PRELIMINARY DRAINAGE REPORT
FOR
ESTATES AT CATHEDRAL PINES,
EL PASO COUNTY, COLORADO

PCD File No. PUDSP2210

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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.

Please stamp and sign

Ryan Burns, Colorado P.E. # 0054412 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: Villagree Development, LLC

By:

Gregg & Elaine Cawlfield

Title:

Address: 5710 Vessey Road
Colorado Springs CO 80908

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.

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

Conditions:

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PURPOSE

This document is the Preliminary Drainage Report for Estates at Cathedral Pines. The purpose of this report is to identify on-site and off-site drainage patterns, culverts, areas tributary to the site, and to safely route developed storm water to adequate outfall facilities.

GENERAL LOCATION AND DESCRIPTION

General Location

The proposed Estates at Cathedral Pines development, hereby known as "the site", is located within the southeast quarter of Section 2, Township 12 South, Range 66 West of the 6th Prime Meridian, El Paso County, Colorado. The proposed development is 35.09 acres containing approximately 8 – 2.7 to 4.1 acre single-family lots, 2.5 acres of open space, and associated infrastructure. The site is bounded on the east by Winslow Drive, by Cathedral Pines Subdivision Filing No. 1 to the east and north, properties at 13855 Highway 83 and 13580 Bridle Bit Road to the west, and by Falcon Forest Subdivision Filing No. 2 to the south. A vicinity map of the area is presented in Appendix A.

Description of Property

The site is currently covered by an existing forested area with a large portion that has suffered damage from a fire. There is an existing grove of trees in the middle of the property that are healthy with little to no fire damage. The proposed development will save as many healthy trees as possible. Multiple natural drainage paths run through the site and range from poorly-defined to well-defined. The existing ground cover is sparse vegetation and open space with slopes that range from 3% to 30% generally draining from east to west.

Soils located within the site as shown on the USDA Natural Resources Conservation Service Soil Survey Map are kettle gravelly loamy sand. These soils are characterized as Hydrologic Soil Group B, which have a moderate infiltration rate when thoroughly wet and have a moderate rate of water transmission. A soils map is included in Appendix A of this report.

There are no major drainageways or known irrigation facilities located on the project site. There are no known utilities located within the project boundary. There is an existing trail that borders the property to the east.

Floodplain Statement

The FEMA Flood Insurance Rate Map (FIRM) Panel No. 08041C0315G, dated December 7, 2018 is the best representation of the project site. The site is located within Zone X which is defined as areas determined to be outside the 0.2% annual chance floodplain, and therefore there is little threat of a flood. See the FIRM map in Appendix A.

EXISTING DRAINAGE CONDITIONS

Major Basin Descriptions

The site lies within the Black Squirrel Creek Drainage Basin. The DPBS for this basin was prepared by URS Corporation and dated January 1989. See excerpts in Appendix D for more information. The Black Squirrel Creek DBPS modeled the site assuming residential development of 5-acre single-family lots. The proposed development is composed of 2.7 to 4.1 acre single-family lots, which is denser than was originally assumed. This site will detain major runoff to historic rates to prevent any negative impacts to the existing downstream drainage. The DBPS identified major channel system improvements with grade control structures within the reaches adjacent to the site. There are no proposed major DBPS improvements proposed within the project site.

Existing Sub-basin Drainage

Existing basin drainage patterns are generally from east to west by way of sheet flow overland and then concentrated flow within natural channels. There are two locations where off-site flows enters onto the site. First, off-site flows enter the property at design point (DP) P1 via an 18" RCP pipe from an existing pond part of the Cathedral Pines Subdivision Filing No.1 development, and flows east to west through an existing natural channel. A 24" RCP pipe adjacent to the existing Cathedral Pines Subdivision Filing No. 1 pond crosses onto the site, which conveys the pond emergency flows from the spillway onto the site. See excerpts of the Cathedral Pines Subdivision Filing No. 1 FDR and as-built construction drawings in Appendix D. From a visual inspection during a site visit, the existing pond and outfall onto the site appears to be functioning as intended. Second, off-site flows enter the site along the southern property line and are routed through the site via an existing natural channel. The off-site basin is a large lot residential single-family home and is predominantly composed of undeveloped land. Large portions of these basins are heavily wooded.

Unresolved from Submittal 1 - engineer must confirm in the DR that the existing natural channels are functioning properly and do not require stabilization.

The existing basin delineation as shown in the existing drainage map in Appendix E is as follows:

Basin EX-1 is approximately 0.84 acres and in its existing condition is undeveloped land. Runoff (Q_5=0.3 cfs, Q_{100}=1.8 cfs) flows overland towards DP1 and off-site onto the adjacent Cathedral Pines Subdivision Filing No. 1 property to the north. For applicable excerpts from the Drainage Report and Plan for Cathedral Pines Subdivision Filing No. 1, refer to Appendix D.

Basin EX-2 is approximately 3.16 acres and in its existing condition is undeveloped land. Runoff (Q_5=0.8 cfs, Q_{100}=5.6 cfs) flows overland towards DP2 and off-site onto the adjacent Cathedral Pines Subdivision Filing No. 1 property to the north. For applicable excerpts from the Drainage Report and Plan for Cathedral Pines Subdivision Filing No. 1, refer to Appendix D.

Basin EX-3 is approximately 4.89 acres and in its existing condition is undeveloped land, and existing drainageways (both poorly and well-defined). Runoff flows will follow the historic path east

to west overland and in swales towards DP3 (Q_5=1.1 cfs, Q_{100}=7.5 cfs). Flows continue off-site onto the property at 13855 Highway 83 to the west.

Basin EX-4 is approximately 2.67 acres and in its existing condition is undeveloped land, and existing drainageways (both poorly and well-defined). Runoff flows will follow the historic path east to west overland towards DP4 (Q_5=0.7 cfs, Q_{100}=4.6 cfs). Flows continue off-site onto the property at 13580 Bridle Bit Road to the west.

Basin EX-5 is approximately 8.29 acres and in its existing condition is undeveloped land, existing drainageways (both poorly and well-defined), and a portion of Winslow Drive. Runoff flows will follow the historic path east to west overland towards DP5 (Q_5=2.3 cfs, Q_{100}=14.4 cfs). Flows continue off-site onto the property at 13580 Bridle Bit Road to the west.

Basin EX-6 is approximately 4.74 acres and in its existing condition is undeveloped land, existing drainageways (both poorly and well-defined), and a portion of Winslow Drive. Runoff flows will follow the historic path east to west overland towards DP6 (Q_5=1.5 cfs, Q_{100}=9.6 cfs). Flows continue off-site onto the property at 13580 Bridle Bit Road to the west.

Basin EX-7 is approximately 8.06 acres and in its existing condition is undeveloped land, existing drainageways (both poorly and well-defined), and a portion of Winslow Drive. Runoff flows will follow the historic path east to west overland towards DP7 (Q_5=2.3 cfs, Q_{100}=14.0 cfs). The existing Cathedral Pines Subdivision Filing No. 1 pond located to the east of Winslow Drive releases flows within the existing 18” RCP at DPP1 (Q_5=3.7 cfs, Q_{100}=10.9 cfs). Flows from DPP1 enters the existing swale and combines with DP7 at DP7.1 (Q_5=6.0 cfs, Q_{100}=24.9 cfs). DP7.1 flows continue off-site onto the property at 13580 Bridle Bit Road to the west and combine at DP8.2. As mentioned above, the 24” RCP emergency spillway overflow culvert from Cathedral Pines Subdivision Filing No. 1 also enters the existing swale through the site should the exiting pond overflow.

Basin OS-1 is approximately 2.44 acres and in its existing condition is comprised of part of a single-family lot with a house, asphalt drive, and a portion of Winslow Drive. This is an off-site basin to the south, a part of the Falcon Forest Subdivision Filing No. 2 development. Due to the basin location off-site, no work is proposed within this basin. Runoff flows will follow the historic path east to west overland to the existing natural channel at DPO1 (Q_5=1.7 cfs, Q_{100}=6.7 cfs) where it will enter Basin EX-8 and follow the drainage patterns of the basin as described below. Flows will combine with DP8 at DP8.1.

Basin EX-8 is approximately 3.64 acres and in its existing condition is undeveloped land, existing drainageways (both poorly and well-defined), and a portion of Winslow Drive. Runoff flows will follow the historic path east to west overland towards DP8 (Q_5=1.1 cfs, Q_{100}=6.5 cfs). DP8 flows will combine with DPO1 at DP8.1 (Q_5=2.3 cfs, Q_{100}=11.5 cfs) and continue off-site onto the property at 13580 Bridle Bit Road to the west and combines at DP8.2 (Q_5=8.2 cfs, Q_{100}=36.1 cfs). Flows continue within the existing swale flowing west.

Proposed Conveyance

Developed flows are collected in existing natural swales, proposed roadside ditches, and proposed culverts which convey water to the proposed detention areas on the north and south ends of the site. As previously noted, there are large portions of the site that have experienced fire damage. A grove of trees located centrally on the site are considered healthy due to them having little to no fire damage. Therefore, a design goal of the proposed drainage conveyance was to limit the disturbance to the healthy trees and natural aesthetics of the site.

Roadside swales will be designed per the typical county rural roadside ditch section. Proposed swale sections will be 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 or 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. Specific locations where the TRM is required in swale sections is 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. Natural drainage swales are analyzed by the tributary flows and physical geometry to ensure stability and sufficient capacity for the proposed flows. Detailed swale calculations, sections, and TRM specifications can all be found in Appendix C.

In addition to the swales, proposed culverts also convey flows under roadways. Culverts under proposed local paved roadways will be sized to ensure that flows will not over-top the roadway. The outlets of the proposed culverts will be protected with riprap to limit potential erosion. The riprap protection sizing calculations for the proposed culverts are located in Appendix C.

Proposed Sub-basin Drainage

In the proposed condition, the site will be developed into eight 2.5-acre minimum single-family lots, proposed roadways, proposed swales, proposed roadside swales, undeveloped land, existing drainageways (both well and poorly defined), culverts, and two proposed full-spectrum extended detention basins (EDBs). The drainage design is intended to limit the impacts of development and impact to the natural landscape and the healthy tree grove by utilizing the existing well-vegetated natural drainage paths as much as possible. In general, the proposed drainage conditions follow the historic path from east to west utilizing pervious surfaces and the existing natural channels. Flows will then follow the historic paths in proposed or existing natural channels onto the unplatted properties to the west.

Proposed hydrologic analysis was performed utilizing the Rational Method calculations for the on-site drainage basins. Proposed imperviousness in the 2.5-acre (minimum) residential lots will be limited to a maximum of 10%, in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. See the proposed water quality map in Appendix E. If development in any of the residential lots exceeds 10% impervious, a lot specific drainage report must be submitted to address the additional imperviousness, water quality/detention requirements, and additional

anticipated runoff. Runoff from these single-family lots does not include any proposed roadway flows and therefore follows the historic drainage patterns flowing off-site undetained or treated.

The proposed basin delineation as shown in proposed drainage map in Appendix E is as follows;

Basin A is approximately 0.84 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lot 8. Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the north undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=0.4 cfs, Q_{100}=1.8 cfs) sheet flows generally northwest to DP1 and onto the adjacent Cathedral Pines Subdivision Filing No. 1 property to the north. For applicable excerpts from the Drainage Report and Plan for Cathedral Pines Subdivision Filing No. 1, refer to Appendix D.

Basin B is approximately 2.36 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lots 7 and 8. Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the north undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=1.1 cfs, Q_{100}=4.8 cfs) sheet flows generally northwest to DP2 and onto the adjacent Cathedral Pines Subdivision Filing No. 1 property to the north. For applicable excerpts from the Drainage Report and Plan for Cathedral Pines Subdivision Filing No. 1, refer to Appendix D.

Basin C is approximately 2.06 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lot 7 and existing drainageways (both poorly and well-defined). Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the northwest undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=1.0 cfs, Q_{100}=4.2 cfs) sheet flows generally northwest to DP3 and onto the unplatted adjacent property to the west.

Basin D is approximately 4.49 acres and in its proposed condition is comprised of a portion of existing Winslow Drive, a portion of the proposed roadways, parts of 2.5-acre developed Lots 6-8, proposed roadside swales, and existing undeveloped landscaping areas. Runoff generated by this basin (Q_5=2.9 cfs, Q_{100}=10.3 cfs) sheets flows into the roadside swales and flows north to DP4. Flows are combined with DP5 at the 24” FES located at DP5.1.

Basin E is approximately 0.65 acres and in its proposed condition is comprised of a portion of the proposed roadways and proposed roadside swales. Runoff generated by this basin (Q_5=1.1 cfs, Q_{100}=2.6 cfs) sheets flows into the roadside swales and flows north to DP5. Flows are combined with DP4 at DP5.1 (Q_5=3.8 cfs, Q_{100}=12.4 cfs), the 24” FES. Flows are then piped via a 24” RCP storm sewer into the forebay within the full-spectrum EDB within Basin F.

Basin F is approximately 0.31 acres and in its proposed condition is comprised of a proposed full-spectrum EDB (North Pond) and associated infrastructure. Runoff generated by this basin (Q_5=0.4 cfs, Q_{100}=1.2 cfs) sheets flows to the North Pond at DP6. Flow at DP6.1 (Q_5=4.1 cfs, Q_{100}=13.1 cfs) combines the flow of DP5.1 (the Type C sump inlet) and DP6, representing the total inflow into the North Pond. Flows will be released through the outlet structure at DP6.2 (Q_5=1.2 cfs, Q_{100}=7.9 cfs). Flows will then enter Basin G and follow the drainage patterns of the basin as described below. Flows will combine with DP7 at DP7.1.

Basin G is approximately 2.08 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lots 6 and 7 and a proposed swale. Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the west undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=1.0 cfs, Q_{100}=4.2 cfs) sheet flows to the proposed swale that flows from the North Pond berm to the west to DP7. Flows from the North Pond's outlet structure outfall to this basin at DP6.2. Flows from DP6.2 and DP7 combine at DP7.1 (Q_5=2.2 cfs, Q_{100}=12.1 cfs) and continue off-site onto the property at 13855 Highway 83 to the west.

Basin H is approximately 1.94 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lots 5 and 6. Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the west undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=0.9 cfs, Q_{100}=3.9 cfs) sheet flows generally follows the historic drainage pattern of east to west to DP8 and continue off-site onto the property at 13580 Bridle Bit Road to the west.

Basin I is approximately 5.01 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lots 4-6 and existing drainageways (both poorly and well-defined). Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the west undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=2.7 cfs, Q_{100}=11.6 cfs) sheet flows to an existing natural channel and generally follows the historic drainage pattern from east to west to DP9 and continue off-site onto the property at 13580 Bridle Bit Road to the west.

Basin J is approximately 0.82 acres and in its proposed condition is comprised of part of proposed landscaping and undeveloped land. Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the west undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=0.4 cfs, Q_{100}=2.2 cfs) sheet flows to the existing natural channel and generally follows the historic drainage pattern of east to west to DP10, a

proposed culvert. Flows from DP10 enter into Basin K and follow the drainage patterns of the basin as described below. Flows will combine with DP11 at DP11.1.

Basin K is approximately 3.48 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lots 3 and 4 and existing drainageways (both poorly and well-defined). Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the west undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=1.9 cfs, Q_{100}=8.1 cfs) sheet flows to an existing natural channel and generally follows the historic drainage pattern from east to west to DP11. Flows from DP10 and DP11 combine at DP11.1 (Q_5=2.3 cfs, Q_{100}=9.9 cfs) and continue off-site onto the property at 13580 Bridle Bit Road to the west.

Basin L is approximately 2.58 acres and in its proposed condition is comprised of a portion of existing Winslow Drive, a portion of the proposed roadways, parts of 2.5-acre developed Lots 1-2, proposed roadside swales, and existing undeveloped landscaping areas. Runoff generated by this basin (Q_5=2.6 cfs, Q_{100}=7.6 cfs) sheets flows into the roadside swales and flows south to DP12. The existing Cathedral Pines Subdivision Filing No. 1 pond located to the east of Winslow Drive releases flows within the existing 18” RCP at DPP1 (Q_5=3.7 cfs, Q_{100}=10.9 cfs). Flows from DPP1 enters the existing swale to the proposed convergence within the roadside swale at DP12.1 (Q_5=6.3 cfs, Q_{100}=18.5 cfs). DP12.1 then combines flows with DP13 at the Type C sump inlet located at DP13.1. As mentioned above, the 24” RCP emergency spillway overflow culvert from Cathedral Pines Subdivision Filing No. 1 also enters the existing swale through the site should the exiting pond overflow. For more information on the emergency overflow conveyance design, see the end of this section below and Appendix C for calculations.

Basin M is approximately 0.45 acres and in its proposed condition is comprised of a portion of the proposed roadways and proposed roadside swales. Runoff generated by this basin (Q_5=0.9 cfs, Q_{100}=2.1 cfs) sheets flows into the roadside swales and flows south to DP13. Flows are combined with DP12.1 at DP13.1 (Q_5=7.1 cfs, Q_{100}=20.2 cfs), the Type C sump inlet. Flows are then piped via a 24” RCP storm sewer into the forebay within the full-spectrum EDB within Basin N.

Basin N is approximately 0.75 acres and in its proposed condition is comprised of a proposed full-spectrum EDB (South Pond), associated infrastructure, and lawn areas. Runoff generated by this basin (Q_5=0.6 cfs, Q_{100}=2.5 cfs) sheets flows to the South Pond at DP14. Flow at DP14.1 (Q_5=7.6 cfs, Q_{100}=22.0 cfs) combines the flow of DP13.1 (the Type C sump inlet) and DP14, representing the total inflow into the South Pond. Flows will be released through the outlet structure at DP14.2 (Q_5=0.6 cfs, Q_{100}=4.3 cfs). Flows will then enter Basin O and follow the drainage patterns of the basin as described below. Flows will combine with DP15 at DP15.1.

Basin O is approximately 4.83 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lots 2-4 and existing drainageways (both poorly and well-defined). Runoff from

this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the west undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=2.5 cfs, Q_{100}=10.7 cfs) sheets flows to the existing natural channel that flows to the west to DP15. Flows from South Pond's outlet structure outfall to this basin at DP14.2. Flows from DP14.2 and DP15 combine at DP15.1 (Q_5=3.1 cfs, Q_{100}=15.0 cfs) and continue onto the property at 13580 Bridle Bit Road to the west and combine at DP16.2.

Basin OS-1 is approximately 0.13 acres and in its existing condition is comprised of a portion of Winslow Drive. The basin is off-site and therefore no work is proposed within this basin. Runoff from this basin does not include any modification to existing roadway flows and therefore follows the historic drainage pattern flowing off-site to the west undetained or treated. This is in accordance with Section I.7.1.B.3 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=0.3 cfs, Q_{100}=0.7 cfs) will follow the historic path east to west overland to the existing natural channel at DPO1. Flows will then enter Basin P and follow the drainage patterns of the basin as described below. Flows will combine with DPO2 and DP16 at DP16.1.

Basin OS-2 is approximately 2.44 acres and in its existing condition is comprised of part of a single-family lot with a house, asphalt drive, and a portion of Winslow Drive. This is an off-site basin to the south, a part of the Falcon Forest Subdivision Filing No. 2 development. Due to the basin location off-site, no work is proposed within this basin. Runoff generated by this basin (Q_5=1.7 cfs, Q_{100}=6.7 cfs) will follow the historic path east to west overland to the existing natural channel at DPO2. Flows will then enter Basin P and follow the drainage patterns of the basin as described below. Flows will combine with DPO1 and DP16 at DP16.1.

Basin P is approximately 3.51 acres and in its proposed condition is comprised of part of proposed 2.5-acre developed Lots 1 and 2 and existing drainageways (both poorly and well-defined). Runoff from this basin does not include any proposed roadway flows and therefore follows the historic drainage pattern flowing off-site to the west undetained or treated. This is in accordance with Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Runoff generated by this basin (Q_5=1.6 cfs, Q_{100}=6.8 cfs) sheet flows to an existing natural channel and generally follows the historic drainage pattern from east to west to DP16. DP16 flows will combine with DPO1 and DPO2 at DP16.1 (Q_5=2.9 cfs, Q_{100}=12.0 cfs) continue off-site onto the property at 13580 Bridle Bit Road to the west and combines at DP16.2 (Q_5=5.6 cfs, Q_{100}=25.1 cfs). Flows continue within the existing swale flowing west.

In the existing condition, the total released flows off-site are from DP 1-6 and 8.2 for a total flow of Q_5=14.9 cfs and Q_{100}=79.5 cfs flowing north and west to adjacent properties. In the proposed condition, the total released flows off-site are from DP 1-3, 7.1, 8-9, 11.1, and 16.2 for a total flow of Q_5=16.2 cfs and Q_{100}=73.4 cfs. The flows follow the historic pattern released off-site to the north and west. Comparing the existing and proposed total flows released off-site, the major flows released in the proposed condition are less than the existing condition. Therefore, there are no

negative impacts anticipated to downstream conveyances or properties with the development of the site.

In the case where the existing pond part of Cathedral Pines Subdivision Filing No. 1 overtops, the proposed conveyance was analyzed to ensure emergency flows would get to the desired location. The existing pond would overtop the emergency spillway and flow to the existing 24" RCP culvert before crossing onto the site. Flows (Q_{100}=35.6 cfs) would then enter the existing swale to the combination with the proposed roadside swale at DP12.1. The total flow within the proposed Basin L roadside swale would be Q_{100}=43.2 cfs. The Basin L emergency overflow swale calculation shows that flows would stay within the proposed swale to the Type C inlet at DP13.1. The inlet calculation shows that the flows would overtop the proposed Type C inlet at DP13.1 and flow into the South Pond. For the South Pond emergency spillway, the total flow would be the existing pond emergency overflow (Q_{100}=35.6 cfs) as well as the South Pond emergency overflow (Q_{100}=22.0 cfs) for a total flow of Q_{100}=57.6 cfs. The spillway weir calculation shows that the South Pond spillway would direct flows to the Basin O existing swale. Flows would then combine with DP15 at DP15.1, the existing swale with a total flow of Q_{100}=68.3 cfs. The Basin O emergency overflow swale calculation shows that the existing swale would contain the flows and convey them off-site following the historic path west. See the end of Appendix C for applicable emergency overflow conveyance calculations.

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 "City of Colorado Springs 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. On-site drainage improvements were designed based on the 5 year (minor) storm event and the 100-year (major) storm event. Runoff was calculated using the Rational Method, and rainfall intensities for the 5-year and the 100-year storm return frequencies were obtained from Figure 6-5 Intensity Duration Frequency Curve of the Colorado Springs DCM. Runoff coefficients were determined based on proposed land use and from data in Table 6-6 from the DCM. Time of concentrations were developed using equations from the DCM. The flows for the off-site pond released flows at DP-P1 was routed into the Rational Method calculations by taking the released flows and dividing by the adjacent basin intensity to calculate C*A. Then the routing

continued using the standard calculations per the Rational Method to the next design point. All runoff calculations and applicable charts and graphs are included in Appendix B.

Hydraulic Criteria

The Rational Method and USDCM's SF-2 and SF-3 forms were used to determine the runoff from the minor and major storms on the site. Autodesk Inc.'s Hydraflow Express Extension (Volume 10.5) was used to size the roadside ditches and drainage swales per criteria. Hydraflow Express was also used to analyze the proposed culverts within the Estates at Cathedral Pines development. Per Section 6.4.1 of the EPCDCM, culverts were sized as to not overtop the road in the 100-year storm. UDFCD Volume 2 Chapter 9 Figure 9-35 will be used to size the riprap protection around the proposed culverts. The MHFD-Detention_v4.06 spreadsheet was utilized for evaluating proposed detention and water quality for the North and South Ponds. Required detention volumes and allowable release rates were designed per USDCM and CCS/EPCDCM. Bentley StormCAD v8i was used to analyze the hydraulic grade lines and energy grade lines for the storm sewer network. See Appendix C for calculations.

DRAINAGE FACILITY DESIGN

Provide a statement in the hydraulic Criteria and Drainage Facility Design section of the report that hydraulic design will be finalized with the Final Drainage Report.

Unresolved - dotschoenheit
01/04/2024 8:09:31 AM

General Concept

The combination of the proposed and existing stormwater conveyance system was designed to convey the developed Estates at Cathedral Pines flows to one of two full-spectrum EDB via roadside ditches and swales. The drainage design is intended to utilize the existing well-vegetated natural drainage paths on-site and reduce the impacts of development. The proposed full-spectrum EDBs will be located at the northern and southern ends of the proposed main roadway. The North Pond will outfall to a proposed swale that will route flow to follow the historic drainage path of east to west between Lots 6 and 7. The South Pond will utilize an existing natural channel to outfall flows on the adjacent unplatted property. Development of the 2.5 acre (min.) single-family lots in basins A-C, G-K, and O-P will be limited to 10% or less for areas that do not have a water quality feature downstream in order to satisfy Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure. Impacts to adjacent properties will be limited as proposed developed flows will be released at below existing rates of flow.

Specific Details

All proposed drainage items in this report will be designed to accept both 5-year and 100-year flows. All culverts will have a flared end section (FES) on both sides of the pipe. All culverts will have riprap protection downstream as a method of erosion protection prior to the stormwater entering the proposed swales. The proposed forebays will have a concrete bottom leading to the soil riprap berm. The proposed pond forebays and weir contain 1% of the required Water Quality Capture Volume (WQCV). The forebays weir will release 2% of the undetained peak 100-year inflow into the full-spectrum EDB via a notch in the berm and onto the proposed concrete trickle channel. The trickle

channel will direct flows into the proposed full-spectrum EDB outlet structure, which will detain water per times specified by criteria.

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 acre min.) with lawn areas interspersed within the development which helps disconnect impervious areas and reduce runoff volumes. The development is intended to limit the impact to the natural landscape and preserve the existing healthy tree grove by creating an open space preservation easement for this area. Roadways will utilize roadside ditches to further disconnect impervious areas. Proposed flow in general follows the historic path over pervious surfaces into existing drainage paths. These practices will also allow for increased infiltration and reduce runoff volume.

Step 2, Stabilize Drainageways: This site utilizes roadside ditches with culvert crossings throughout the site. These roadside ditches will then direct the applicable on-site and off-site development flows to a proposed full-spectrum EDB within the project. The proposed full-spectrum EDB's will be designed to release flows at or below historic rates. Roadside ditches will be stabilized by keeping velocities below 5 ft/s, or providing additional erosion protection. Developed flows leaving the site are limited to below existing rates, and therefore no impact to downstream drainageways is anticipated.

Step 3, Provide WQCV: Runoff from this development is treated through capture and slow release of the WQCV in the two on-site proposed permanent full-spectrum EDBs that are be designed per current El Paso County drainage criteria. The 2.5-acre (minimum) residential lots will be limited to a maximum of 10% imperviousness to meet the requirements of Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure for water quality through a plat note. Should any lot exceed 10% imperviousness, a lot specific drainage report addressing the increased imperviousness must be submitted.

Step 4, Consider the need for Industrial and Commercial BMP's: No industrial or commercial uses are proposed within this development. 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. As previously stated, the applicable

exclusions for Basins A-C, G-K, and O-P fall under Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure for areas with large single-family lots (2.5-acre min.). In addition, one of the basins J is an proposed open space tract that is excluded under the Section I.7.1.B.7 of the ECM Stormwater Quality Policy and Procedure for land disturbance to undeveloped land that will remain undeveloped. The proposed roadway will be treated within the proposed full-spectrum EDBs. Outlet structure release rates will be limited to less than historic rates to minimize adverse impacts to downstream stormwater facilities.

Proposed Full-Spectrum EDBs

Water quality is provided for the site by two private full-spectrum detention and water quality extended detention basins. The proposed North Pond is sized to provide water quality and detention for a total of 5.5 acres at 21.5% impervious. The proposed South Pond is sized to provide water quality and detention for a total of 4.0 acres at 27% impervious. Table 1 below shows the basin parameters for both ponds. Refer to Appendix C for the UD-Detention design sheets that include the tributary basin parameters as well as the stage-storage table and outlet structure design. The outlet structure includes an orifice plate, overflow grate, and restrictor plate to release stormwater at the appropriate rates. The WQCV will be released within 40 hours, the EURV will be released within 72 hours, and the minor and major flows will be released at or below the pre-development flow rate. Table 2 below gives the design storm results for the North and South Ponds.

A broad-crested weir lined with Type L buried soil riprap is provided as an emergency spillway along the western embankment of both ponds. The North Pond emergency flows are conveyed via a proposed drainage swale to the properties to the west per historic drainage patterns. The South Pond emergency flows are conveyed via an existing drainage swale to the properties to the west per historic drainage patterns. A separate analysis for the existing Cathedral Pines Subdivision Filing No. 1 pond emergency overflow shows that the South Pond spillway would direct flows to the desired location to the existing swale within Basin O.

Table 1 - Watershed Design Parameters for both EDBs

Name	Watershed Area	Percent Impervious	Watershed Slope
North Pond	5.5 AC	21.5%	0.040 ft/ft
South Pond	4.0 AC	27.0%	0.045 ft/ft

Table 2- Full-spectrum EDB Design for both EDBs

Name	**Required Volume (ac-ft)**	**Provided Volume (ac-ft)**	**WQCV (ac-ft)**	**EURV (ac-ft)**	**5-year Release (cfs)**	**100-year Release (cfs)**
North	0.30	0.42	0.06	0.12	1.2	7.9
South	0.25	0.28	0.05	0.11	0.6	4.3

Prel nes

Note: A BMP maintenance agreement will need to be signed by the developer prior to plat recording. This will need to be submitted with the Final Plat submittal.

This should be revised to the Developer, HOA or District (based on how the comment within LOI V2 is addressed. Unresolved V1 comment.

Unresolved - dotschoenheit
01/04/2024 8:22:48 AM

Calculations and pond design parameters are presented in Appendix C.

Erosion Control Plan

We respectfully request that the Final Erosion Control Plan and Cost Estimate to be submitted in conjunction with the construction drawings and plat 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 any platted County R.O.W. (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 ponds, drainageway culverts and drainageway improvements) will be owned and maintained by the property owner unless another party accepts such responsibility in writing and responsibility is properly assigned through legal documentation. The proposed local road is private and therefore also maintained by the property owner. Inspection access for El Paso County will be provided through a maintenance easement.

Drainage and Bridge Fees

The proposed site lies within the Black Squirrel Drainage Basin. The drainage and basin fees will be assessed in conjunction with the construction drawings and plat prior to obtaining a grading permit.

Construction Cost Opinion

A construction cost opinion for the drainage infrastructure will be provided in conjunction with the construction drawings and plat prior to obtaining a grading permit.

SUMMARY

The Preliminary Drainage Report for Estates at Cathedral Pines identifies on-site and off-site drainage patterns, storm sewer, culvert locations, areas tributary to the site, and safely routes developed storm water to adequate outfall facilities. The proposed Estates at Cathedral Pines development will not adversely affect the off-site 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. FEMA Flood Insurance Rate Map (F.I.R.M.) Panel No. 08041C0535G, effective date December 7, 2018.

4. "Soil Survey of El Paso County Area, Colorado," by the USDA Natural Resources Conservation Service.

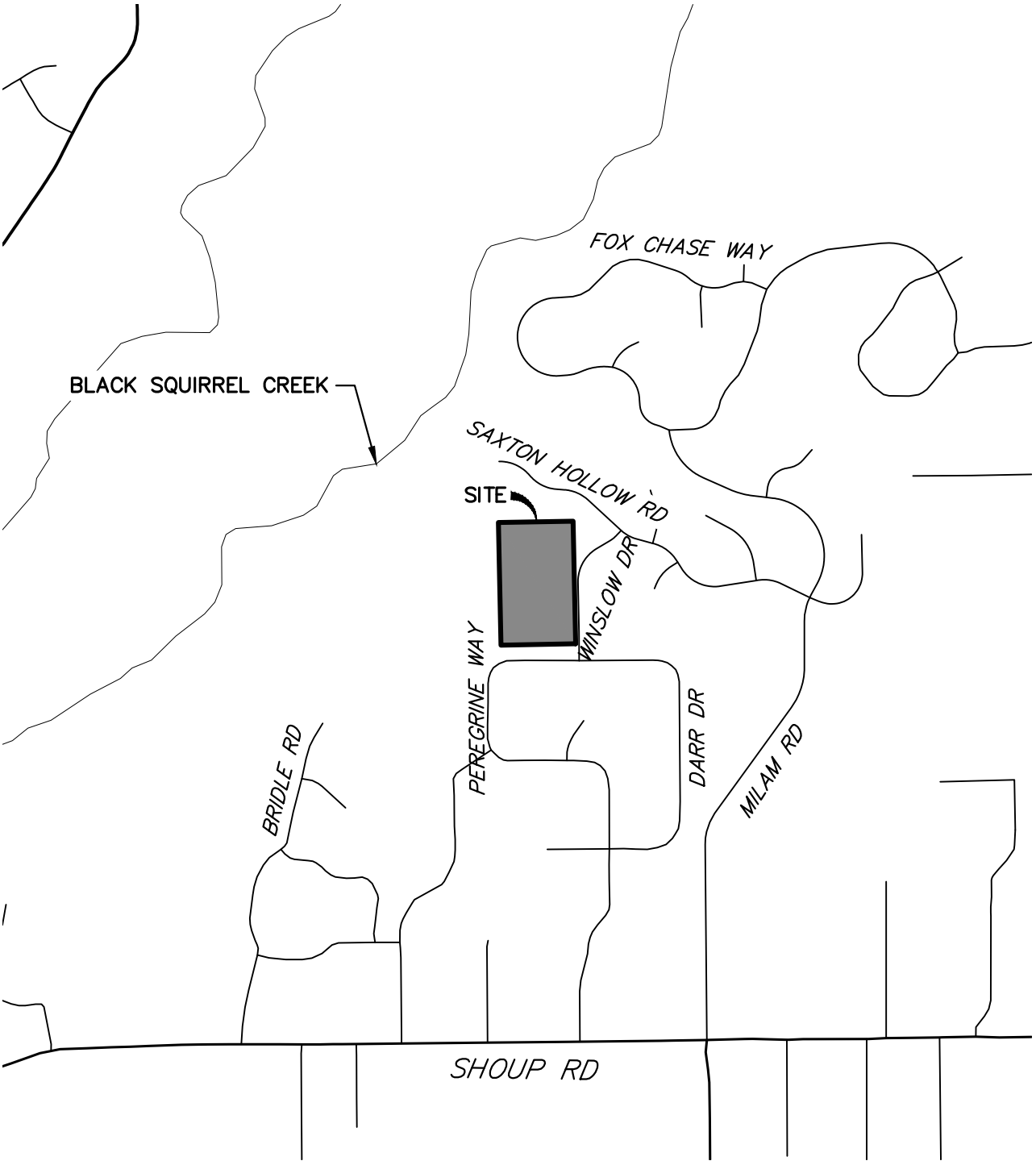
5. Black Squirrel Creek Drainage Basin Planning Study, prepared by URS Corporation and dated January, 1989.

6. Final Drainage Report and Plan for Cathedral Pines Subdivision Filing No. 1, prepared by Leigh Whitehead & Associates, Inc. and dated January 2005.

7. Cathedral Pines Subdivision Filing No. 1-As-Built Construction Drawings, prepared by Stillwater Engineering and dated October 8, 2008.

APPENDIX A

FIGURES AND EXHIBITS



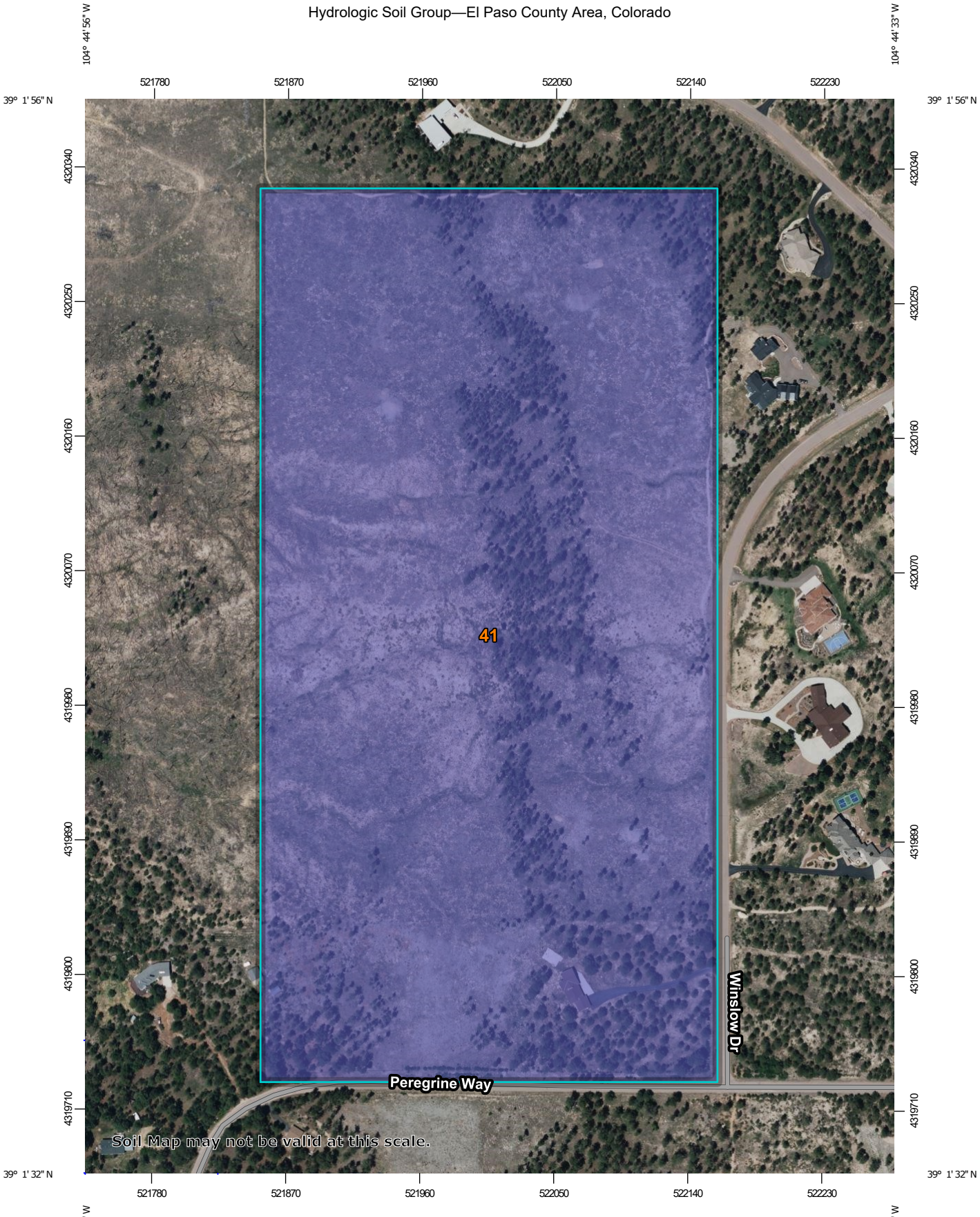
2000 1000 0 2000

ORIGINAL SCALE: 1" = 2000'

CATHEDRAL PINES
VICINITY MAP
2000-5260.00
08-17-2022
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: 1:3,500 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 150 300 600 900

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.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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 19, Aug 31, 2021

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	45.5	100.0%
Totals for Area of Interest			**45.5**	**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

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

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 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/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

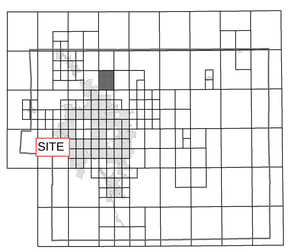
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

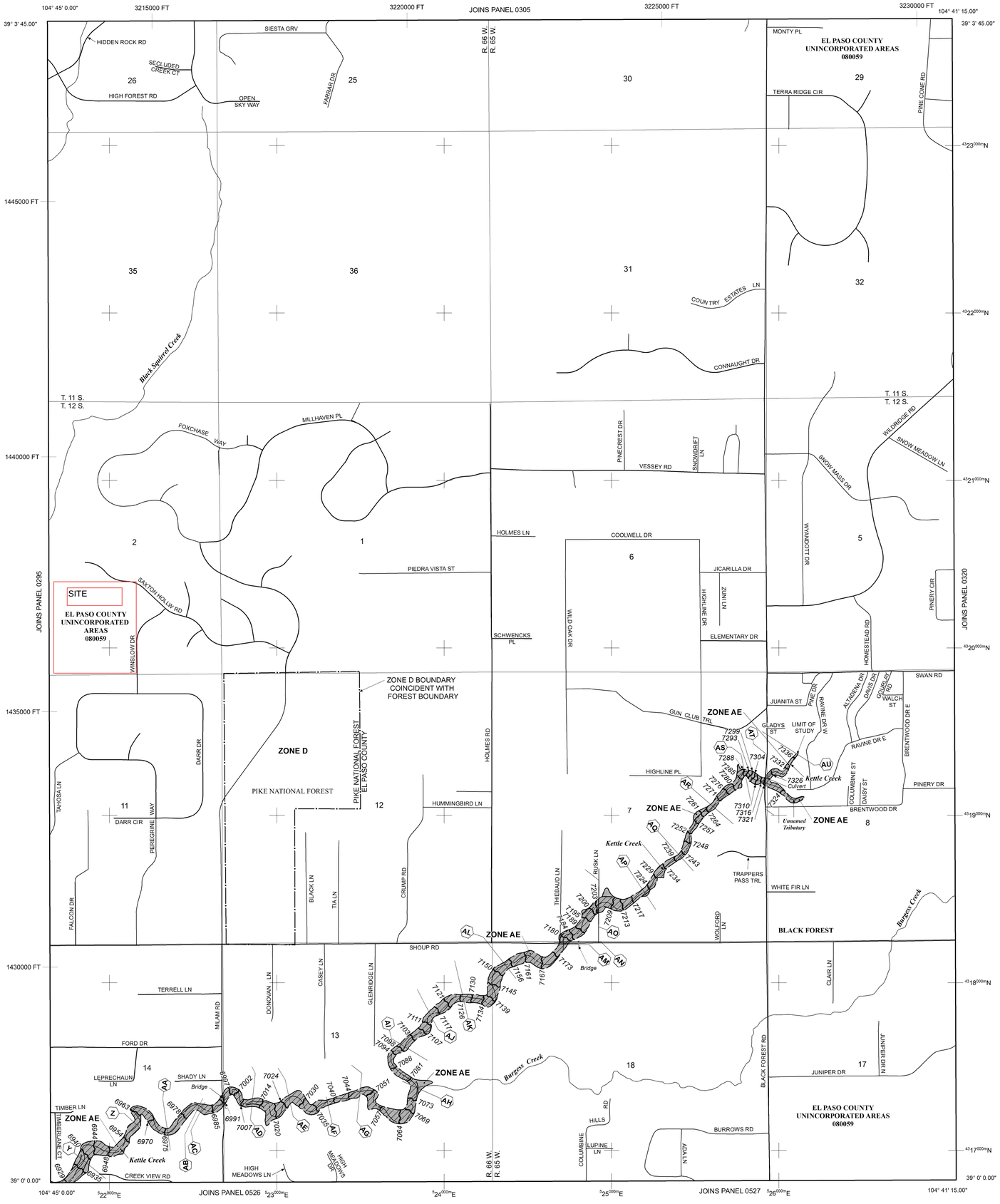
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

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



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.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
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
23 — 23 — Transect line
97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT — 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
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.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

PANEL 0315G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 315 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0315	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
08041C0315G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

APPENDIX B

HYDROLOGIC CALCULATIONS

EXISTING COMPOSITE % IMPERVIOUS/C VALUE CALCULATIONS

Subdivision: Cathedral Pines
Location: El Paso County

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 9/8/23

Basin ID	Total Area (ac)	Hardscape/Water (100% Impervious)				2.5 Acre Lots (10% Impervious)				Lawns (2% 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}	Area (ac)	Weighted % Imp.	C_5	C_{100}	
EX-1	0.84	0.90	0.96	0.00	0.0%	0.16	0.41	0.00	0.0%	0.09	0.36	0.84	2.0%	0.09	0.36	2.0%
EX-2	3.16	0.90	0.96	0.00	0.0%	0.16	0.41	0.00	0.0%	0.09	0.36	3.16	2.0%	0.09	0.36	2.0%
EX-3	4.89	0.90	0.96	0.00	0.0%	0.16	0.41	0.00	0.0%	0.09	0.36	4.89	2.0%	0.09	0.36	2.0%
EX-4	2.67	0.90	0.96	0.00	0.0%	0.16	0.41	0.00	0.0%	0.09	0.36	2.67	2.0%	0.09	0.36	2.0%
EX-5	8.29	0.90	0.96	0.07	0.9%	0.16	0.41	0.00	0.0%	0.09	0.36	8.22	2.0%	0.10	0.37	2.9%
EX-6	4.74	0.90	0.96	0.05	1.0%	0.16	0.41	0.00	0.0%	0.09	0.36	4.69	2.0%	0.10	0.37	3.0%
EX-7	8.06	0.90	0.96	0.10	1.2%	0.16	0.41	0.00	0.0%	0.09	0.36	7.96	2.0%	0.10	0.37	3.2%
EX-8	3.64	0.90	0.96	0.05	1.4%	0.16	0.41	0.00	0.0%	0.09	0.36	3.59	2.0%	0.10	0.37	3.4%
OS-1	2.44	0.90	0.96	0.05	2.0%	0.16	0.41	2.39	9.8%	0.09	0.36	0.00	0.0%	0.17	0.42	11.8%
TOTAL	38.73															3.3%

EXISTING STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Cathedral Pines
Location: El Paso County

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 9/8/23

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)
EX-1	0.84	B	2%	0.09	0.36	255	7.3%	15.1	0	0.0%	7.0	0.0	0.0	15.1	255.0	25.7	15.1
EX-2	3.16	B	2%	0.09	0.36	300	5.6%	17.9	400	5.3%	7.0	1.6	4.1	22.0	700.0	28.8	22.0
EX-3	4.89	B	2%	0.09	0.36	300	4.4%	19.4	850	4.6%	7.0	1.5	9.4	28.8	1150.0	32.8	28.8
EX-4	2.67	B	2%	0.09	0.36	300	4.3%	19.5	370	4.9%	7.0	1.5	4.0	23.5	670.0	28.7	23.5
EX-5	8.29	B	3%	0.10	0.37	300	7.4%	16.2	780	5.9%	7.0	1.7	7.6	23.8	1080.0	31.2	23.8
EX-6	4.74	B	3%	0.10	0.37	110	12.0%	8.4	975	6.4%	7.0	1.8	9.2	17.6	1085.0	32.3	17.6
EX-7	8.06	B	3%	0.10	0.37	220	9.4%	12.8	1,035	4.9%	7.0	1.5	11.1	23.9	1255.0	33.7	23.9
EX-8	3.64	B	3%	0.10	0.37	150	6.2%	12.1	1,020	5.0%	7.0	1.6	10.9	23.0	1170.0	33.5	23.0
OS-1	2.44	B	12%	0.17	0.42	180	6.9%	11.8	0	0.0%	7.0	0.0	0.0	11.8	180.0	24.0	11.8

NOTES:

$$t_c = t_i + t_t$$

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

t_t = channelized 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-

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

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: Cathedral Pines
Location: El Paso County
Design Storm: 5-Year

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 9/8/23

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	EX-1	0.84	0.09	15.1	0.08	3.51	0.3															Sheet flows overland to DP1 Flows off-site onto Cathedral Pines Sub. Filing No. 1 Tract 1
	2	EX-2	3.16	0.09	22.0	0.28	2.94	0.8															Sheet flows overland to DP2 Flows off-site onto Cathedral Pines Sub. Filing No. 1 Lot 30
	3	EX-3	4.89	0.09	28.8	0.44	2.54	1.1															Sheet flows overland to existing swale to DP3 Flows off-site onto property at 13855 Highway 83
	4	EX-4	2.67	0.09	23.5	0.24	2.85	0.7															Sheet flows overland to DP4 Flows off-site onto property at 13580 Bridle Bit Road
	5	EX-5	8.29	0.10	23.8	0.81	2.83	2.3															Sheet flows overland to DP5 Flows off-site onto property at 13580 Bridle Bit Road
	6	EX-6	4.74	0.10	17.6	0.46	3.28	1.5															Sheet flows overland to DP6 Flows off-site onto property at 13580 Bridle Bit Road
	P1	-	15.50	-	-	1.31	-	3.7															Released flows from off-site pond via 18" RCP culvert Enters Basin EX-7 and combines at DP7.1
	7	EX-7	8.06	0.10	23.9	0.80	2.82	2.3															Sheet flows overland to existing swale to DP7 Combines in existing swale at DP7.1
	7.1								23.9	2.11	2.82	6.0											Combines flows of DPP1 and DP7 in existing swale Combines flows in existing swale at DP8.2
	O1	OS-1	2.44	0.17	11.8	0.43	3.87	1.7															Sheet flows overland to existing swale to DPO1 Combines in existing swale at DP8.1
	8	EX-8	3.64	0.10	23.0	0.37	2.88	1.1															Sheet flows overland to existing swale to DP8 Combines in existing swale at DP8.1
	8.1								23.0	0.80	2.88	2.3											Combines flows of DPO1 and DP8 in existing swale Combines flows in existing swale at DP8.2
	8.2								23.9	2.91	2.82	8.2											Combines flows of DP7.1 and DP8.1 in existing swale Flows off-site onto property at 13580 Bridle Bit Road

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
Values in blue indicate that they are from "Cathedral Pines Subdivision Filing No. 1 Drainage Report & Plan"

EXISTING STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Cathedral Pines
Location: El Paso County
Design Storm: 100-Year

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 9/8/23

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	EX-1	0.84	0.36	15.1	0.30	5.90	1.8															Sheet flows overland to DP1 Flows off-site onto Cathedral Pines Sub. Filing No. 1 Tract 1
	2	EX-2	3.16	0.36	22.0	1.14	4.94	5.6															Sheet flows overland to DP2 Flows off-site onto Cathedral Pines Sub. Filing No. 1 Lot 30
	3	EX-3	4.89	0.36	28.8	1.76	4.26	7.5															Sheet flows overland to existing swale to DP3 Flows off-site onto property at 13855 Highway 83
	4	EX-4	2.67	0.36	23.5	0.96	4.78	4.6															Sheet flows overland to DP4 Flows off-site onto property at 13580 Bridle Bit Road
	5	EX-5	8.29	0.37	23.8	3.03	4.74	14.4															Sheet flows overland to DP5 Flows off-site onto property at 13580 Bridle Bit Road
	6	EX-6	4.74	0.37	17.6	1.73	5.51	9.5															Sheet flows overland to DP6 Flows off-site onto property at 13580 Bridle Bit Road
	P1	-	15.50	-	-	2.30	-	10.9															Released flows from off-site pond via 18" RCP culvert Enters Basin EX-7 and combines at DP7.1
	7	EX-7	8.06	0.37	23.9	2.96	4.73	14.0															Sheet flows overland to existing swale to DP7 Combines in existing swale at DP7.1
	7.1								23.9	5.26	4.73	24.9											Combines flows of DPP1 and DP7 in existing swale Combines flows in existing swale at DP8.2
	O1	OS-1	2.44	0.42	11.8	1.03	6.51	6.7															Sheet flows overland to existing swale to DPO1 Combines in existing swale at DP8.1
	8	EX-8	3.64	0.37	23.0	1.34	4.83	6.5															Sheet flows overland to existing swale to DP8 Combines in existing swale at DP8.1
	8.1								23.0	2.37	4.83	11.5											Combines flows of DPO1 and DP8 in existing swale Combines flows in existing swale at DP8.2
	8.2								23.9	7.63	4.73	36.1											Combines flows of DP7.1 and DP8.1 in existing swale Flows off-site onto property at 13580 Bridle Bit Road

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
Values in blue indicate that they are from "Cathedral Pines Subdivision Filing No. 1 Drainage Report & Plan"

PROPOSED COMPOSITE % IMPERVIOUS/C VALUE CALCULATIONS

Subdivision: Cathedral Pines
Location: El Paso County

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

Basin ID	Total Area (ac)	Hardscape/Water (100% Impervious)				Gravel Hardscape (80% Impervious)				2.5 Acre Lots (10% Impervious)				Lawns/Open Space (2% 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}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	
A	0.84	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	0.84	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
B	2.36	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	2.36	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
C	2.06	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	2.06	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
D	4.49	0.90	0.96	0.46	10.2%	0.59	0.70	0.07	1.2%	0.16	0.41	2.32	5.2%	0.09	0.36	1.64	0.7%	0.22	0.45	17.4%
E	0.65	0.90	0.96	0.24	36.9%	0.59	0.70	0.03	3.7%	0.16	0.41	0.38	5.8%	0.09	0.36	0.00	0.0%	0.45	0.63	46.5%
F	0.31	0.90	0.96	0.02	6.5%	0.59	0.70	0.04	10.3%	0.16	0.41	0.25	8.1%	0.09	0.36	0.00	0.0%	0.26	0.48	24.8%
G	2.08	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	2.08	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
H	1.94	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	1.94	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
I	5.01	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	5.01	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
J	0.82	0.90	0.96	0.04	4.9%	0.59	0.70	0.00	0.0%	0.16	0.41	0.00	0.0%	0.09	0.36	0.78	1.9%	0.13	0.39	6.8%
K	3.48	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	3.48	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
L	2.58	0.90	0.96	0.44	17.1%	0.59	0.70	0.04	1.2%	0.16	0.41	2.10	8.1%	0.09	0.36	0.00	0.0%	0.29	0.51	26.4%
M	0.45	0.90	0.96	0.19	42.2%	0.59	0.70	0.03	5.3%	0.16	0.41	0.23	5.1%	0.09	0.36	0.00	0.0%	0.50	0.66	52.7%
N	0.75	0.90	0.96	0.01	1.3%	0.59	0.70	0.07	7.5%	0.16	0.41	0.23	3.1%	0.09	0.36	0.44	1.2%	0.17	0.42	13.0%
O	4.83	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	4.83	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
P	3.51	0.90	0.96	0.00	0.0%	0.59	0.70	0.00	0.0%	0.16	0.41	3.51	10.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
OS-1	0.13	0.90	0.96	0.05	37.6%	0.59	0.70	0.00	0.0%	0.16	0.41	0.00	0.0%	0.09	0.36	0.08	1.2%	0.39	0.59	38.9%
OS-2	2.44	0.90	0.96	0.05	2.0%	0.59	0.70	0.00	0.0%	0.16	0.41	2.39	9.8%	0.09	0.36	0.00	0.0%	0.17	0.42	11.8%
TOTAL N. POND	5.45																			21.3%
TOTAL S. POND	3.78																			26.9%

PROPOSED STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Cathedral Pines
Location: El Paso County

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

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	0.84	B	10%	0.16	0.41	300	5.0%	17.3	80	5.0%	7.0	1.6	0.9	18.1	380.0	24.9	18.1
B	2.36	B	10%	0.16	0.41	300	5.5%	16.7	500	5.5%	7.0	1.6	5.1	21.8	800.0	27.7	21.8
C	2.06	B	10%	0.16	0.41	200	5.7%	13.5	680	4.2%	7.0	1.4	7.9	21.4	880.0	29.6	21.4
D	4.49	B	17%	0.22	0.45	190	4.5%	13.4	590	3.5%	7.0	1.3	7.5	20.9	780.0	27.6	20.9
E	0.65	B	46%	0.45	0.63	26	2.0%	4.7	605	3.8%	7.0	1.4	7.4	12.1	631.0	21.4	12.1
F	0.31	B	25%	0.26	0.48	50	15.0%	4.4	70	0.5%	7.0	0.5	2.4	6.7	120.0	23.1	6.7
G	2.08	B	10%	0.16	0.41	300	4.7%	17.7	395	4.3%	7.0	1.5	4.5	22.2	695.0	27.4	22.2
H	1.94	B	10%	0.16	0.41	300	4.3%	18.2	370	4.9%	7.0	1.5	4.0	22.1	670.0	27.0	22.1
I	5.01	B	10%	0.16	0.41	155	6.5%	11.4	565	6.9%	7.0	1.8	5.1	16.6	720.0	27.8	16.6
J	0.82	B	7%	0.13	0.39	100	8.4%	8.7	180	6.0%	7.0	1.7	1.7	10.4	280.0	26.1	10.4
K	3.48	B	10%	0.16	0.41	145	12.0%	9.0	700	5.0%	7.0	1.6	7.5	16.5	845.0	29.3	16.5
L	2.58	B	26%	0.29	0.51	26	2.0%	5.9	800	3.8%	7.0	1.4	9.8	15.7	826.0	26.9	15.7
M	0.45	B	53%	0.50	0.66	26	2.0%	4.4	470	3.8%	7.0	1.4	5.7	10.1	496.0	19.5	10.1
N	0.75	B	13%	0.17	0.42	55	27.0%	4.2	90	0.8%	7.0	0.6	2.5	6.7	145.0	25.4	6.7
O	4.83	B	10%	0.16	0.41	235	11.9%	11.5	645	4.8%	7.0	1.5	7.0	18.5	880.0	29.0	18.5
P	3.51	B	10%	0.16	0.41	150	6.0%	11.5	1180	5.0%	7.0	1.6	12.6	24.1	1330.0	32.8	24.1
OS-1	0.13	B	39%	0.39	0.59	12	2.0%	3.5	20	14.0%	7.0	2.6	0.1	3.6	32.0	19.5	5.0
OS-2	2.44	B	12%	0.17	0.42	185	6.9%	12.0	0	0.0%	7.0	0.0	0.0	12.0	185.0	24.0	12.0

PROPOSED STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Cathedral Pines
Location: El Paso County

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

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)

$$t_c = t_i + t_t$$ Equation 6-2

Where:

t_c = computed time of concentration (minutes)
t_i = overland (initial) flow time (minutes)
t_t = channelized flow time (minutes).

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$ Equation 6-4

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).

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$ Equation 6-3

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).

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$ Equation 6-5

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).

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: Cathedral Pines
Location: El Paso County
Design Storm: 5-Year

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

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	0.84	0.16	18.1	0.13	3.24	0.4															Sheet flows overland to DP1 Flows off-site onto Cathedral Pines Sub. Filing No. 1 Tract 1
	2	B	2.36	0.16	21.8	0.38	2.96	1.1															Sheet flows overland to DP2 Flows off-site onto Cathedral Pines Sub. Filing No. 1 Lot 30
	3	C	2.06	0.16	21.4	0.33	2.99	1.0															Sheet flows overland to existing swale to DP3 Flows off-site onto property at 13855 Highway 83
	4	D	4.49	0.22	20.9	0.97	3.02	2.9															Sheet flows overland to proposed swale to DP4 Combines with DP5 at DP5.1
	5	E	0.65	0.45	12.1	0.29	3.84	1.1															Flows to proposed swale to DP5 Combines with DP4 at DP5.1
	5.1								20.9	1.26	3.02	3.8											Combines flows of DP4 and DP5 Piped to North Pond forebay and combines at DP6.1
	6	F	0.31	0.26	6.7	0.08	4.72	0.4															Sheet flows overland to DP6 Combines with DP5.1 at DP6.1
	6.1								20.9	1.34	3.02	4.1											Combines flows of DP5.1 and DP6 North Pond flows, released through outlet at DP6.2
	6.2								-	0.41	-	1.2											North Pond outlet structure controlled release Combines with DP7 at DP7.1
	7	G	2.08	0.16	22.2	0.33	2.93	1.0															Sheet flows overland to proposed swale to DP7 Combines flow at DP7.1
	7.1								22.2	0.74	2.93	2.2											Combines flow of DP6.2 and DP7 Flows off-site onto property at 13580 Bridle Bit Road
	8	H	1.94	0.16	22.1	0.31	2.94	0.9															Sheet flows overland to existing swale at DP8 Flows off-site onto property at 13580 Bridle Bit Road

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Cathedral Pines
Location: El Paso County
Design Storm: 5-Year

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

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)	
	9	I	5.01	0.16	16.6	0.80	3.37	2.7															Sheet flows overland to ex. natural channel at DP9 Flows off-site onto property at 13580 Bridle Bit Road
	10	J	0.82	0.13	10.4	0.11	4.07	0.4															Flows in existing swale to proposed culvert at DP10 Flows onto Basin K and combines at DP11.1
	11	K	3.48	0.16	16.5	0.56	3.38	1.9															Flows in existing swale to DP11 Combines flow at DP11.1
	11.1								16.5	0.67	3.38	2.3											Combines flows of DP10 and DP11 Flows off-site onto property at 13580 Bridle Bit Road
	P1	-	15.50	-	-	1.07	-	3.7															Released flows from off-site pond via 18" RCP culvert Enters Basin L and combines at DP13.1
	12	L	2.58	0.29	15.7	0.76	3.45	2.6															Sheet flows overland to proposed swale to DP12 Combines with DPP1 at DP12.1
	12.1								15.7	1.83	3.45	6.3											Combines flows of DPP1 and DP12 Continues in proposed swale to DP13.1
	13	M	0.45	0.50	10.1	0.23	4.11	0.9															Flows to proposed swale to DP13 Combines with DP12.1 at DP13.1
	13.1								15.7	2.06	3.45	7.1											Combines flows of DP12.1 and DP13 Piped to South Pond forebay and combines at DP14.1
	14	N	0.75	0.17	6.7	0.13	4.74	0.6															Sheet flows overland to DP14 Combines with DP13.1 at DP14.1
	14.1								15.7	2.19	3.45	7.6											Combines flows of DP13.1 and DP14 South Pond flows, released through outlet at DP14.2
	14.2								-	0.19	-	0.6											South Pond outlet structure controlled release Combines with DP15 at DP15.1
	15	O	4.83	0.16	18.5	0.77	3.21	2.5															Sheet flows overland to existing swale to DP15 Combines flow at DP15.1
	15.1								18.5	0.96	3.21	3.1											Combines flow of DP14.2 and DP15 Combines flow in existing swale at DP16.2

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Cathedral Pines
Location: El Paso County
Design Storm: 5-Year

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

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)	
	O1	OS-1	0.13	0.39	5.0	0.05	5.17	0.3															Sheet flows overland to DPO1 Enters Basin P and combines at DP16.1
	O2	OS-2	2.44	0.17	12.0	0.43	3.85	1.7															Sheet flows overland to DPO2 Enters Basin P and combines at DP16.1
	16	P	3.51	0.16	24.1	0.56	2.81	1.6															Sheet flows overland to existing swale to DP16 Combines flow at DP16.1
	16.1								24.1	1.04	2.81	2.9											Combines flow of DPO1, DP02, and DP16 Combines flow in existing swale at DP16.2
	16.2								24.1	2.00	2.81	5.6											Combines flow of DP15.1 and DP16.1 Flows off-site onto property at 13580 Bridle Bit Road

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
Values in blue indicate that they are from "Cathedral Pines Subdivision Filing No. 1 Drainage Report & Plan"

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Cathedral Pines
Location: El Paso County
Design Storm: 100-Year

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

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	0.84	0.41	18.1	0.34	5.43	1.8															Sheet flows overland to DP1 Flows off-site onto Cathedral Pines Sub. Filing No. 1 Tract 1
	2	B	2.36	0.41	21.8	0.97	4.97	4.8															Sheet flows overland to DP2 Flows off-site onto Cathedral Pines Sub. Filing No. 1 Lot 30
	3	C	2.06	0.41	21.4	0.84	5.01	4.2															Sheet flows overland to existing swale to DP3 Flows off-site onto property at 13855 Highway 83
	4	D	4.49	0.45	20.9	2.03	5.08	10.3															Sheet flows overland to proposed swale to DP4 Combines with DP5 at DP5.1
	5	E	0.65	0.63	12.1	0.41	6.45	2.6															Flows to proposed swale to DP5 Combines with DP4 at DP5.1
	5.1								20.9	2.44	5.08	12.4											Combines flows of DP4 and DP5 Piped to North Pond forebay and combines at DP6.1
	6	F	0.31	0.48	6.7	0.15	7.93	1.2															Sheet flows overland to DP6 Combines with DP5.1 at DP6.1
	6.1								20.9	2.59	5.08	13.1											Combines flows of DP5.1 and DP6 North Pond flows, released through outlet at DP6.2
	6.2								-	1.61	-	7.9											North Pond outlet structure controlled release Combines with DP7 at DP7.1
	7	G	2.08	0.41	22.2	0.85	4.92	4.2															Sheet flows overland to proposed swale to DP7 Combines flow at DP7.1
	7.1								22.2	2.46	4.92	12.1											Combines flow of DP6.2 and DP7 Flows off-site onto property at 13580 Bridle Bit Road
	8	H	1.94	0.41	22.1	0.80	4.93	3.9															Sheet flows overland to existing swale at DP8 Flows off-site onto property at 13580 Bridle Bit Road

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Cathedral Pines
Location: El Paso County
Design Storm: 100-Year

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

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)	
	9	I	5.01	0.41	16.6	2.05	5.66	11.6															Sheet flows overland to ex. natural channel at DP9 Flows off-site onto property at 13580 Bridle Bit Road
	10	J	0.82	0.39	10.4	0.32	6.83	2.2															Flows in existing swale to proposed culvert at DP10 Flows onto Basin K and combines at DP11.1
	11	K	3.48	0.41	16.5	1.43	5.68	8.1															Flows in existing swale to DP11 Combines flow at DP11.1
	11.1								16.5	1.75	5.68	9.9											Combines flows of DP10 and DP11 Flows off-site onto property at 13580 Bridle Bit Road
	P1	-	15.50	-	-	1.88	-	10.9															Released flows from off-site pond via 18" RCP culvert Enters Basin L and combines at DP13.1
	12	L	2.58	0.51	15.7	1.31	5.80	7.6															Sheet flows overland to proposed swale to DP12 Combines with DPP1 at DP12.1
	12.1								15.7	3.19	5.80	18.5											Combines flows of DPP1 and DP12 Continues in proposed swale to DP13.1
	13	M	0.45	0.66	10.1	0.30	6.90	2.1															Flows to proposed swale to DP13 Combines with DP12.1 at DP13.1
	13.1								15.7	3.49	5.80	20.2											Combines flows of DP12.1 and DP13 Piped to South Pond forebay and combines at DP14.1
	14	N	0.75	0.42	6.7	0.31	7.95	2.5															Sheet flows overland to DP14 Combines with DP13.1 at DP14.1
	14.1								15.7	3.80	5.80	22.0											Combines flows of DP13.1 and DP14 South Pond flows, released through outlet at DP14.2
	14.2								-	0.80	-	4.3											South Pond outlet structure controlled release Combines with DP15 at DP15.1
	15	O	4.83	0.41	18.5	1.98	5.38	10.7															Sheet flows overland to existing swale to DP15 Combines flow at DP15.1
	15.1								18.5	2.78	5.38	15.0											Combines flow of DP14.2 and DP15 Combines flow in existing swale at DP16.2

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Cathedral Pines
Location: El Paso County
Design Storm: 100-Year

Project Name: Estates at Cathedral Pines
Project No.: 25260.00
Calculated By: GAG
Checked By:
Date: 10/24/23

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)	
	O1	OS-1	0.13	0.59	5.0	0.08	8.68	0.7															Sheet flows overland to DPO1 Enters Basin P and combines at DP16.1
	O2	OS-2	2.44	0.42	12.0	1.03	6.47	6.7															Sheet flows overland to DPO2 Enters Basin P and combines at DP16.1
	16	P	3.51	0.41	24.1	1.44	4.72	6.8															Sheet flows overland to existing swale to DP16 Combines flow at DP16.1
	16.1								24.1	2.55	4.72	12.0											Combines flow of DPO1, DP02, and DP16 Combines flow in existing swale at DP16.2
	16.2								24.1	5.33	4.72	25.1											Combines flow of DP15.1 and DP16.1 Flows off-site onto property at 13580 Bridle Bit Road

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
Values in blue indicate that they are from "Cathedral Pines Subdivision Filing No. 1 Drainage Report & Plan"

APPENDIX C

HYDRAULIC CALCULATIONS

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 24 2023

Basin C Existing Swale

User-defined

Invert Elev (ft)	= 7311.50
Slope (%)	= 6.00
N-Value	= 0.030

Calculations

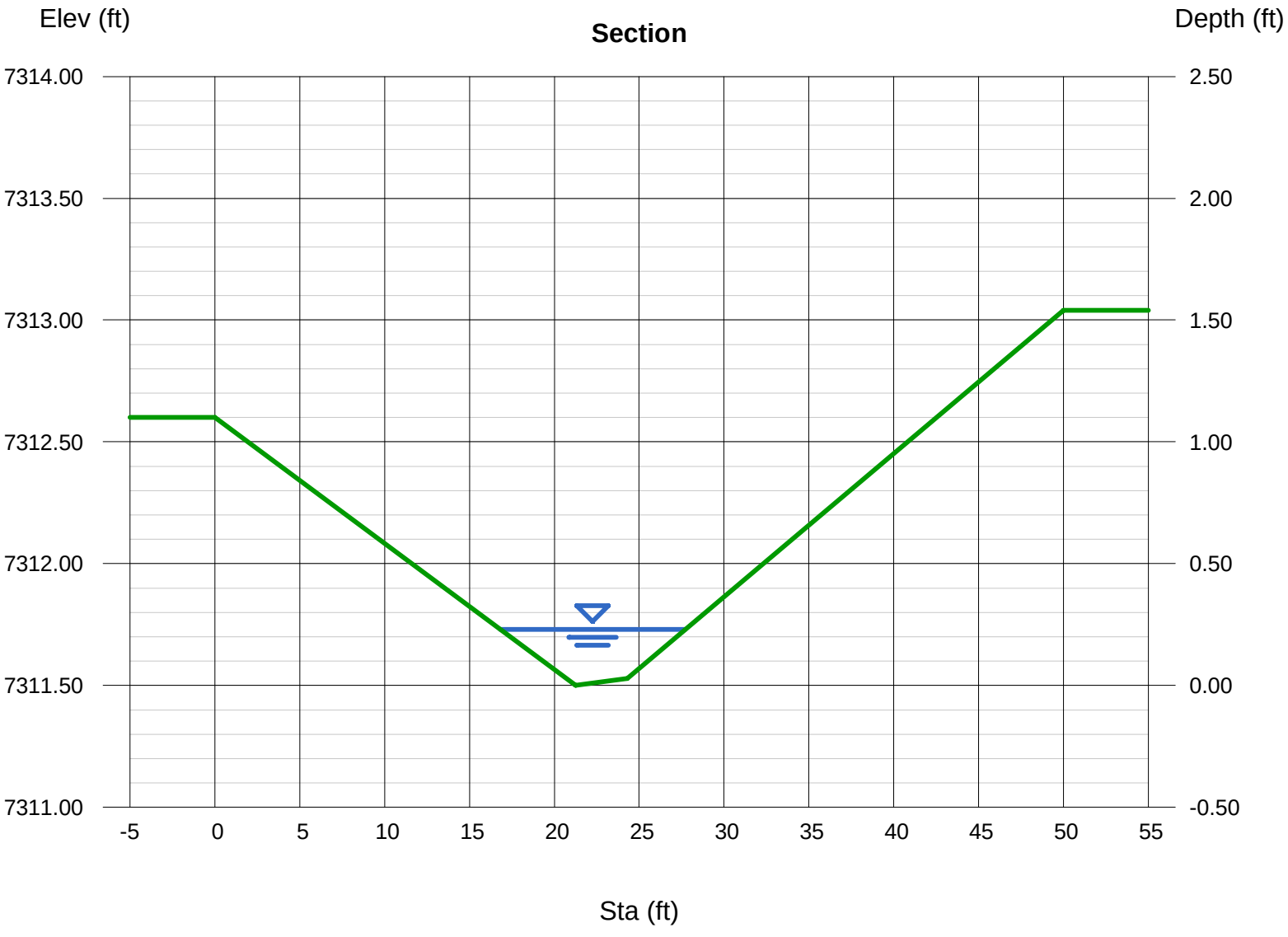
Compute by:	Known Q
Known Q (cfs)	= 4.50

Highlighted

Depth (ft)	= 0.23
Q (cfs)	= 4.500
Area (sqft)	= 1.51
Velocity (ft/s)	= 2.98
Wetted Perim (ft)	= 10.92
Crit Depth, Yc (ft)	= 0.28
Top Width (ft)	= 10.91
EGL (ft)	= 0.37

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

(0.00, 7312.60) -(21.25, 7311.50, 0.030) -(24.31, 7311.53, 0.030) -(50.00, 7313.04, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Oct 18 2023

Basin D Roadside Swale-Capacity

Triangular

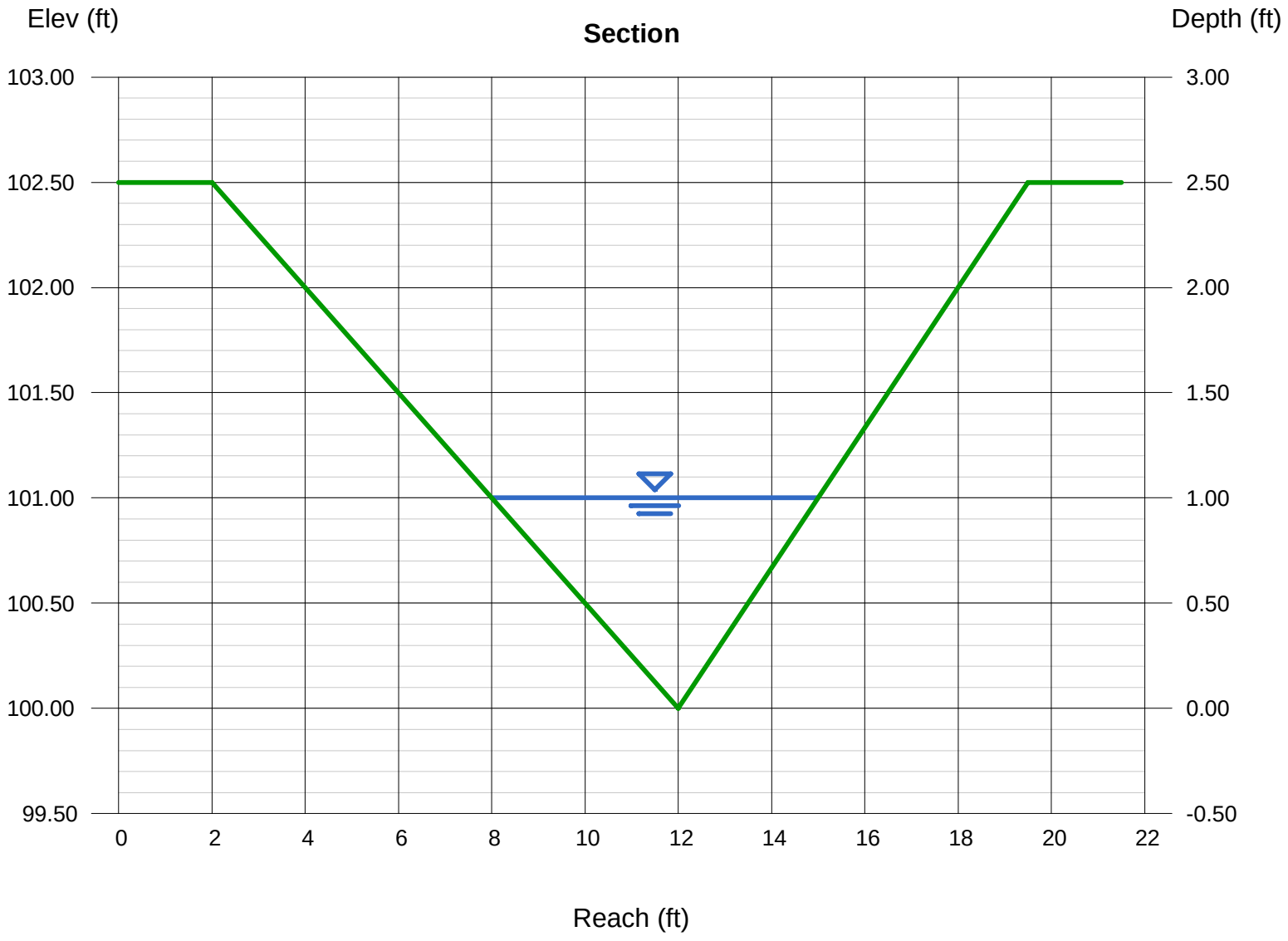
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 10.50

Highlighted

Depth (ft)	= 1.00
Q (cfs)	= 10.50
Area (sqft)	= 3.50
Velocity (ft/s)	= 3.00
Wetted Perim (ft)	= 7.29
Crit Depth, Yc (ft)	= 0.90
Top Width (ft)	= 7.00
EGL (ft)	= 1.14



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Oct 18 2023

Basin D Roadside Swale-Velocity

Triangular

Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 8.00
N-Value	= 0.030

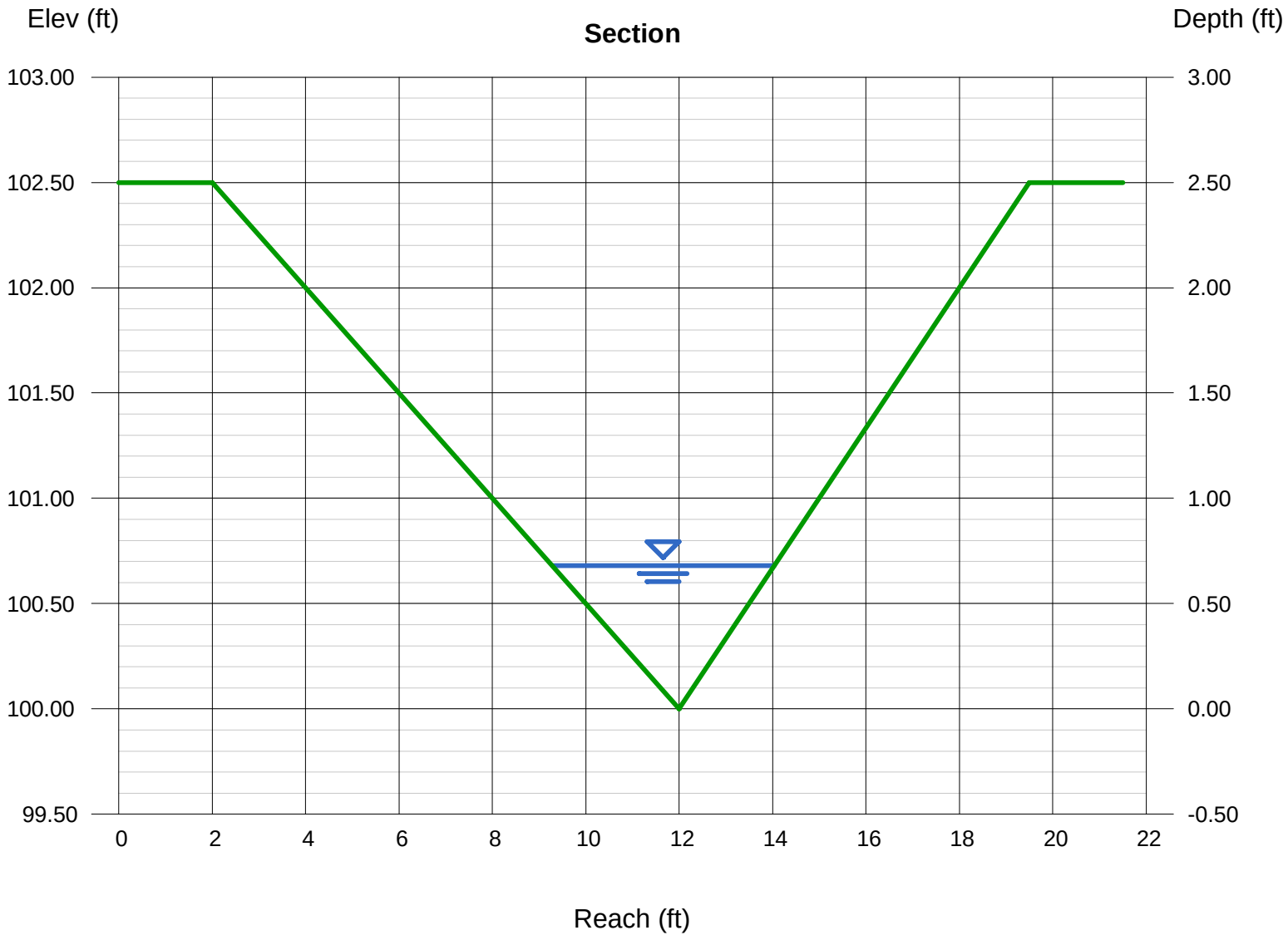
Calculations

Compute by:	Known Q
Known Q (cfs)	= 10.50

Highlighted

Depth (ft)	= 0.68
Q (cfs)	= 10.50
Area (sqft)	= 1.62
Velocity (ft/s)	= 6.49
Wetted Perim (ft)	= 4.95
Crit Depth, Yc (ft)	= 0.90
Top Width (ft)	= 4.76
EGL (ft)	= 1.33

Slopes over 3.9% for this section will require TRM as the velocity > 5 ft/s



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Oct 18 2023

Basin E Roadside Swale-Capacity

Triangular

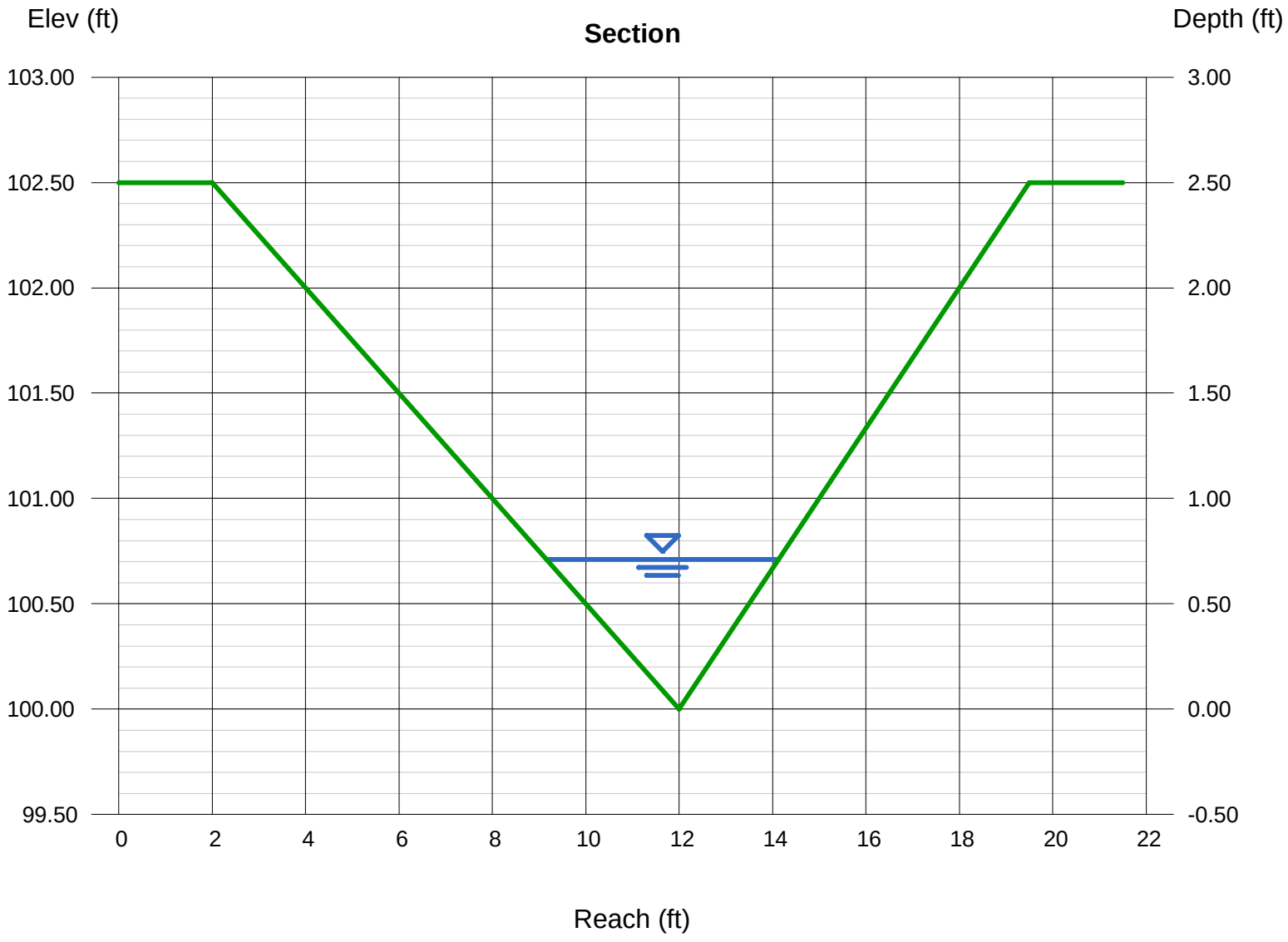
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.50
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3.00

Highlighted

Depth (ft)	= 0.71
Q (cfs)	= 3.000
Area (sqft)	= 1.76
Velocity (ft/s)	= 1.70
Wetted Perim (ft)	= 5.17
Crit Depth, Yc (ft)	= 0.54
Top Width (ft)	= 4.97
EGL (ft)	= 0.75



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Oct 18 2023

Basin E Roadside Swale-Velocity

Triangular

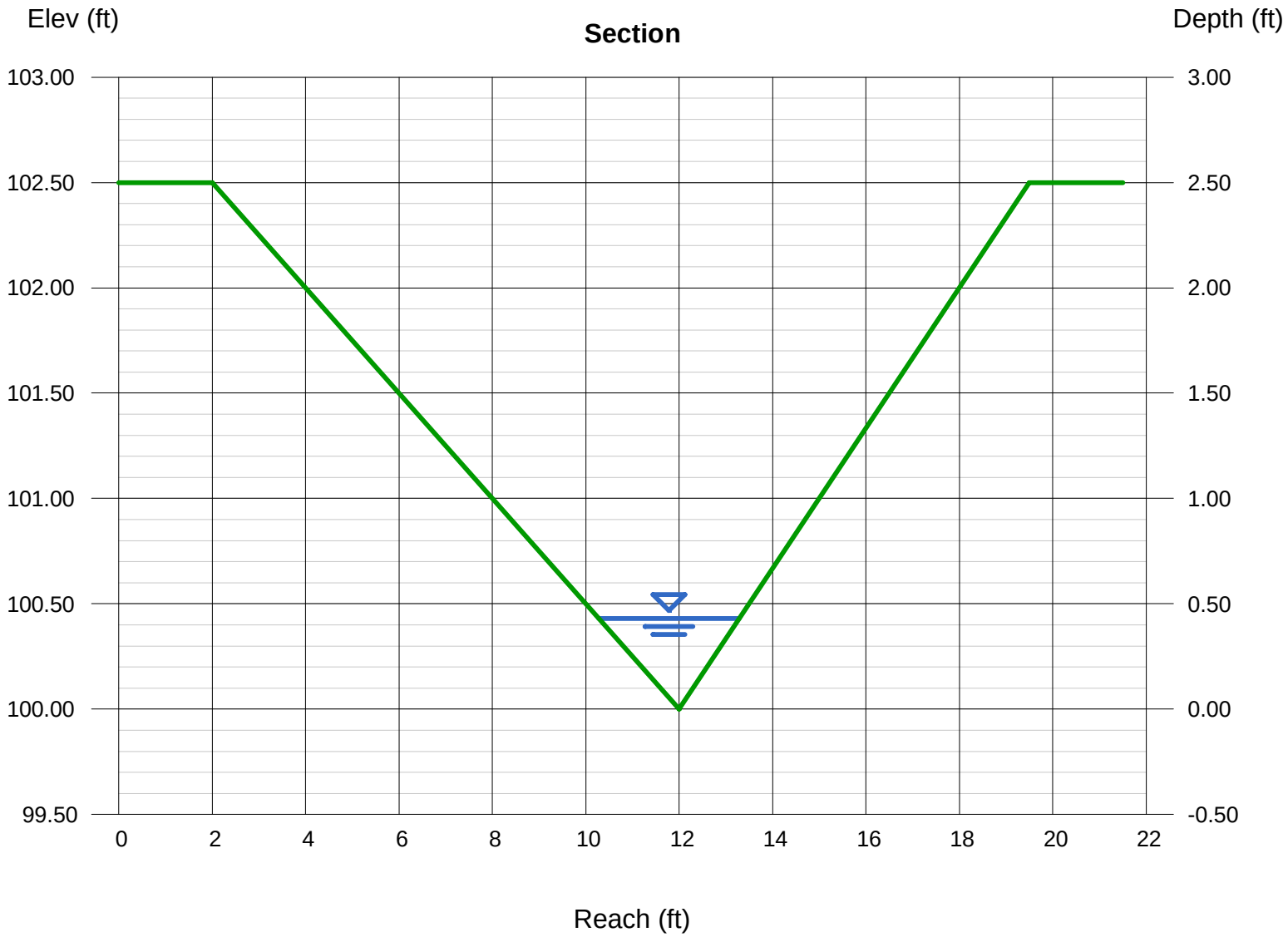
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 8.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3.00

Highlighted

Depth (ft)	= 0.43
Q (cfs)	= 3.000
Area (sqft)	= 0.65
Velocity (ft/s)	= 4.64
Wetted Perim (ft)	= 3.13
Crit Depth, Yc (ft)	= 0.54
Top Width (ft)	= 3.01
EGL (ft)	= 0.76



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 24 2023

Basin G-Proposed Swale (Flatter)

Trapezoidal

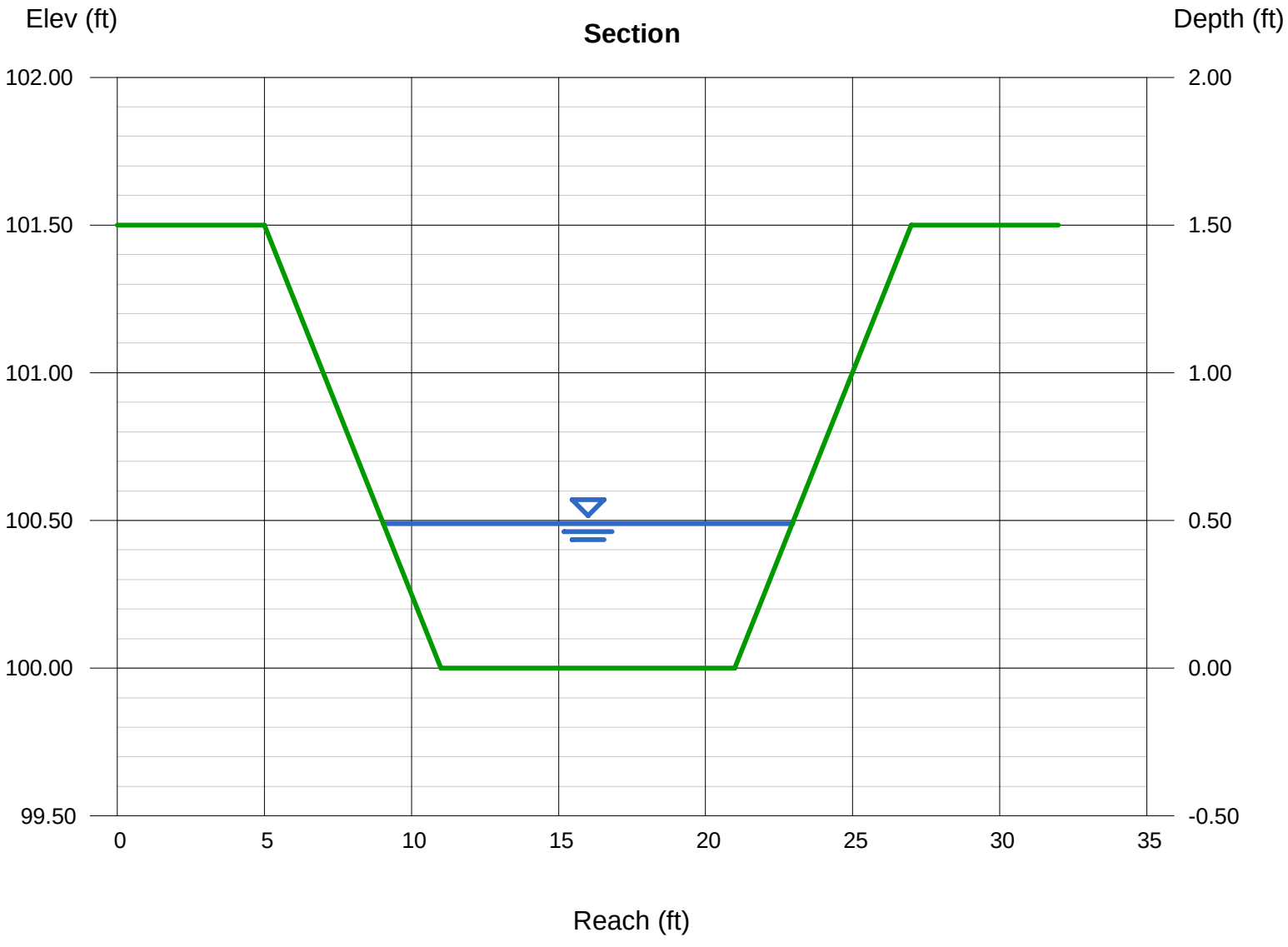
Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.60
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 12.50

Highlighted

Depth (ft)	= 0.49
Q (cfs)	= 12.50
Area (sqft)	= 5.86
Velocity (ft/s)	= 2.13
Wetted Perim (ft)	= 14.04
Crit Depth, Yc (ft)	= 0.35
Top Width (ft)	= 13.92
EGL (ft)	= 0.56



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 24 2023

Basin G-Proposed Swale (Steeper)

Trapezoidal

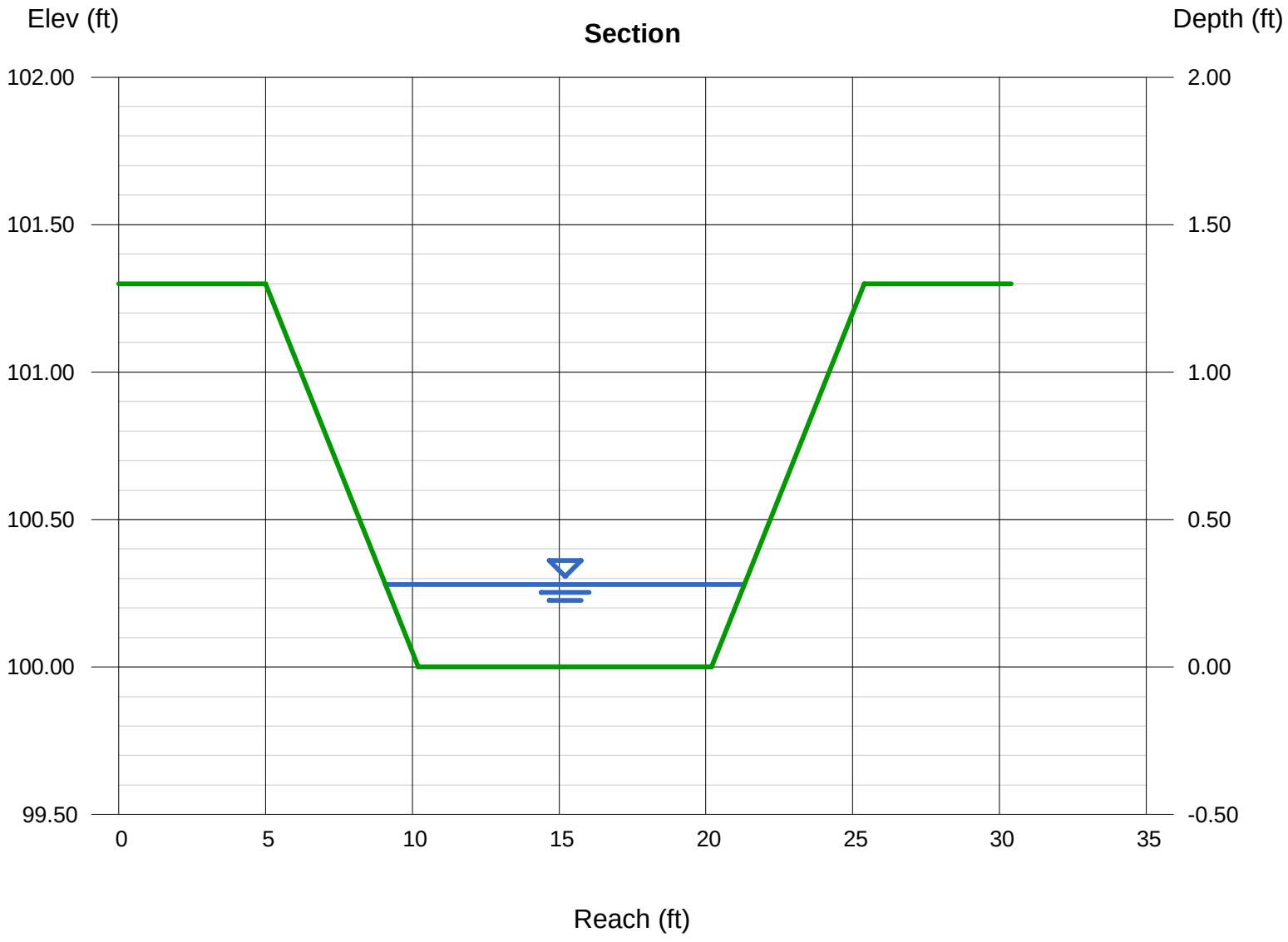
Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 1.30
Invert Elev (ft)	= 100.00
Slope (%)	= 4.20
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 12.50

Highlighted

Depth (ft)	= 0.28
Q (cfs)	= 12.50
Area (sqft)	= 3.11
Velocity (ft/s)	= 4.01
Wetted Perim (ft)	= 12.31
Crit Depth, Yc (ft)	= 0.35
Top Width (ft)	= 12.24
EGL (ft)	= 0.53



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 24 2023

Basin I Existing Swale

User-defined

Invert Elev (ft)	= 7306.04
Slope (%)	= 8.00
N-Value	= 0.030

Calculations

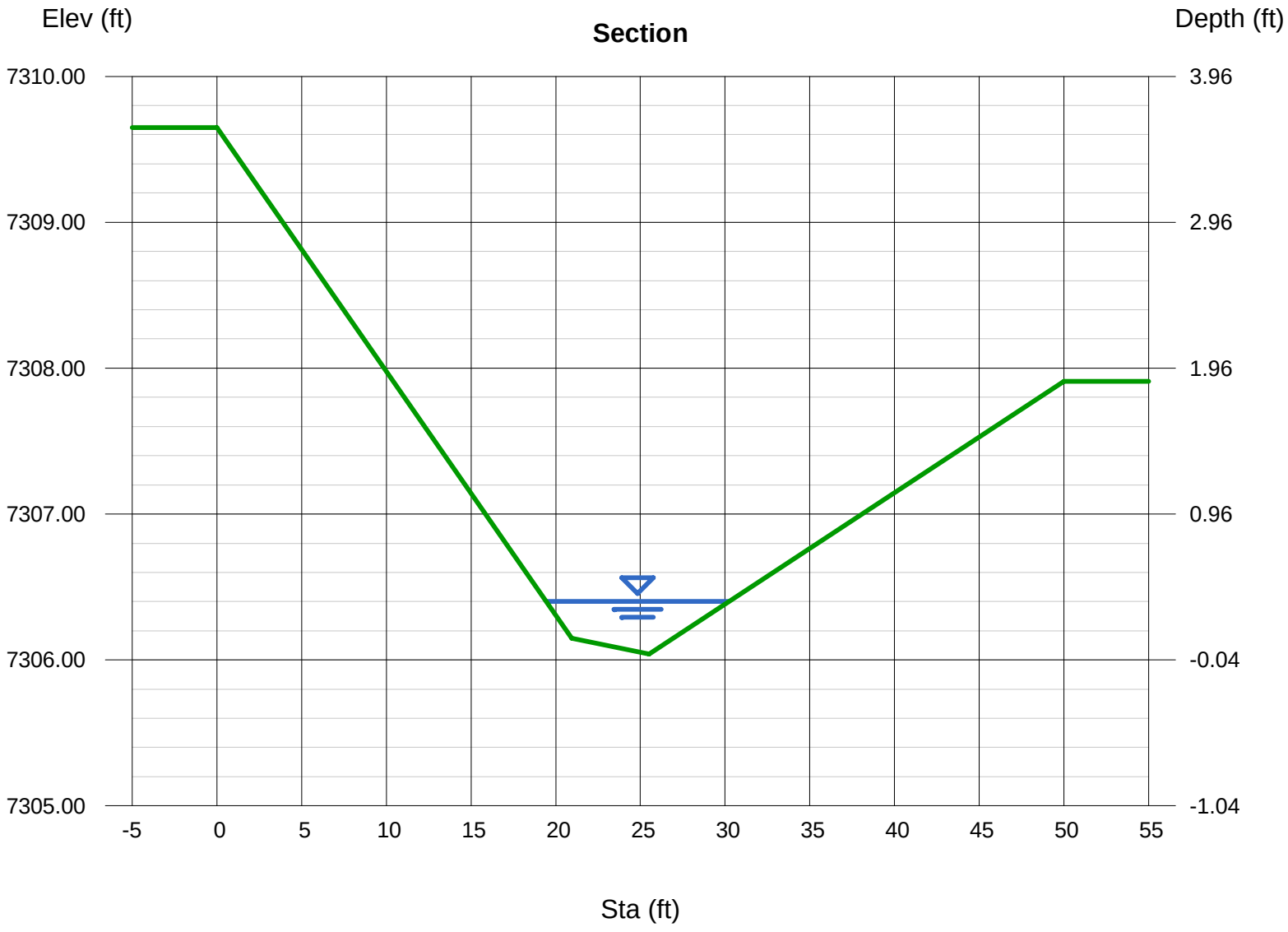
Compute by:	Known Q
Known Q (cfs)	= 12.00

Highlighted

Depth (ft)	= 0.36
Q (cfs)	= 12.00
Area (sqft)	= 2.42
Velocity (ft/s)	= 4.95
Wetted Perim (ft)	= 10.80
Crit Depth, Yc (ft)	= 0.49
Top Width (ft)	= 10.76
EGL (ft)	= 0.74

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

(0.00, 7309.65) -(20.95, 7306.15, 0.030) -(25.50, 7306.04, 0.030) -(50.00, 7307.91, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 24 2023

Basin J Existing Swale

User-defined

Invert Elev (ft)	= 7350.36
Slope (%)	= 7.50
N-Value	= 0.030

Calculations

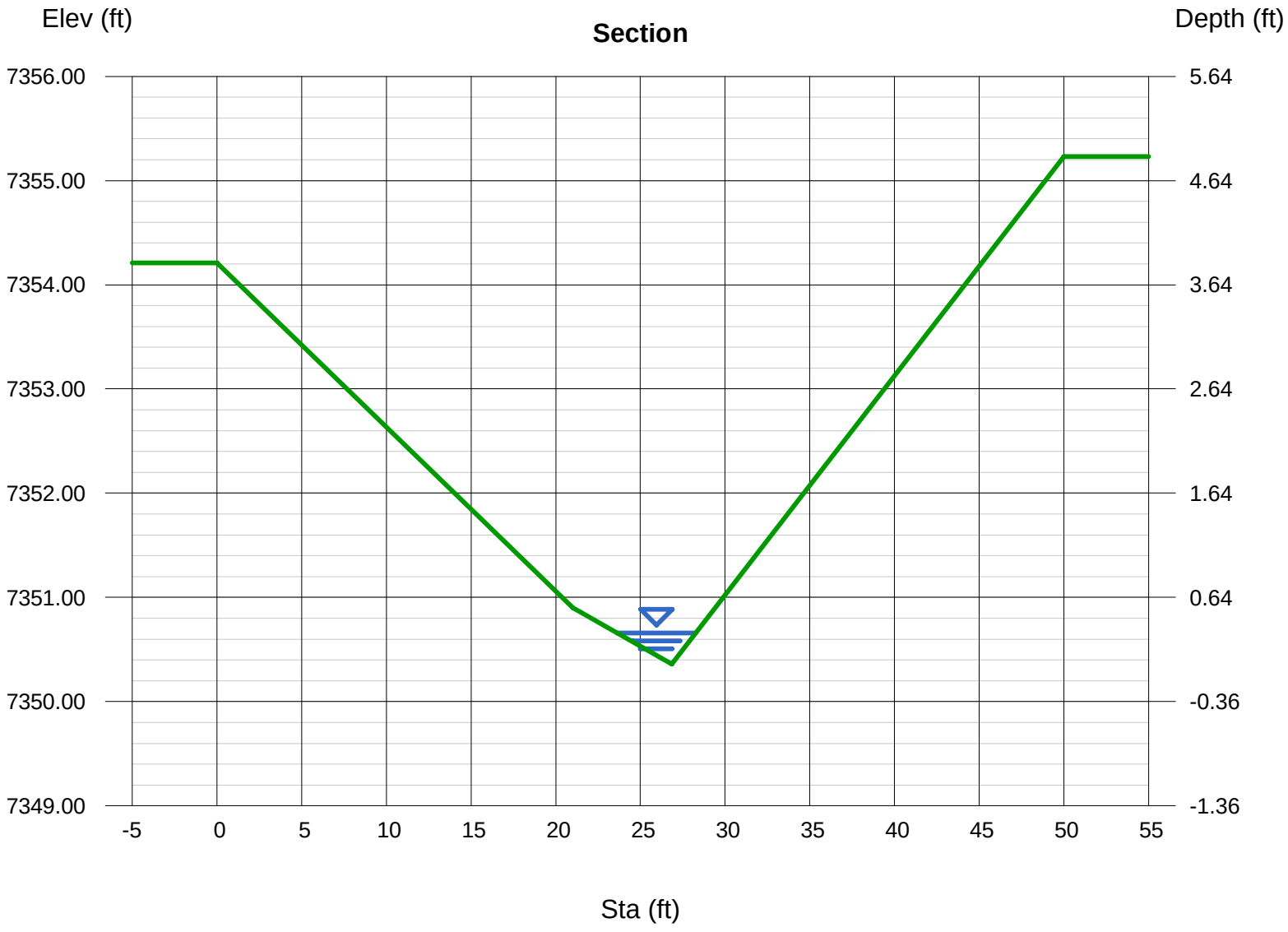
Compute by:	Known Q
Known Q (cfs)	= 2.50

Highlighted

Depth (ft)	= 0.30
Q (cfs)	= 2.500
Area (sqft)	= 0.70
Velocity (ft/s)	= 3.58
Wetted Perim (ft)	= 4.71
Crit Depth, Yc (ft)	= 0.37
Top Width (ft)	= 4.66
EGL (ft)	= 0.50

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

(0.00, 7354.21) -(21.02, 7350.90, 0.030) -(26.85, 7350.36, 0.030) -(50.00, 7355.23, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 24 2023

Basin K Existing Swale

User-defined

Invert Elev (ft)	= 7305.29
Slope (%)	= 6.50
N-Value	= 0.030

Calculations

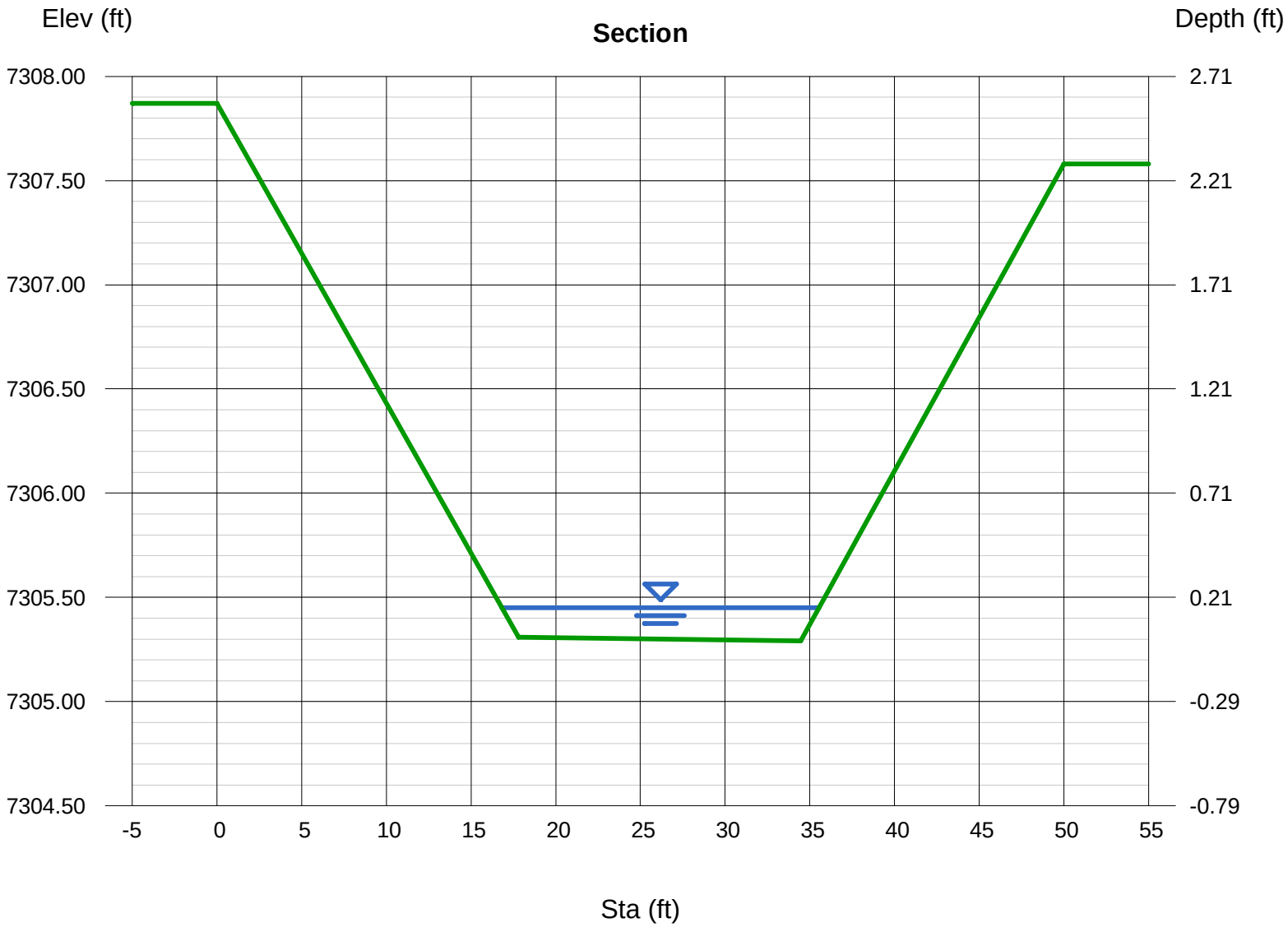
Compute by:	Known Q
Known Q (cfs)	= 8.50

Highlighted

Depth (ft)	= 0.16
Q (cfs)	= 8.500
Area (sqft)	= 2.66
Velocity (ft/s)	= 3.20
Wetted Perim (ft)	= 18.76
Crit Depth, Yc (ft)	= 0.21
Top Width (ft)	= 18.74
EGL (ft)	= 0.32

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

(0.00, 7307.87) -(17.79, 7305.31, 0.030) -(34.47, 7305.29, 0.030) -(50.00, 7307.58, 0.030)



Channel Report

P1 Swale to Combination

Triangular

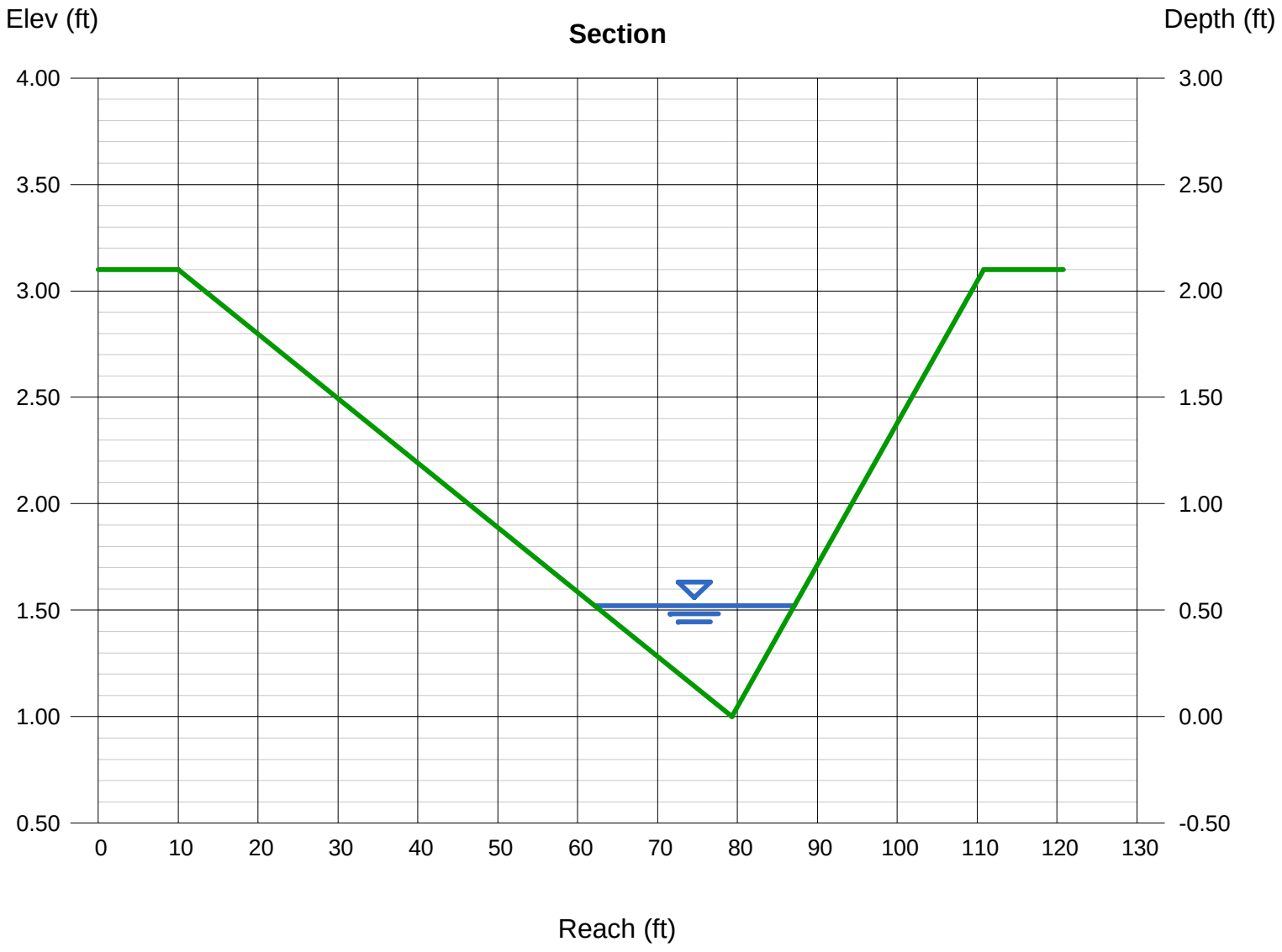
Side Slopes (z:1)	= 33.00, 15.00
Total Depth (ft)	= 2.10
Invert Elev (ft)	= 1.00
Slope (%)	= 1.00
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 11.00

Highlighted

Depth (ft)	= 0.52
Q (cfs)	= 11.00
Area (sqft)	= 6.49
Velocity (ft/s)	= 1.70
Wetted Perim (ft)	= 24.99
Crit Depth, Yc (ft)	= 0.42
Top Width (ft)	= 24.96
EGL (ft)	= 0.56



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Oct 23 2023

Basin L Roadside Swale-Capacity

Triangular

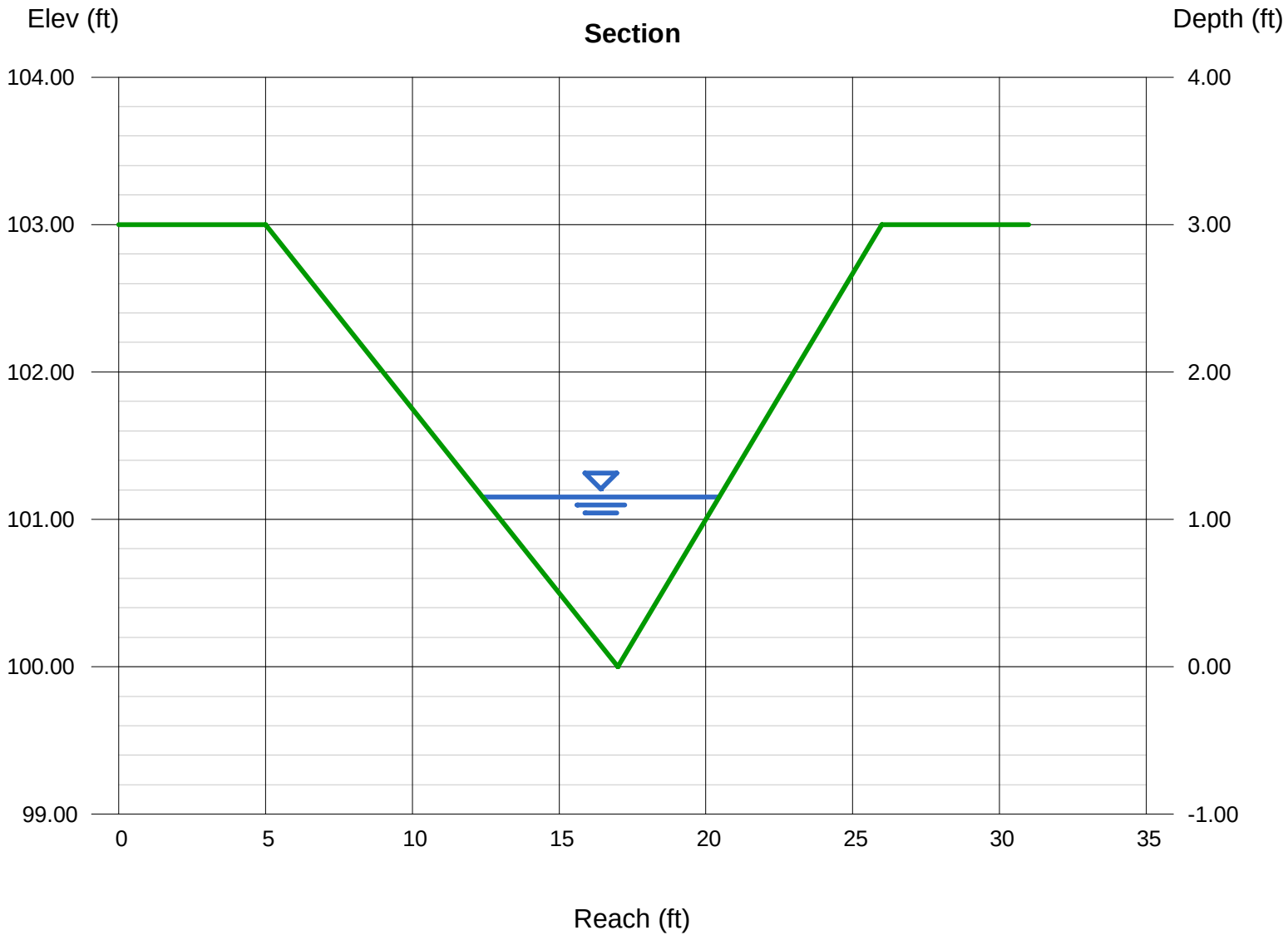
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.50
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 18.50

Highlighted

Depth (ft)	= 1.15
Q (cfs)	= 18.50
Area (sqft)	= 4.63
Velocity (ft/s)	= 4.00
Wetted Perim (ft)	= 8.38
Crit Depth, Yc (ft)	= 1.12
Top Width (ft)	= 8.05
EGL (ft)	= 1.40



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Oct 23 2023

Basin L Roadside Swale-Velocity

Triangular

Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 8.00
N-Value	= 0.030

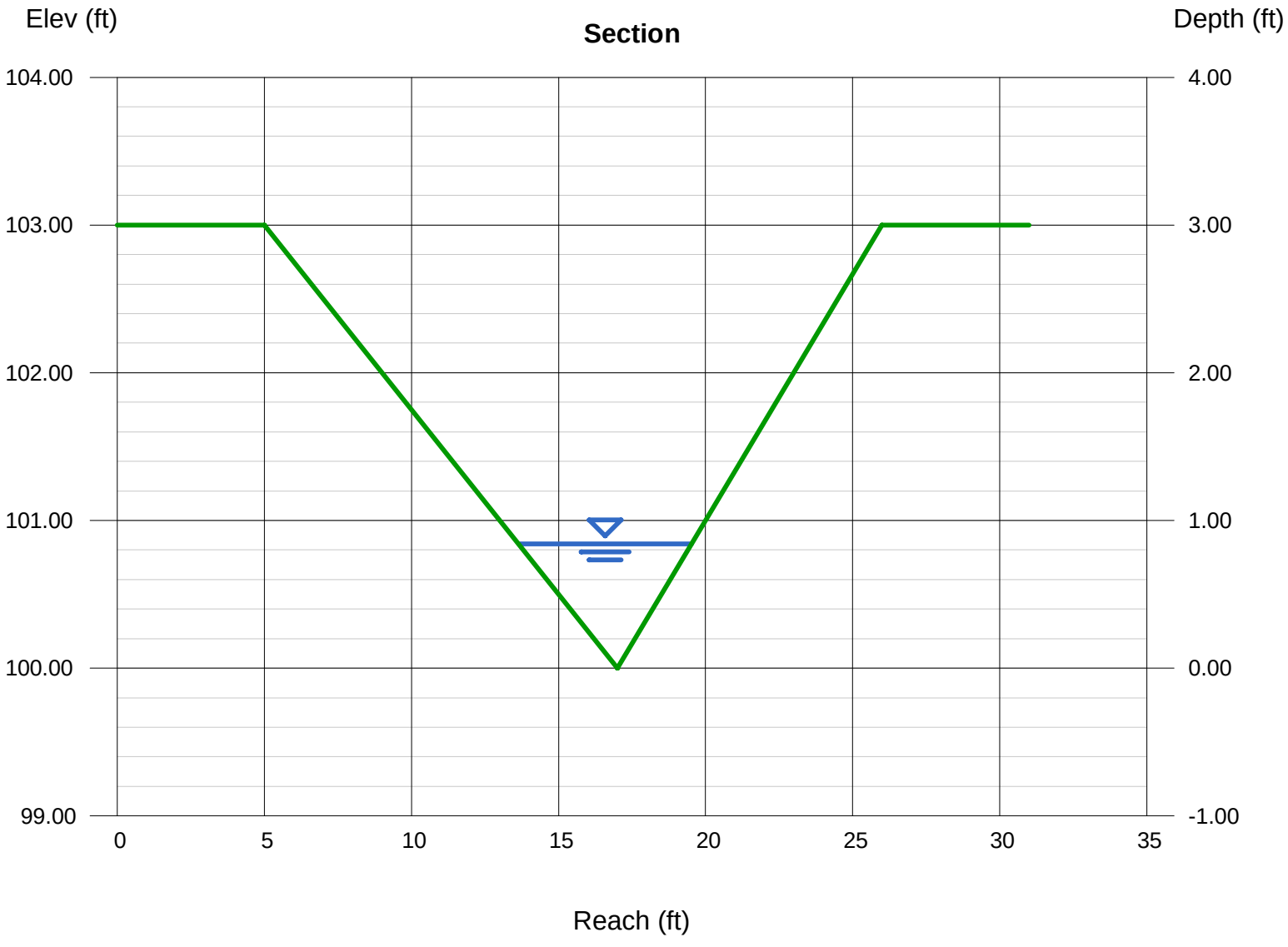
Calculations

Compute by:	Known Q
Known Q (cfs)	= 18.50

Highlighted

Depth (ft)	= 0.84
Q (cfs)	= 18.50
Area (sqft)	= 2.47
Velocity (ft/s)	= 7.49
Wetted Perim (ft)	= 6.12
Crit Depth, Yc (ft)	= 1.12
Top Width (ft)	= 5.88
EGL (ft)	= 1.71

Slopes over 2.7% for this section will require TRM as the velocity > 5 ft/s



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Oct 23 2023

Basin M Roadside Swale-Capacity

Triangular

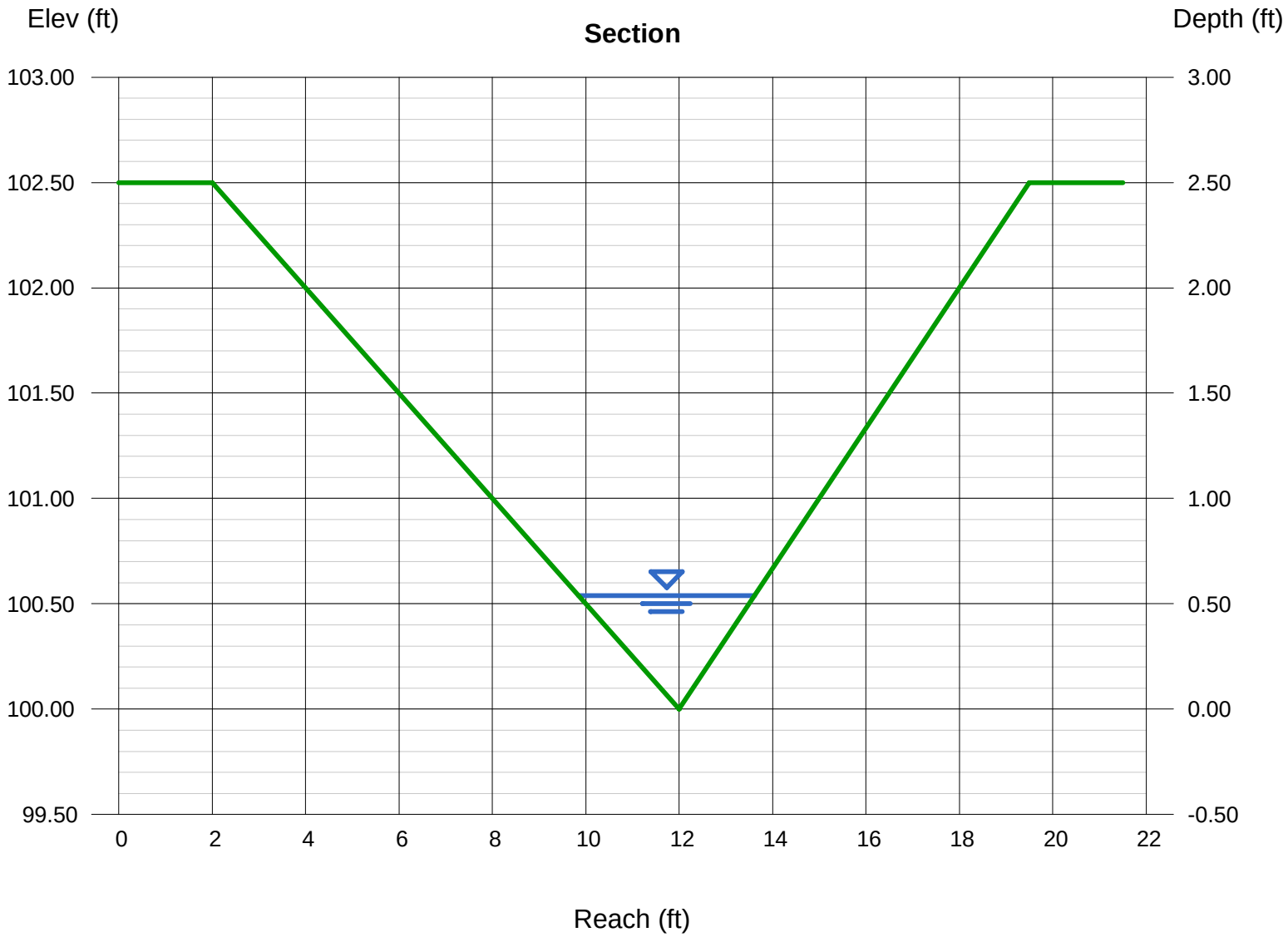
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 1.50
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 2.50

Highlighted

Depth (ft)	= 0.54
Q (cfs)	= 2.500
Area (sqft)	= 1.02
Velocity (ft/s)	= 2.45
Wetted Perim (ft)	= 3.93
Crit Depth, Yc (ft)	= 0.51
Top Width (ft)	= 3.78
EGL (ft)	= 0.63



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Oct 23 2023

Basin M Roadside Swale-Velocity

Triangular

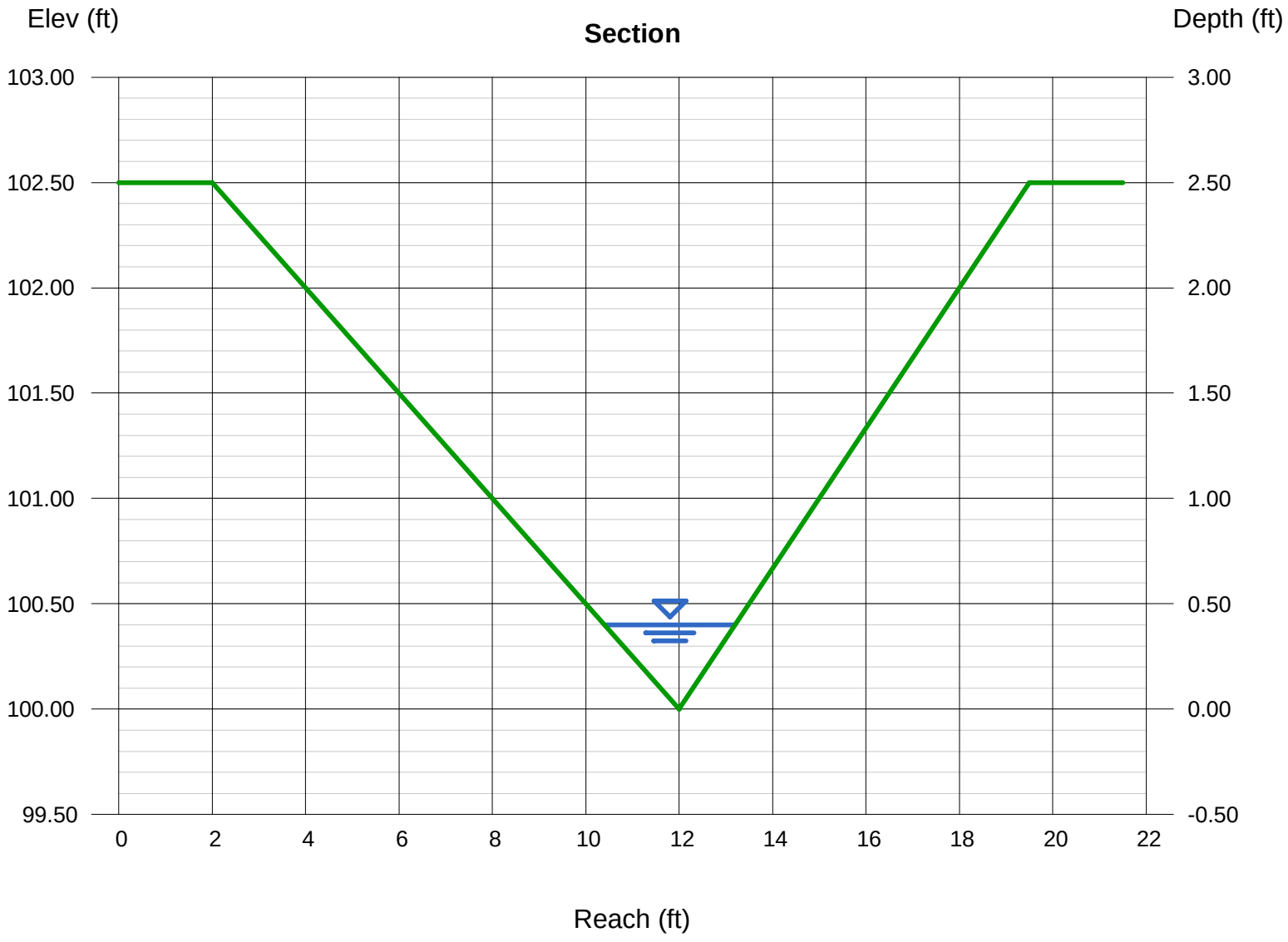
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 100.00
Slope (%)	= 8.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 2.50

Highlighted

Depth (ft)	= 0.40
Q (cfs)	= 2.500
Area (sqft)	= 0.56
Velocity (ft/s)	= 4.46
Wetted Perim (ft)	= 2.91
Crit Depth, Yc (ft)	= 0.51
Top Width (ft)	= 2.80
EGL (ft)	= 0.71



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Oct 23 2023

Basin O Existing Swale

User-defined

Invert Elev (ft)	= 7303.25
Slope (%)	= 5.00
N-Value	= 0.030

Calculations

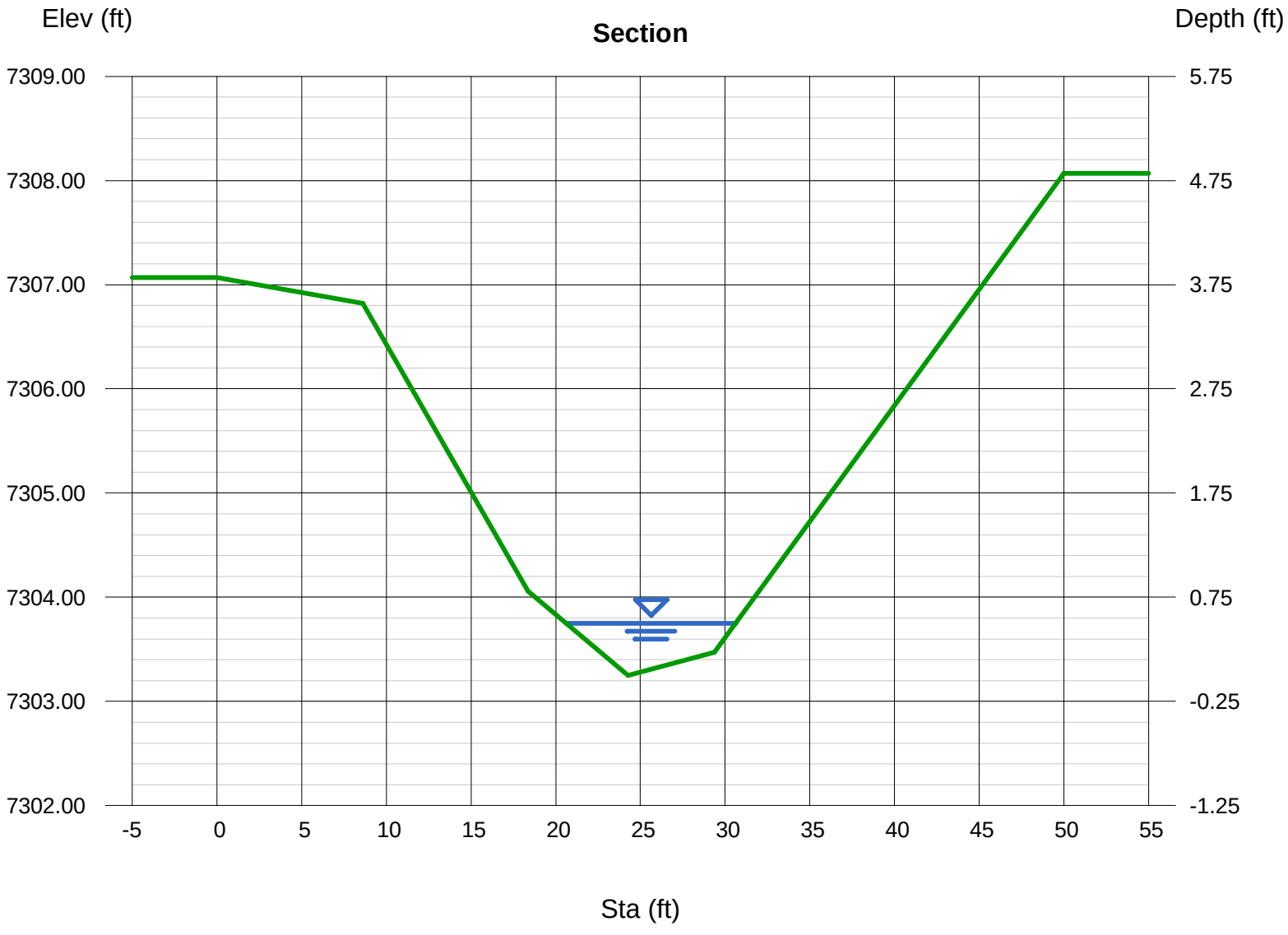
Compute by:	Known Q
Known Q (cfs)	= 15.00

Highlighted

Depth (ft)	= 0.50
Q (cfs)	= 15.00
Area (sqft)	= 3.08
Velocity (ft/s)	= 4.87
Wetted Perim (ft)	= 10.08
Crit Depth, Yc (ft)	= 0.62
Top Width (ft)	= 10.01
EGL (ft)	= 0.87

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

(0.00, 7307.07) -(8.60, 7306.82, 0.030) -(18.35, 7304.06, 0.030) -(24.28, 7303.25, 0.030) -(29.38, 7303.47, 0.030) -(50.00, 7308.07, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 7 2023

Basin P Existing Swale

User-defined

Invert Elev (ft)	= 7297.91
Slope (%)	= 6.50
N-Value	= 0.030

Calculations

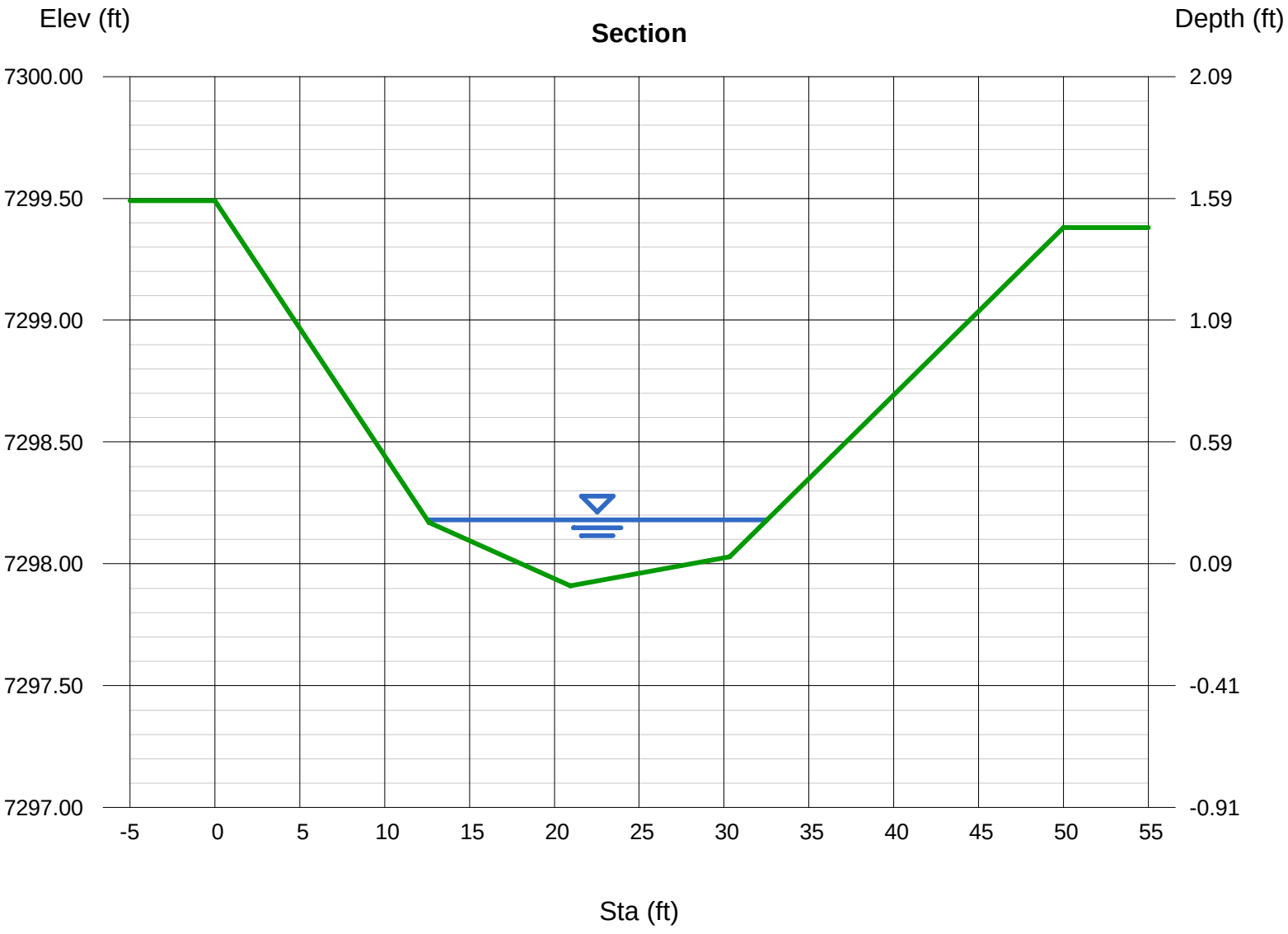
Compute by:	Known Q
Known Q (cfs)	= 12.00

Highlighted

Depth (ft)	= 0.27
Q (cfs)	= 12.00
Area (sqft)	= 3.30
Velocity (ft/s)	= 3.63
Wetted Perim (ft)	= 20.00
Crit Depth, Yc (ft)	= 0.34
Top Width (ft)	= 19.99
EGL (ft)	= 0.48

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

(0.00, 7299.49) -(12.62, 7298.17, 0.030) -(20.94, 7297.91, 0.030) -(30.32, 7298.03, 0.030) -(50.00, 7299.38, 0.030)



VMax® TRMs

ROLLMAX™
ROLLED EROSION CONTROL

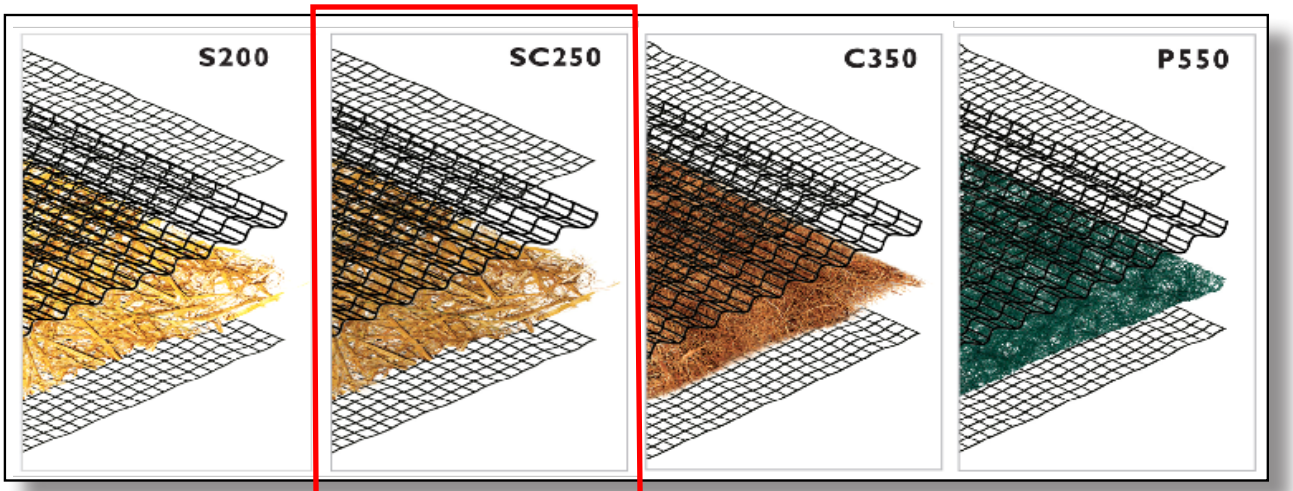
A Permanent Turf Reinforcement Mat Solution for Every Design

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

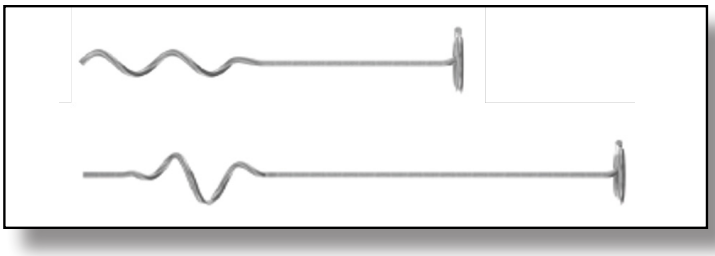
VMax® TRMs cont.

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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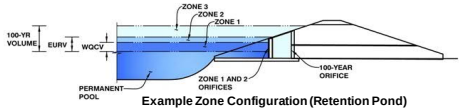
(800) 772-2040 | www.nagreen.com

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Cathedral Pines

Basin ID: North Pond



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	5.50	acres
Watershed Length =	795	ft
Watershed Length to Centroid =	350	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	21.50%	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) =	0.056	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.118	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.126	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.224	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.317	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.467	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.575	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.725	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 4 in.) =	1.405	acre-feet	4.00	inches
Approximate 2-yr Detention Volume =	0.082	acre-feet		
Approximate 5-yr Detention Volume =	0.120	acre-feet		
Approximate 10-yr Detention Volume =	0.190	acre-feet		
Approximate 25-yr Detention Volume =	0.233	acre-feet		
Approximate 50-yr Detention Volume =	0.246	acre-feet		
Approximate 100-yr Detention Volume =	0.300	acre-feet		

Define Zones and Basin Geometry

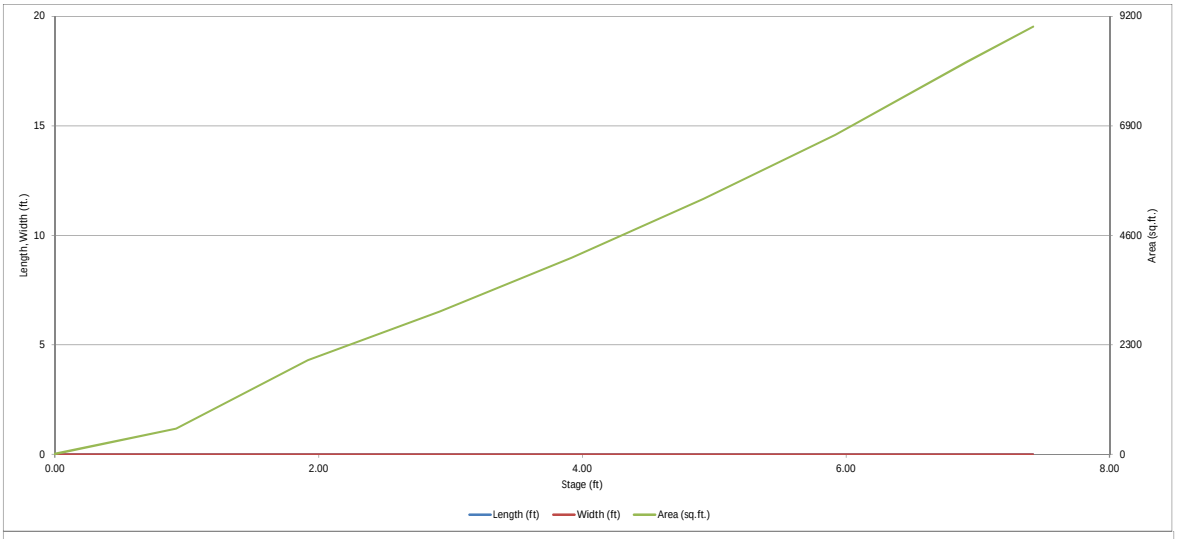
Zone 1 Volume (WQCV) =	0.056	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.062	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.182	acre-feet
Total Detention Basin Volume =	0.300	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (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

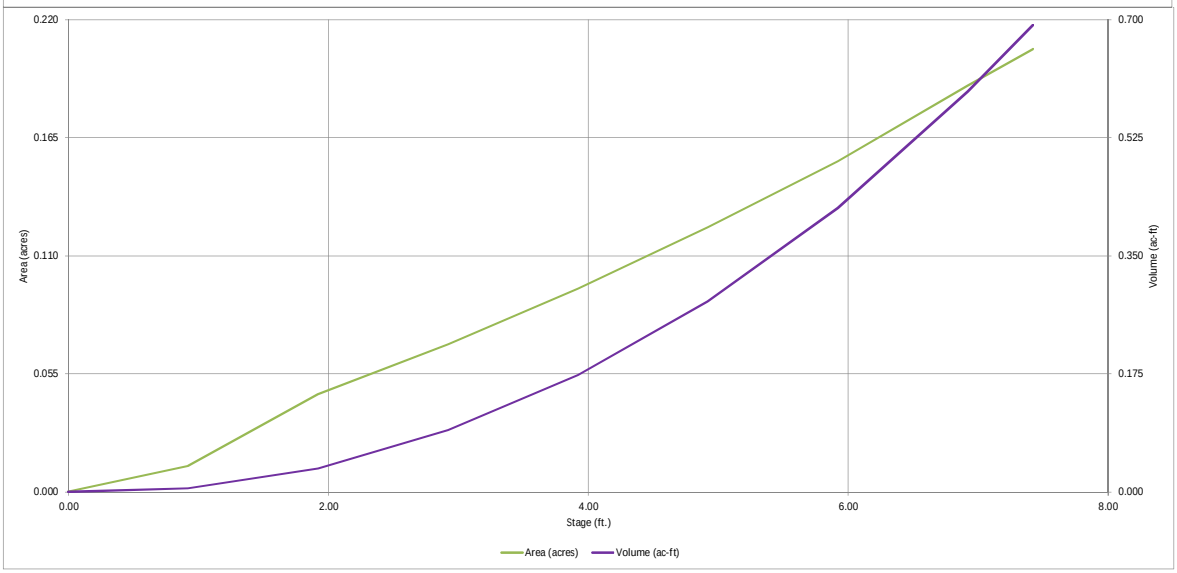
Depth Increment = ft

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		
7329	--	0.92	--	--	--	537	0.012	252	0.006
7330	--	1.92	--	--	--	1,979	0.045	1,510	0.035
7331	--	2.92	--	--	--	3,000	0.069	3,999	0.092
7332	--	3.92	--	--	--	4,130	0.095	7,564	0.174
7333	--	4.92	--	--	--	5,368	0.123	12,313	0.283
7334-Crest	--	5.92	--	--	--	6,715	0.154	18,355	0.421
7335	--	6.92	--	--	--	8,247	0.189	25,836	0.593
7335.5-Top	--	7.42	--	--	--	8,984	0.206	30,143	0.692

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



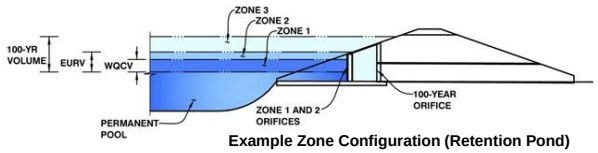


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Cathedral Pines

Basin ID: North Pond



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.34	0.056	Orifice Plate
Zone 2 (EURV)	3.28	0.062	Orifice Plate
Zone 3 (100-year)	5.06	0.182	Weir&Pipe (Restrict)
Total (all zones)		0.300	

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

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

Underdrain Orifice Diameter = N/A inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = N/A ft^2

Underdrain Orifice Centroid = N/A feet

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

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = 3.50 ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = N/A inches

Orifice Plate: Orifice Area per Row = N/A sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row = N/A ft^2

Elliptical Half-Width = N/A feet

Elliptical Slot Centroid = N/A feet

Elliptical Slot Area = N/A ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.80	2.80					
Orifice Area (sq. inches)	0.25	0.25	0.25					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.50	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Close Mesh Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.50	N/A	feet
Overflow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.67	N/A	
Overflow Grate Open Area w/o Debris =	7.12	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.56	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	8.50		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.82	N/A	ft^2
Outlet Orifice Centroid =	0.41	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.52	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= 5.91 ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = 10.00 feet

Spillway End Slopes = 4.00 H:V

Freeboard above Max Water Surface = 1.00 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth= 0.41 feet

Stage at Top of Freeboard = 7.32 feet

Basin Area at Top of Freeboard = 0.20 acres

Basin Volume at Top of Freeboard = 0.67 acre-ft

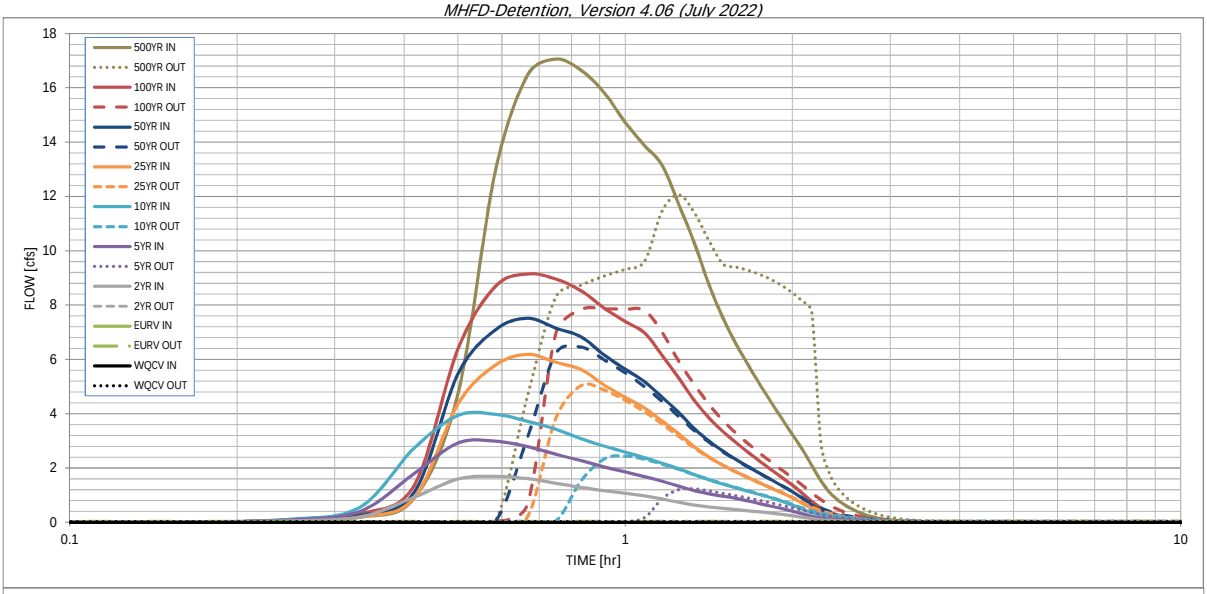
Routed Hydrograph Results

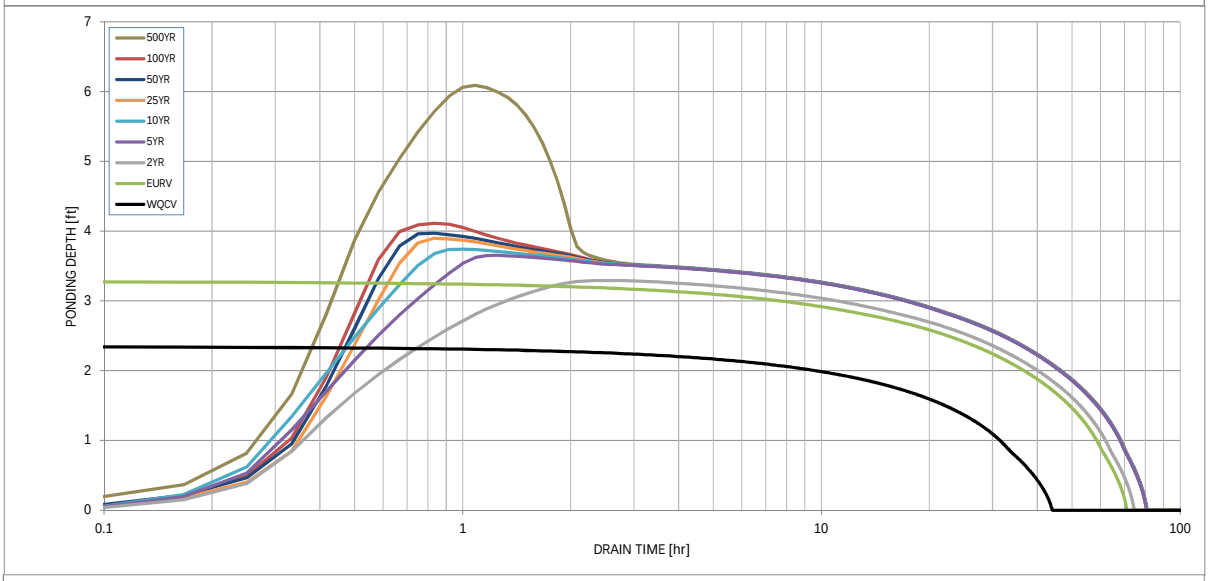
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

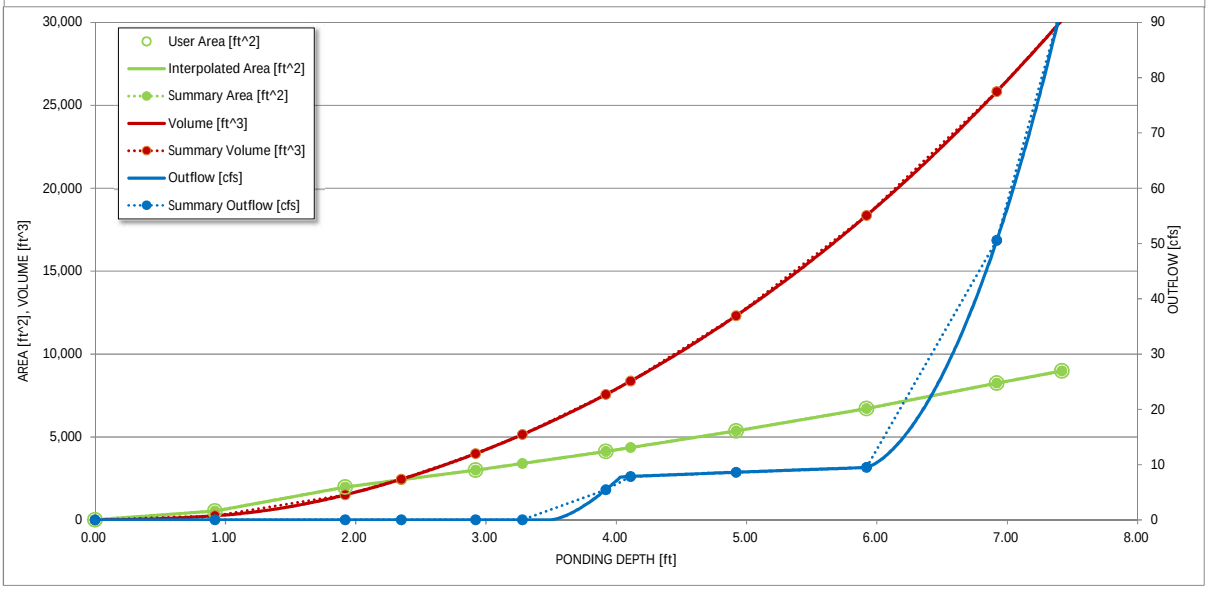
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	4.00
CUHP Runoff Volume (acre-ft) =	0.056	0.118	0.126	0.224	0.317	0.467	0.575	0.725	1.405
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.126	0.224	0.317	0.467	0.575	0.725	1.405
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.7	1.9	2.8	4.9	6.2	7.7	15.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.34	0.51	0.90	1.13	1.41	2.76
Peak Inflow Q (cfs) =	N/A	N/A	1.7	3.0	4.0	6.2	7.5	9.1	17.1
Peak Outflow Q (cfs) =	0.0	0.0	0.0	1.2	2.4	5.0	6.5	7.9	12.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.9	1.0	1.0	1.0	0.8
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 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	0.2	0.3	0.7	0.9	1.1	1.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	63	66	68	66	62	60	57	44
Time to Drain 99% of Inflow Volume (hours) =	42	68	71	75	73	71	69	68	62
Maximum Ponding Depth (ft) =	2.35	3.28	3.29	3.65	3.74	3.90	3.97	4.11	6.09
Area at Maximum Ponding Depth (acres) =	0.06	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.16
Maximum Volume Stored (acre-ft) =	0.056	0.118	0.119	0.149	0.157	0.171	0.177	0.192	0.448

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.05
	0:15:00	0.00	0.00	0.06	0.09	0.11	0.08	0.09	0.09	0.19
	0:20:00	0.00	0.00	0.20	0.41	0.56	0.20	0.25	0.32	0.88
	0:25:00	0.00	0.00	0.92	1.79	2.73	0.89	1.10	1.35	4.75
	0:30:00	0.00	0.00	1.60	2.92	3.94	4.36	5.46	6.38	12.90
	0:35:00	0.00	0.00	1.69	2.99	3.98	5.78	7.08	8.67	16.46
	0:40:00	0.00	0.00	1.61	2.79	3.72	6.19	7.51	9.15	17.05
	0:45:00	0.00	0.00	1.44	2.51	3.43	5.89	7.15	8.96	16.64
	0:50:00	0.00	0.00	1.29	2.27	3.08	5.62	6.83	8.53	15.82
	0:55:00	0.00	0.00	1.16	2.04	2.81	5.06	6.16	7.88	14.73
	1:00:00	0.00	0.00	1.06	1.86	2.59	4.60	5.63	7.39	13.88
	1:05:00	0.00	0.00	0.97	1.68	2.38	4.21	5.18	6.98	13.13
	1:10:00	0.00	0.00	0.85	1.51	2.17	3.72	4.60	6.13	11.68
	1:15:00	0.00	0.00	0.74	1.33	1.97	3.25	4.03	5.30	10.26
	1:20:00	0.00	0.00	0.64	1.16	1.75	2.77	3.44	4.48	8.72
	1:25:00	0.00	0.00	0.57	1.05	1.56	2.40	2.99	3.83	7.52
	1:30:00	0.00	0.00	0.51	0.96	1.41	2.10	2.62	3.34	6.57
	1:35:00	0.00	0.00	0.47	0.88	1.27	1.86	2.31	2.93	5.77
	1:40:00	0.00	0.00	0.42	0.78	1.14	1.64	2.04	2.57	5.06
	1:45:00	0.00	0.00	0.38	0.69	1.02	1.44	1.80	2.24	4.41
	1:50:00	0.00	0.00	0.34	0.59	0.90	1.25	1.56	1.93	3.80
	1:55:00	0.00	0.00	0.29	0.50	0.77	1.07	1.34	1.64	3.23
	2:00:00	0.00	0.00	0.24	0.41	0.64	0.90	1.13	1.37	2.69
	2:05:00	0.00	0.00	0.19	0.32	0.49	0.70	0.88	1.07	2.09
	2:10:00	0.00	0.00	0.13	0.23	0.36	0.51	0.64	0.78	1.54
	2:15:00	0.00	0.00	0.10	0.16	0.28	0.35	0.44	0.54	1.10
	2:20:00	0.00	0.00	0.08	0.13	0.22	0.25	0.32	0.38	0.82
	2:25:00	0.00	0.00	0.06	0.10	0.18	0.18	0.24	0.28	0.61
	2:30:00	0.00	0.00	0.05	0.09	0.15	0.14	0.18	0.20	0.45
	2:35:00	0.00	0.00	0.04	0.07	0.12	0.10	0.13	0.14	0.33
	2:40:00	0.00	0.00	0.03	0.05	0.09	0.08	0.10	0.10	0.23
	2:45:00	0.00	0.00	0.02	0.04	0.07	0.06	0.08	0.07	0.16
	2:50:00	0.00	0.00	0.02	0.03	0.05	0.04	0.06	0.05	0.12
	2:55:00	0.00	0.00	0.02	0.03	0.04	0.03	0.04	0.04	0.09
	3:00:00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.07
	3:05:00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.02	0.06
	3:10:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.04
	3:15:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.03
	3:20:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	3:25:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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 4.06 (July 2022)

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]
7328.08-Top of Micropool	0.00	10	0.000	0	0.000	0.00
7329	0.92	537	0.012	252	0.006	0.01
7330	1.92	1,979	0.045	1,510	0.035	0.02
7330.43-WQCV	2.35	2,418	0.056	2,455	0.056	0.02
7331	2.92	3,000	0.069	3,999	0.092	0.03
7331.36-EURV	3.28	3,407	0.078	5,152	0.118	0.03
7332	3.92	4,130	0.095	7,564	0.174	5.47
7332.19-100 yr	4.11	4,365	0.100	8,371	0.192	7.86
7333	4.92	5,368	0.123	12,313	0.283	8.63
7334.00-Spillway Crest	5.92	6,715	0.154	18,355	0.421	9.52
7335	6.92	8,247	0.189	25,836	0.593	50.57
7335.50-Top of Pond	7.42	8,984	0.206	30,143	0.692	93.22

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'.

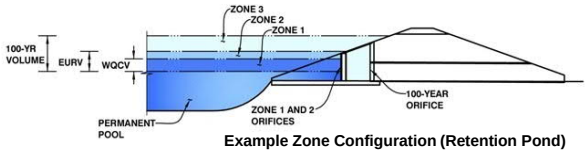
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Estates at Cathedral Pines

Basin ID: South Pond



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.11	0.047	Orifice Plate
Zone 2 (EURV)	2.93	0.063	Orifice Plate
Zone 3 (100-year)	4.19	0.139	Weir&Pipe (Restrict)
Total (all zones)		0.249	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.944E-03	ft^2
Depth at top of Zone using Orifice Plate =	3.71	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 =	0.28	sq. inches (diameter = 9/16 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.50	2.25					
Orifice Area (sq. inches)	0.28	0.28	0.28					

	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 =	3.15	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.15	N/A	feet
Overflow Weir Front Edge Length =	3.00	N/A	feet	Overflow Weir Slope Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	15.57	N/A	
Horiz. Length of Weir Sides =	3.00	N/A	feet	Overflow Grate Open Area w/o Debris =	7.12	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	3.56	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.46	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.27	N/A	feet
Restrictor Plate Height Above Pipe Invert =	5.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.17	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.42	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.27	feet
Spillway Crest Length =	10.00	feet	Stage at Top of Freeboard =	5.69	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.19	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.49	acre-ft

Calculated Parameters for Spillway

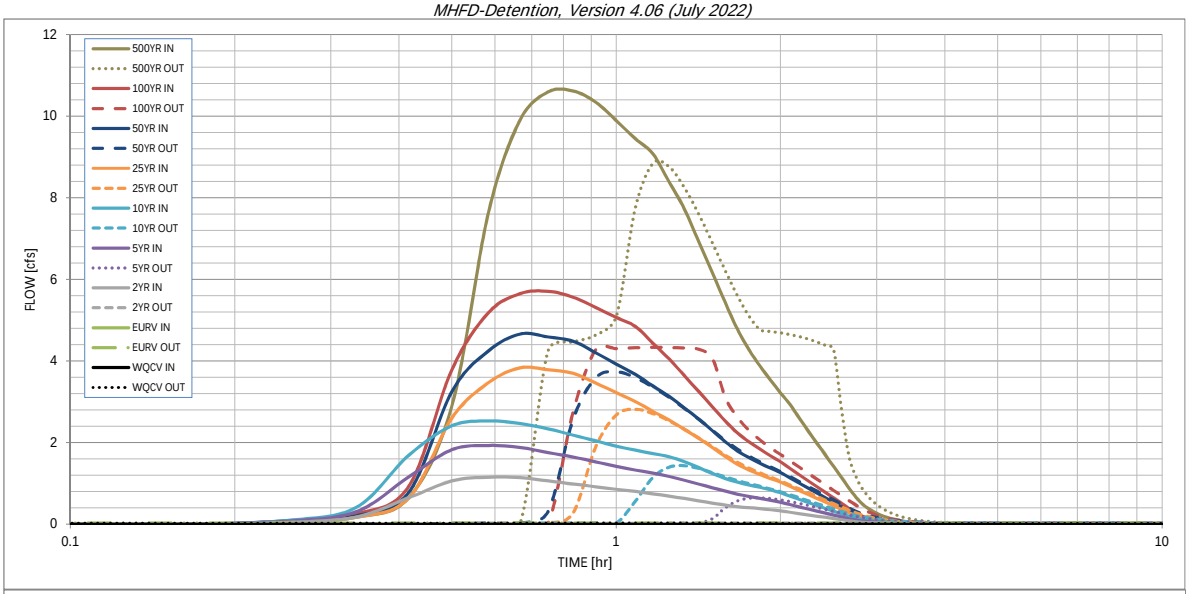
Routed Hydrograph Results

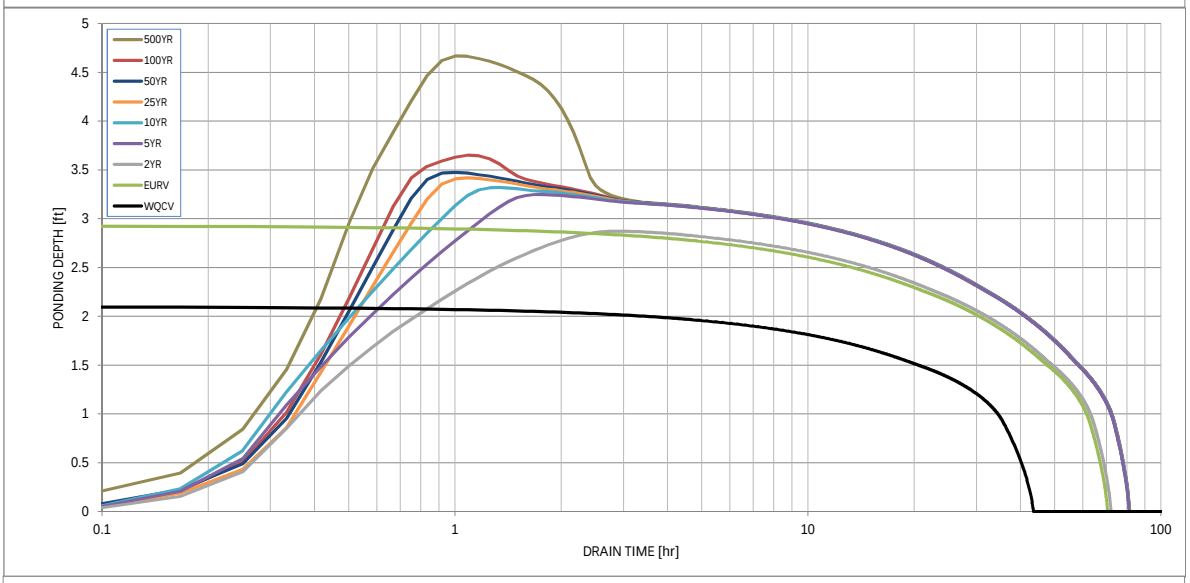
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

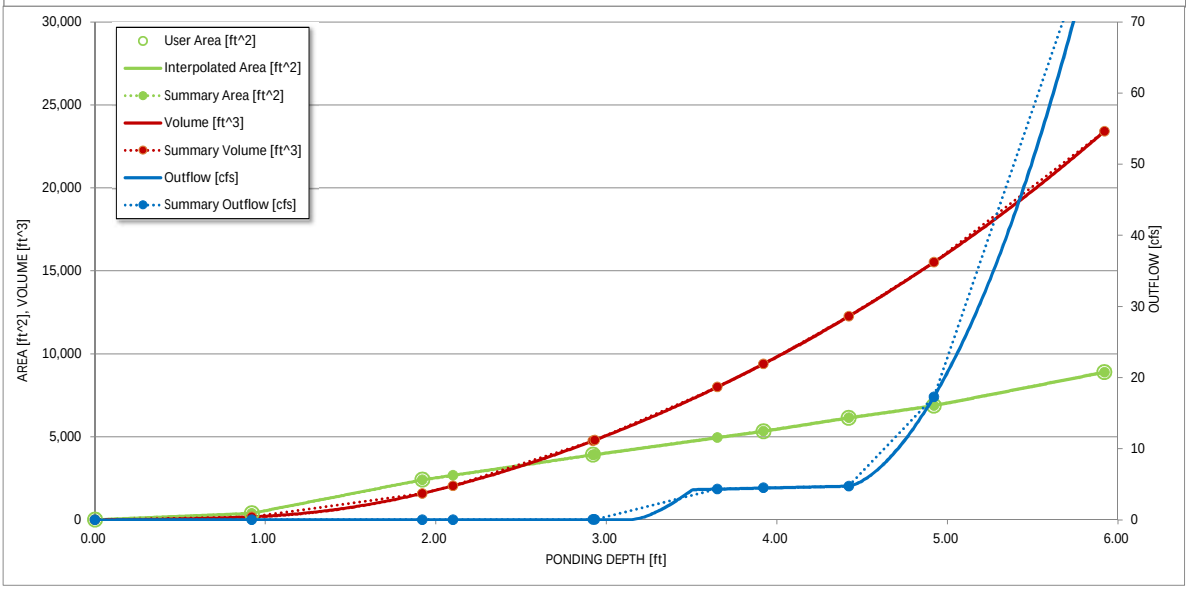
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	4.00
CUHP Runoff Volume (acre-ft) =	0.047	0.110	0.112	0.187	0.257	0.365	0.446	0.554	1.055
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.112	0.187	0.257	0.365	0.446	0.554	1.055
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.4	1.0	1.5	2.8	3.5	4.5	8.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.09	0.25	0.38	0.69	0.87	1.12	2.20
Peak Inflow Q (cfs) =	N/A	N/A	1.2	1.9	2.5	3.8	4.7	5.7	10.6
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.6	1.4	2.8	3.7	4.3	8.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.9	1.0	1.1	1.0	1.0
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 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	0.1	0.2	0.4	0.5	0.6	0.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	64	66	72	69	65	63	59	48
Time to Drain 99% of Inflow Volume (hours) =	42	68	69	77	76	74	73	72	66
Maximum Ponding Depth (ft) =	2.10	2.93	2.87	3.25	3.32	3.42	3.48	3.65	4.67
Area at Maximum Ponding Depth (acres) =	0.06	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.15
Maximum Volume Stored (acre-ft) =	0.047	0.110	0.105	0.140	0.147	0.157	0.164	0.184	0.316

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04
	0:15:00	0.00	0.00	0.05	0.08	0.10	0.07	0.08	0.08	0.17
	0:20:00	0.00	0.00	0.18	0.31	0.41	0.18	0.21	0.25	0.65
	0:25:00	0.00	0.00	0.65	1.17	1.70	0.64	0.79	0.94	2.92
	0:30:00	0.00	0.00	1.07	1.83	2.42	2.61	3.26	3.80	7.65
	0:35:00	0.00	0.00	1.15	1.93	2.53	3.47	4.25	5.19	9.92
	0:40:00	0.00	0.00	1.15	1.88	2.47	3.84	4.66	5.65	10.60
	0:45:00	0.00	0.00	1.06	1.76	2.34	3.79	4.59	5.71	10.62
	0:50:00	0.00	0.00	0.99	1.65	2.19	3.70	4.49	5.57	10.35
	0:55:00	0.00	0.00	0.92	1.53	2.05	3.46	4.20	5.32	9.89
	1:00:00	0.00	0.00	0.86	1.42	1.92	3.23	3.93	5.07	9.45
	1:05:00	0.00	0.00	0.81	1.33	1.82	3.01	3.68	4.85	9.08
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	1:25:00	0.00	0.00	0.58	0.99	1.39	2.11	2.58	3.25	6.16
	1:30:00	0.00	0.00	0.52	0.90	1.25	1.88	2.29	2.88	5.43
	1:35:00	0.00	0.00	0.47	0.81	1.12	1.66	2.03	2.53	4.78
	1:40:00	0.00	0.00	0.43	0.74	1.03	1.47	1.80	2.24	4.28
	1:45:00	0.00	0.00	0.41	0.68	0.97	1.33	1.63	2.02	3.88
	1:50:00	0.00	0.00	0.39	0.63	0.91	1.22	1.50	1.84	3.53
	1:55:00	0.00	0.00	0.36	0.59	0.84	1.12	1.38	1.68	3.22
	2:00:00	0.00	0.00	0.33	0.54	0.77	1.03	1.27	1.53	2.93
	2:05:00	0.00	0.00	0.29	0.48	0.69	0.93	1.13	1.36	2.59
	2:10:00	0.00	0.00	0.26	0.43	0.61	0.82	1.00	1.21	2.27
	2:15:00	0.00	0.00	0.23	0.37	0.53	0.73	0.88	1.06	1.98
	2:20:00	0.00	0.00	0.20	0.32	0.46	0.63	0.76	0.92	1.69
	2:25:00	0.00	0.00	0.17	0.27	0.39	0.54	0.65	0.78	1.42
	2:30:00	0.00	0.00	0.14	0.23	0.32	0.45	0.54	0.65	1.15
	2:35:00	0.00	0.00	0.11	0.18	0.26	0.37	0.44	0.52	0.89
	2:40:00	0.00	0.00	0.09	0.14	0.20	0.29	0.33	0.39	0.66
	2:45:00	0.00	0.00	0.07	0.10	0.15	0.21	0.24	0.27	0.48
	2:50:00	0.00	0.00	0.05	0.08	0.12	0.15	0.17	0.19	0.36
	2:55:00	0.00	0.00	0.04	0.06	0.10	0.11	0.13	0.14	0.27
	3:00:00	0.00	0.00	0.03	0.05	0.08	0.08	0.10	0.10	0.20
	3:05:00	0.00	0.00	0.03	0.04	0.07	0.06	0.07	0.08	0.15
	3:10:00	0.00	0.00	0.02	0.04	0.06	0.05	0.06	0.06	0.11
	3:15:00	0.00	0.00	0.02	0.03	0.05	0.04	0.05	0.04	0.08
	3:20:00	0.00	0.00	0.02	0.02	0.04	0.03	0.04	0.03	0.06
	3:25:00	0.00	0.00	0.01	0.02	0.03	0.02	0.03	0.02	0.05
	3:30:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.04
	3:35:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.03
	3:40:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	3:45:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
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	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	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 4.06 (July 2022)

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]
7324.08-Top of Micropool	0.00	10	0.000	0	0.000	0.00
7325	0.92	396	0.009	187	0.004	0.01
7326	1.92	2,414	0.055	1,592	0.037	0.02
7326.18-WQCV	2.10	2,685	0.062	2,051	0.047	0.02
7327	2.92	3,918	0.090	4,758	0.109	0.03
7327.01-EURV	2.93	3,932	0.090	4,797	0.110	0.03
7327.73-100 yr	3.65	4,958	0.114	7,997	0.184	4.34
7328	3.92	5,342	0.123	9,388	0.216	4.49
7328.50-Crest	4.42	6,150	0.141	12,261	0.281	4.75
7329	4.92	6,882	0.158	15,519	0.356	17.30
7330.00-Top of Pond	5.92	8,899	0.204	23,409	0.537	87.03

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).

APPENDIX D

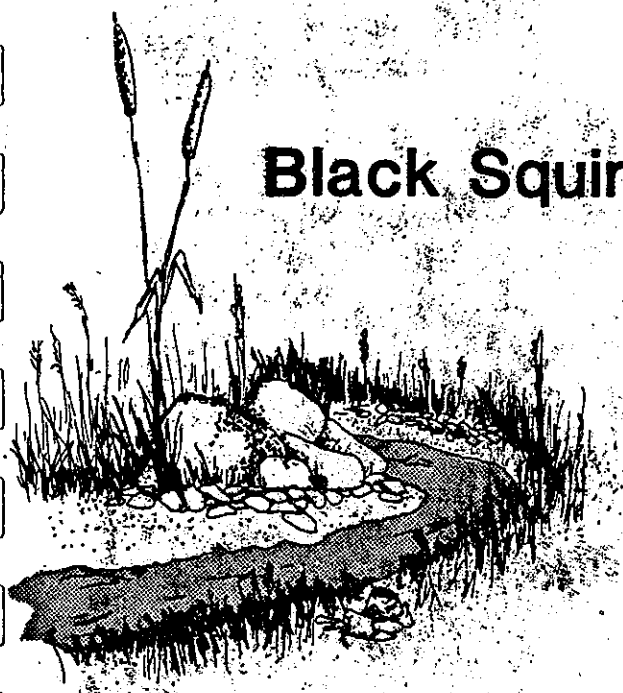
REFERENCE MATERIALS

Approved
El Paso County
Planning Commission
This 17th day of Jan. 1989

Chairman

Elaine Rebex, Secretary

URS
CONSULTANTS
MAKING
TECHNOLOGY
WORK™



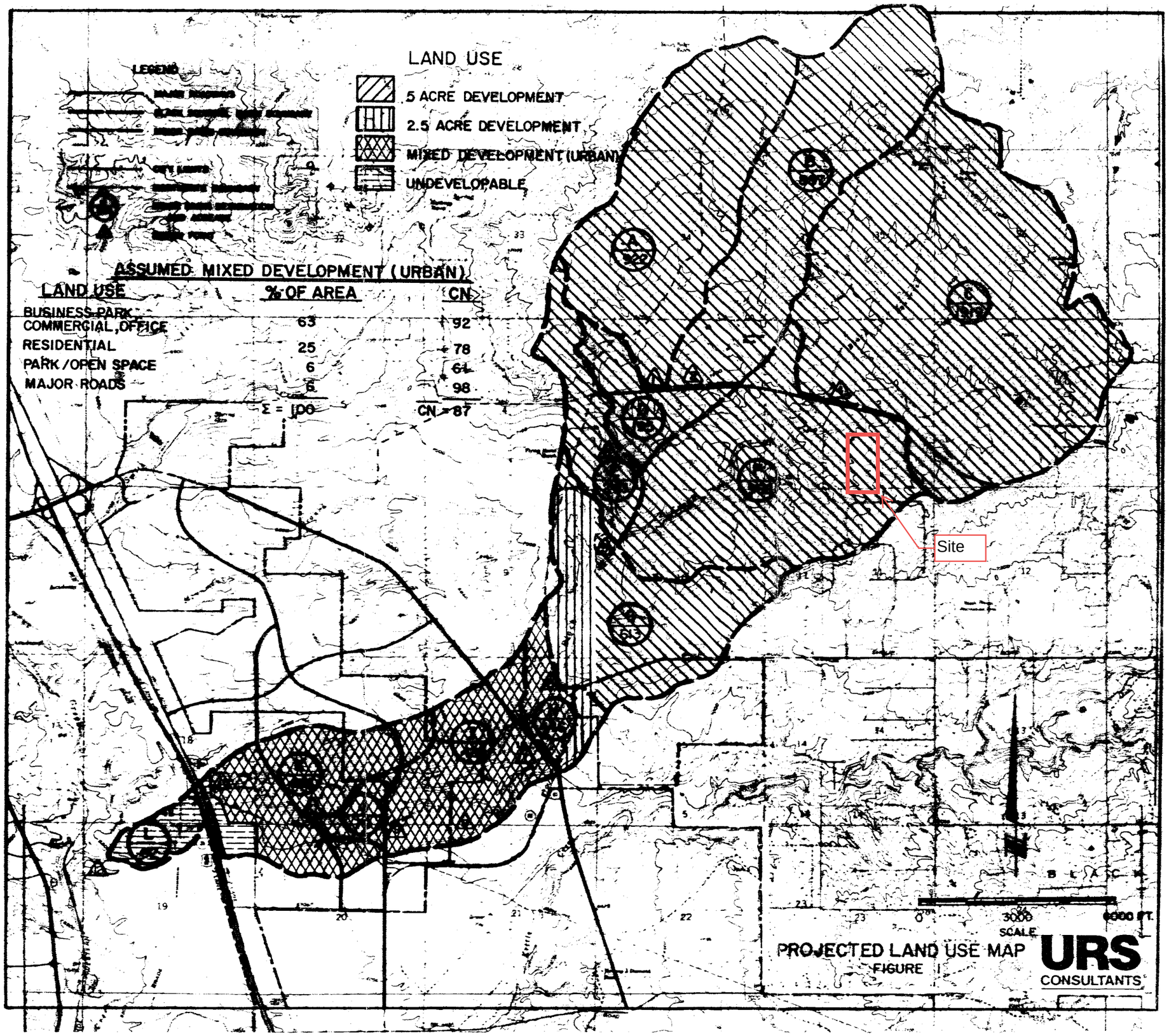
Black Squirrel Creek Drainage Basin Planning Study

City of Colorado Springs

and El Paso County

January, 1989

Department, the City Public Works Department, the City Planning Department, along with the aid of the Black Forest Preservation Study, the Urban Planning Area Map, and the Northgate Master Plan. The area between Interstate 25 and State Highway 83 (Downstream of D.P. #6)was assumed to be developed as if it was an urban type development. A buffer area was also assumed along State Highway 83 consisting of 2.5 acre development. This buffer area was assumed to be included within the urban development. The remaining area was assumed to be developed in a rural type development with an average lot size of 5 acres per current zoning and presently platted subdivisions within the basin. This was assumed to be appropriate due to the limiting density where City services are anticipated to be available and the desirability of maintaining the forest area in a more rural type setting. The Air Force Academy land was assumed to remain undeveloped and was not included in the drainage and bridge fee calculations. Future changes in land use beyond this concept would require a revision to this study. Land use assumptions for the basin are depicted on Figure 1.

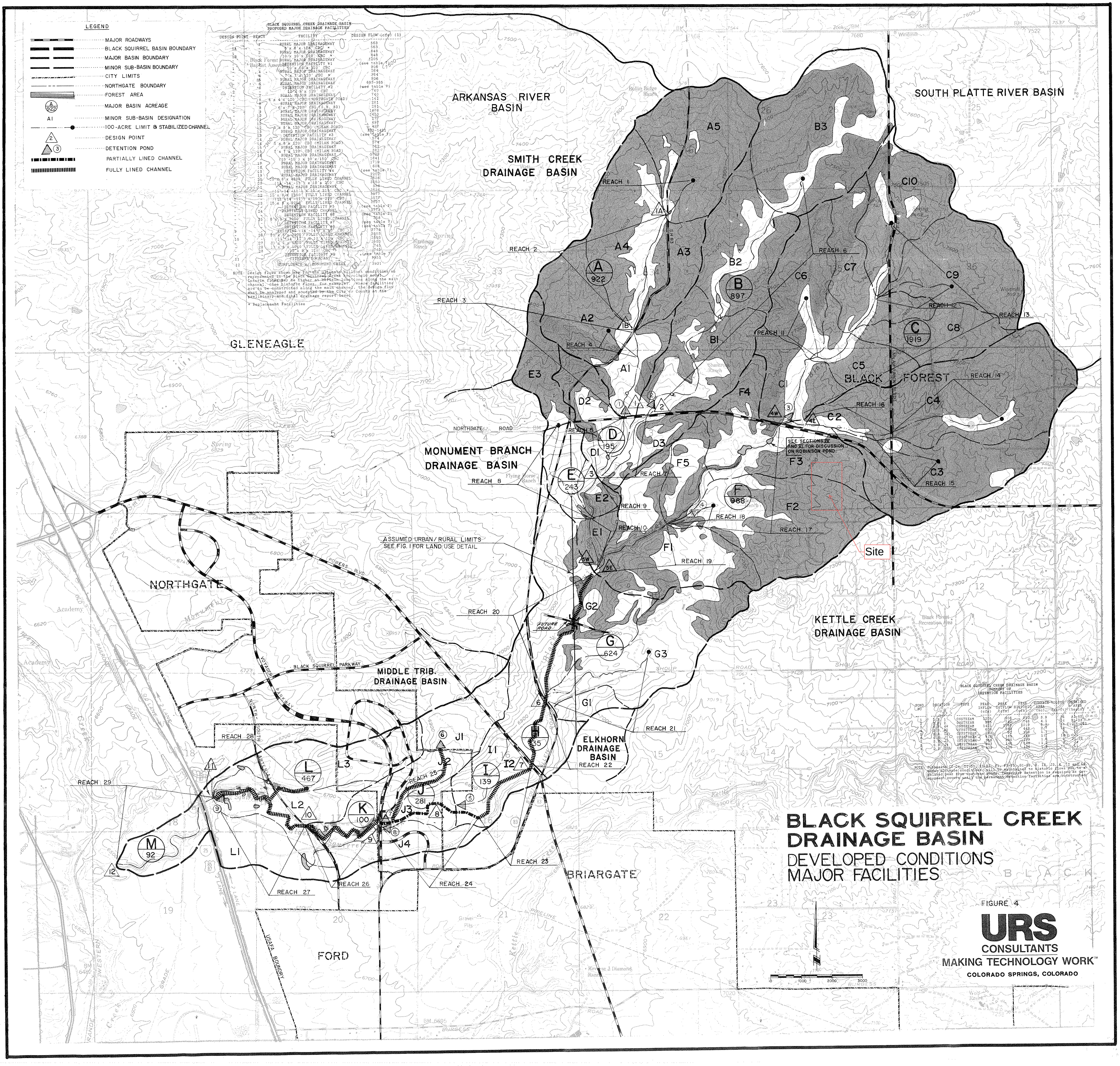

LAND USE
.5 ACRE DEVELOPMENT
2.5 ACRE DEVELOPMENT
MIXED DEVELOPMENT (URBAN)
UNDEVELOPABLE
ASSUMED MIXED DEVELOPMENT (URBAN)
LAND USE | % OF AREA | CN
BUSINESS PARK, COMMERCIAL, OFFICE | 63 | 92
RESIDENTIAL | 25 | 78
PARK / OPEN SPACE | 6 | 61
MAJOR ROADS | 6 | 98
Σ = 100 | CN = 87
Site
SCALE
3000
6000 FT.
PROJECTED LAND USE MAP
FIGURE 1
URS
CONSULTANTS

Curve number development for the rural area was generated by assuming five acre type development. The five acre parcel was assumed to consist of approximately 16% developed area (CN=93) with the remaining 84% being split based on percentage of forest (CN=63) and range (CN=69) land in the subbasin. The developed area, within the five acre parcel, was assumed to include approximately 7% of impervious area (CN=98) and 9% of gravel driveway and adjacent road (CN=89). The curve numbers presented are intended to be conservative to allow for uncertainties in land use predictions, present and future paved driveways and roads, and assuming "fair" to "poor" hydrological conditions for range and forest land uses due to a general lack of ground cover.

Drainage facilities are designed and constructed according to the City/County Criteria Manual. Other possible requirements may be imposed through the Corps of Engineers 404 permit process and through the Flood Plain Administrator concerning current FEMA mapping, map revisions, and amendments in conjunction with the planning process. Additional costs associated with these processes have not been included here.

MAJOR CHANNEL SYSTEM

Reaches 1 through 19 and 21 are primarily located in the upper reaches of the basin. These reaches are proposed to remain as natural as possible except for the addition of grade control structures and riprap at sharp horizontal bends for the purpose of stabilizing the channel. A total of 136 grade control


LEGEND
MAJOR ROADWAYS
BLACK SQUIRREL BASIN BOUNDARY
MAJOR BASIN BOUNDARY
MINOR SUB-BASIN BOUNDARY
CITY LIMITS
NORTHGATE BOUNDARY
FOREST AREA
MAJOR BASIN ACREAGE
MINOR SUB-BASIN DESIGNATION
100-ACRE LIMIT & STABILIZED CHANNEL
DESIGN POINT
DETENTION POND
PARTIALLY LINED CHANNEL
FULLY LINED CHANNEL
BLACK SQUIRREL CREEK DRAINAGE BASIN
PROPOSED MAJOR DRAINAGE FACILITIES
ARKANSAS RIVER BASIN
SOUTH PLATTE RIVER BASIN
SMITH CREEK DRAINAGE BASIN
GLENEAGLE
MONUMENT BRANCH DRAINAGE BASIN
NORTHGATE ROAD
BLACK FOREST
SEE SECTIONS IV AND VI FOR DISCUSSION ON ROBINSON POND.
Site
ASSUMED URBAN/RURAL LIMITS SEE FIG. I FOR LAND USE DETAIL
NORTHGATE
KETTLE CREEK DRAINAGE BASIN
MIDDLE TRIB. DRAINAGE BASIN
BLACK SQUIRREL PARKWAY
ELKHORN DRAINAGE BASIN
BRIARGATE
FORD
A 922
B 897
C 1919
D 195
E 243
F 968
G 624
H 35
I 139
J 281
K 100
L 467
M 92
REACH 1
REACH 2
REACH 3
REACH 4
REACH 6
REACH 7
REACH 8
REACH 9
REACH 10
REACH 11
REACH 12
REACH 13
REACH 14
REACH 15
REACH 16
REACH 17
REACH 18
REACH 19
REACH 20
REACH 21
REACH 22
REACH 23
REACH 24
REACH 25
REACH 26
REACH 27
REACH 28
REACH 29
BLACK SQUIRREL CREEK DRAINAGE BASIN
DEVELOPED CONDITIONS
MAJOR FACILITIES
FIGURE 4
URS CONSULTANTS
MAKING TECHNOLOGY WORK™
COLORADO SPRINGS, COLORADO

LEGEND

- MAJOR ROADWAYS
- BLACK SQUIRREL BASIN BOUNDARY
- CITY LIMITS
- NORTHGATE BOUNDARY
- FOREST AREA
- DETENTION PONDS (MAJOR SYSTEM)
- 100 ACRE LIMIT
- DESIGN POINT
- INLET
- EXISTING INITIAL SYSTEM
- 24" RCP
- 30" RCP
- 36" RCP
- 42" RCP
- 48" RCP
- RURAL INITIAL SYSTEM
- RURAL INITIAL SYSTEM DESIGNATION (SEE TABLE 9)

ARKANSAS RIVER BASIN

SOUTH PLATTE RIVER BASIN

GLENEAGLE

NORTHGATE

BLACK FOREST

BRIARGATE

USAFA

FORD

ASSUMED URBAN/RURAL LIMITS
SEE FIG. 1 FOR DETAIL

Site

BLACK SQUIRREL CREEK DRAINAGE BASIN

DEVELOPED CONDITIONS
INITIAL DRAINAGE SYSTEM

FIGURE 5

URS
CONSULTANTS
MAKING TECHNOLOGY WORK™
COLORADO SPRINGS, COLORADO

FINAL
DRAINAGE REPORT AND PLAN
FOR
CATHEDRAL PINES SUBDIVISION FILING NO. 1

January, 2005

Leigh
& Whitehead
Associates, Inc.

CONSULTING CIVIL ENGINEERS & SURVEYORS
2906 BEACON STREET
COLORADO SPRINGS, CO 80907-6192

LWA Project No. 04040.62

TABLE 1

BASIN ID		AREA		Q5 cfs		Q100 cfs	
Exist.	Prop.	Exist.	Prop.	Exist.	Prop.	Exist.	Prop.
DP-1	DP-1	0.22 sm.	0.36 sm.	40.0	57.0	175.0	189.0
DP-2	DP-2	1.02 sm.	0.87 sm.	68.0	141.0	335.0	465.0
DP-3	DP-3	1.24 sm.	1.43 sm.	76.0	218.0	385.0	733.0
D	D	8.61 Ac.	5.06 Ac.	1.8	5.0	4.9	12.3
E	E	20.20 Ac.	15.50 Ac.	4.2	13.4	11.3	32.8
F	F	2.79 Ac.	2.79 Ac.	0.9	0.9	2.5	2.5

TABLE 1

sm = Square Miles Ac. = Acres

Culverts have been sized in accordance with the requirements of the Bureau of Public Roads, nomographs, and the City of Colorado Springs/El Paso County Drainage Criteria Manual. The computer program "Culvert Master for Windows", Culvert Design and Analysis Software, Version 1.0, developed by Haestad Methods, was used in the computations for sizing of culverts. This software program is in accordance with the Bureau of Public Road's standards for developing culvert sizes. The culverts have been sized as R.C.P., using a Manning's roughness coefficient of 0.013. The culvert design data computations are in the back of this report. The rip-rap at the outlet of the culverts, have been designed in accordance with CDOT Std. M-601-12, and a copy of this standard is located in the back of this report. These rip-rap pads are shown on the detailed street plan and profiles and the calculations are in the back of this report. These rip-rap pads have been sized in accordance with the appropriate requirements.

There are plans to construct 2-detention facilities. One is located at design point 3 (DP-3) in basin B, and the other one is located at Winslow Drive in basin E. These detention facilities release runoff at or below historic rates.

The detention pond at DP-3 has been sized to accept runoff from Filing No. 1, which contributes 381.67 acres. This does include basins B21 and D. The remaining 413.6 undeveloped acres from the adjacent portion will sheet flow westerly to Black Squirrel Creek, and will not be intercepted by this detention facility. Developed peak flow at DP-3 for the 381.67 acres is 142.0 cfs for the 5 year event, and 444.0 cfs for the 100 year event.

Historic flows at this location are 44.0 cfs for the 5 year event and 219.0 cfs for the 100 year event. This detention facility will release flows of 41.8 cfs for the 5 year event and 192.6 cfs for the 100 year event. These flows are below historic runoff. This detention pond will detain 5.84 acre feet (100.2 cfs) for the 5 year event and 17.26 acre (251.4 cfs) for the 100 year event When the remaining portion of this basin is developed, detailed evaluation will be required to determine the best solution to reduce developed runoff from exiting the property.

The detention pond at Basin E has been sized to accept runoff from 15.50 acres, which generates a peak developed flow of 13.4 cfs for the 5 year event and 32.8 cfs for the 100 year event. Historic flows at this location are 4.2 cfs for the 5 year event and 11.3 cfs for the 100 year event. This detention facility will release runoff of 3.7 cfs for the 5 year event and 10.9 cfs for the 100 year event. These flows are below historic runoff. This detention pond will detain 0.25 acre feet (9.7 cfs) for the 5 year event and0.56 acre feet (21.9 cfs) for the 100 year event

Detention facilities were analyzed using Haestad methods "Pond Pack-Detention Pond Design and Analysis" computer program for both the 5 year and 100 year events. Pond volumes were determined by conic method. The detention ponds are private drainage facilities and will be maintained by the homeowners association. Calculations for the two detention ponds are included in the back of this report. These ponds will have adequate maintenance access.

The proposed detention facilities include outlet structures that will control both the minor and major storms. The are dual-stage outlet facilities. The calculations for the emergency spillway are shown on the construction documents. Any seeding that is developed in the detention pond areas will be in accordance with the NRCS specifications that are shown on sheet 2 of the construction documents.

Located throughout the property are small stock or ranch ponds that are currently in existence. These ponds will be removed and regraded, and will not be part of the storm drainage system. All runoff calculations for this development did not take into account these stock ponds. Grades for the proposed roads may cause high storm water flow velocities and create the need for roadside ditch protection. The roadside ditches generate

RUNOFF COMPUTATIONS
RATIONAL METHOD

CATHEDRAL PINES SUBDIVISION FILING NO. 1
HOLMES ROAD, Sec.'s 1 & 2, T12S, R66W
EL PASO COUNTY, COLORADO

TABLE A: LWA # 04040.62
PROPOSED CONDITIONS

04040_62.xls

LEIGH WHITEHEAD & ASSOCIATES,INC.
Engineers, Surveyors & Planners
2906 BEACON STREET
COLORADO SPRINGS, COLORADO
(719) 636-5179

16-Nov-04

BASIN	AREA	SOIL TYPE	C 5 / C 100	GEOMETRY LENGTH / SLOPE	GEOMETRY HEIGHT	Tt 5 / Tt 100	V / Tt	tc 5 / tc 100	i 5 / i 100	Q5	Q100	COMMENTS
B29	7.60	B	0.30	300	42.0	10.85	3.95	14.31	3.45	7.9		
		26/40	0.40		14.00	9.49	3.46	12.95	6.32		19.2	
B30	8.85	B	0.30	300	48.0	10.38	3.37	14.29	3.45	9.2		
		26	0.40		16.00	9.08	3.91	12.99	6.31		22.3	
B31	15.46	B	0.30	300	38.0	11.21	3.60	18.38	3.05	14.1		
		26/40	0.40		12.67	9.81	7.17	16.98	5.54		34.3	
B32	37.25	B	0.30	300	12.0	16.40	4.01	29.68	2.33	26.1		
		26/40/71	0.40		4.00	14.35	13.28	27.63	4.25		63.3	
B32	69.16	B	0.30	300	42.0	10.85	Varies	26.87	2.47	51.3		B29 through B32
(cum.)		26/40/71	0.40		14.00	9.49	16.02	25.51	4.45		123.1	
DP-3	916.42	B	0.29	300	15.0	15.43	Varies	66.25	1.39	370.2		Rational; OS-B1 -- B32
		26/40/41/71	0.39		5.00	13.52	50.82	64.34	2.48		887.2	
DP-3	1.4319	B	CN							218		HEC-1; OS-B1 -- B32
		26/40/41/71	64.51								733	(Ultimate Condition)
DP-3	381.67	B	0.29	300	15.0	15.43	Varies	46.05	1.78	196.6		Rational Analysis
		26/40/41/71	0.39		5.00	13.52	30.62	44.14	3.19		474.7	
DP-3	0.5964	B	CN							142		HEC-1; OS-B1 -- B32
		26/40/41/71	64.51								444	(For Detention Purposes)
D	5.06	B	0.30	300	23.0	13.23	3.81	15.77	3.29	5.0		
		41	0.40		7.67	11.58	2.54	14.12	6.07		12.3	
E	15.50	B	0.30	300	17.0	14.62	3.54	20.37	2.89	13.4		
		41	0.40		5.67	12.79	5.75	18.54	5.30		32.8	
F	2.79	B	0.10	350	40.0	15.66		15.66	3.30	0.9		Undisturbed
		41	0.15		11.43	14.88		14.88	5.92		2.5	
Milam Cir.	1.22	B	0.40	200	9.0	11.27		11.27	3.85	1.9		
		41	0.50		4.50	9.66		9.66	7.18		4.4	

Culvert Designer/Analyzer Report
Winslow Drive - 2

Peak Discharge Method: User-Specified			
Design Discharge	4.7 cfs	Check Discharge	11.7 cfs
Grades Model: Inverts			
Invert Upstream	7,365.00 ft	Invert Downstream	7,364.00 ft
Length	70.00 ft	Slope	0.014286 ft/ft
Drop	1.00 ft		
Headwater Model: Maximum Allowable HW			
Headwater Elevation	7,368.00 ft		
Tailwater properties: Triangular Channel			
Slope	0.020000 ft/ft	Mannings Coefficient	0.035
Depth	0.78 ft	Left Side Slope	6 H : V
Right Side Slope	6 H : V		
Tailwater conditions for Design Storm.			
Discharge	4.7 cfs	Bottom Elevation	7,364.00 ft
Depth	0.56 ft	Velocity	2.53 ft/s
Tailwater conditions for Check Storm.			
Discharge	11.7 cfs	Bottom Elevation	7,364.00 ft
Depth	0.78 ft	Velocity	3.18 ft/s

	Name	Desc	Discharge	HW Elev	Velocity
	Trial-1	1-18 inch Circular	4.7 cfs	7,366.34 ft	6.59 ft/s
x	Trial-2	1-18 inch Circular	11.7 cfs	7,367.74 ft	8.06 ft/s

Len Beasley
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Culvert Designer/Analyzer Report
Winslow Drive - 2

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	7,368.00 ft	Storm Event	Design
Computed Headwater Elevation	7,366.34 ft	Discharge	4.7 cfs
Headwater Depth/ Height	0.89	Tailwater Elevation	7,364.56 ft
Inlet Control HW Elev	7,366.23 ft	Control Type	Outlet Control
Outlet Control HW Elev	7,366.34 ft		

Grades			
Upstream Invert	7,365.00 ft	Downstream Invert	7,364.00 ft
Length	70.00 ft	Constructed Slope	0.014286 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.64 ft
Slope Type	Steep	Normal Depth	0.64 ft
Flow Regime	Supercritical	Critical Depth	0.83 ft
Velocity Downstream	6.59 ft/s	Critical Slope	0.005655 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	7,366.34 ft	Upstream Velocity Head	0.34 ft
Ke	0.50	Entrance Loss	0.17 ft

Inlet Control Properties			
Inlet Control HW Elev	7,366.23 ft	Flow Control	Unsubmerged
Inlet Type	End-Section Conforming to fill slope	Area Full	1.8 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Len Beasley
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Culvert Designer/Analyzer Report
Winslow Drive - 2

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	7,368.00 ft	Storm Event	Check
Computed Headwater Elevation	7,367.74 ft	Discharge	11.7 cfs
Headwater Depth/ Height	1.83	Tailwater Elevation	7,364.78 ft
Inlet Control HW Elev	7,367.74 ft	Control Type	Inlet Control
Outlet Control HW Elev	7,367.50 ft		

Grades			
Upstream Invert	7,365.00 ft	Downstream Invert	7,364.00 ft
Length	70.00 ft	Constructed Slope	0.014286 ft/ft

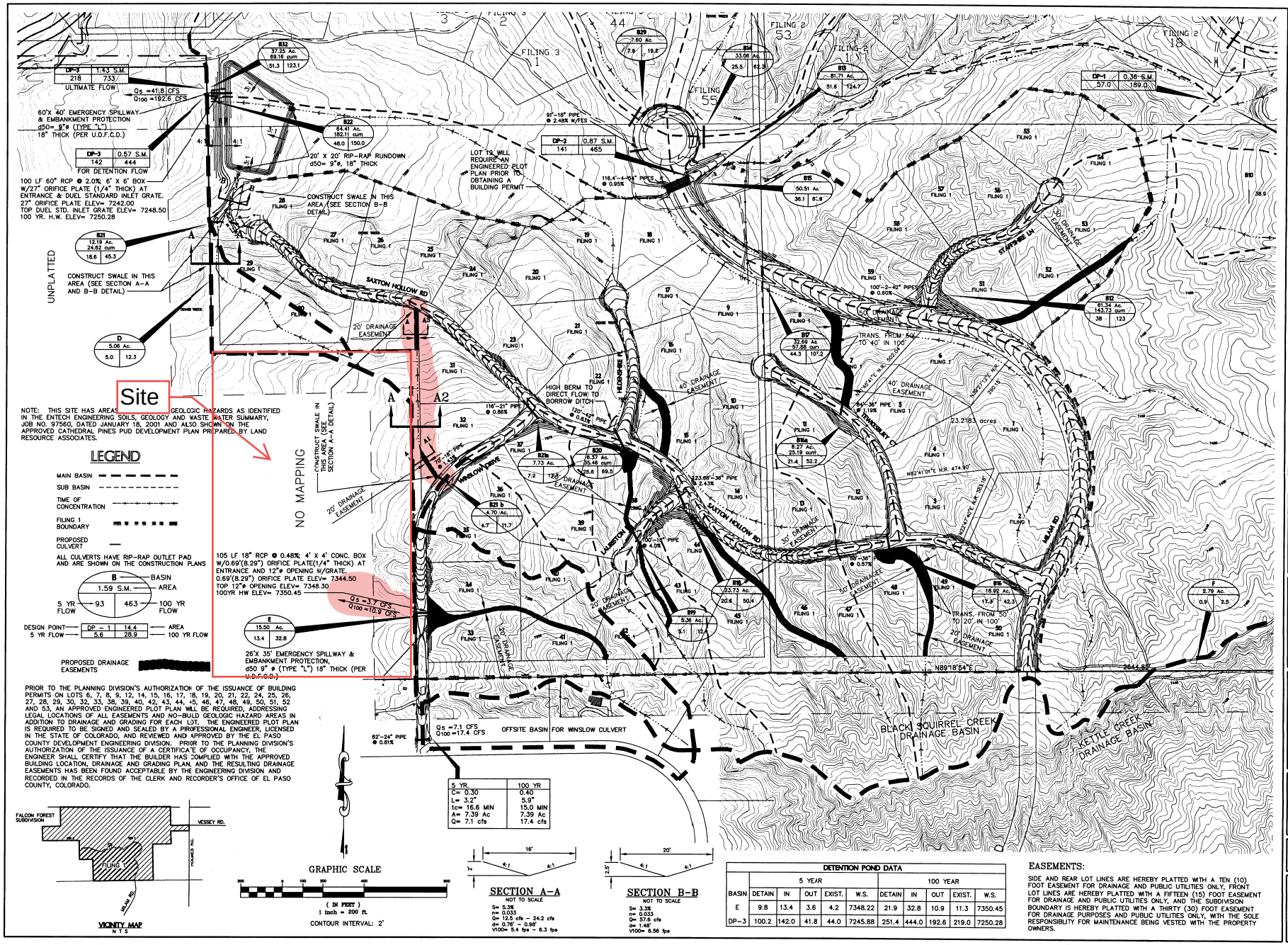
Hydraulic Profile			
Profile	S2	Depth, Downstream	1.15 ft
Slope Type	Steep	Normal Depth	1.15 ft
Flow Regime	Supercritical	Critical Depth	1.30 ft
Velocity Downstream	8.06 ft/s	Critical Slope	0.011352 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	7,367.50 ft	Upstream Velocity Head	0.80 ft
Ke	0.50	Entrance Loss	0.40 ft

Inlet Control Properties			
Inlet Control HW Elev	7,367.74 ft	Flow Control	Submerged
Inlet Type	End-Section Conforming to fill slope	Area Full	1.8 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Len Beasley
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666



DETENTION POND DATA											
	5 YEAR					100 YEAR				
BASIN	DETAIN	IN	OUT	EXIST.	W.S.	DETAIN	IN	OUT	EXIST.	W.S.
E	9.8	13.4	3.6	4.2	7348.22	21.9	32.8	10.9	11.3	7350.45
DP-3	100.2	142.0	41.8	44.0	7245.88	251.4	444.0	192.6	219.0	7250.28

EASEMENTS:

SIDE AND REAR LOT LINES ARE HEREBY PLATTED WITH A TEN (10) FOOT EASEMENT FOR DRAINAGE AND PUBLIC UTILITIES ONLY, FRONT LOT LINES ARE HEREBY PLATTED WITH A FIFTEEN (15) FOOT EASEMENT FOR DRAINAGE AND PUBLIC UTILITIES ONLY, AND THE SUBDIVISION BOUNDARY IS HEREBY PLATTED WITH A THIRTY (30) FOOT EASEMENT FOR DRAINAGE PURPOSES AND PUBLIC UTILITIES ONLY, WITH THE SOLE RESPONSIBILITY FOR MAINTENANCE BEING VESTED WITH THE PROPERTY OWNERS.

ENGINEERS PLANNERS SURVEYORS
LEIGH WHITEHEAD & ASSOCIATES
3720 EAST YAMPA STREET, SUITE 1
COLORADO SPRINGS, CO 80909
PHONE (719) 596-0170 * FAX (719) 596-0190

SHEET TITLE: FINAL DRAINAGE PLAN PROPOSED CONDITIONS
PROJECT NAME: CATHEDRAL PINES SUBDIVISION FILING NO. 1

BENCHMARK:
TOP OF 5/8" DIA. REBAR 23' NORTH AND 20' EAST OF THE SOUTHWEST COR. OF SECTION 1
ELEV= 7436.65 - NAVD '88

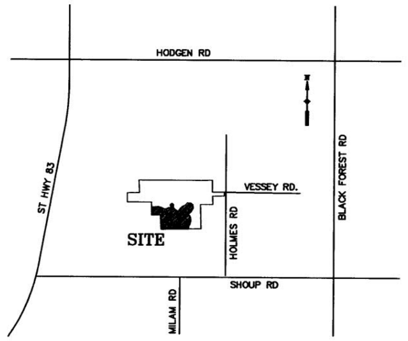
REVISIONS:

SCALE: 1" = 200'
DATE: 1/18/05
DRAWN BY: CLH
CHECKED BY: LAB

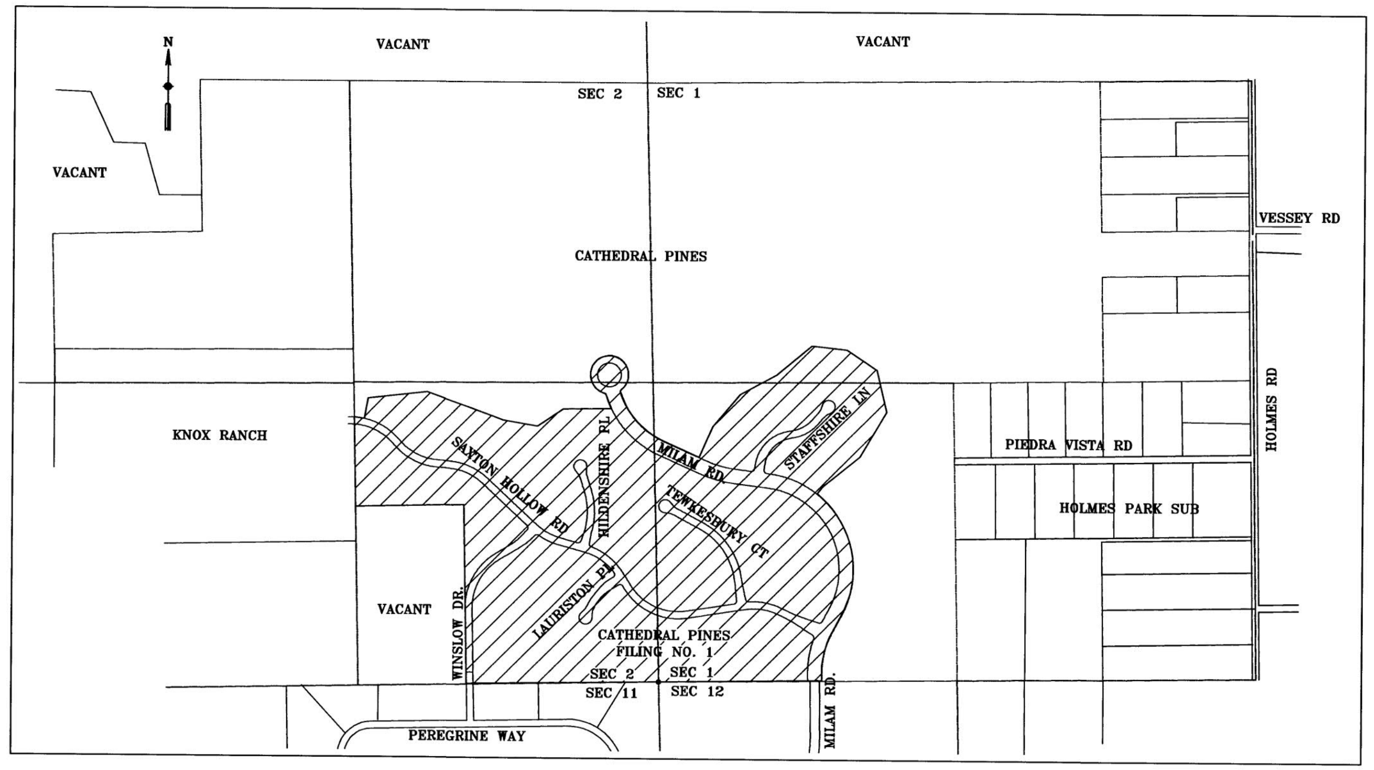
SHEET NO: 2 OF 2

PROJECT NO: 04040
DRAWING NAME: Final Drainage
VIEW: PROPOSED

CATHEDRAL PINES SUBDIVISION
FILING NO. 1
EL PASO COUNTY, COLORADO



VICINITY MAP
N T S



SITE MAP
1" = 800'

DEVELOPER'S STATEMENT:

I, THE DEVELOPER, HAVE READ AND WILL COMPLY WITH ALL THE REQUIREMENTS IN THIS CONSTRUCTION AND EROSION CONTROL PLAN.

BY ____________________ DATE

ENGINEER STATEMENT:

THESE DETAILED PLANS AND SPECIFICATIONS WERE PREPARED UNDER MY DIRECTION AND SUPERVISION. SAID DETAILED PLANS AND SPECIFICATIONS HAVE BEEN PREPARED ACCORDING TO THE CRITERIA ESTABLISHED BY THE CITY/COUNTY FOR DETAILED DRAINAGE PLANS AND SPECIFICATIONS, AND SAID DETAILED PLANS AND SPECIFICATIONS ARE IN CONFORMITY WITH THE MASTER PLAN OF THE DRAINAGE BASIN. SAID DETAILED DRAINAGE PLANS AND SPECIFICATIONS MEET THE PURPOSES FOR WHICH THE PARTICULAR DRAINAGE FACILITY(S) IS DESIGNED. I ACCEPT RESPONSIBILITY FOR ANY LIABILITY CAUSED BY NEGLIGENT ACTS, ERRORS OR OMISSIONS ON MY PART IN THE PREPARATION OF THESE DETAILED DRAINAGE PLANS AND SPECIFICATIONS.

P.E. COLORADO#

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF LEIGH WHITEHEAD & ASSOCIATES, INC.

COUNTY PLAN REVIEW IS PROVIDED ONLY FOR GENERAL CONFORMANCE WITH COUNTY DESIGN CRITERIA. THE COUNTY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, DIMENSIONS AND/OR ELEVATIONS WHICH SHALL BE CONFIRMED AT THE JOB SITE. THE COUNTY, THROUGH THE APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

JOHN A. McCARTY, P.E. DATE
DIRECTOR/COUNTY ENGINEER

TABLE 1: SIGHT DISTANCE

STREET NAME	CLASSIFICATION	DESIGN SPEED	POSTED SPEED	ENTERING SIGHT DISTANCE	MINIMUM STOPPING SIGHT DISTANCE
SAXTON HOLLOW ROAD	RESIDENTIAL	30 MPH	30 MPH	390	200
WINSLOW DRIVE	RESIDENTIAL	30 MPH	30 MPH	390	200
LAURISTON PLACE	RESIDENTIAL	30 MPH	30 MPH	325	200
TEWKESBURY COURT	RESIDENTIAL	30 MPH	30 MPH	325	200
MILAM ROAD	COLLECTOR	40 MPH	35 MPH	546	275
STAFFSHIRE LANE	RESIDENTIAL	30 MPH	30 MPH	325	200

INDEX OF SHEETS

1. COVER SHEET
2. TYPICAL NOTES & DETAILS
3. DRAINAGE NOTES & DETAILS
4. SAXTON HOLLOW ROAD–PLAN & PROFILE – STA: 1+00.00 TO 14+50.00
5. SAXTON HOLLOW ROAD–PLAN & PROFILE – STA: 14+50.00 TO 28+00.00
6. SAXTON HOLLOW ROAD–PLAN & PROFILE – STA: 28+00.00 TO 44+00.00
7. SAXTON HOLLOW ROAD–PLAN & PROFILE – STA: 44+00.00 TO 47+31.44
8. WINSLOW DRIVE–PLAN & PROFILE – STA: 1+00.00 TO 10+50.00
9. WINSLOW DRIVE–PLAN & PROFILE – STA: 10+50.00 TO 20+32.84
10. HILDENSHIRE PLACE–PLAN & PROFILE – STA: 1+00.00 TO 8+85.78
11. LAURISTON PLACE–PLAN & PROFILE – STA: 1+00.00 TO 6+45.18
12. TEWKESBURY COURT–PLAN & PROFILE – STA: 1+00.00 TO 13+22.24
13. MILAM ROAD–PLAN & PROFILE – STA: 10+00.00 TO 23+50.00
14. MILAM ROAD–PLAN & PROFILE – STA: 23+50.00 TO 37+50.00
15. MILAM ROAD–PLAN & PROFILE – STA: 37+50.00 TO 46+88.43
16. MILAM CIRCLE–PLAN & PROFILE – STA: 1+00.00 TO 9+16.79
17. STAFFSHIRE LANE–PLAN & PROFILE – STA: 1+00.00 TO 11+01.49
18. EROSION CONTROL PLAN – SHEET 1
19. EROSION CONTROL PLAN – SHEET 2
20. EROSION CONTROL PLAN – SHEET 3
21. EROSION CONTROL PLAN – SHEET 4
22. EROSION CONTROL PLAN – SHEET 5
23. EROSION CONTROL PLAN – SHEET 6
24. EROSION CONTROL PLAN – SHEET 7
25. EROSION CONTROL PLAN – SHEET 8
26. EROSION CONTROL PLAN – SHEET 9
27. STREET SIGNING PLAN – SHEET 1
28. STREET SIGNING PLAN – SHEET 2

LEGEND:

Symbol	Description
	DAYLIGHT LINE
—··—··—	RIGHT OF WAY LINE
—·—·—	PROPERTY BOUNDARY
—— · ——	LOT LINES
—— – – ——	PROPOSED UTILITY & GRADING EASEMENT
- - - - - - -	PROPOSED DRAINAGE EASEMENT
═ ═ ═	EXISTING CONTOURS
═══	PROPOSED CONTOURS
■■■■■■■■	C350 REINFORCED MAT NORTH AMERICAN GREEN
▬ ▬ ▬	SC150 REINFORCED MAT NORTH AMERICAN GREEN
———	SILT FENCE
	RETAINING WALL
(shaded)	NEW PAVEMENT
54	LOT NUMBERS

GOVERNING AGENCIES

EL PASO COUNTY DEPARTMENT OF TRANSPORTATION
3460 N. MARKSHEFFEL ROAD
COLORADO SPRINGS, CO 80922
PHONE: (719) 520-6460

MOUNTAIN VIEW ELECTRIC ASSOCIATION
11140 E. WOODMEN ROAD
FALCON, CO 80831
PHONE: (719) 495-2283

TRI-LAKES FIRE PROTECTION DISTRICT
18370 ROLLER COASTER ROAD
MONUMENT, CO 80132
PHONE: (719) 481-9644

BASIS OF BEARINGS

THE BASIS OF BEARINGS FOR THIS PLAT IS THE SOUTH LINE OF THE SOUTHWEST QUARTER OF SECTION 1, S89°18'49"E – 2644.82 FEET. THIS IS A GRID BEARING OF THE COLORADO STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE, NORTH AMERICAN DATUM 1983.

UPON SATISFACTORY INSPECTION, BUT BEFORE ACCEPTANCE BY THE COUNTY, A BOND SHALL BE POSTED TO INSURE THE SATISFACTORY PERFORMANCE OF GEOTEXTILE FABRICS INSTALLED IN THE ROADSIDE DITCHES CALLED OUT HEREIN. THIS BOND SHALL REMAIN POSTED FOR THREE YEARS.

These as-builts are effective per field survey data collected 10-08-08.

stillwater engineering
CONSULTING ENGINEERS
AND SURVEYORS
225 COLORADO AVENUE
PUEBLO CO 81004
719-534-1941, 543-1944 FAX

AS-BUILT STATEMENT I have made periodic site visits to the site during the construction process and verified that the improvements were installed according to the approved set of construction documents. Design revisions to these plans during construction are noted on the final as-built drawing provided by Stillwater Engineering. I have verified that the improvements have been constructed according to the applicable standards and specifications required by the El Paso County. In my professional judgment, the relative elevations and drainage patterns as built are in substantial conformance with the approved drainage report and final grading plan for Cathedral Pines Filing No.1. The drainage structures and grading have been constructed so as to facilitate the design intent of the approved drainage report. All permanent erosion and storm drainage features shown on the approved construction documents for this site are installed.

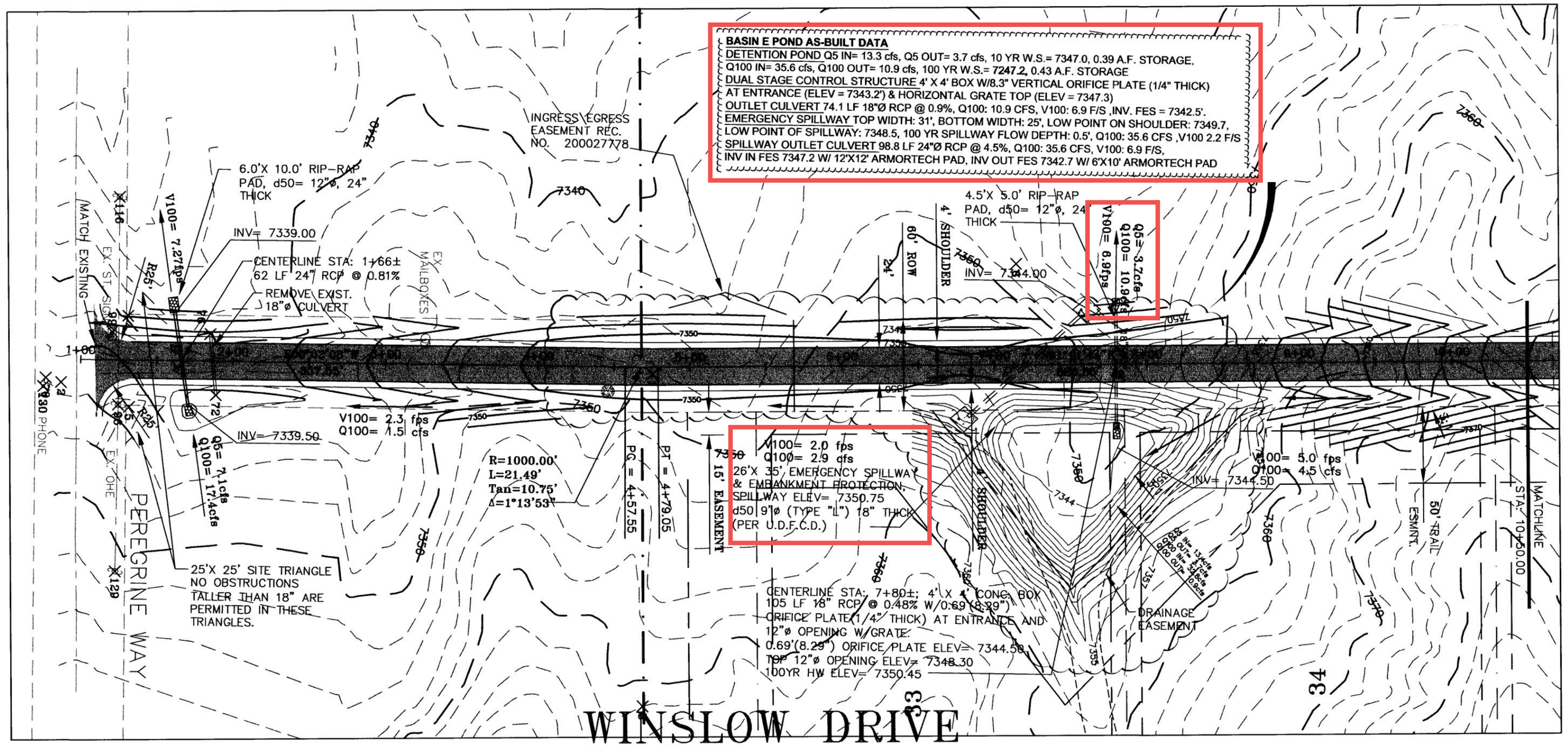
11/13/08
David Pyeatt, PE

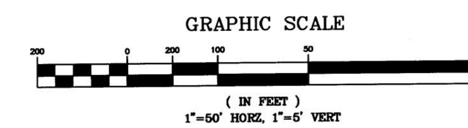
STREET PLAN & PROFILES
COVER SHEET
CATHEDRAL PINES FILING NO. 1
EL PASO COUNTY, COLORADO

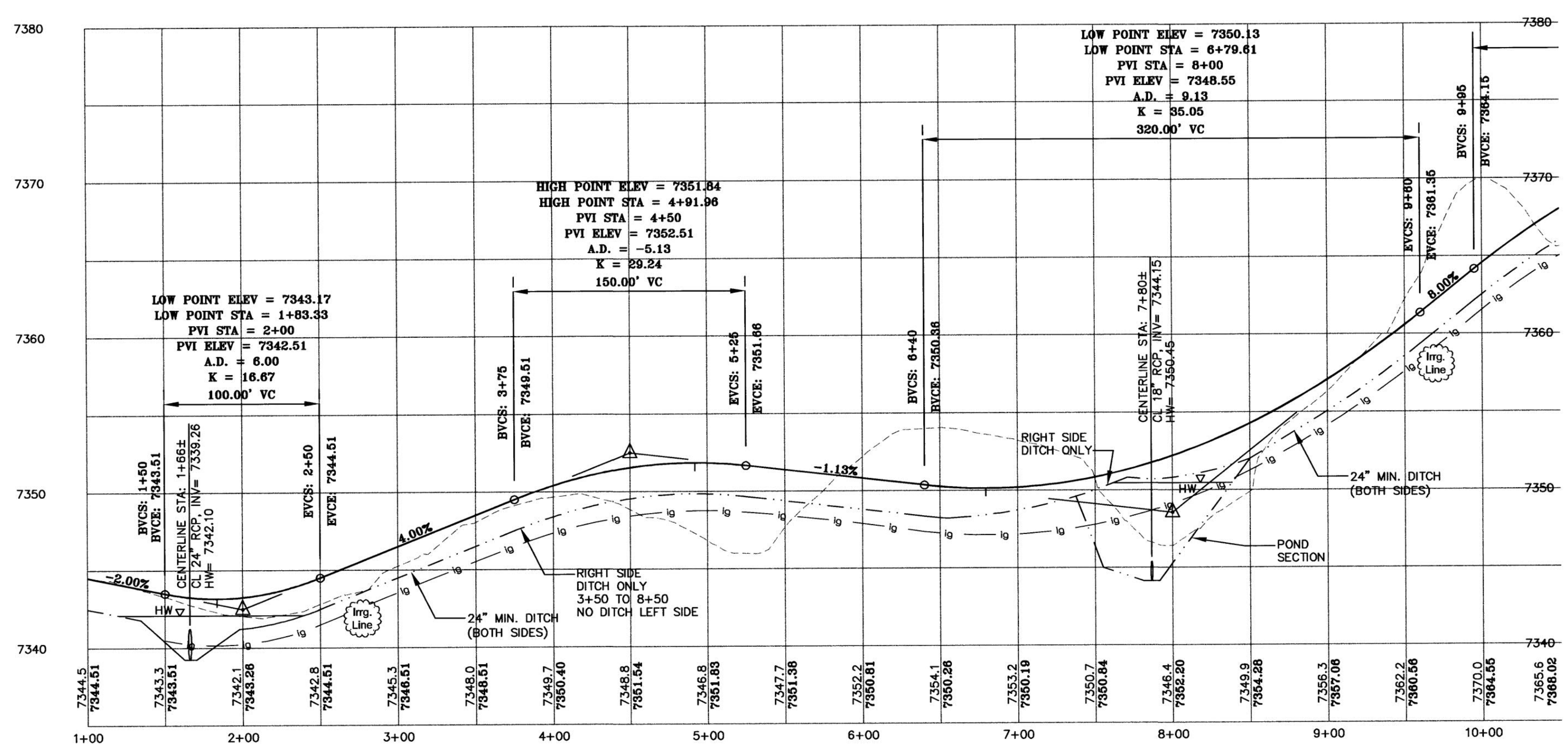
BENCHMARK
TOP OF 5/8" DIA. REBAR 23' NORTH AND 20' EAST OF THE SOUTHWEST COR. OF SEC. 1
ELEV=7436.65
NAVD '88

AS-BUILT DRAWINGS

DATE:	13 August 2008
DRAWN BY:	CLH/AGM
CHECKED BY:	DAP
JOB NO.:	2007-27
SHEET NO.	1 OF 28







These as-builds are effective per field survey data collected 10-08-08.

AS-BUILT STATEMENT I have made periodic site visits to the site during the construction process and verified that the improvements were installed according to the approved set of construction documents. Design revisions to these plans during construction are noted on the final as-built drawing provided by Stillwater Engineering. I have verified that the improvements have been constructed according to the applicable standards and specifications required by the El Paso County. In my professional judgment, the relative elevations and drainage patterns as built are in substantial conformance with the approved drainage report and final grading plan for Cathedral Pines Filing No.1. The drainage structures and grading have been constructed so as to facilitate the design intent of the approved drainage report. All permanent erosion and storm drainage features shown on the approved construction documents for this site are installed.

David Pyeatt, PE

stillwater engineering
CONSULTING ENGINEERS AND SURVEYORS
225 COLORADO AVENUE
PUEBLO CO 81004
719-534-1941, 543-1944 FAX

WINSLOW DRIVE
STA 1+00 TO 10+50
CATHEDRAL PINES FILING NO. 1
EL PASO COUNTY, COLORADO

BENCHMARK
TOP OF 5/8" DIA. REBAR 23' NORTH AND 20' EAST OF THE SOUTHWEST COR. OF SEC. 1
ELEV=7436.65
NAVD '88

AS-BUILT DRAWINGS

DATE:	13 August 2008
DRAWN BY:	CLH/AGM
CHECKED BY:	DAP
JOB NO.:	2007-27
SHEET NO.	8 OF 28

APPENDIX E

DRAINAGE MAPS

CATHEDRAL PINES
EXISTING DRAINAGE MAP

LAYER LINETYPE LEGEND

EXISTING

- SECTION LINE
- BOUNDARY LINE
- PROPERTY LINE
- EASEMENT LINE
- RIGHT OF WAY
- CENTERLINE
- ELECTRIC (E)
- FIBER OPTIC (FO)
- GAS MAIN (G)
- IRRIGATION MAIN (IRR)
- OVERHEAD UTILITY (OHU)
- SANITARY SEWER (S)
- STORM SEWER
- TELEPHONE (T)
- WATER MAIN (W)
- SWALE/WATERWAY FLOWLINE
- INDEX CONTOUR (6100)
- INTERMEDIATE CONTOUR
- DEPRESSION CONT. (INDEX) (6100)
- DEPRESSION CONT. (INTER)
- CURB & GUTTER
- WALL

BASIN ID — ID / AC / C_5 / C_{100}

DESIGN POINT DESIGNATION — 4

FLOW DIRECTION (EXISTING)

SUB-BASIN DRAINAGE AREA

DESIGN POINT SUMMARY TABLE

DP#	Q_5	Q_{100}
1	0.3	1.8
2	0.8	5.6
3	1.1	7.5
4	0.7	4.6
5	2.3	14.4
6	1.5	9.5
P1	3.7	10.9
7	2.3	14.0
7.1	6.0	24.9
O1	1.7	6.7
8	1.1	6.5
8.1	2.3	11.5
8.2	8.2	36.1

Values in blue indicate that they are from "Cathedral Pines Subdivision Filing No. 1 Drainage Report & Plan".

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
EX-1	0.84	2%	0.09	0.36	15.1	0.3	1.8
EX-2	3.16	2%	0.09	0.36	22.0	0.8	5.6
EX-3	4.89	2%	0.09	0.36	28.8	1.1	7.5
EX-4	2.67	2%	0.09	0.36	23.5	0.7	4.6
EX-5	8.29	3%	0.10	0.37	23.8	2.3	14.4
EX-6	4.74	3%	0.10	0.37	17.6	1.5	9.5
EX-7	8.06	3%	0.10	0.37	23.9	2.3	14.0
EX-8	3.64	3%	0.10	0.37	23.0	1.1	6.5
OS-1	2.44	12%	0.17	0.42	11.8	1.7	6.7

100 50 0 100 200

ORIGINAL SCALE: 1" = 100'

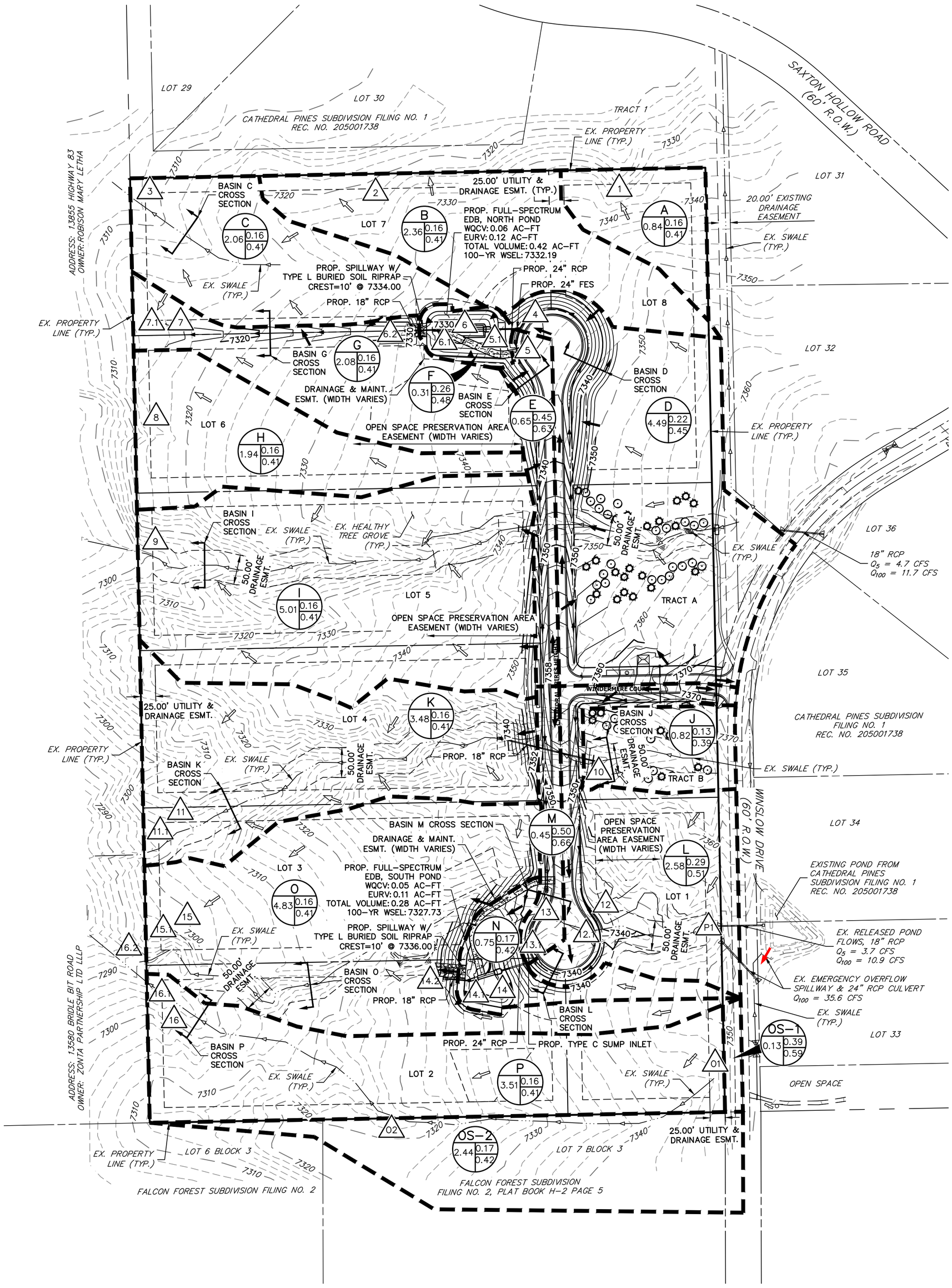
EXISTING DRAINAGE MAP
CATHEDRAL PINES
JOB NO. 25260.00
09/15/2023
SHEET 1 OF 1

J·R ENGINEERING
A Westrian Company

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

ESTATES AT CATHEDRAL PINES

PROPOSED DRAINAGE MAP



LAYER LINETYPE LEGEND

	EXISTING	PROPOSED
SECTION LINE		
BOUNDARY LINE		
PROPERTY LINE		
EASEMENT LINE		
RIGHT OF WAY		
CENTERLINE		
ELECTRIC	E	E
FIBER OPTIC	FO	FO
GAS MAIN	G	G
IRRIGATION MAIN	IRR	IRR
OVERHEAD UTILITY	OHU	OHU
SANITARY SEWER	S	
STORM SEWER		
TELEPHONE	T	T
WATER MAIN	W	W
SWALE/WATERWAY FLOWLINE		
INDEX CONTOUR	6100	6100
INTERMEDIATE CONTOUR		
DEPRESSION CONT. (INDEX)	6100	6100
DEPRESSION CONT. (INTER)		
CURB & GUTTER		
WALL		

BASIN ID (ID / AC / C_5 / C_{100})

DESIGN POINT DESIGNATION (4)

FLOW DIRECTION (PROPOSED)

FLOW DIRECTION (EXISTING)

SUB-BASIN DRAINAGE AREA

DESIGN POINT SUMMARY TABLE

DP#	Q_5	Q_{100}
1	0.4	1.8
2	1.1	4.8
3	1.0	4.2
4	2.9	10.3
5	1.1	2.6
5.1	3.8	12.4
6	0.4	1.2
6.1	4.1	13.1
6.2	1.2	7.9
7	1.0	4.2
7.1	2.2	12.1
8	0.9	3.9
9	2.7	11.6
10	0.4	2.2
11	1.9	8.1
11.1	2.3	9.9
P1	3.7	10.9
12	2.6	7.6
12.1	6.3	18.5
13	0.9	2.1
13.1	7.1	20.2
14	0.6	2.5
14.1	7.6	22.0
14.2	0.6	4.3
15	2.5	10.7
15.1	3.1	15.0
O1	0.3	0.7
O2	1.7	6.7
16	1.6	6.8
16.1	2.9	12.0
16.2	5.6	25.1

Values in blue indicate that they are from "Cathedral Pines Subdivision Filing No. 1 Drainage Report & Plan".

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
A	0.84	10%	0.16	0.41	18.1	0.4	1.8
B	2.36	10%	0.16	0.41	21.8	1.1	4.8
C	2.06	10%	0.16	0.41	21.4	1.0	4.2
D	4.49	17%	0.22	0.45	20.9	2.9	10.3
E	0.65	46%	0.45	0.63	12.1	1.1	2.6
F	0.31	25%	0.26	0.48	6.7	0.4	1.2
G	2.08	10%	0.16	0.41	22.2	1.0	4.2
H	1.94	10%	0.16	0.41	22.1	0.9	3.9
I	5.01	10%	0.16	0.41	16.6	2.7	11.6
J	0.82	7%	0.13	0.39	10.4	0.4	2.2
K	3.48	10%	0.16	0.41	16.5	1.9	8.1
L	2.58	26%	0.29	0.51	15.7	2.6	7.6
M	0.45	53%	0.50	0.66	10.1	0.9	2.1
N	0.75	13%	0.17	0.42	6.7	0.6	2.5
O	4.83	10%	0.16	0.41	18.5	2.5	10.7
P	3.51	10%	0.16	0.41	24.1	1.6	6.8
OS-1	0.13	39%	0.39	0.59	5.0	0.3	0.7
OS-2	2.44	12%	0.17	0.42	12.0	1.7	6.7

Lot Culvert Table

Lot #	Culvert Size
1	24" RCP
2	24" RCP
3	12" RCP
4	12" RCP
5	12" RCP
6	12" RCP
7	24" RCP
8	24" RCP

100 50 0 100 200

ORIGINAL SCALE: 1" = 100'

PROPOSED DRAINAGE MAP
ESTATES AT CATHEDRAL PINES
JOB NO. 25260.00
10/24/2023
SHEET 1 OF 1

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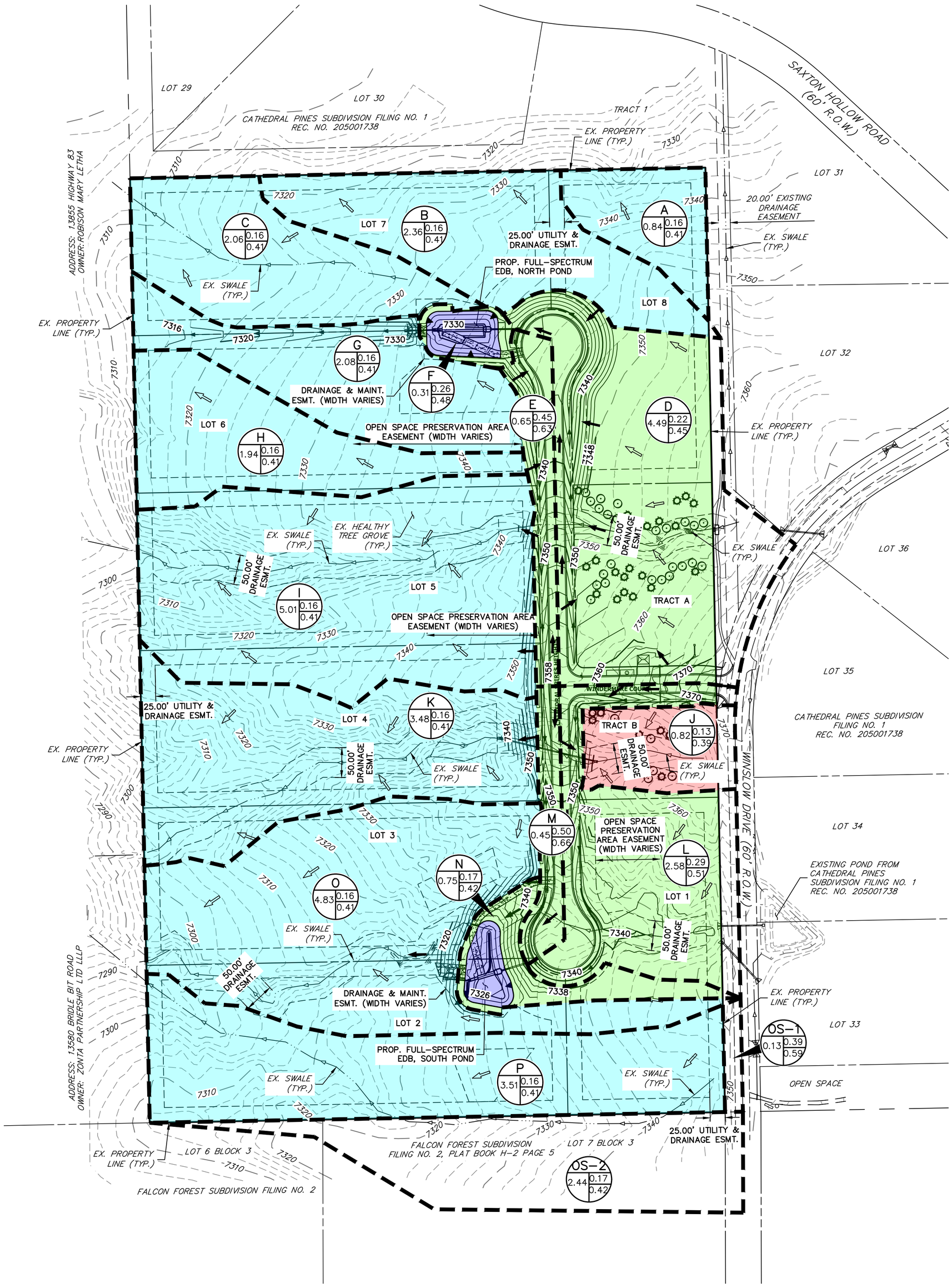
A Westrian Company
Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

ESTATES AT CATHEDRAL PINES

PROPOSED WATER QUALITY MAP



LAYER LINETYPE LEGEND

	EXISTING	PROPOSED
SECTION LINE		
BOUNDARY LINE		
PROPERTY LINE		
EASEMENT LINE		
RIGHT OF WAY		
CENTERLINE		
ELECTRIC	E	E
FIBER OPTIC	FO	FO
GAS MAIN	G	G
IRRIGATION MAIN	IRR	IRR
OVERHEAD UTILITY	OHU	OHU
SANITARY SEWER	S	
STORM SEWER		
TELEPHONE	T	T
WATER MAIN	W	W
SWALE/WATERWAY FLOWLINE		
INDEX CONTOUR	6100	6100
INTERMEDIATE CONTOUR		
DEPRESSION CONT. (INDEX)	6100	6100
DEPRESSION CONT. (INTER)		
CURB & GUTTER		
WALL		

BASIN ID — ID / AC / C5 / C100

DESIGN POINT DESIGNATION — 4

FLOW DIRECTION

SUB-BASIN DRAINAGE AREA

- LARGE-LOT SINGLE FAMILY DEVELOPMENT UNDETAINED AREA PER ECM APP I.7.1.B.5
- LAND DISTURBANCE TO UNDEVELOPED LAND THAT WILL REMAIN UNDEVELOPED AREA PER ECP APP I.7.1.B.7
- DETAINED AND TREATED AREAS WITHIN PROPOSED EDB'S
- APPROXIMATE EDB FOR DETENTION AND WATER QUALITY

Basin ID	Total Area (ac)	Area Tributary to Ponds (ac)	Area Excluded from WQ Per ECM App I.7.1.B.5 (ac)	Area Excluded from WQ Per ECM App I.7.1.B.7 (ac)	Applicable WQ Exclusions
A	0.84	-	0.84	-	ECM App I.7.1.B.5
B	2.36	-	2.36	-	ECM App I.7.1.B.5
C	2.06	-	2.06	-	ECM App I.7.1.B.5
D	4.49	4.49	-	-	-
E	0.65	0.65	-	-	-
F	0.31	0.31	-	-	-
G	2.08	-	2.08	-	ECM App I.7.1.B.5
H	1.94	-	1.94	-	ECM App I.7.1.B.5
I	5.01	-	5.01	-	ECM App I.7.1.B.5
J	0.82	-	-	0.82	ECM App I.7.1.B.7
K	3.48	-	3.48	-	ECM App I.7.1.B.5
L	2.58	2.58	-	-	-
M	0.45	0.45	-	-	-
N	0.75	0.75	-	-	-
O	4.83	-	4.83	-	ECM App I.7.1.B.5
P	3.51	-	3.51	-	ECM App I.7.1.B.5
OS-1	0.13	-	-	-	-
OS-2	2.44	-	-	2.44	ECM App I.7.1.B.5
Total	38.73	9.23	26.11	3.26	

N

100 50 0 100 200

ORIGINAL SCALE: 1" = 100'

PROPOSED WATER QUALITY MAP
ESTATES AT CATHEDRAL PINES
JOB NO. 25260.00
10/24/2023
SHEET 1 OF 1

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V2_Drainage Report - Preliminary_Comments.pdf Markup Summary

Callout (1)

Subject: Callout
Page Label: 15
Author: eschoenheit
Date: 1/4/2024 8:44:15 AM
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This should be revised to the Developer, HOA or District (based on how the comment within LOI V2 is addressed. Unresolved V1 comment.

Highlight (5)

caused by any negligе

Ryan Burns, Colorado
For and On Behalf of

Subject: Highlight
Page Label: 1
Author: eschoenheit
Date: 1/4/2024 8:28:14 AM
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Villagree Development,

Gregg & Elaine Cawlfie

5710 Vessey Road

Subject: Highlight
Page Label: 1
Author: eschoenheit
Date: 1/4/2024 8:28:15 AM
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Author: eschoenheit
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Author: eschoenheit
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Author: eschoenheit
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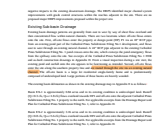
SW - Highlight (1)



Subject: SW - Highlight
Page Label: 4
Author: Mikayla Hartford
Date: 1/4/2024 11:12:21 AM
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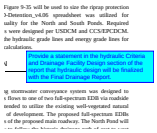
re routed through the site via an existing natural channel.

Text Box (4)



Subject: Text Box
Page Label: 12
Author: eschoenheit
Date: 1/4/2024 8:09:28 AM
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Provide a statement in the hydraulic Criteria and Drainage Facility Design section of the report that hydraulic design will be finalized with the Final Drainage Report.

Subject: Text Box
Page Label: 15
Author: eschoenheit
Date: 1/4/2024 9:59:56 AM
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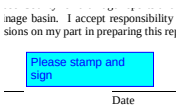
Note: A BMP maintenance agreement will need to be signed by the developer prior to plat recording. This will need to be submitted with the Final Plat submittal.



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Page Label: 1
Author: eschoenheit
Date: 1/4/2024 8:28:09 AM
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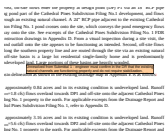
Please stamp and sign



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Author: Mikayla Hartford
Date: 1/4/2024 11:10:49 AM
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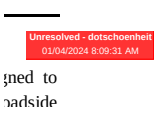
Unresolved from Submittal 1 - engineer must confirm in the DR that the existing natural channels are functioning properly and do not require stabilization.

Unresolved (2)



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Author: eschoenheit
Date: 1/4/2024 8:09:31 AM
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Unresolved - dotschoenheit
01/04/2024 8:22:48 AM

e submitted in

Subject: Unresolved
Page Label: 15
Author: eschoenheit
Date: 1/4/2024 8:44:17 AM
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