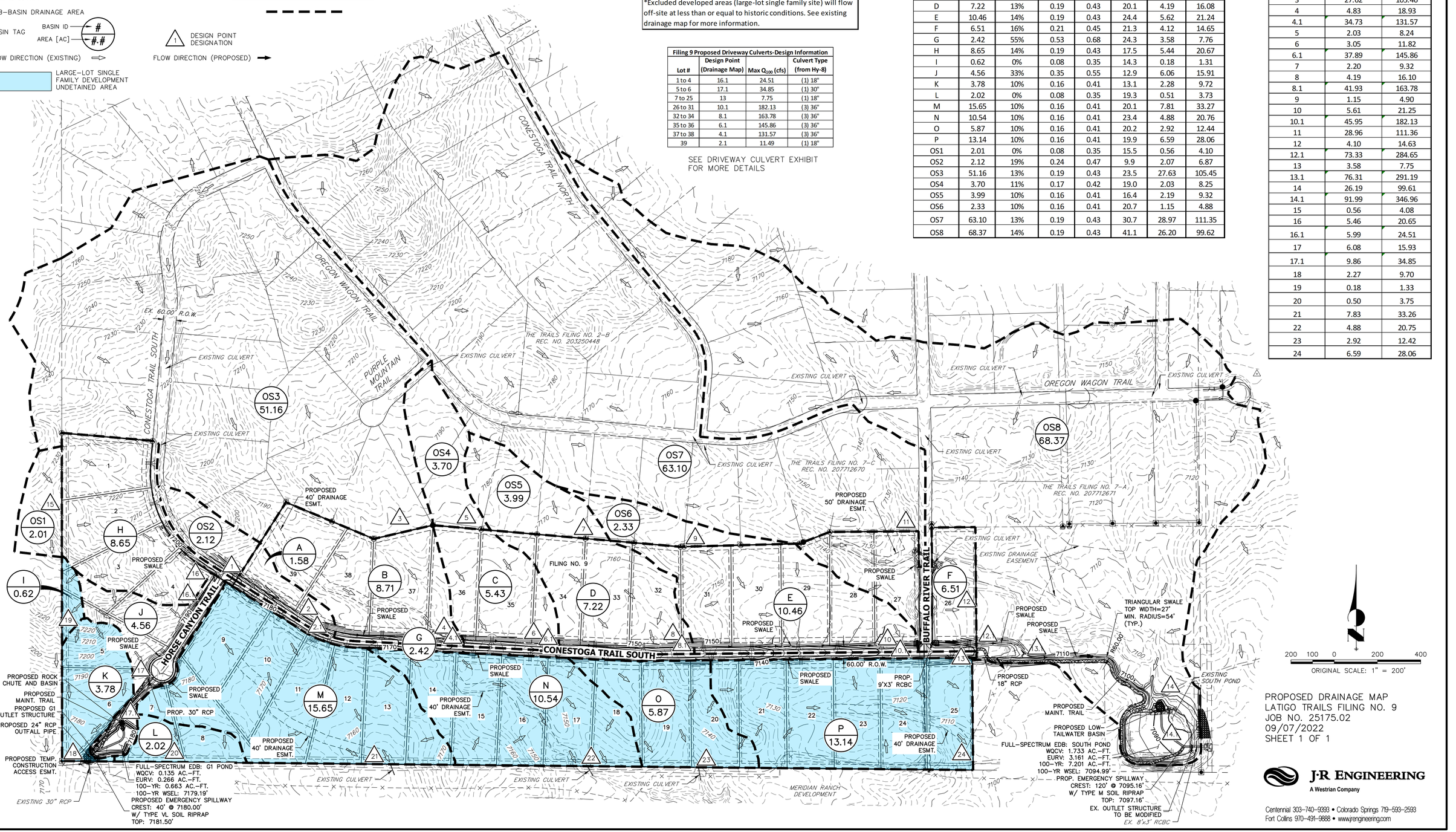
*Excluded developed areas (large-lot single family site) will flow off-site at less than or equal to historic conditions. See existing drainage map for more information.

Filing 9 Proposed Driveway Culverts-Design Information			
Lot #	Design Point (Drainage Map)	Max Q_{100} (cfs)	Culvert Type (from Hy-8)
1 to 4	16.1	24.51	(1) 18"
5 to 6	17.1	34.85	(1) 30"
7 to 25	13	7.75	(1) 18"
26 to 31	10.1	182.13	(3) 36"
32 to 34	8.1	163.78	(3) 36"
35 to 36	6.1	145.86	(3) 36"
37 to 38	4.1	131.57	(3) 36"
39	2.1	11.49	(1) 18"

SEE DRIVEWAY CULVERT EXHIBIT FOR MORE DETAILS

BASIN SUMMARY TABLE							
Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
A	1.58	22%	0.26	0.48	11.1	1.64	5.11
B	8.71	13%	0.18	0.43	20.7	4.84	18.95
C	5.43	13%	0.19	0.43	20.9	3.06	11.82
D	7.22	13%	0.19	0.43	20.1	4.19	16.08
E	10.46	14%	0.19	0.43	24.4	5.62	21.24
F	6.51	16%	0.21	0.45	21.3	4.12	14.65
G	2.42	55%	0.53	0.68	24.3	3.58	7.76
H	8.65	14%	0.19	0.43	17.5	5.44	20.67
I	0.62	0%	0.08	0.35	14.3	0.18	1.31
J	4.56	33%	0.35	0.55	12.9	6.06	15.91
K	3.78	10%	0.16	0.41	13.1	2.28	9.72
L	2.02	0%	0.08	0.35	19.3	0.51	3.73
M	15.65	10%	0.16	0.41	20.1	7.81	33.27
N	10.54	10%	0.16	0.41	23.4	4.88	20.76
O	5.87	10%	0.16	0.41	20.2	2.92	12.44
P	13.14	10%	0.16	0.41	19.9	6.59	28.06
OS1	2.01	0%	0.08	0.35	15.5	0.56	4.10
OS2	2.12	19%	0.24	0.47	9.9	2.07	6.87
OS3	51.16	13%	0.19	0.43	23.5	27.63	105.45
OS4	3.70	11%	0.17	0.42	19.0	2.03	8.25
OS5	3.99	10%	0.16	0.41	16.4	2.19	9.32
OS6	2.33	10%	0.16	0.41	20.7	1.15	4.88
OS7	63.10	13%	0.19	0.43	30.7	28.97	111.35
OS8	68.37	14%	0.19	0.43	41.1	26.20	99.62

DESIGN POINT SUMMARY TABLE		
DP#	Q_5	Q_{100}
1	2.07	6.89
2	1.63	5.14
2.1	3.46	11.49
3	27.62	105.46
4	4.83	18.93
4.1	34.73	131.57
5	2.03	8.24
6	3.05	11.82
6.1	37.89	145.86
7	2.20	9.32
8	4.19	16.10
8.1	41.93	163.78
9	1.15	4.90
10	5.61	21.25
10.1	45.95	182.13
11	28.96	111.36
12	4.10	14.63
12.1	73.33	284.65
13	3.58	7.75
13.1	76.31	291.19
14	26.19	99.61
14.1	91.99	346.96
15	0.56	4.08
16	5.46	20.65
16.1	5.99	24.51
17	6.08	15.93
17.1	9.86	34.85
18	2.27	9.70
19	0.18	1.33
20	0.50	3.75
21	7.83	33.26
22	4.88	20.75
23	2.92	12.42
24	6.59	28.06



200 100 0 200 400

ORIGINAL SCALE: 1" = 200'

PROPOSED DRAINAGE MAP
LATIGO TRAILS FILING NO. 9
JOB NO. 25175.02
09/07/2022
SHEET 1 OF 1

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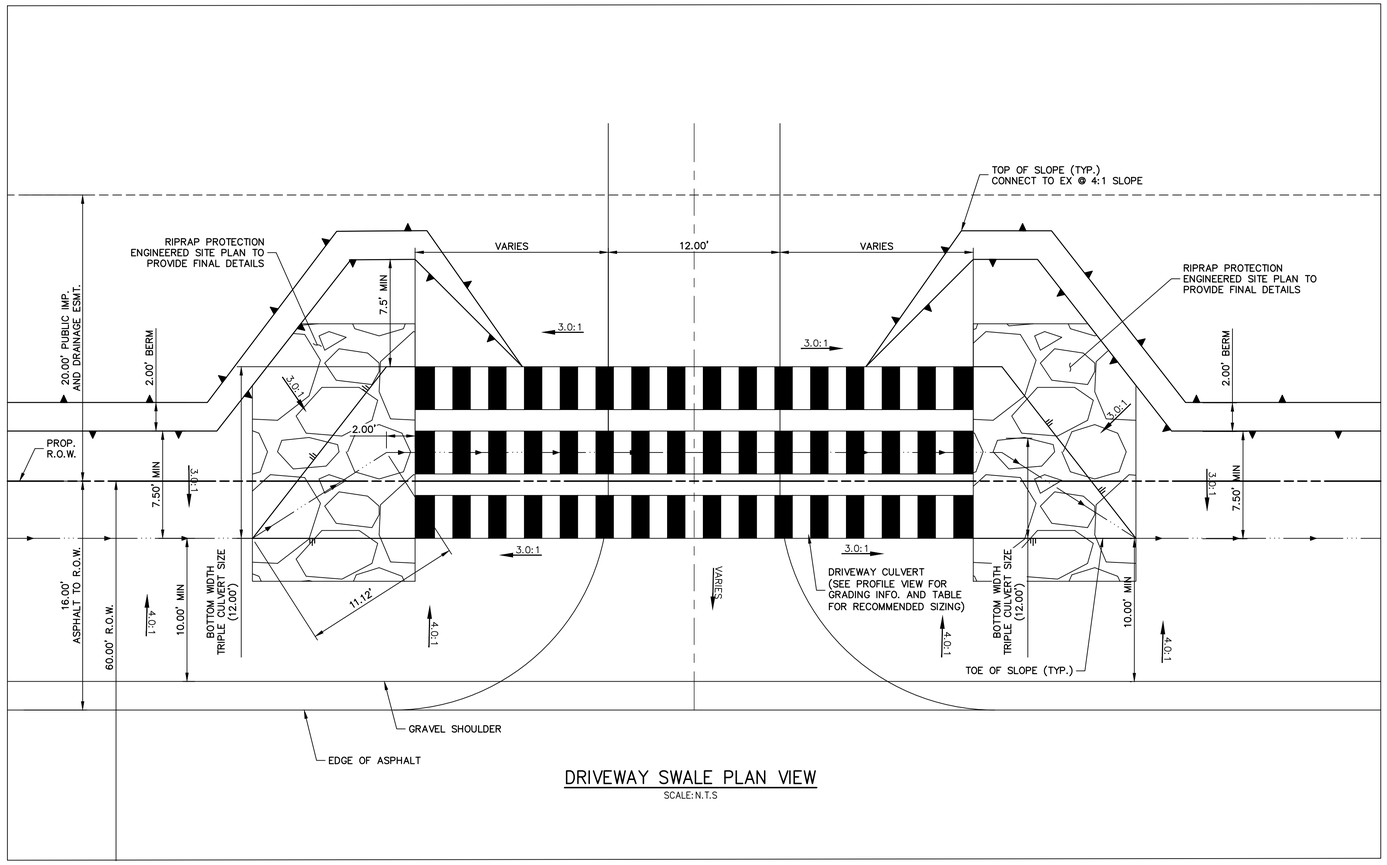
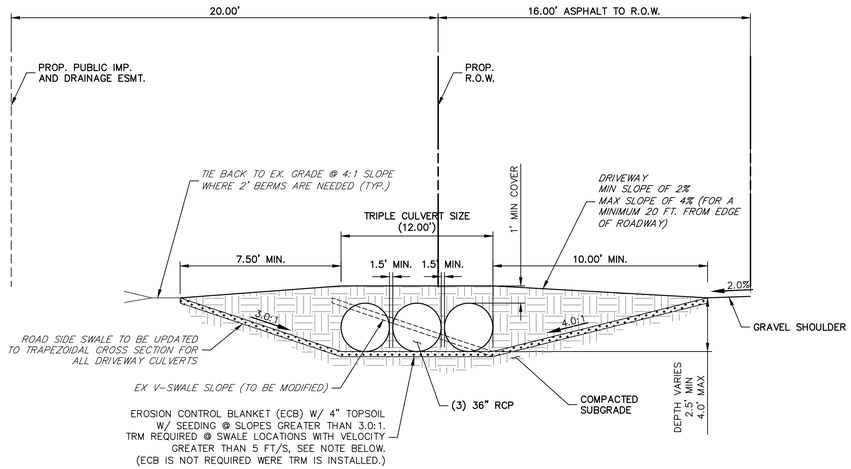
LATIGO TRAILS FILING NO. 9

DRIVEWAY CULVERT EXHIBIT



DRIVEWAY SWALE PLAN VIEW

SCALE: N.T.S

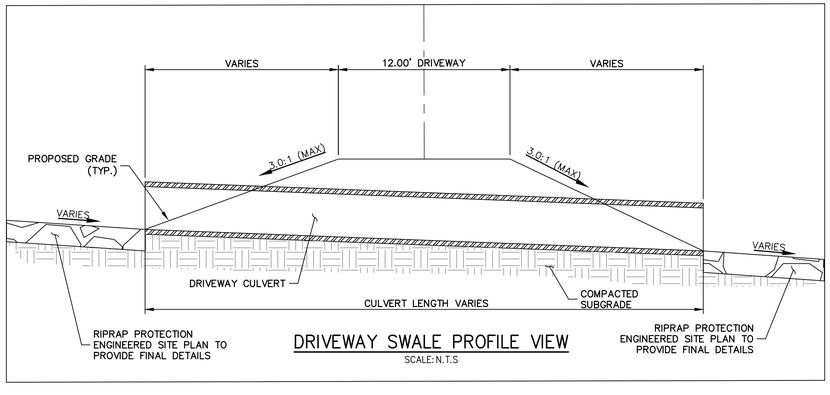


DRIVEWAY SWALE SECTION

SCALE: N.T.S

Filing 9 Proposed Driveway Culverts-Design Information

Lot #	Design Point (Drainage Map)	Max Q_{100} (cfs)	Culvert Type (from Hy-8)
1 to 4	16.1	24.51	(1) 18"
5 to 6	17.1	34.85	(1) 30"
7 to 25	13	7.75	(1) 18"
26 to 31	10.1	182.13	(3) 36"
32 to 34	8.1	163.78	(3) 36"
35 to 36	6.1	145.86	(3) 36"
37 to 38	4.1	131.57	(3) 36"
39	2.1	11.49	(1) 18"



DRIVEWAY SWALE PROFILE VIEW

SCALE: N.T.S

NOTES:

1. FUTURE ENGINEERED SITE PLANS WILL PROVIDE FINAL DETAILS FOR THE INDIVIDUAL LOT DRIVEWAYS AND WILL BE CONSTRUCTED BY OTHERS.
2. SEE FINAL DRAINAGE REPORT FOR DRIVEWAY CULVERT SIZING CALCULATIONS.

LATIGO TRAILS FILING NO. 9
DRIVEWAY CULVERT EXHIBIT
JOB NO. 2517502
9/9/2022
SHEET 1 OF 1

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LATIGO TRAILS FILING NO. 9

EL PASO COUNTY, COLORADO

ULTIMATE CONDITIONS DRAINAGE MAP

LAYER LINETYPE LEGEND

	EXISTING	PROPOSED
BOUNDARY LINE		
PROPERTY LINE		
EASEMENT LINE		
RIGHT OF WAY		
CENTERLINE		
STORM SEWER		
SWALE/WATERWAY FLOWLINE		
INDEX CONTOUR	6100	6100
INTERMEDIATE CONTOUR		
CURB & GUTTER		

SUB-BASIN DRAINAGE AREA

BASIN TAG — BASIN ID: # / AREA [AC]: #.#

1 DESIGN POINT DESIGNATION

FLOW DIRECTION (EXISTING)

FLOW DIRECTION (PROPOSED)

LARGE-LOT SINGLE FAMILY DEVELOPMENT UNDETAINED AREA

PBMP Summary Table		
Basins	PBMP Tributary Area (Acres)	PBMP
A-G, OS2-OS8	237.10	South Pond
H, J, OS1	15.22	G1 Pond
I, K- P	51.63	Excluded*

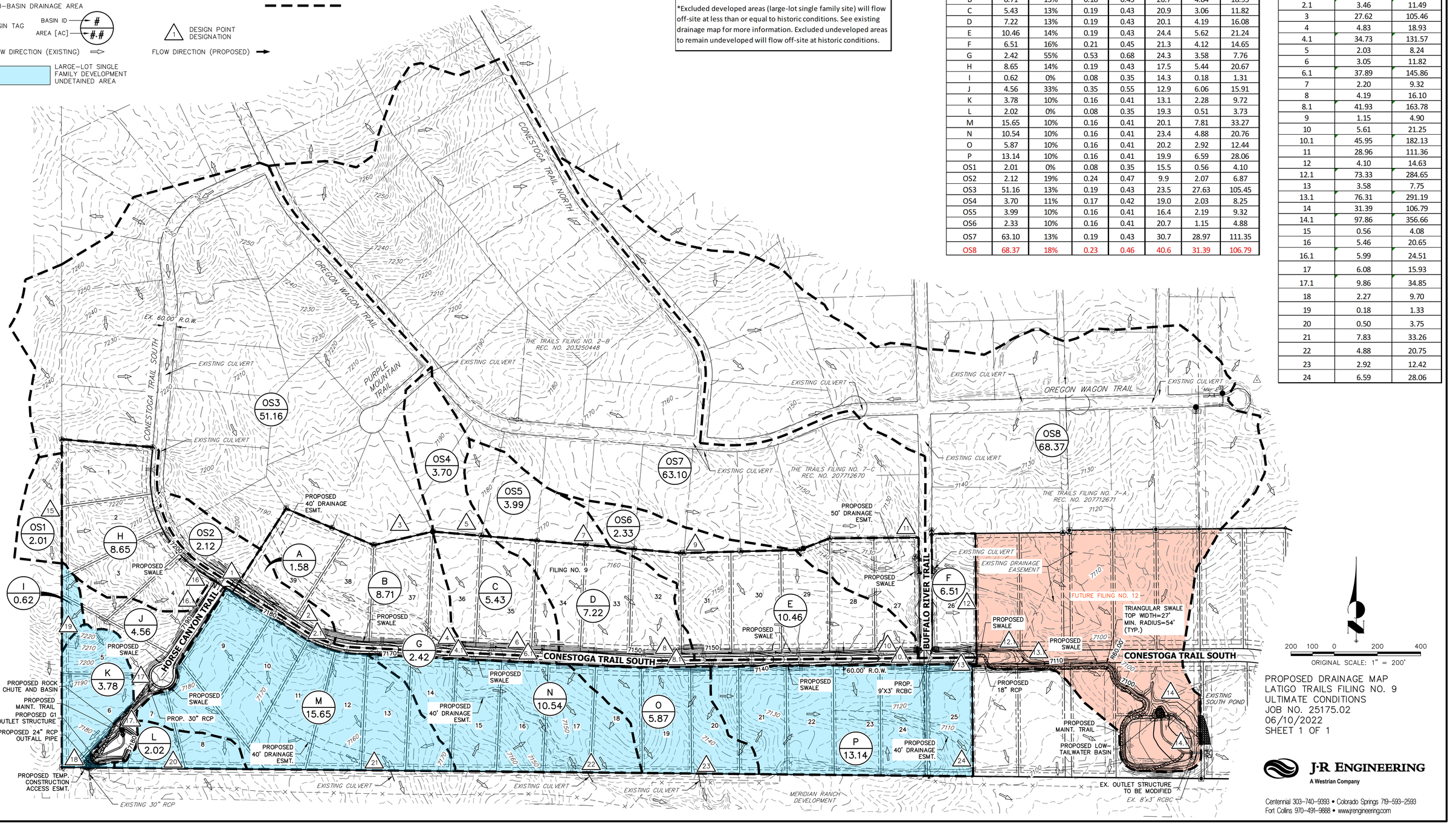
*Excluded developed areas (large-lot single family site) will flow off-site at less than or equal to historic conditions. See existing drainage map for more information. Excluded undeveloped areas to remain undeveloped will flow off-site at historic conditions.

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
A	1.58	22%	0.26	0.48	11.1	1.64	5.11
B	8.71	13%	0.18	0.43	20.7	4.84	18.95
C	5.43	13%	0.19	0.43	20.9	3.06	11.82
D	7.22	13%	0.19	0.43	20.1	4.19	16.08
E	10.46	14%	0.19	0.43	24.4	5.62	21.24
F	6.51	16%	0.21	0.45	21.3	4.12	14.65
G	2.42	55%	0.53	0.68	24.3	3.58	7.76
H	8.65	14%	0.19	0.43	17.5	5.44	20.67
I	0.62	0%	0.08	0.35	14.3	0.18	1.31
J	4.56	33%	0.35	0.55	12.9	6.06	15.91
K	3.78	10%	0.16	0.41	13.1	2.28	9.72
L	2.02	0%	0.08	0.35	19.3	0.51	3.73
M	15.65	10%	0.16	0.41	20.1	7.81	33.27
N	10.54	10%	0.16	0.41	23.4	4.88	20.76
O	5.87	10%	0.16	0.41	20.2	2.92	12.44
P	13.14	10%	0.16	0.41	19.9	6.59	28.06
OS1	2.01	0%	0.08	0.35	15.5	0.56	4.10
OS2	2.12	19%	0.24	0.47	9.9	2.07	6.87
OS3	51.16	13%	0.19	0.43	23.5	27.63	105.45
OS4	3.70	11%	0.17	0.42	19.0	2.03	8.25
OS5	3.99	10%	0.16	0.41	16.4	2.19	9.32
OS6	2.33	10%	0.16	0.41	20.7	1.15	4.88
OS7	63.10	13%	0.19	0.43	30.7	28.97	111.35
OS8	68.37	18%	0.23	0.46	40.6	31.39	106.79

DESIGN POINT SUMMARY TABLE

DP#	Q_5	Q_{100}
1	2.07	6.89
2	1.63	5.14
2.1	3.46	11.49
3	27.62	105.46
4	4.83	18.93
4.1	34.73	131.57
5	2.03	8.24
6	3.05	11.82
6.1	37.89	145.86
7	2.20	9.32
8	4.19	16.10
8.1	41.93	163.78
9	1.15	4.90
10	5.61	21.25
10.1	45.95	182.13
11	28.96	111.36
12	4.10	14.63
12.1	73.33	284.65
13	3.58	7.75
13.1	76.31	291.19
14	31.39	106.79
14.1	97.86	356.66
15	0.56	4.08
16	5.46	20.65
16.1	5.99	24.51
17	6.08	15.93
17.1	9.86	34.85
18	2.27	9.70
19	0.18	1.33
20	0.50	3.75
21	7.83	33.26
22	4.88	20.75
23	2.92	12.42
24	6.59	28.06



200 100 0 200 400

ORIGINAL SCALE: 1" = 200'

PROPOSED DRAINAGE MAP
LATIGO TRAILS FILING NO. 9
ULTIMATE CONDITIONS
JOB NO. 25175.02
06/10/2022
SHEET 1 OF 1

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