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Final Drainage Report

Monument Small Engine Storage

Project No. 61092

Revised: October 24, 2019

PCD File No.

PPR1946

Final Drainage Report

for

Monument Small Engine Storage

Project No. 61092

Revised: October 24, 2019

prepared for

David P. Hellbusch
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prepared by

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61092-Monument Small Engine-FDR-Revised.odt

Statements and Acknowledgments

Engineer's Statement

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable 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.

____ ________________

David R. Gorman, P.E. Colorado No. 31672 Date
For and on Behalf of MVE, Inc.

Developer's Statement

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

____ ________________

David P. Hellbusch Date
Owner
137 N. Monument Lake Rd
Monument, CO 80132

El Paso County

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

____ ________________

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

Contents

Final Drainage Report

The purpose of this Final Drainage Report is to identify drainage patterns and quantities within and affecting the proposed Monument Small Engine Storage site. This land use application is an amendment to a prior site development plan approved August 23, 2018 by El Paso County Planning and Community Development. This revised amended drainage report is in support of a site plan approval for the 2018 rezone application to allow outdoor RV storage on the property. The report will “identify specific solutions to problems on-site and off-site resulting from the proposed project. The report and included maps present results of hydrologic and drainage facilities analyses. The report will discuss the recommended drainage improvements to the site and identify drainage requirements relative to the proposed project. This report has been prepared and submitted in accordance with the requirements of the El Paso County development approval process. An Appendix is included with this report with pertinent calculations and graphs used in the drainage analyses and design.

1 General Location and Description

1.1 Location

The proposed Monument Small Engine Storage site is located within the southwest one-quarter of the northeast one-quarter of Section 15, Township 11 South, Range 67 west of the 6th principal meridian in El Paso County, Colorado. The 3.89± acre site is situated north of the intersection of Mitchell Avenue and Monument Lake Road. The site is generally west of the Denver & Rio Grand Railroad, north of Monument Lake Road at Mitchell Avenue. The site contains an existing business using the address of 137 N. Monument Lake Road. The El Paso County Assessor's Schedule Number for the site is 711510008. The proposed site has never been platted. A **Vicinity Map** is included in the **Appendix**.

The south edge of the site is adjacent to an unplatted parcel containing a single-family residence and zoned PRD (Planned Residential Development). This parcel is located in the Town of Monument and separates the site from Monument Lake Road (60' R.O.W.) which is located along the south edge of the parcel. Mount Herman RV Storage Subdivision, located along the east side of the site, is located within the Town of Monument, is zoned PID (Planned Industrial Development) and contains an RV storage business. Unplatted and undeveloped property, located within El Paso County and zoned RR-5 (Residential Rural), lies north of the site. Unplatted property zoned RR-5 and containing a single family residence is located adjacent to the east side of the site.

Crystal Creek, a tributary to Monument Creek, flows northeast to southwest through the adjacent property to north. The site is located in El Paso County's Crystal Creek Drainage Basin.

1.2 Description of Property

The Monument Small Engine Storage site 3.89± acres and is zoned CS (Commercial Service). The property is the location of a business with an existing shop, garage building, shed, gravel drives and parking areas, mostly concentrated at the southeast portion.

The site has been used for many years as an equipment and engine repair shop with an approved Variance of Use from El Paso County. A past use of the site has been as a plant and tree nursery with green house buildings, gravel drives and open space. Terraced railroad tie retaining walls are provide a reference to the reception no. and a copy of the document that vacated the easement.

located in the western portion of the site. A gravel parking area is located in the northeastern portion. A gravel access drive formerly ran through the site from north to south that is also used to serve the adjacent residence. The access easement has been vacated and this gravel drive is no longer used to access the adjacent property. Ground cover in the non gravels areas is typically native grasses and weeds with sparse trees and shrubs scattered. The condition of the ground cover on the site varies from poor to good, depending on location within the site. Former drive areas are relatively bare, but the nursery areas are in good condition. Access to the site is via one point off of North Monument Lake Road from the south. Power poles and lines are also located near and through the site.

The site slopes generally from east to west with grades ranging from 1% to 6% with intermittent walls or short terraces. The lowest point on the site is the southwester corner. An existing stormwater quality pond exists on the adjacent property on the east which outfalls onto the site near the eastern boundary in the center. An existing 12” CMP culvert discharges from the pond into the site and the outflow is intercepted by a shallow ditch, which directs the flows to the northwest corner and then offsite. No significant drainageways flow through the site and no significant drainage improvements or drainage facilities currently exist on the site.

According to the National Resource Conservation Service, the soil in the area of the Monument Small Engine Storage site consists of Tomah-Crowfoot loamy sand (map unit 92). The soil is deep and well drained. Permeability is moderately rapid, surface runoff is slow, and the hazard of erosion is slight to moderate. Tomah-Crowfoot loamy sand is classified as being part of Hydrologic Soil Group B. A portion of the Soil Map and data tables from the National Cooperative Soil Survey and relevant Official Soil Series Descriptions (OSD) are included in the **Appendix**.[1] [2]

There are no major drainageways in the Monument Small Engine Storage site. However, Crystal Creek is located to the north of the site. Crystal Creek drains into Monument Reservoir and is tributary to Monument Creek.

The current Flood Insurance Study of the region includes Flood Insurance Rate Maps (FIRM), effective on December 7, 2018.[3] The proposed subdivision is included in two Community Panels Numbered 08041C0276 G of the Flood Insurance Rate Maps for the El Paso County. No part of the site is shown to be included in a 100-year flood hazard area as determined by FEMA. A portion of the current FEMA Flood Insurance Rate Maps with the site delineated is included in the **Appendix**.

2 Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

The Monument Small Engine Storage site is located in the Crystal Creek Drainage Basin (FOFO5300) of the Fountain Creek Major Drainage Basin (FO). This basin drains to Monument Creek. The *Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study* provides development recommendations and requirements for drainage development in the Crystal Creek Drainage Basin (DBPS).[4] The Crystal Creek Drainage Basin encompasses a part of the northwest portion of the Town of Monument and extends to the north and east. The drainage basin and Crystal Creek drains southwest into Monument Creek. The Monument Small Engine Storage site is located east of Crystal Creek as it flows offsite towards Monument Creek . The site is located in sub-basin CC 185, upstream of Design Point 185 of the Drainage Basin Planning Study. The closest drainage improvements that the study recommends is offsite at the Monument Lake Road crossing of Crystal Creek. No other improvements are recommended on or near the project site. A copy of a portion of the **“*Drainage Area Identification Study*”**[5] **map**, showing the site location within the Basin is included in the **Appendix**. The proposed Monument Small Engine Storage project is in conformance with the DBPS.

1 WSS
2 OSD
3 FIRM
4 DBPS
5 Drain. Area Ident. Study

2.2 Other Drainage Reports

The adjacent property in the east was studied as detailed in the report “Final Drainage Report, Mount Herman RV Storage Subdivision, Town of Monument Colorado” by M.V.E., Inc. dated January 30, 2014.[6] The Mount Herman report establishes the offsite basin conditions to the east, including the existing storm water quality sand filter basin. The offsite basin and pond were re-evaluated in the report “Final Drainage Report, Monument Small Engine Storage” by M.V.E., Inc. dated June 15, 2018 using the current drainage criteria adopted by the County and those updated results are included in this revised Monument Small Engine Storage drainage report.

2.3 Sub-Basin Description

The existing drainage patterns of the Monument Small Engine Storage are described by two on-site drainage basins and one offsite basin. All of these basins are previously disturbed or developed to a degree as described below. All existing basin delineations and data are depicted on the attached **Existing Drainage Map**.

2.3.1 Existing Drainage Patterns (Off-Site)

Existing off site sub-basin OSA1 is located to the east of the site, containing the developed Lot 1 Mount Herman RV Storage Subdivision with existing RV storage area, pond area, landscape area and railroad right-of-way. The basin drains to the existing water quality pond and then into the site by way of an exiting 12” CMP pipe from the pond along with the pond spillway located on the property line. This flow enters the onsite basin A1 and continues through the site.

2.3.2 Existing Drainage Patterns (On-Site)

The site generally drains to the west, but contains a gravel drive and ditch that drains to towards the northwest corner of the site. The northeast portion of the site, combined with flows from off-site Basin OSA1 drain towards the northwest corner of the site. The remaining potion of the site drains west towards the site's western boundary.

Existing sub-basin A1 is located in the northeastern portion of the site and contains some gravel parking area and slope leading to the existing ditch and gravel drive. The existing 12” CMP from offsite Basin OSA1 outfalls into Basin A1. All flows from Basin A1 exit the site at the southwest corner into the adjacent site to the west, which is also owned by the owner of the adjacent property to the east. These flows continue west through the adjacent properties to Crystal Creek.

Existing sub-basin A2 is also located in the northeastern portion of the site, just south of sub-basin A1. The sub-basin contains gravel drive, leach field area, and pasture/meadow. All flows from sub-basin A2 exit the site at the west property line. The western adjacent property is owned by the owner of the adjacent property to the east. These flows continue west through the adjacent property and into Crystal Creek.

Existing sub-basin B1 is located on the southerly and westerly portion of the site, containing the existing shop, garage, and shed buildings, paved parking and walk areas, gravel drive and parking areas and open meadow areas with tiered railroad tie walls. The previously existing greenhouse buildings in this basin have been removed. The flows generated by this basin drain to the west and exit the site by sheet flow into the adjacent site to the west. These flows continue west through the adjacent properties to Crystal Creek. All flows from the site eventually enter Monument Reservoir and then Monument Creek.

3 Drainage Design Criteria

3.1 Development Criteria Reference

This Final Drainage Report for Monument Small Engine Storage has been prepared according to the report guidelines presented in the latest edition of *El Paso County Drainage Criteria Manual* (DCM)[7].

6 Mount Herman FDR
7 DCM Section 4.3 and Section 4.4

The County has also adopted portions of the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, especially concerning the calculation of rainfall runoff flow rates.[8] [9] The hydrologic analysis is based on a collection of data from the DCM, the NRCS Web Soil Survey[10], Existing topographic data by Cornerstone Surveying, and proposed site plan by RMJ Designs.

3.2 Hydrologic Criteria

For this Final Drainage Report, the Rational Method as described in the D*rainage Criteria Manual* has been used for all Storm Runoff calculations, as the development and all sub-basins are less than 130 acres in area. "Colorado Springs Rainfall Intensity Duration Frequency" curves, Figure 6-5 in the DCM, was used to obtain the design rainfall values; a copy is included in the **Appendix**. The "Overland (Initial) Flow Equation" (Eq. 6-8) in the DCM, and Manning's equation with estimated depths were used in time of concentration calculations. "Runoff Coefficients for Rational Method", Table 6-6 in the DCM, was utilized as a guide in estimating runoff coefficient and Percent Impervious values; a copy is included in the **Appendix**. Peak runoff discharges were calculated for each drainage sub-basin for both the 5-year storm event and the 100-year storm event with the Rational Method formula, (Eq. 6-5) in the DCM.[11]

The "Water Quality Control Volume procedure, Section 3.2.3 of the *Urban Drainage and Flood Control District Drainage Criteria Manual, Volume 3* (UDFCD)[12] [13]method was used for water quality volume calculations with the aid of the "UD-BMP_v3.06" spreadsheet developed by the Urban Drainage and Flood Control District. Storm routing calculation through the proposed water quality basin was performed using triangular hydrographs based on the rational method peak discharges and times of concentrations with the aid of the detention design spreadsheet, "UD-Detention_v3.07", developed by the Urban Drainage and Flood Control District.[14]

4 Drainage Facility Design

4.1 General Concept

The intent of the drainage concept presented in this Final Drainage Report is to maintain the existing drainage patterns on the site while addressing water quality requirements for the site. Major and minor storm flows will continue to be safely conveyed through the site and downstream.

The existing and proposed drainage hydrologic conditions are described in more detail below. Input data and results for all calculations are included in the **Appendix**. Drainage maps for the hydrology are also included in the **Appendix**.

4.2 Specific Details

4.2.1 Existing Hydrologic Conditions

The off-site drainage area east of the site, Basin OSA1, contains the existing RV storage area, pond area, landscape area and railroad right-of-way. The sub-basin is 4.05 acres in area and drains westerly and into the existing offsite water quality pond. Basin OSA1 generates peak storm runoff discharges of Q_5 = 7.6 cfs and Q_{100} = 16.6 cfs (existing flows) which enter the pond, which is a full-infiltration type Sand Filter basin. The Water Quality Capture Volume (WQCV) is captured and percolates into the ground. Runoff greater than the WQCV from the existing pond discharges into the site by way of the 12" CMP and emergency spillway with peak flows of Q_5 = 2.8 cfs and Q_{100} = 12.1 cfs (existing flows), which enter the site into sub-basin A1. In the 100 year rainfall event, approximately 4.4 cfs exits the pond from the existing 12" CMP and is discharged onto the site, while approximately 7.7 cfs exits through the emergency spillway crest and into the site. Once in the site, these flows continue to drain to the northwest corner.

8 CS DCM Vol 1
9 CS DCM Vol 2
10 WSS
11 DCM
12 UDFCD V.2
13 UDFCDV.3
14 UDFCD

The stated flows entering the site from sub-basin OSA1 are an existing condition which is greater than flows from a pre-developed condition. However, this site and the easterly offsite property was previously used for many years as a landscape nursery with significant areas dedicated to greenhouse buildings and landscape operations characterized with packed gravel drives and material storage. In the current condition, the greenhouse buildings have been removed and storage areas are gone. The current offsite condition with recycled asphalt surface is not significantly different than the previously existing (at least 38 years) with greenhouses and compacted gravel. The developed flows from the sub-basin OSA1 travel through the site and enters Crystal Creek located approximately 250 feet northwest of the site. The Crystal Creek Basin extends more than two miles to the north of the site with a contributing area of more than 550 acres upstream of the site. The peak flows from off-site sub-basin OSA1, along with the on-site flows discussed below, reach Crystal Creek and pass downstream well before the peak discharges of the much larger basin travel by the area. The small increase flows have no effect on peak flows in Crystal Creek and do not present a hazard to the downstream properties, drainage basin, or drainageways.

Existing sub-basin A1 is 1.42 acres in area located on the northern portion of the site and contained a gravel drive and meadow area. The sub-basin accepts the offsite flows from sub-basin OSA1 as described above. Sub-basin A1 produces peak discharges of Q_5 = 0.7 cfs and Q_{100} = 3.4 cfs (existing flows) which drain westerly to the existing gravel drive and ditch, joining the off-site flows from Basin OSA1. The combined flows of Q_5 = 3.5 cfs and Q_{100} = 15.5 cfs (existing flows) continue towards the northwest corner of the site to existing Design Point 1 (DP1). The flows continue westerly offsite, through the adjacent property and into Crystal Creek.

Existing sub-basin A2, located in the northwestern portion of the site and just south of sub-basin A1, is 0.32 acres in area. Sub-basin A2 contains a gravel drive, leach field and meadow/pasture area. Peak storm runoff rates are Q_5 = 0.2 cfs and Q_{100} = 1.0 cfs (existing flows) which drain westerly into the adjacent property, in a combination of sheet flow and an area of concentrated flow in the southwest edge of the basin. The concentrated flow occurs in an existing swale flowing to the west through the adjacent property towards Crystal Creek. Flows from existing Design Point 1 also flow into this swale. The combined discharges of Design Point 1 and sub-basin A2 are Q_5 = 3.7 cfs and Q_{100} = 16.3 cfs (existing flows). The flows continue westerly offsite, through the adjacent property and into Crystal Creek.

Existing sub-basin B1 (2.15 acres) is comprised of the southerly and westerly portion of the site and contains the existing shop, garage, and shed buildings, paved parking and walk areas, gravel drive and parking areas and open meadow areas with tiered railroad tie walls. The sub-basin generates flows of Q_5 = 2.0 cfs and Q_{100} = 6.1 cfs (existing flow), which drains westerly and exit the site by sheet flow into the adjacent property. These flows, along with the flows from existing DP1 and sub-basin A2, continue offsite to Crystal Creek and into Monument Reservoir and Monument Creek as described in Section 2.3 above.

The **Existing Drainage Map** depicts the existing topographic mapping, drainage basin delineations, drainage patterns, existing drives, drainage facilities, and runoff quantities with a data table including drainage areas and flow rates.

4.2.2 Proposed Hydrologic Conditions

Water quality treatment for the new disturbed and impervious areas on the site will be provided by a proposed Sand Filter Basin which will capture, contain, treat and release the Water Quality Capture Volume (WQCV). No detention for flood control is being provided because the downstream effects of the minor increases in peak flow rates are negligible. Several greenhouse buildings have been removed from the site in recent months and additional buildings are to be removed in the proposed site plan. This building removal partially offsets the additional parking areas on the site. The parking area surface is not completely impervious, but rather compacted recycled asphalt material or gravel, which allows a degree of perviousness on the site. Additionally, the developed flows from the offsite and onsite sub-basins travel through the site and enters Crystal Creek located approximately 250 feet northwest of the site. The Crystal Creek Basin extends more than two miles to the north of the site with a contributing area of more than 550 acres upstream of the site. The peak flows from off-site sub-basin OSA1, along with the on-site flows discussed below, reach Crystal Creek and pass downstream well before the peak discharges of the much larger basin travel by the area. The small increase flows have no effect on peak flows in Crystal Creek and do not present a hazard to the downstream properties, drainage basin, or drainageways and no storm detention is required in addition to the WQCV.

The off-site drainage basin, OSA1 (4.05 acres), will continue to drain into the site as in existing conditions. The discharges entering the site from the existing offsite water quality pond are Q_5 = 2.8 cfs and Q_{100} = 12.1 cfs (proposed flow) which enter proposed onsite sub-basin A2. The existing pond discharges into the site by way of the 12" CMP and emergency spillway with peak flows of Q_5 = 2.8 cfs and Q_{100} = 12.1 cfs (existing flows), which enter the site into sub-basin A2. In the 100 year rainfall event, approximately 4.4 cfs exits the pond from the existing 12" CMP and is discharged onto the site, while approximately 7.7 cfs exits through the emergency spillway crest and into the site. Once in the site, these flows continue to drain to the northwest corner.

Proposed sub-basin A1 (0.51 acres) is comprised of a portion of the south side of site. The sub-basin will contain the proposed new shop building and recycled asphalt product parking surface. The existing garage and shed will be removed and the existing gravel drive will be reconfigured. A concrete sidewalk will also be installed adjacent to the building on two sides. The developed discharges from sub-basin A1 are Q_5 = 0.9 cfs and Q_{100} = 2.0 cfs (proposed flows). These flows travel overland to the northwest and will be directed by new drainage swale on the west and north sides of the new building to a new 8" hdpe pipe at Design Point (DP1) to the northeast and enter the ditch/swale in sub-basin A2.

Proposed sub-basin A2 (1.97 acres) will be more developed with RV parking area and the parking surface will be stabilized with recycled asphalt product. The sub-basin will continue to accept the off-site flows from sub-basin OSA1 to the east. These flows will continue to be conveyed in the existing drainage ditch/swale located along the east edge of the existing gravel drive. This ditch/swale will be reshaped. The developed discharges generated by sub-basin A2 are Q_5 = 4.3 cfs and Q_{100} = 9.2 cfs (proposed flow), which drains westerly to the existing ditch/swale and combine with the off-site flows from sub-basin OSA1 and the pipe flow from sub-basin A1 until reaching the northwest corner of the site at Design Point 2 (DP2). The combined discharges at Design Point 2 (DP2) are Q_5 = 7.4 cfs and Q_{100} = 22.0 cfs (proposed flow). These flows will enter the proposed water quality sand filter basin (WQSF) to be located in the northwest corner of the site.

Update the narrative. Is the standpipe sufficient or will it also discharge over the spillway in the minor storm event.

Proposed sub-basin A3 (0.42 acres) will be more developed with RV parking area and the parking surface will be stabilized with recycled asphalt product. These flows will be directed to the north by a proposed berm and ditch/swale to be constructed along the west side of the existing gravel drive. The developed discharges generated by sub-basin A3 are Q_5 = 0.9 cfs and Q_{100} = 2.0 cfs (proposed flow), which drains northerly and will enter the proposed WQSF basin to be located in the northwest corner of the site.

The proposed WQSF basin (DP3) will be 2,134 cubic feet in volume and have a sand surface area of 1,390 square feet. The proposed water quality basin will have an under drain with metered outfall, a 12" hdpe outfall pipe and a 15' wide emergency spillway stabilized with soil covered rip-rap. Outflows from the pond are Q_5 = 5.3 cfs and Q_{100} = 21.4 cfs (proposed flow). In the 100-year rainfall event, approximately 1.4 cfs exits the pond from the 12" standpipe inlet located just above the WQCV elevation in the pond and the remaining 20.0 cfs exits by way of the emergency spillway. Pond outflows will be discharged to a culvert and swale in sub-basin A4. The outflows will be spread and evenly distributed as sheet flow before exiting the west site boundary by a riprap lined spreading depression.

Proposed sub-basin A4 consist of primarily undisturbed pasture/meadow with the addition of a swale directing the flows from the WQSF basin to the south and into a rip rap lined spreading depression and berm that will force the flow to sheet over a wide area reducing velocities depth at the property line and is a suitable outfall of the pond outflows. The developed discharges generated by sub-basin A4 are Q_5 = 0.3 cfs and Q_{100} = 2.2 cfs (proposed flow), combine with the flows from the WQCV pond at Design Point 3 (DP3). The combined discharges at Design Point 4 (DP4) are Q_5 = 5.6 cfs and Q_{100} = 23.6 cfs (proposed flow). These flows will continue westerly through the adjacent property and flow towards Crystal Creek, the same as existing conditions. The existing stable flow path through the adjacent site is adequate to carry the existing and developed flows. Flow velocities in the existing flow path are not erosive and require no special lining. The flow path delivers the flows west to Crystal Creek.

Proposed sub-basin A5 consists of a small portion of the downhill slope of the proposed WQSF basin (0.11 acres) at the north end of the site. This basin is grassed pervious area. The discharges generated by sub-basin A5 are Q_5 = 0.0 cfs and Q_{100} = 0.3 cfs (proposed flow).

Existing sub-basins OSA1, A1 and A2 generated a combined flow of Q_5 = 3.7 cfs and Q_{100} = 16.5 cfs (historic flow) directed generally towards the existing structures on the adjacent property to the west. The combined historic flows that leave the site along the west edge from existing sub-basins A1, A2 & B1 are Q_5 = 5.7 cfs and Q_{100} = 22.6 cfs. In the developed condition, the proposed WQSF basin outfall and rip rap lined spreading depression and berm will direct flows south and away from the existing structures and into an area of open grassland to be released over a wide area. The combined developed condition discharges leaving the property at Design Point 4 (DP4) are Q_5 = 5.6 cfs and Q_{100} = 23.6 cfs (proposed flow), which is 0.1 cfs less than existing flow during the 5 year event and 1.0 cfs greater than the existing flows in the in the 100 year event. The implementation of the development includes the removal of structures and paved area, the new RV parking areas are not paved with impervious materials and the proposed water quality sand filter basin provides a degree of storm peak attenuation. The calculated increase in the 100-year event is an insignificant and negligible increase for the 3.9 acre site and no detention is required.

4.3 Erosion Control

During future construction, best management practices (BMP's) for erosion control will be employed based on the previously referenced City of Colorado Springs Drainage Criteria Manual Volume 2 and the Erosion Control Plan for the site. During Construction, silt fencing, sediment control log, vehicle tracking control and concrete washout area will be in place to minimize erosion from the site. Silt Fencing will be placed along the northern and western sides of the disturbed areas. This will inhibit suspended sediment form leaving the site during construction. Silt fencing is to remain in place until the parking area is stabilized with the recycled asphalt and until vegetation is reestablished in the other disturbed areas which are to be reseeded. Vehicle tracking control will be placed at the access point in the private driveway connecting to Monument Lake Road. Inlet protection will be placed at the water quality pond outlet locations. BMP's will be utilized as deemed necessary by the contractor, engineer, owner, or County inspector and are not limited to the measures described above. The water quality sand filters will also serve as sediment traps until construction is compete.

4.4 Water Quality Enhancement Best Management Practices

The Sand Filter Basins described above will provide storage for the Water Quality Capture Volume (WQCV) for the site. A Grading and Erosion Control Plan for the construction of the site has been prepared in accordance with the provisions of the DCM. Placement of construction stormwater BMP's will as required by the plan will limit soil erosion and deposition by stormwater flowing over the site.

The El Paso County Engineering Criteria Manual (Appendix I, Section I.7.2) requires the consideration of a “Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long term source controls”. The Four Step Process is incorporated in this project and the elements are discussed below.

1) Runoff Reduction Practices are employed in this project. Impervious surfaces have been reduced as much as practically possible. Some of the existing structures on the site are being removed, reducing impervious surfaces. There is only minimal concrete or other hard surfaces proposed. RV storage area will be stabilized with recycled asphalt surfacing, which remains a partially pervious surface. Minimized Directly Connected Impervious Areas (MDCIA) is employed on the project because runoff passes through the western open space meadow area before leaving the site.

2) All drainage paths on the site are stabilized with pavement or appropriate landscape treatment. The water quality ponds are intended to intercept flows from developed areas. Additionally, the pond outflow points will have rip rap protection.

3) The project contains no potentially hazardous uses. All developed areas drain into a proposed a WQCV BMP.

4) The site contains no storage of potentially harmful substances or use of potentially harmful substances. No Site Specific or Other Source Control BMP's are required.

5 Opinion of Probable Cost for Drainage Facilities

There is no public or private storm drain system proposed for development of this site. The private water quality facilities will be constructed as part of the site grading plan at the time of building construction. The property owner is responsible for construction and maintenance of the water quality facilities.

6 Drainage and Bridge Fees

The site is not being platted. No Drainage or Bridge Fees are due for this project.

7 Conclusion

This Final Drainage Report presents existing and proposed drainage conditions for the proposed Monument Small Engine Storage project. The development will have negligible and inconsequential effects on the existing site drainage and drainage conditions downstream. Water Quality treatment will be provided. The proposed project will not, with respect to stormwater runoff, negatively impact the adjacent properties and downstream properties.

References

NRCS Web Soil Survey. United States Department of Agriculture, Natural Resources Conservation Service ("http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx", accessed March, 2018).

NRCS Official Soil Series Descriptions. United States Department of Agriculture, Natural Resources Conservation Service ("http://soils.usda.gov/technical/classification/osd/index.html", accessed March, 2018).

Flood Insurance Rate Map. Federal Emergency Management Agency, National Flood Insurance Program (Washingon D.C.: FEMA, March 17, 1997).

Drainage Area Identification Study. Muller Engineering Company, Inc. (Lakewood, CO: , 1986).

Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study. Kiowa Engineering Corporation (Colorado Springs: El Paso County, September, 1993).

Final Drainage Report, Mount Herman RV Storage Subdivision, Town of Monument, Colorado. M.V.E., Inc. (Colorado Springs, CO: , January 30, 2014).

NCSS Web Soil Survey. United States Department of Agriculture, Natural Resources Conservation Service ("http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx", accessed May, 2017).

Drainage Criteria Manual Volume 2, Stormwater Quality Policies, Procedures and Best Management Practices (BMPs). City of Colorado Spring Engineering Division (Colorado Springs: , May 2014).

City of Colorado Springs Drainage Criterial Manual, Volume 1. City of Colorado Springs Engineering Division Staff, Matrix Desgin Group/Wright Water Engineers (Colorado Springs: , May 2014).

City of Colorado Springs/El Paso County Drainage Criteria Manual. City of Colorado Springs, Department of Public Works, Engineering Division; HDR Infrastructure, Inc.; El Paso County, Department of Public Works, Engineering Division (Colorado Springs: City of Colorado Springs, Revised November 1991).

City of Colorado Springs Drainage Criteria Manual Volume 1. City of Colorado Springs Engineering Division with Matrix Design Group and Wright Water Engineers (Colorado Springs, Colorado: , May 2014).

Detention Design Spreadsheet. Urban Drainage and Flood Control District ("http://www.udfcd.org/downloads/software/UD-Detention_v2.2.xls", accessed January 2010).

Urban Storm Drainage Criteria Manual Volume 3. Urban Drainage and Flood Control District (Denver, Colorado: , August, 2011).

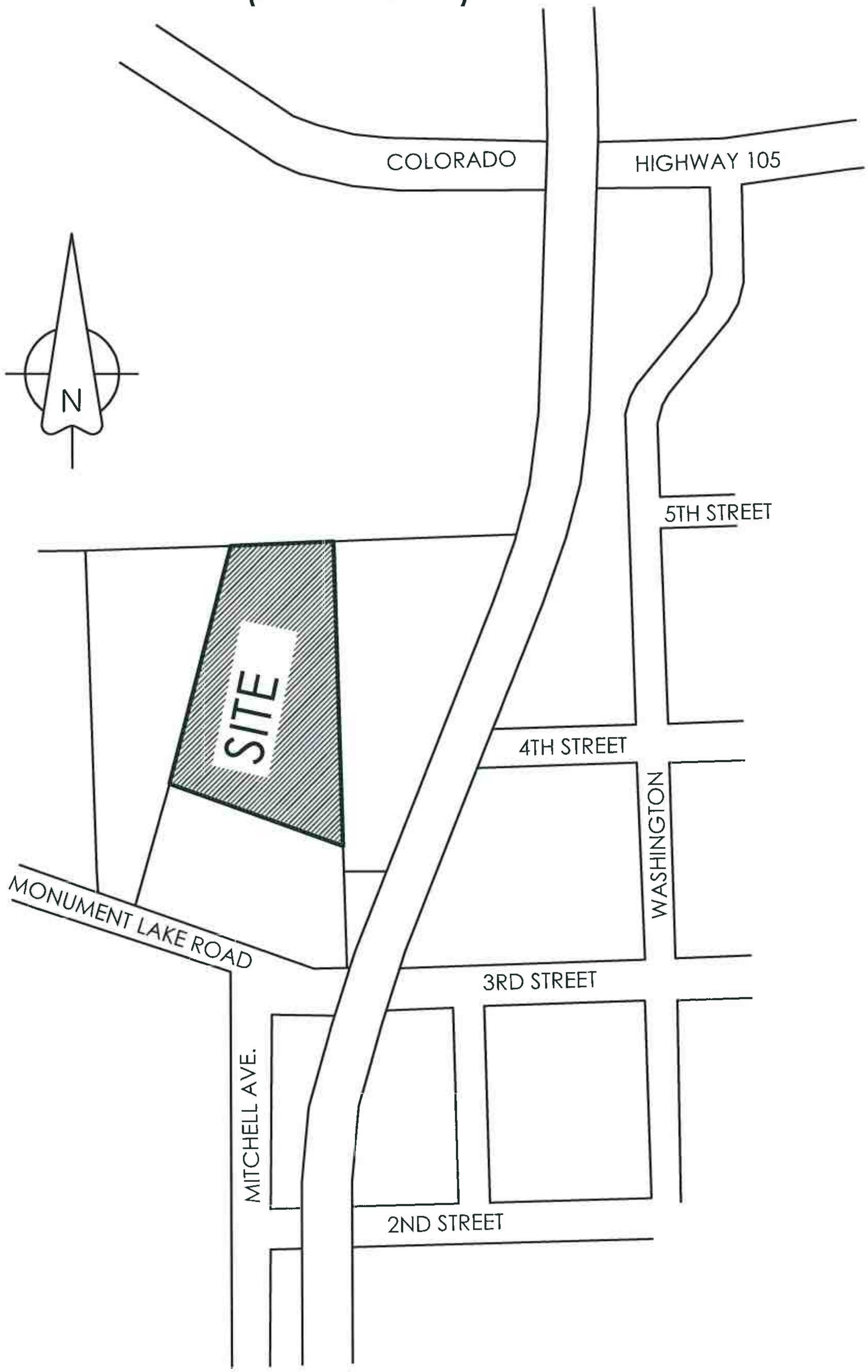
Drainage Criteria Manual (Volume 2). Urban Drainage and Flood Control District (Denver, Colorado: Urban Drainage and Flood Control District, Rev. April, 2008).

Appendices

8 General Maps and Supporting Data

Vicinity Map
Portions of Flood Insurance Rate Map
Portion of Drainage Area Identification Study Map
NRCS Soil Map and Tables
SCS Soil Type Descriptions
Hydrologic Soil Group Map and Tables

VICINITY MAP
(no scale)

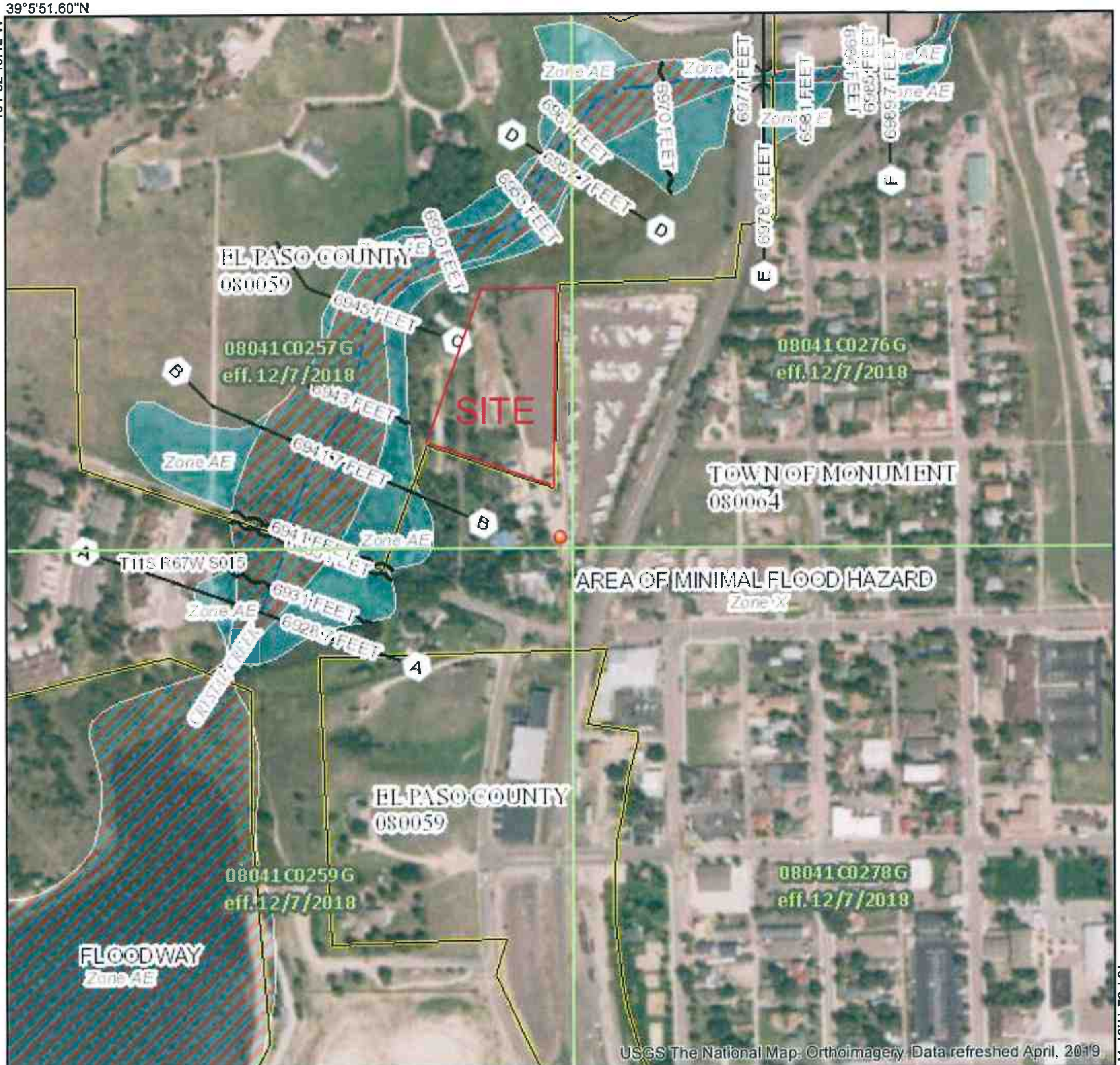


National Flood Hazard Layer FIRMette

FEMA

39°5'51.60"N

104°52'49.12"W



104°52'11.67"W

39°5'23.68"N

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

1:6,000

Legend

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

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

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

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

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

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

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

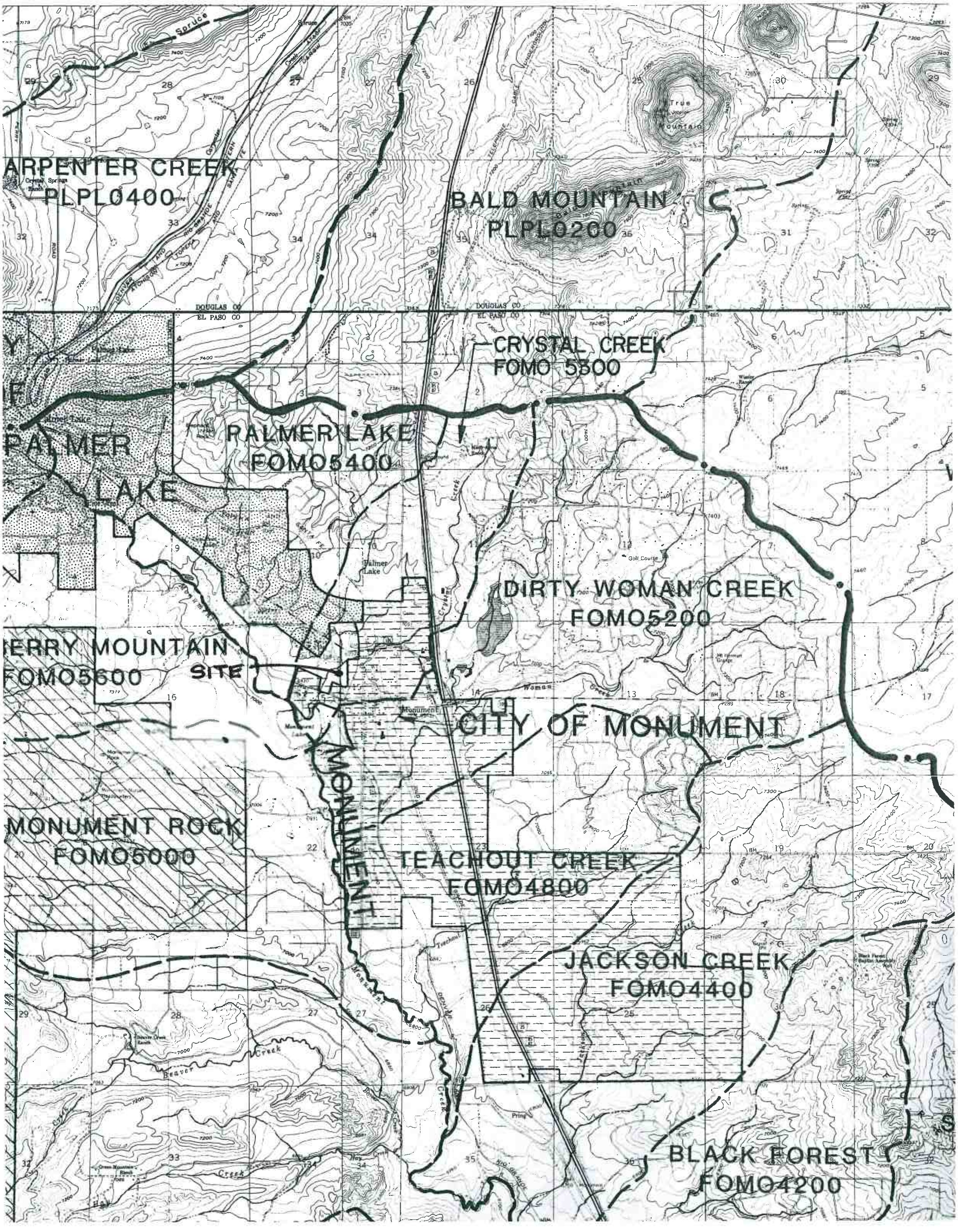
N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/27/2019 at 1:22:06 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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


ARPENTER CREEK
PLPL0400
BALD MOUNTAIN
PLPL0200
CRYSTAL CREEK
FOMO 5300
PALMER LAKE
FOMO5400
PALMER
LAKE
DIRTY WOMAN CREEK
FOMO5200
ERRY MOUNTAIN
FOMO5600
SITE
CITY OF MONUMENT
MONUMENT
MONUMENT ROCK
FOMO5000
TEACHOUT CREEK
FOMO4800
JACKSON CREEK
FOMO4400
BLACK FOREST
FOMO4200
DOUGLAS CO
EL PASO CO

Soil Map—El Paso County Area, Colorado
(Monument Small Engine)

Map Scale: 1:1,070 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 15, 30, 60, 90

Feet: 0, 50, 100, 200, 300

N

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 Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

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 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Feb 22, 2014—Mar 9, 2017

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	0.1	1.8%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	3.2	98.2%
Totals for Area of Interest		**3.3**	**100.0%**

cludes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Elbeth-Pring complex, 5 to 30 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Olney and Vona soils, eroded, is an undifferentiated group in this survey area.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Pits, gravel is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The military impact area described in some map units consists of a large area on the Fort Carson Military Reservation. It is used as an artillery and bombing target area. This area has not been surveyed, but most of the soils mapped adjacent to the area are in the Heldt, Kim, Midway, Razor, and Wiley series. It is estimated that most of the impact area is Razor-Midway complex.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Soil descriptions

1—Alamosa loam, 1 to 3 percent slopes. This deep, poorly drained soil formed in alluvium on flood plains and fans. Elevation ranges from 7,200 to 7,700 feet. The average annual precipitation is about 18 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark gray loam about 6 inches thick. The subsoil is clay loam about 27 inches thick; it is very dark gray in the upper part and gray in the lower part. The substratum is dark greenish gray and light gray sandy clay loam and sandy loam. Mottles are common in the subsoil and substratum.

Included with this soil in mapping are small areas of Ellicott loamy coarse sand, 0 to 5 percent slopes; Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 1 to 5 percent slopes; and Pring coarse sandy loam, 3 to 8 percent slopes.

Permeability of this Alamosa soil is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Organic matter content of the surface layer is high. This soil has a high water table, usually between May and October. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used mostly for native hay or pasture.

The potential plant community is mainly slender wheatgrass, Baltic rush, Nebraska sedge, timothy, and reedgrassses. Willows are a part of the plant community.

If the range has deteriorated, it consists mostly of Kentucky bluegrass and willows. If overgrazing is severe, denuding of the soil and gullying are possible and reestablishment of a good plant cover is very difficult. Where seeding is practical, smooth brome, orchardgrass, Garrison creeping foxtail, or reed canarygrass should be used.

Wet areas of this soil are well suited to shallow water developments, which encourage wetland wildlife such as waterfowl and a number of shore birds. Because of the availability of moisture, this soil provides excellent waterfowl nesting cover. Rangeland wildlife, such as deer and cottontail, use the areas where excellent cover is provided by willows, rushes, and other wetland vegetation. Wildlife on this soil can best be aided by using proper livestock grazing practices and allowing natural vegetation, such as willows and cattails, to grow.

This soil has poor potential for homesites. The main limitations for this use are a high water table and the hazard of flooding. Capability subclass Vw.

2—Ascalon sandy loam, 1 to 3 percent slopes. This deep, well drained soil formed in mixed alluvium and wind-laid material on uplands. Elevation ranges from 5,500 to 6,500 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 140 days.

Typically, the surface layer is brown sandy loam about 8 inches thick. The subsoil is brown, yellowish brown, and pale brown sandy clay loam about 22 inches thick. The substratum is calcareous, very pale brown sandy loam and loamy sand.

Included with this soil in mapping are small areas of Bresser sandy loam, 0 to 3 percent slopes; Olney sandy loam, 0 to 3 percent slopes; Vona sandy loam, 1 to 3 percent slopes; and Fort Collins loam, 0 to 3 percent slopes.

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

This soil is used mainly as cropland.

A typical rotation is wheat and summer fallow. Summer fallow is necessary because rainfall is insufficient for yearly cropping. Feed grains such as millet are used as a strength. Special designs for buildings and roads are required to offset these limitations. Methods of sewage disposal other than septic tank absorption fields are needed because of the limited depth to bedrock. Capability subclass VIe.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Map Scale: 1:1,070 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 15, 30, 60, 90

Feet: 0, 50, 100, 200, 300

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.
>
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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.

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Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Feb 22, 2014—Mar 9, 2017

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
1	Alamosa loam, 1 to 3 percent slopes	D	0.1	1.8%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	3.2	98.2%
Totals for Area of Interest			**3.3**	**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.

9 Hydrologic Calculations

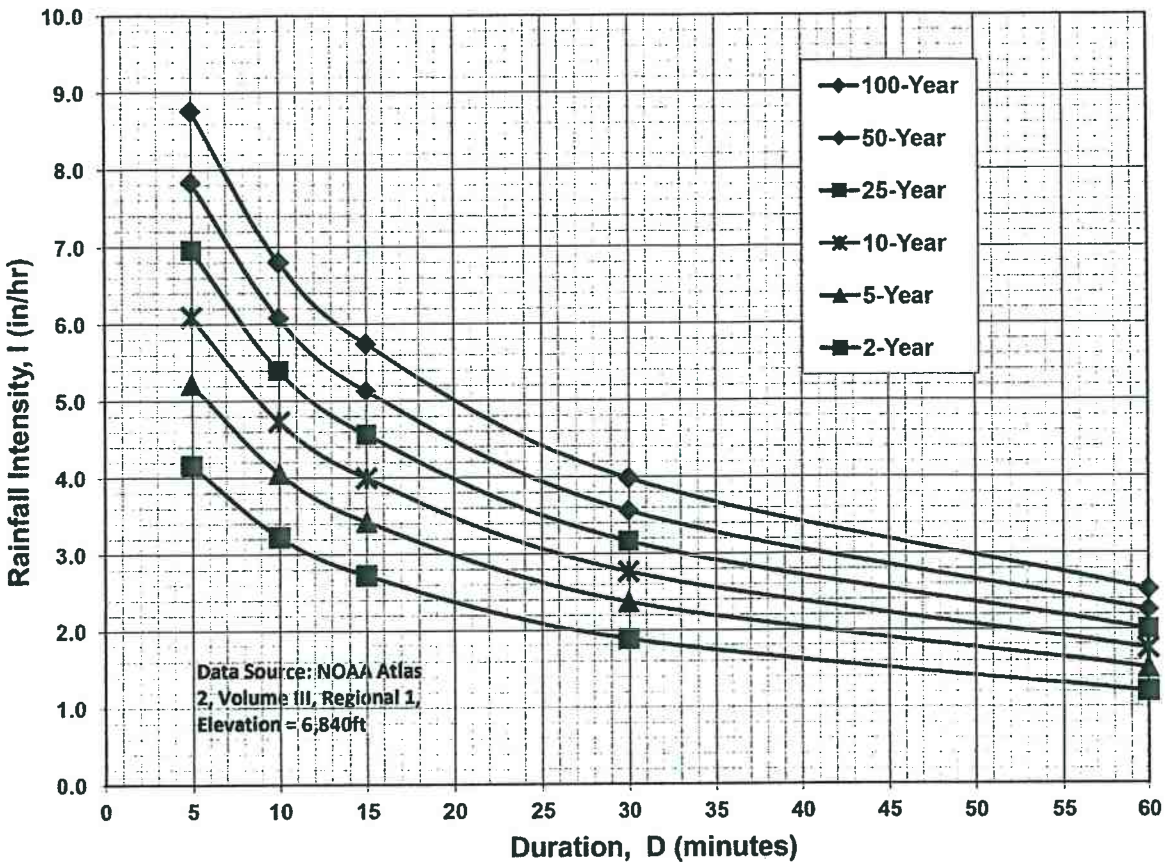
Runoff Coefficients and Percent Imperviousness Table 6-6
Colorado Springs Rainfall Intensity Duration Frequency Table 6-5
Hydrologic Calculations Summary Form SF-1 for Existing & Developed Conditions
Hydrologic Calculations Summary 5-yr Form SF-2 for Existing & Developed Conditions
Hydrologic Calculations Summary 100-yr Form SF-2 for Existing & Developed Conditions
Percent Imperviousness Calculation for proposed Lots 1 & 2

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

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

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

$$I_{5} = -1.50 \ln(D) + 7.583$$

$$I_{2} = -1.19 \ln(D) + 6.035$$

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

Job No.: **61092**
Project: **Monument Small Engine Storage**

Date: **10/24/2019 9:06**
Calcs By: **D. Gorman**
Checked By:

Time of Concentration (Modified from Standard Form SF-1)

Sub-Basin	Sub-Basin Data				Overland			Shallow Channel				Channelized				t_c Check		t_c
	Area (Acres)	C_5	C_{100}/CN	% Imp.	L_0 (ft)	S_0 (%)	t_i (min)	L_{0t} (ft)	S_{0t} (ft/ft)	v_{0sc} (ft/s)	t_t (min)	L_{0c} (ft)	S_{0c} (ft/ft)	v_{0c} (ft/s)	t_c (min)	L (min)	$t_{c,alt}$ (min)	(min)
EX-OSA1	4.05	0.48	0.62	62%	100	3%	7.7	335	0.022	1.5	3.7	0	0.000	0.0	0.0	435	N/A	11.4
EX-A1	1.42	0.13	0.39	8%	100	3%	11.9	50	0.140	3.7	0.2	285	0.032	3.0	1.6	435	N/A	13.7
EX-A2	0.32	0.17	0.41	13%	75	6%	8.0	94	0.074	2.7	0.6	0	0.000	0.0	0.0	169	N/A	8.6
EX-B1	2.15	0.26	0.48	27%	100	2%	12.0	195	0.041	1.4	2.3	85	0.082	4.5		380	N/A	14.7
DV-A1	0.51	0.49	0.63	61%	100	2%	9.7	137	0.015	1.2	1.9	156	0.019	1.8	1.4	393	N/A	13.0
DV-A2	1.97	0.49	0.63	65%	100	3%	7.5	50	0.140	3.7	0.2	177	0.051	4.1	0.7	327	N/A	8.4
DV-A3	0.42	0.53	0.66	70%	100	4%	6.5	137	0.011	1.0	2.2	116	0.039	2.5	0.8	353	N/A	9.5
DV-A4	0.89	0.08	0.35	0%	75	6%	8.7	94	0.074	2.7	0.6	0	0.000	0.0	0.0	169	N/A	9.3
DV-A5	0.11	0.08	0.35	0%	14	29%	2.3	0	0.000	0.0	0.0	0	0.000	0.0	0.0	14	N/A	5.0

Job No.: 61092
Project: Monument Small Engine Storage
Design Storm: 5-Year Storm *(20% Probability)*
Jurisdiction: DCM

Date: 10/24/2019 9:06
Calcs By: D. Gorman
Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
DP	Sub-Basin	Area (Acres)	C5	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	v_{Osc} (ft/s)	t_t (min)
	EX-OSA1	4.05	0.48	11.4	1.93	3.93	7.6															
	EX-A1	1.42	0.13	13.7	0.19	3.65	0.7															
EX DP1	OSA1,A1	5.47	0.13					13.7			3.5											
	EX-A2	0.32	0.17	8.6	0.05	4.36	0.2															
EX DP1+A2	OSA1,A1,A2	5.79	0.14					13.7			3.7											
	EX-B1	2.15	0.26	14.7	0.56	3.56	2.0															
	DV-A1	0.51	0.49	13.0	0.25	3.74	0.9															
DV DP1		0.51	0.49					13.0			0.0											
	DV-A2	1.97	0.49	8.4	0.97	4.39	4.3															
DV DP2	OSA1,A1,A2	2.48	0.49					13.0			0.0											
	DV-A3	0.42	0.53	9.5	0.22	4.21	0.9															
DV DP3	DP2, A3	2.90	0.50					13.0	1.44	3.74	5.4											
	DV-A4	0.89	0.08	9.3	0.07	4.24	0.3															
DV DP4	DP3 Out, A4	0.89	0.08					9.3	0.07	4.24	0.3											
	DV-A5	0.11	0.08	5.0	0.01	5.17	0.0															

DCM: I = C1 * ln (tc) + C2
C1: 1.5
C1: 7.583

Job No.: 61092
Project: Monument Small Engine Storage
Design Storm: 100-Year Storm *(1% Probability)*
Jurisdiction: DCM

Date: 10/24/2019 9:06
Calcs By: D. Gorman
Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
DP	Sub-Basin	Area (Acres)	C100	t_c (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	t_c (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	v_{Osc} (ft/s)	t_t (min)
	EX-OSA1	4.05	0.62	11.4	2.52	6.60	16.6															
	EX-A1	1.42	0.39	13.7	0.55	6.13	3.4															
EX DP1	OSA1,A1	1.42	0.39					13.7	0.55	6.13	3.4											
	EX-A2	5.47	0.41	8.6	2.23	7.33	16.4				15.5											
EX DP1+A2	OSA1,A1,A2	1.74	0.39					13.7	0.68	6.13	4.2											
	EX-B1	5.79	0.48	14.7	2.76	5.97	16.5				16.3											
	DV-A1	0.51	0.63	13.0	0.32	6.28	2.0															
DV DP1		0.51	0.63					13.0	0.32	6.28	2.0											
	DV-A2	5.47	0.63	8.4	3.47	7.37	25.6				22.0											
DV DP2	OSA1,A1,A2	2.48	0.63					13.0	1.57	6.28	9.9											
	DV-A3	5.79	0.66	9.5	3.81	7.07	26.9				23.6											
DV DP3	DP2, A3	2.90	0.64					13.0	1.85	6.28	11.6											
	DV-A4	0.89	0.35	9.3	0.31	7.12	2.2															
DV DP4	DP3 Out, A4	0.89	0.35					9.3			0.0											
	DV-A5	0.11	0.35	5.0	0.04	8.68	0.3															

DCM: I = C1 * ln (tc) + C2
C1: 2.52
C1: 12.735

Sub-Basin EX-OSA1 Runoff Calculations (offsite pond inflow)

Job No.:	61092	Date:	9/26/2019 12:04
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Gravel	137,170	3.15	0.57	0.59	0.63	0.66	0.68	0.7	80%
Landscaping	780	0.02	0.03	0.09	0.17	0.26	0.31	0.36	2%
Pasture/Meadow	38,537	0.88	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	176,487	4.05	0.45	0.48	0.52	0.57	0.60	0.62	62.2%

176487

Basin Travel Time

-

Shallow Channel Ground Cover: Nearly bare ground

$L_{max,Overland}$ 100 ft C_v 10

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	435	11	-	-	-	-	
Initial Time	100	3	0.032	-	7.7	N/A	DCM Eq. 6-8
Shallow Channel	335	8	0.022	1.5	3.7	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch

t_c **11.4 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.14	3.93	4.59	5.24	5.90	6.60
Runoff (cfs)	5.7	7.6	9.7	12.1	14.2	16.6
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	5.7	7.6	9.7	12.1	14.2	16.6

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-A1 Runoff Calculations

Job No.:	61092	Date:	9/26/2019 12:04
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Gravel	6,295	0.14	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	55,489	1.27	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**61,784**	**1.42**	**0.08**	**0.13**	**0.20**	**0.29**	**0.34**	**0.39**	**8.2%**
	61784								

Basin Travel Time

-

Shallow Channel Ground Cover: Nearly bare ground

$L_{max,Overland}$ 100 ft C_v 10

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	435	19	-	-	-	-	
Initial Time	100	3	0.032	-	11.9	N/A	DCM Eq. 6-8
Shallow Channel	50	7	0.140	3.7	0.2	-	DCM Eq. 6-9
Channelized	285	9	0.032	3.0	1.6	-	V-Ditch
				t_c	13.7 min.		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.92	3.65	4.26	4.87	5.48	6.13
Runoff (cfs)	0.3	**0.7**	1.2	2.0	2.6	**3.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.3	**0.7**	1.2	2.0	2.6	**3.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-A2 Runoff Calculations

Job No.:	61092	Date:	9/26/2019 12:04
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Gravel	2,360	0.05	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	11,765	0.27	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**14,125**	**0.32**	**0.11**	**0.17**	**0.23**	**0.32**	**0.36**	**0.41**	**13.4%**
	14125								

Basin Travel Time

-

Shallow Channel Ground Cover: Nearly bare ground

$L_{max,Overland}$ 100 ft C_v 10

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	169	12	-	-	-	-	
Initial Time	75	5	0.063	-	8.0	N/A	DCM Eq. 6-8
Shallow Channel	94	7	0.074	2.7	0.6	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	8.6 min.		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.48	4.36	5.09	5.82	6.55	7.33
Runoff (cfs)	0.1	**0.2**	0.4	0.6	0.8	**1.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.2**	0.4	0.6	0.8	**1.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-B1 Runoff Calculations

Job No.:	61092	Date:	9/26/2019 12:04
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	3,525	0.08	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	22,940	0.53	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	3,660	0.08	0.89	0.9	0.92	0.94	0.95	0.96	100%
Pasture/Meadow	63,448	1.46	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**93,573**	**2.15**	**0.21**	**0.26**	**0.32**	**0.40**	**0.44**	**0.48**	**26.9%**

93573

-

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	380	17	-	-	-	-	
Initial Time	100	2	0.020	-	12.0	N/A	DCM Eq. 6-8
Shallow Channel	195	8	0.041	1.4	2.3	-	DCM Eq. 6-9
Channelized	85	7	0.082	4.5	0.3	-	V-Ditch

t_c **14.7 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.84	3.56	4.15	4.74	5.33	5.97
Runoff (cfs)	1.3	**2.0**	2.9	4.0	5.0	**6.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.3	**2.0**	2.9	4.0	5.0	**6.1**

DCM: $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Combined Sub-Basin Runoff Calculations (DP1)

Includes Basins EX-A1 + offsite pond outflow

Job No.:	**61092**	Date:	**9/26/2019 12:04**
Project:	**Monument Small Engine Storage**	Calcs by:	**D. Gorman**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Gravel	6,295	0.14	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	55,489	1.27	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**61,784**	**1.42**	**0.08**	**0.13**	**0.20**	**0.29**	**0.34**	**0.39**	**8.2%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-A1	-	435	19	-	-	-	-	13.7
Channelized-1									
Channelized-2									
Channelized-3									
Total			435	19					

t_c (min) 13.7

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas Offsite Basin OSA1 Existing Pond Outflow

Q_{Minor} 2.8 (cfs) - 5-year Storm

Q_{Major} 12.1 (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.92	3.65	4.26	4.87	5.48	6.13
Site Runoff (cfs)	0.31	**0.68**	1.20	2.02	2.63	**3.36**
OffSite Runoff (cfs)	-	**2.80**	-	-	-	**12.10**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**3.5**	-	-	-	**15.5**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from pond outflows and other contributing basins are assumed constant, disregarding differing times of concentration.

Combined Sub-Basin Runoff Calculations (DP1 + A2)

Includes Basins EX-A1 EX-A2 + offsite pond outflow

Job No.:	**61092**	Date:	**9/26/2019 12:04**
Project:	**Monument Small Engine Storage**	Calcs by:	**D. Gorman**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Gravel	8,655	0.20	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	67,254	1.54	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**75,909**	**1.74**	**0.08**	**0.14**	**0.20**	**0.30**	**0.34**	**0.39**	**9.1%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-A1	-	435	19	-	-	-	-	13.7
Channelized-1									
Channelized-2									
Channelized-3									
Total			435	19					

t_c (min) 13.7

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas Offsite Basin OSA1 Existing Pond Outflow

Q_{Minor} 2.8 (cfs) - 5-year Storm

Q_{Major} 12.1 (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.92	3.65	4.26	4.87	5.48	6.13
Site Runoff (cfs)	0.42	**0.88**	1.52	2.52	3.28	**4.17**
OffSite Runoff (cfs)	-	**2.80**	-	-	-	**12.10**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**3.7**	-	-	-	**16.3**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from pond outflows and other contributing basins are assumed constant, disregarding differing times of concentration.

Sub-Basin Dv-A1 Runoff Calculations (DP1 Pipe Inflow)

Job No.:	61092	Date:		10/24/2019 9:06
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman	
		Checked by:		
Jurisdiction	DCM	Soil Type	B	
Runoff Coefficient	Surface Type	Urbanization	Non-Urban	

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	5,643	0.13	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	10,223	0.23	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	228	0.01	0.89	0.9	0.92	0.94	0.95	0.96	100%
Pasture/Meadow	6,098	0.14	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**22,192**	**0.51**	**0.46**	**0.49**	**0.53**	**0.58**	**0.61**	**0.63**	**60.8%**

22192

Basin Travel Time

-

Shallow Channel Ground Cover: Nearly bare ground

$L_{max,Overland}$ 100 ft C_v 10

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	393	7	-	-	-	-	
Initial Time	100	2	0.015	-	9.7	N/A	DCM Eq. 6-8
Shallow Channel	137	2	0.015	1.2	1.9	-	DCM Eq. 6-9
Channelized	156	3	0.019	1.8	1.4	-	V-Ditch

t_c **13.0 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.99	3.74	4.36	4.99	5.61	6.28
Runoff (cfs)	0.7	**0.9**	1.2	1.5	1.7	**2.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.7	**0.9**	1.2	1.5	1.7	**2.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Dv-A2 Runoff Calculations

Job No.:	61092	Date:	10/24/2019 9:06
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Gravel	68,463	1.57	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	16,639	0.38	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	618	0.01	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**85,720**	**1.97**	**0.47**	**0.49**	**0.54**	**0.58**	**0.61**	**0.63**	**64.6%**

85720

Basin Travel Time

-

Shallow Channel Ground Cover: Nearly bare ground

$L_{max,Overland}$ 100 ft C_v 10

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	327	19	-	-	-	-	
Initial Time	100	3	0.032	-	7.5	N/A	DCM Eq. 6-8
Shallow Channel	50	7	0.140	3.7	0.2	-	DCM Eq. 6-9
Channelized	177	9	0.051	4.1	0.7	-	V-Ditch

t_c **8.4 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.50	4.39	5.12	5.85	6.59	7.37
Runoff (cfs)	3.2	**4.3**	5.4	6.7	7.9	**9.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	3.2	**4.3**	5.4	6.7	7.9	**9.2**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Combined Sub-Basin Runoff Calculations (East ditch/swale) AT DP 2

Includes Basins DV-A1 DV-A2 + OSA1 pond outflow

Job No.:	61092	Date:	10/24/2019 9:06
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Gravel	78,686	1.81	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	22,737	0.52	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	5,643	0.13	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	846	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**107,912**	**2.48**	**0.46**	**0.49**	**0.54**	**0.58**	**0.61**	**0.63**	**63.8%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	DV-A1	-	393	7	-	-	-	-	13.0
Channelized-1									
Channelized-2									
Channelized-3									
Total			393	7					

t_c (min) **13.0**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas Offsite Basin OSA1 Existing Pond Outflow

Q_{Minor} 2.8 (cfs) - 5-year Storm

Q_{Major} 12.1 (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.99	3.74	4.36	4.99	5.61	6.28
Site Runoff (cfs)	3.43	**4.56**	5.81	7.19	8.46	**9.86**
OffSite Runoff (cfs)	-	**2.80**	-	-	-	**12.10**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**7.4**	-	-	-	**22.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from pond outflows and other contributing basins are assumed constant, disregarding differing times of concentration.

Sub-Basin Dv-A3 Runoff Calculations

Job No.:	61092	Date:	10/24/2019 9:06
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Gravel	16,117	0.37	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	2,229	0.05	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**18,346**	**0.42**	**0.50**	**0.53**	**0.57**	**0.61**	**0.63**	**0.66**	**70.3%**
	18346								

Basin Travel Time

-

Shallow Channel Ground Cover: Nearly bare ground

$L_{max,Overland}$ 100 ft C_v 10

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	353	10	-	-	-	-	
Initial Time	100	4	0.040	-	6.5	N/A	DCM Eq. 6-8
Shallow Channel	137	2	0.011	1.0	2.2	-	DCM Eq. 6-9
Channelized	116	5	0.039	2.5	0.8	-	V-Ditch
				t_c	**9.5 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.36	4.21	4.91	5.61	6.31	7.07
Runoff (cfs)	0.7	**0.9**	1.2	1.4	1.7	**2.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.7	**0.9**	1.2	1.4	1.7	**2.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Combined Sub-Basin Runoff Calculations (DP3 Pond Inflow)

Includes Basins DV-A1 DV-A2 DV-A3 + OSA1 pond outflow

Job No.:	**61092**	Date:	**10/24/2019 9:06**
Project:	**Monument Small Engine Storage**	Calcs by:	**D. Gorman**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Gravel	94,803	2.18	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	24,966	0.57	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	5,643	0.13	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	846	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**126,258**	**2.90**	**0.47**	**0.50**	**0.54**	**0.59**	**0.61**	**0.64**	**64.8%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	DV-A1	-	393	7	-	-	-	-	13.0
Channelized-1									
Channelized-2									
Channelized-3									
Total			393	7					

t_c (min) **13.0**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas Offsite Basin OSA1 Existing Pond Outflow

Q_{Minor} 2.8 (cfs) - 5-year Storm

Q_{Major} 12.1 (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.99	3.74	4.36	4.99	5.61	6.28
Site Runoff (cfs)	4.07	**5.39**	6.86	8.47	9.95	**11.60**
OffSite Runoff (cfs)	-	**2.80**	-	-	-	**12.10**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**8.2**	-	-	-	**23.7**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from pond outflows and other contributing basins are assumed constant, disregarding differing times of concentration.

Sub-Basin Dv-A4 Runoff Calculations

Job No.:	61092	Date:	10/24/2019 9:06
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	38,591	0.89	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**38,591**	**0.89**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

38591

-

Basin Travel Time

Shallow Channel Ground Cover: Nearly bare ground

$L_{max,Overland}$ 100 ft C_v 10

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	169	12	-	-	-	-	
Initial Time	75	5	0.063	-	8.7	N/A	DCM Eq. 6-8
Shallow Channel	94	7	0.074	2.7	0.6	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch

t_c **9.3 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.38	4.24	4.95	5.66	6.36	7.12
Runoff (cfs)	0.1	**0.3**	0.7	1.3	1.7	**2.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.7	1.3	1.7	**2.2**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Combined Sub-Basin Runoff Calculations (DP3 Pond Outflow + A4)

Includes Basins DV-A4

Job No.:	**61092**	Date:	**10/24/2019 9:06**
Project:	**Monument Small Engine Storage**	Calcs by:	**D. Gorman**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Pasture/Meadow	38,591	0.89	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**38,591**	**0.89**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	DV-A4	-	169	12	-	-	-	-	9.3
Channelized-1									
Channelized-2									
Channelized-3									
Total			169	12					

t_c (min) **9.3**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas DP1 Pond Outflow

Q_{Minor} 5.3 (cfs) - 5-year Storm

Q_{Major} 21.4 (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.38	4.24	4.95	5.66	6.36	7.12
Site Runoff (cfs)	0.06	**0.30**	0.66	1.25	1.69	**2.21**
OffSite Runoff (cfs)	-	**5.30**	-	-	-	**21.40**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**5.6**	-	-	-	**23.6**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from pond outflows and other contributing basins are assumed constant, disregarding differing times of concentration.

Sub-Basin Dv-A5 Runoff Calculations

Job No.:	61092	Date:	10/24/2019 9:06
Project:	Monument Small Engine Storage	Calcs by:	D. Gorman
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	4,618	0.11	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**4,618**	**0.11**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	4618								
	-								

Basin Travel Time

Shallow Channel Ground Cover: Nearly bare ground

$L_{max,Overland}$ 100 ft C_v 10

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	14	4	-	-	-	-	
Initial Time	14	4	0.286	-	2.3	N/A	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch

t_c **5.0 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.12	5.17	6.03	6.89	7.75	8.68
Runoff (cfs)	0.0	**0.0**	0.1	0.2	0.2	**0.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.0**	0.1	0.2	0.2	**0.3**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

10 Hydraulic Calculations

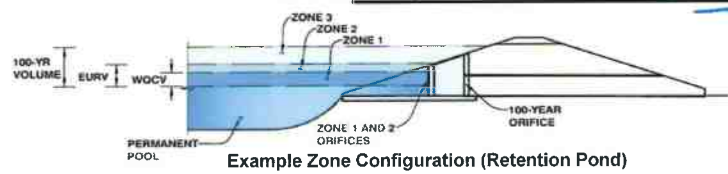
Sand Filter Basin Calculations
Ditch Capacity Calculations

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Mounty Herman RV Storage

Basin ID: Existing WQ/Detention Pond Basin OSA1 (existing pond - offsite)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF			
Watershed Area =	4.05	acres		
Watershed Length =	435	ft		
Watershed Slope =	0.025	ft/ft		
Watershed Imperviousness =	62.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	12.0	hours		
Location for 1-hr Rainfall Depths =	Denver - Capitol Building			
Water Quality Capture Volume (WQCV) =	0.066	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.273	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.225	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.302	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.391	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.511	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.597	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.710	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.4 in.) =	1.023	acre-feet	3.40	inches
Approximate 2-yr Detention Volume =	0.211	acre-feet		
Approximate 5-yr Detention Volume =	0.284	acre-feet		
Approximate 10-yr Detention Volume =	0.364	acre-feet		
Approximate 25-yr Detention Volume =	0.393	acre-feet		
Approximate 50-yr Detention Volume =	0.409	acre-feet		
Approximate 100-yr Detention Volume =	0.445	acre-feet		

Depth Increment = 0.2 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)
Media Surface	--	0.00	--	--	--	885	0.020		
	--	0.20	--	--	--	997	0.023	178	0.004
	--	0.40	--	--	--	1,073	0.025	384	0.009
	--	0.60	--	--	--	1,167	0.027	608	0.014
	--	0.80	--	--	--	1,261	0.029	849	0.019
	--	1.00	--	--	--	1,355	0.031	1,110	0.025
	--	1.20	--	--	--	1,776	0.041	1,419	0.033
	--	1.40	--	--	--	2,197	0.050	1,812	0.042
	--	1.60	--	--	--	2,618	0.060	2,289	0.053
	--	1.80	--	--	--	3,039	0.070	2,851	0.065
12" CMP Inv El	--	2.00	--	--	--	3,460	0.079	3,497	0.080
	--	2.20	--	--	--	3,646	0.084	4,242	0.097
	--	2.40	--	--	--	3,834	0.088	4,990	0.115
	--	2.60	--	--	--	4,020	0.092	5,775	0.133
	--	2.80	--	--	--	4,207	0.097	6,598	0.151
	--	3.00	--	--	--	4,394	0.101	7,458	0.171
	--	3.20	--	--	--	4,592	0.105	8,356	0.192
	--	3.40	--	--	--	4,790	0.110	9,295	0.213
Em Spwy Crest	--	3.60	--	--	--	4,989	0.115	10,273	0.236
	--	3.80	--	--	--	5,187	0.119	11,290	0.259
	--	4.00	--	--	--	5,385	0.124	12,347	0.283
	--		--	--	--				
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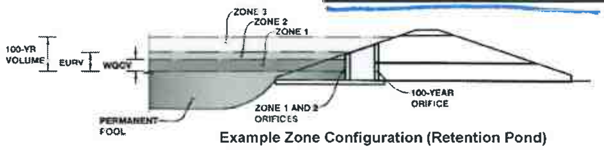
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Mount Herman RV Storage

Basin ID: Existing WQ/Detention Pond Basin OSA1



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.80	0.066	Filtration Media
Zone 2 (5-year)		0.218	Circular Orifice
Zone 3			
		0.284	Total

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

Underdrain Orifice Invert Depth =	2.00	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	1.22	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.05	feet

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

Invert of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	N/A	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	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 (optional)	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	2.00		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.60		ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	12.00		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.79		ft^2
Vertical Orifice Centroid =	0.50		feet

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

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.00		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	.		feet
Overflow Weir Slope =			H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =			feet
Overflow Grate Open Area % =			%, grate open area/total area
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Over Flow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			should be ≥ 4
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.60	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	0.02	feet

Calculated Parameters for Spillway

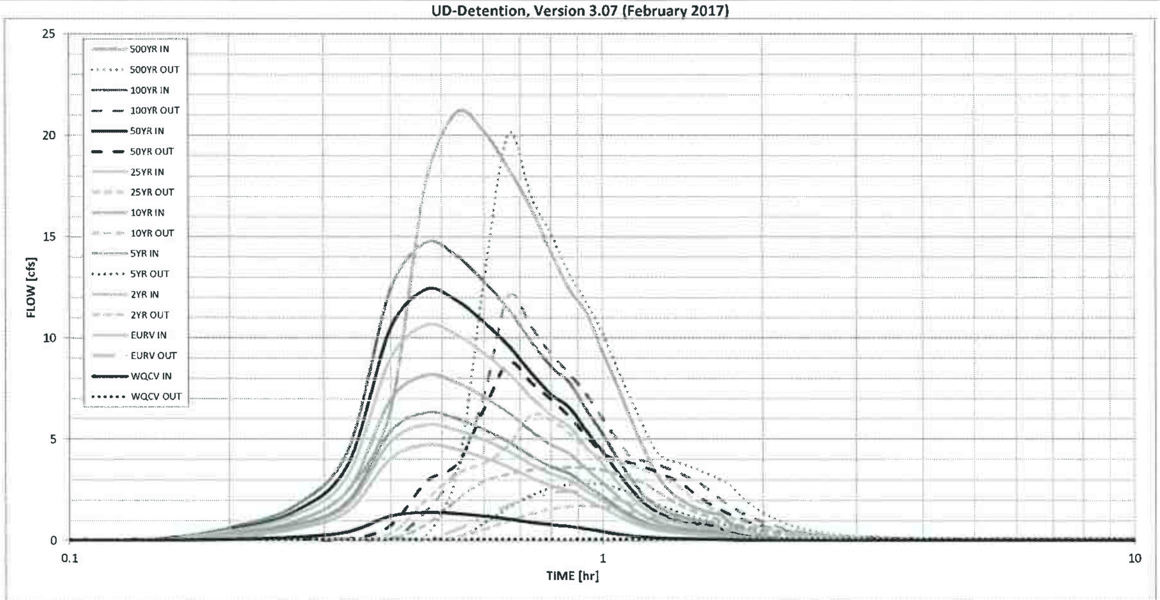
Spillway Design Flow Depth=	0.38	feet
Stage at Top of Freeboard =	4.00	feet
Basin Area at Top of Freeboard =	0.12	acres

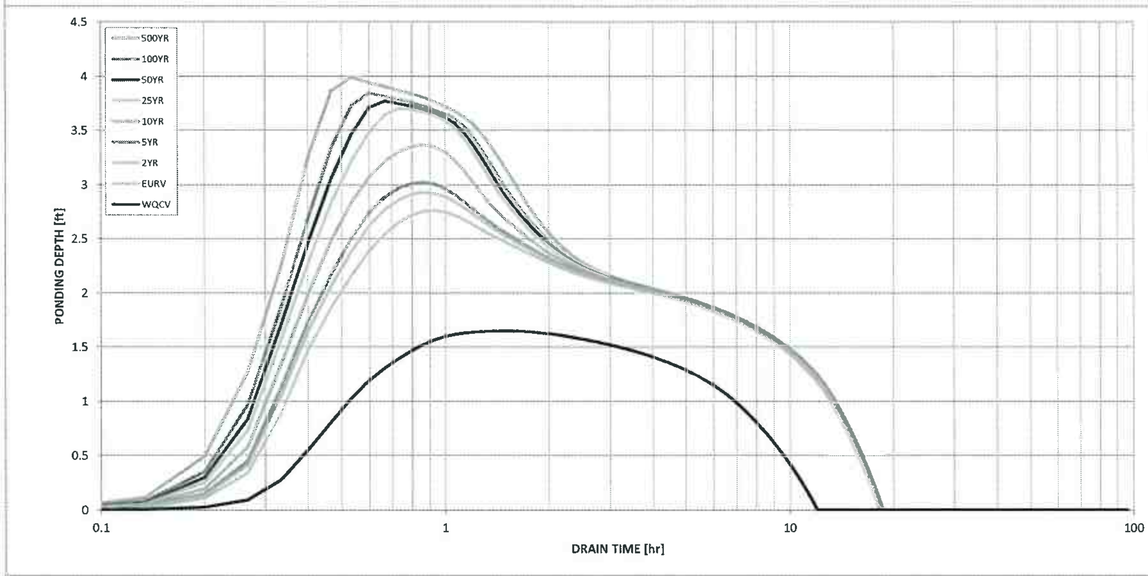
Routed Hydrograph Results

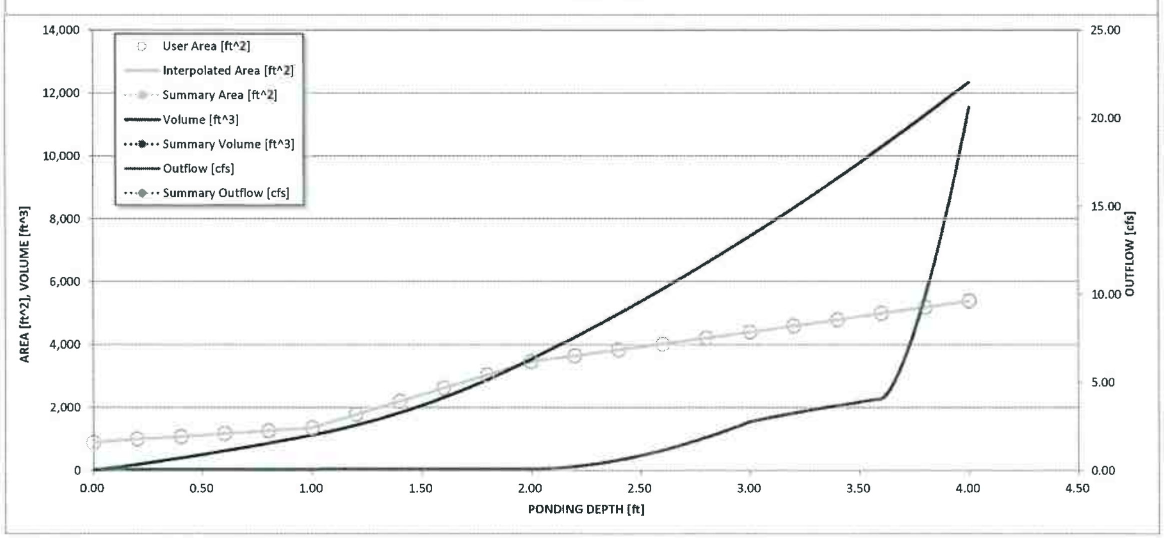
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.40
Calculated Runoff Volume (acre-ft) =	0.066	0.273	0.225	0.302	0.391	0.511	0.597	0.710	1.023
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.066	0.273	0.225	0.302	0.391	0.511	0.597	0.710	1.024
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.02	0.03	0.28	0.87	1.20	1.60	2.55
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.1	1.1	3.5	4.9	6.5	10.3
Peak Inflow Q (cfs) =	1.4	5.7	4.7	6.3	8.2	10.6	12.4	14.7	21.1
Peak Outflow Q (cfs) =	0.1	2.4	1.7	2.8	3.6	6.2	8.8	12.1	20.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	25.1	3.2	1.8	1.8	1.9	1.9
Structure Controlling Flow =	Filtration Media	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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) =	12	17	17	17	16	15	15	14	13
Time to Drain 99% of Inflow Volume (hours) =	12	18	18	18	18	18	17	17	17
Maximum Ponding Depth (ft) =	1.65	2.93	2.76	3.02	3.37	3.70	3.77	3.85	3.99
Area at Maximum Ponding Depth (acres) =	0.06	0.10	0.10	0.10	0.11	0.12	0.12	0.12	0.12
Maximum Volume Stored (acre-ft) =	0.056	0.164	0.148	0.173	0.209	0.247	0.256	0.264	0.282

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







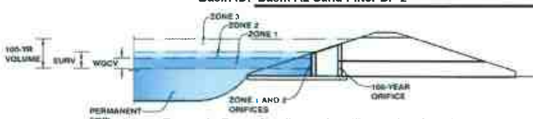
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: **61092 - Monument Small Engine Storage**

Basin ID: **Basin A2 Sand Filter DP 2**



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**SF**	
Watershed Area =	2.96	acres
Watershed Length =	561	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	63.30%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.049	acre-feet
Excess Urban Runoff Volume (EURV) =	0.204	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.168	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.226	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.291	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.378	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.441	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.523	acre-feet
500-yr Runoff Volume (P1 = 3.4 in.) =	0.753	acre-feet
Approximate 2-yr Detention Volume =	0.158	acre-feet
Approximate 5-yr Detention Volume =	0.212	acre-feet
Approximate 10-yr Detention Volume =	0.271	acre-feet
Approximate 25-yr Detention Volume =	0.293	acre-feet
Approximate 50-yr Detention Volume =	0.305	acre-feet
Approximate 100-yr Detention Volume =	0.331	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.40	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.049	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.049	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	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

Total detention volume is less than 100-year volume.

Depth Increment = 0.25 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)
Media Surface	--	0.00	--	--	--	1,322	0.030		
	--	0.25	--	--	--	1,453	0.033	332	0.008
6959	--	0.50	--	--	--	1,619	0.037	715	0.016
	--	0.75	--	--	--	1,763	0.040	1,136	0.026
	--	1.00	--	--	--	1,912	0.044	1,594	0.037
WQCV=6959.76	--	1.25	--	--	--	2,065	0.047	2,090	0.048
Spillway=6960	--	1.50	--	--	--	2,335	0.054	2,637	0.061
	--	1.75	--	--	--	2,538	0.058	3,244	0.074
	--	2.00	--	--	--	2,750	0.063	3,903	0.090
	--	2.25	--	--	--	2,972	0.068	4,645	0.107
Top Berm=6961	--	2.50	--	--	--	3,203	0.074	5,417	0.124
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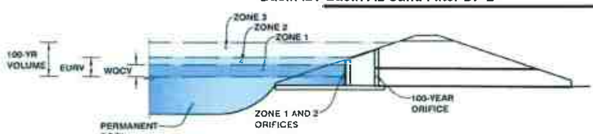
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: 61092 - Monument Small Engine Storage

Basin ID: Basin A2 Sand Filter DP 2



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.26	0.049	Filtration Media
Zone 2			
Zone 3			
		0.049	Total

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

Underdrain Orifice Invert Depth =	2.15	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	1.07	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.04	feet

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

Invert of Lowest Orifice =		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =		ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =		inches
Orifice Plate: Orifice Area per Row =		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 (optional)	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)								
Orifice Area (sq. inches)								

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.26		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	0.89		feet
Overflow Weir Slope =	0.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	0.89		feet
Overflow Grate Open Area % =	81%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =	1.26		feet
Over Flow Weir Slope Length =	0.89		feet
Grate Open Area / 100-yr Orifice Area =	0.82		should be ≥ 4
Overflow Grate Open Area w/o Debris =	0.64		ft^2
Overflow Grate Open Area w/ Debris =	0.32		ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =	2.15		ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	12.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =	0.79		ft^2
Outlet Orifice Centroid =	0.50		feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	15.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	0.50	feet

Calculated Parameters for Spillway

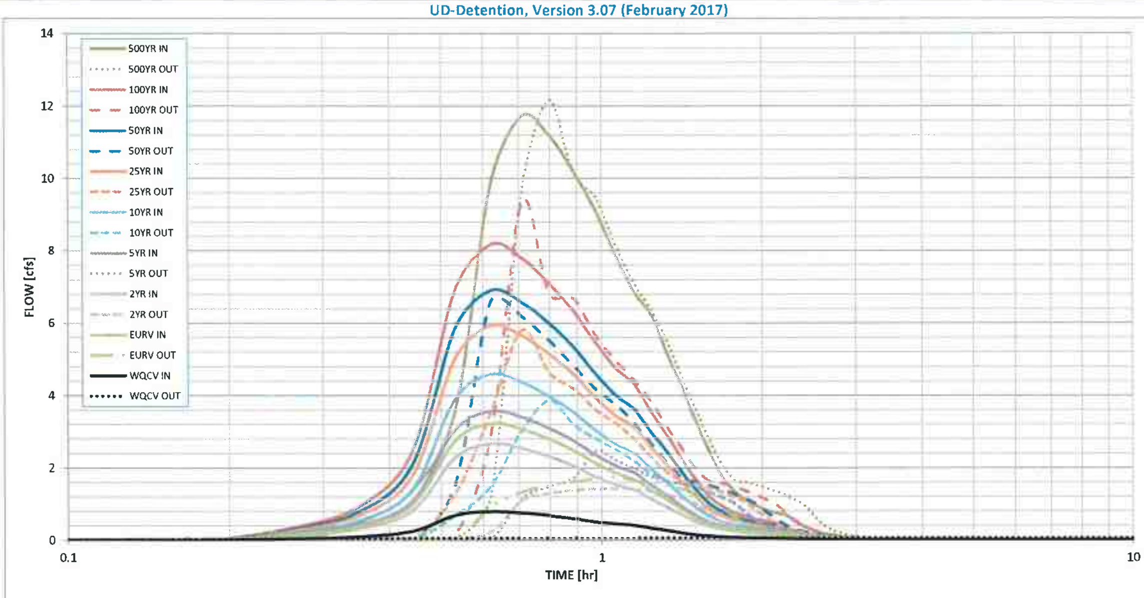
Spillway Design Flow Depth=	0.31	feet
Stage at Top of Freeboard =	2.81	feet
Basin Area at Top of Freeboard =	0.07	acres

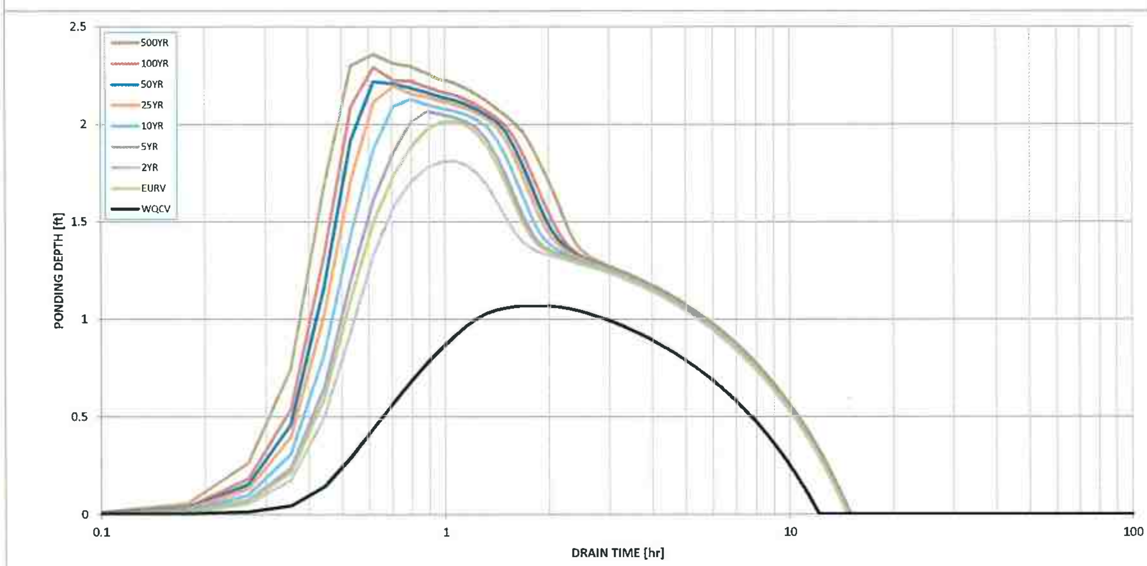
Routed Hydrograph Results

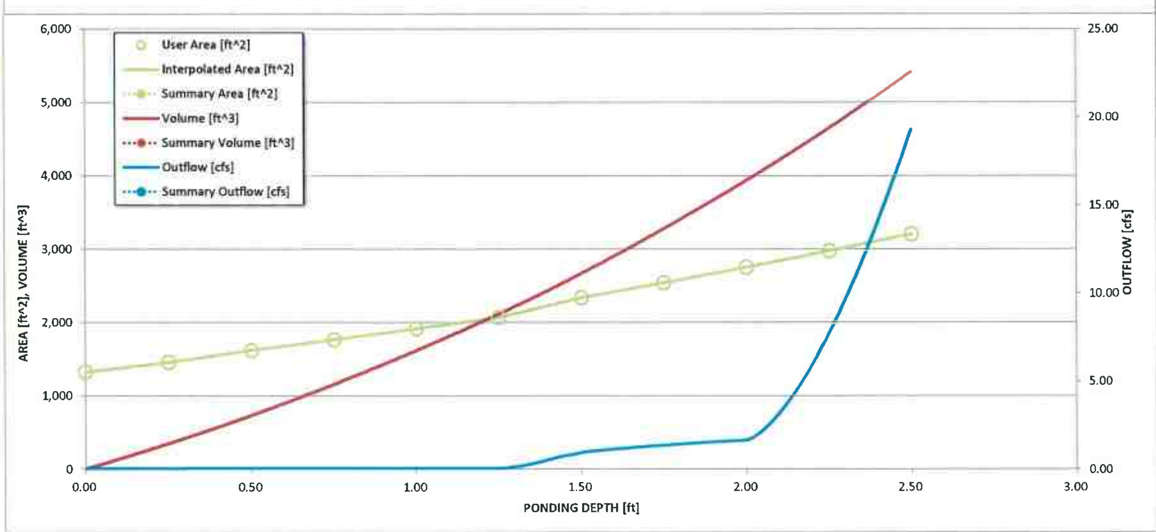
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.40
Calculated Runoff Volume (acre-ft) =	0.049	0.204	0.168	0.226	0.291	0.378	0.441	0.523	0.753
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.049	0.203	0.168	0.225	0.291	0.377	0.440	0.522	0.752
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.18	0.62	0.85	1.15	1.85
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.1	0.5	1.8	2.5	3.4	5.5
Peak Inflow Q (cfs) =	0.8	3.2	2.7	3.6	4.6	5.9	6.9	8.2	11.7
Peak Outflow Q (cfs) =	0.1	1.7	1.4	2.5	3.9	5.8	6.6	9.3	12.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	43.2	7.1	3.2	2.6	2.7	2.2
Structure Controlling Flow =	Filtration Media	Spillway	Overflow Grate 1	Spillway	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	2.47	2.11	2.6	2.7	2.8	2.8	2.9	3.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	12	13	13	13	13	12	11	11	9
Time to Drain 99% of Inflow Volume (hours) =	12	14	14	14	14	14	14	14	13
Maximum Ponding Depth (ft) =	1.07	2.01	1.81	2.06	2.13	2.19	2.22	2.29	2.36
Area at Maximum Ponding Depth (acres) =	0.04	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
Maximum Volume Stored (acre-ft) =	0.040	0.091	0.079	0.094	0.098	0.103	0.104	0.109	0.114

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.06, November 2016)

Designer: D. Gorman
Company: M.V.E., Inc.
Date: September 27, 2019
Project: Monument Small Engine Storage
Location: Basin A2- Pond at DP3

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)	I_a = 63.3 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.633
C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time $WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$	WQCV = 0.20 watershed inches
D) Contributing Watershed Area (including sand filter area)	Area = 129,121 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume $V_{WQCV} = WQCV / 12 * Area$	V_{WQCV} = 2,132 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ____ in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = ____ cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = ____ cu ft
2. Basin Geometry	
A) WQCV Depth	D_{WQCV} = 1.3 ft
B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.	Z = 3.00 ft / ft DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE
C) Minimum Filter Area (Flat Surface Area)	A_{Min} = 1022 sq ft
D) Actual Filter Area	A_{Actual} = 1322 sq ft
E) Volume Provided	V_T = 2637 cu ft
3. Filter Material	Choose One (●) 18" CDOT Class B or C Filter Material ( ) Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One (●) YES ( ) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 2.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 2,132 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 1 - 1 / 16 in

Design Procedure Form: Sand Filter (SF)

Designer: D. Gorman
Company: M.V.E., Inc.
Date: September 27, 2019
Project: Monument Small Engine Storage
Location: Basin A2- Pond at DP3

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6-7. Inlet / Outlet Works A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet	12" pvc pipe outlet and 15' wide emergency spillway

Notes:

Channel Report

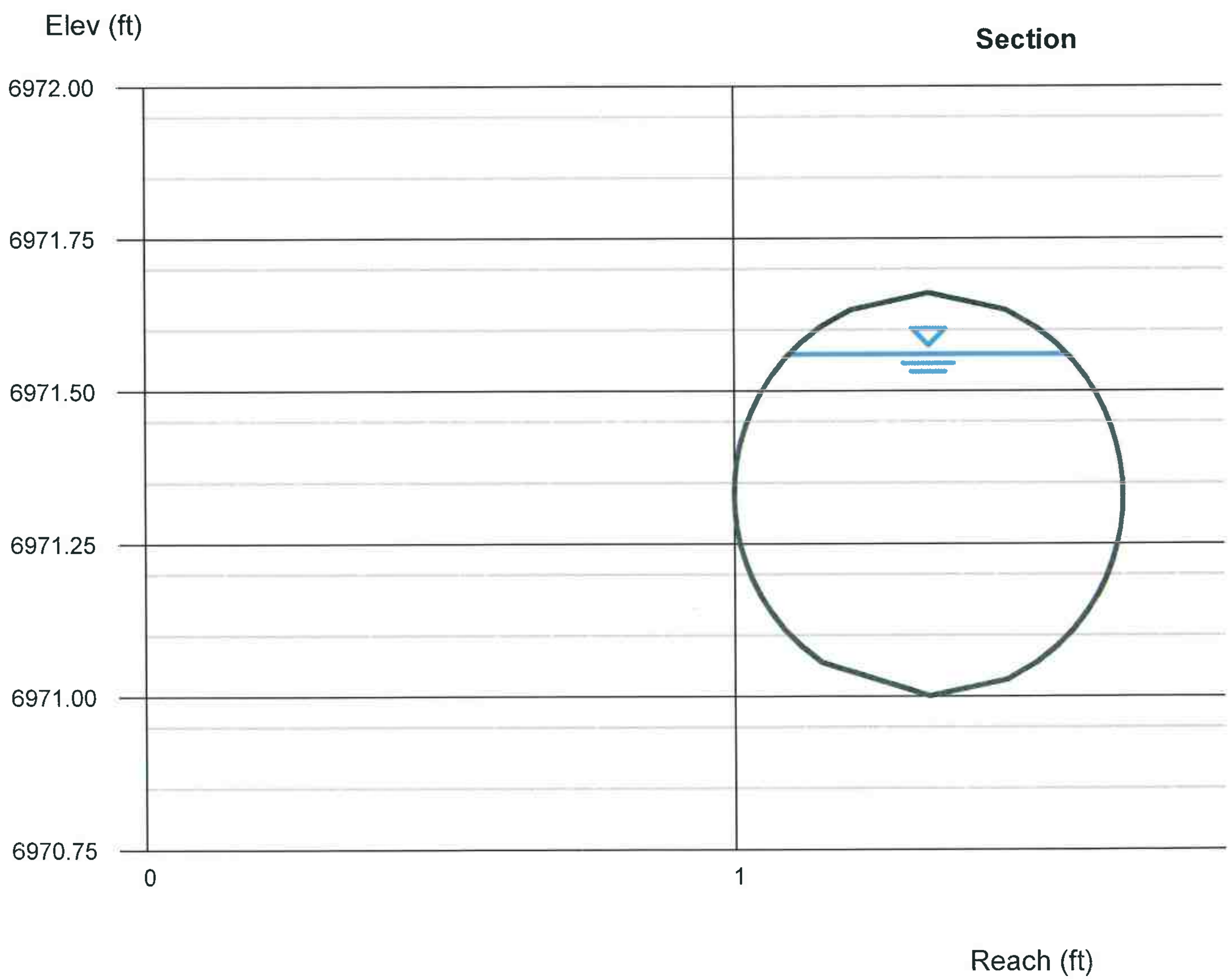
Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 26 2019

61092-DP1 Culvert

Circular	
Diameter (ft)	= 0.66
Invert Elev (ft)	= 6971.00
Slope (%)	= 2.00
N-Value	= 0.011

Calculations	
Compute by:	Known Q
Known Q (cfs)	= 2.00

Highlighted	
Depth (ft)	= 0.56
Q (cfs)	= 2.000
Area (sqft)	= 0.31
Velocity (ft/s)	= 6.46
Wetted Perim (ft)	= 1.55
Crit Depth, Yc (ft)	= 0.63
Top Width (ft)	= 0.47
EGL (ft)	= 1.21



Channel Report

Proposed V-Ditch Swale A

Triangular

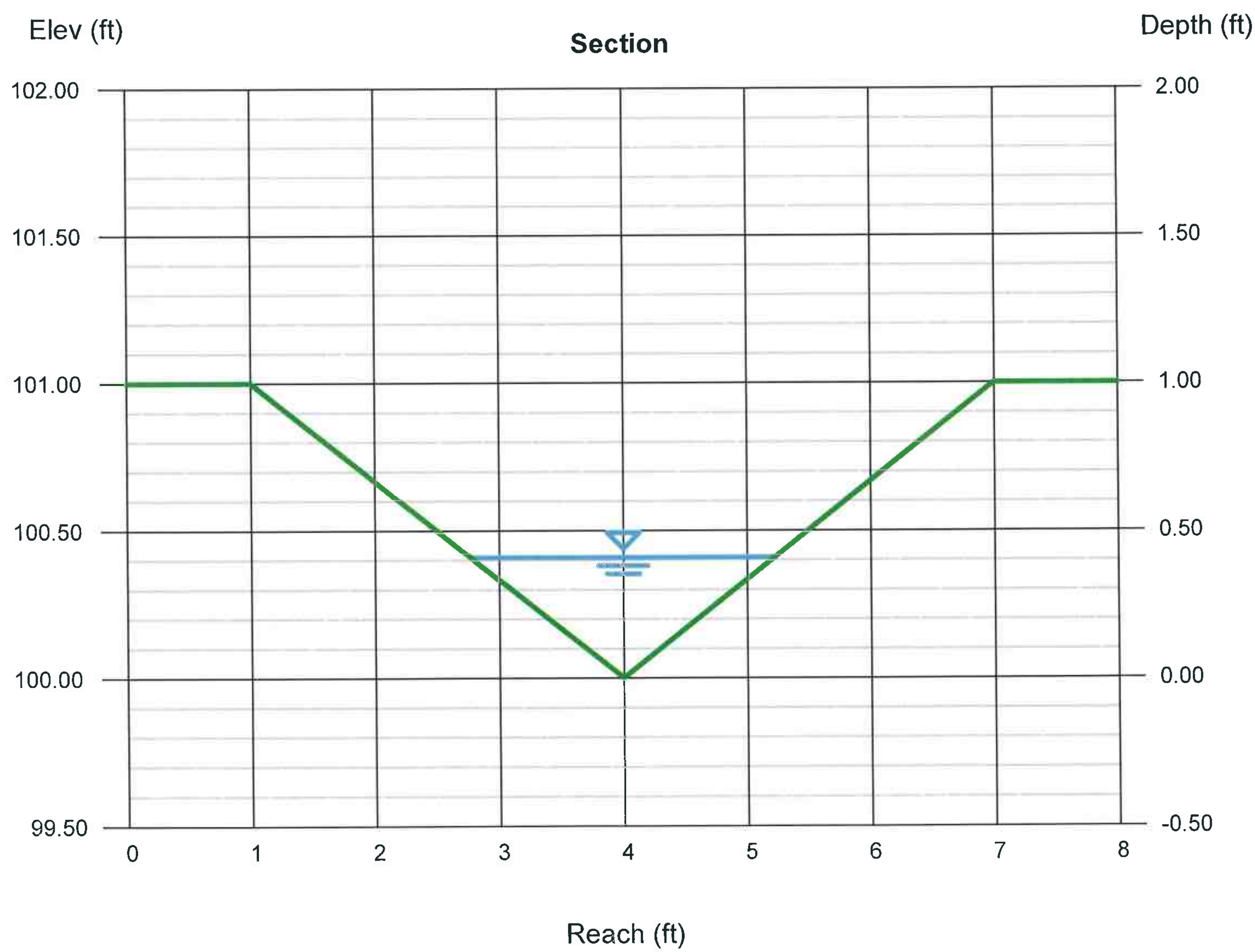
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 1.00
Invert Elev (ft)	= 100.00
Slope (%)	= 4.00
N-Value	= 0.025

Calculations

Compute by:	Known Q
Known Q (cfs)	= 2.00

Highlighted

Depth (ft)	= 0.41
Q (cfs)	= 2.000
Area (sqft)	= 0.50
Velocity (ft/s)	= 3.97
Wetted Perim (ft)	= 2.59
Crit Depth, Yc (ft)	= 0.49
Top Width (ft)	= 2.46
EGL (ft)	= 0.65

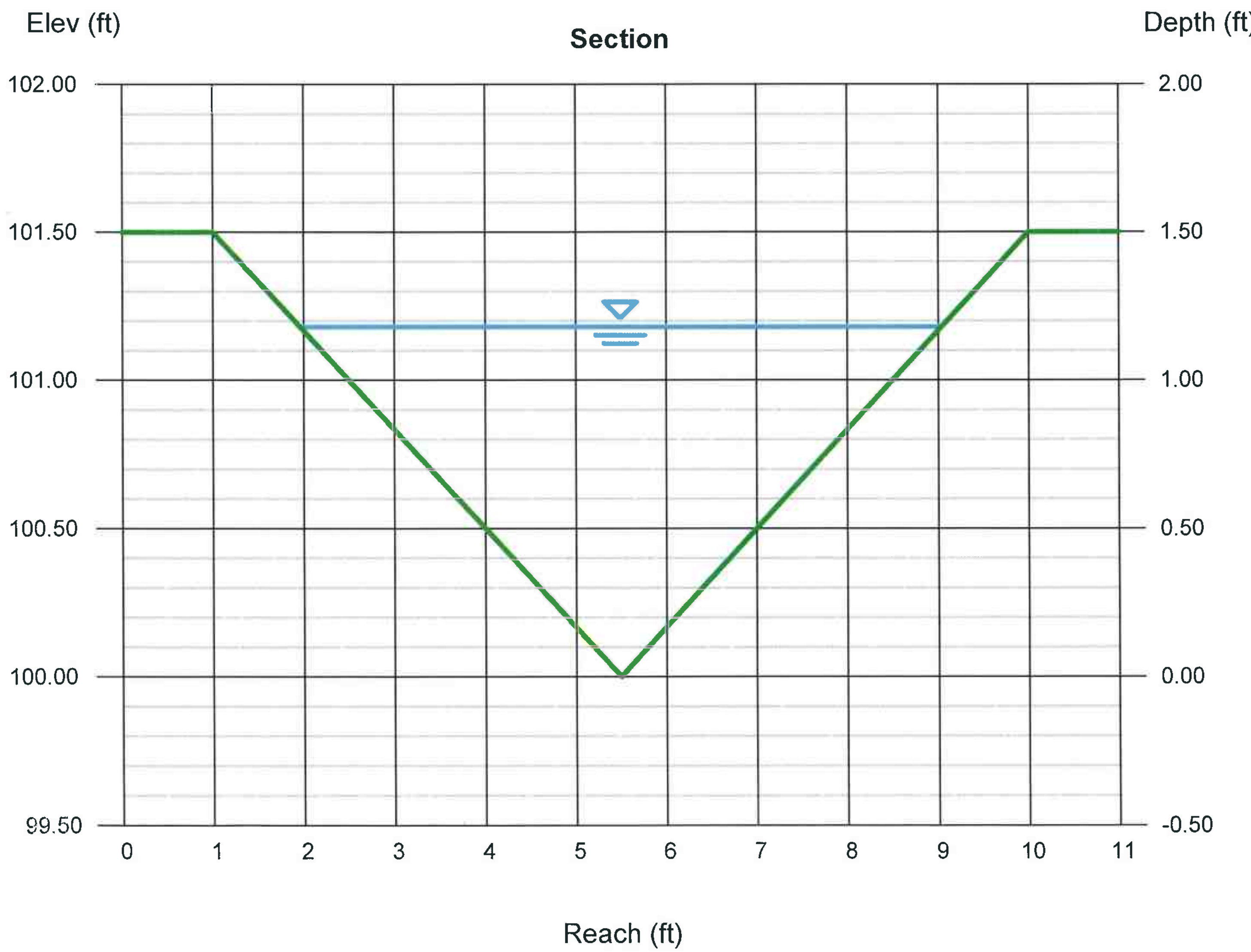


Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 26 2019

Proposed V-Ditch Swale B

Triangular		**Highlighted**	
Side Slopes (z:1)	= 3.00, 3.00	Depth (ft)	= 1.18
Total Depth (ft)	= 1.50	Q (cfs)	= 23.80
		Area (sqft)	= 4.18
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 5.70
Slope (%)	= 2.00	Wetted Perim (ft)	= 7.46
N-Value	= 0.025	Crit Depth, Yc (ft)	= 1.32
		Top Width (ft)	= 7.08
Calculations		EGL (ft)	= 1.68
Compute by:	Known Q		
Known Q (cfs)	= 23.80		

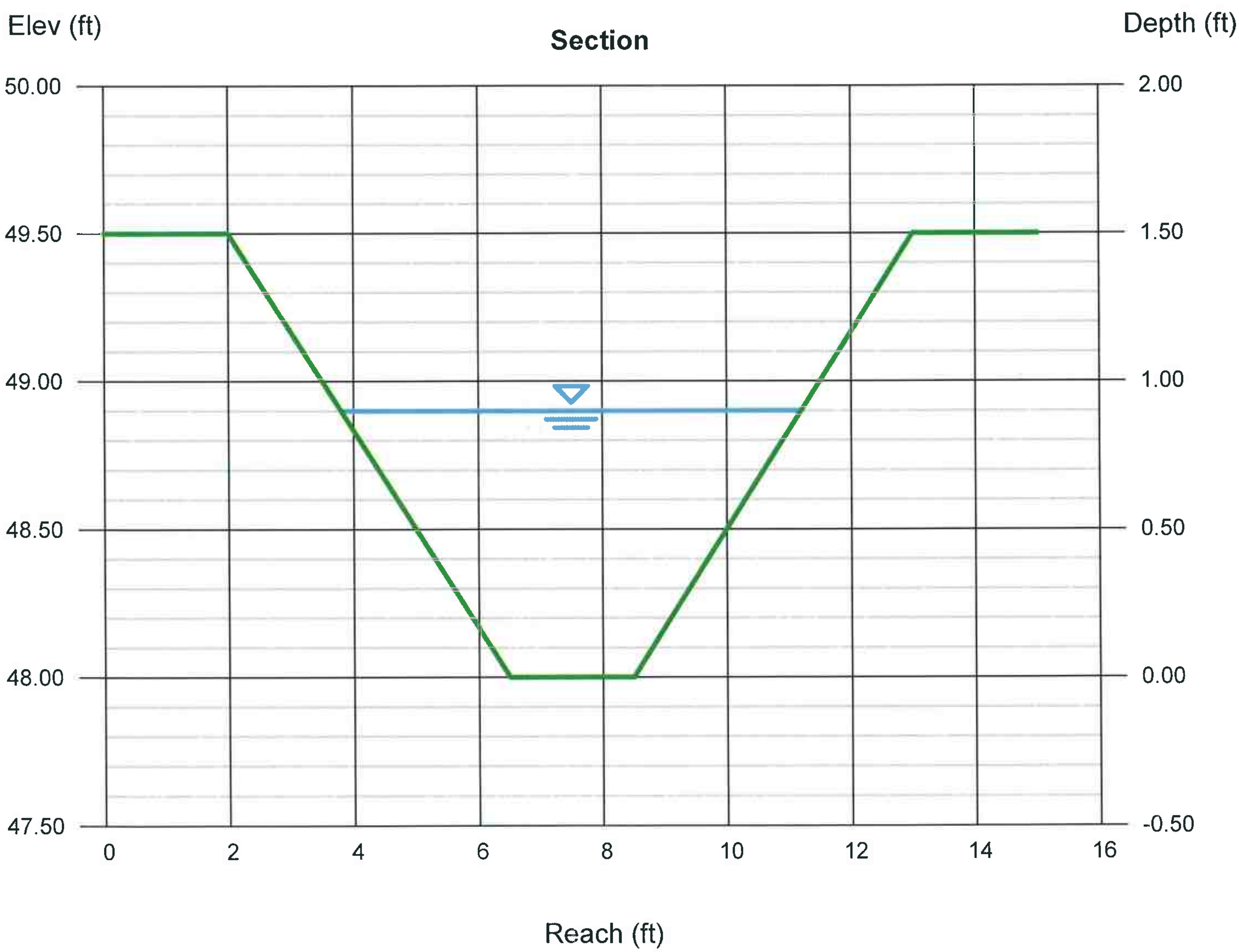


Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.　　Thursday, Sep 26 2019

Pond Outfall Swale C

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 2.00	Depth (ft)	= 0.90
Side Slopes (z:1)	= 3.00, 3.00	Q (cfs)	= 23.80
Total Depth (ft)	= 1.50	Area (sqft)	= 4.23
Invert Elev (ft)	= 48.00	Velocity (ft/s)	= 5.63
Slope (%)	= 4.00	Wetted Perim (ft)	= 7.69
N-Value	= 0.035	Crit Depth, Yc (ft)	= 1.03
		Top Width (ft)	= 7.40
Calculations		EGL (ft)	= 1.39
Compute by:	Known Q		
Known Q (cfs)	= 23.80		



61092 Monument Small Engine RV Storage

Date: 9/26/2019

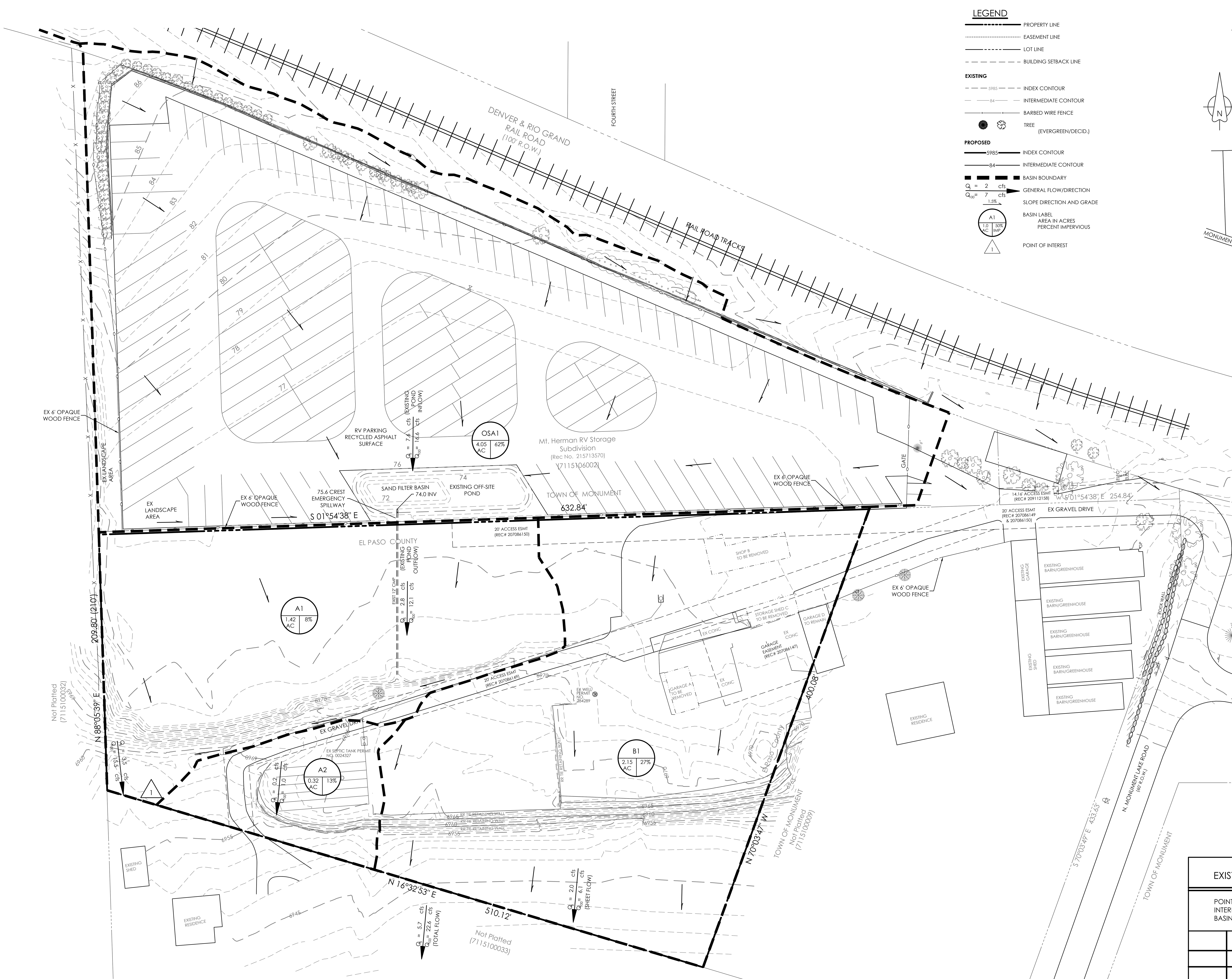
Riprap Type sizing

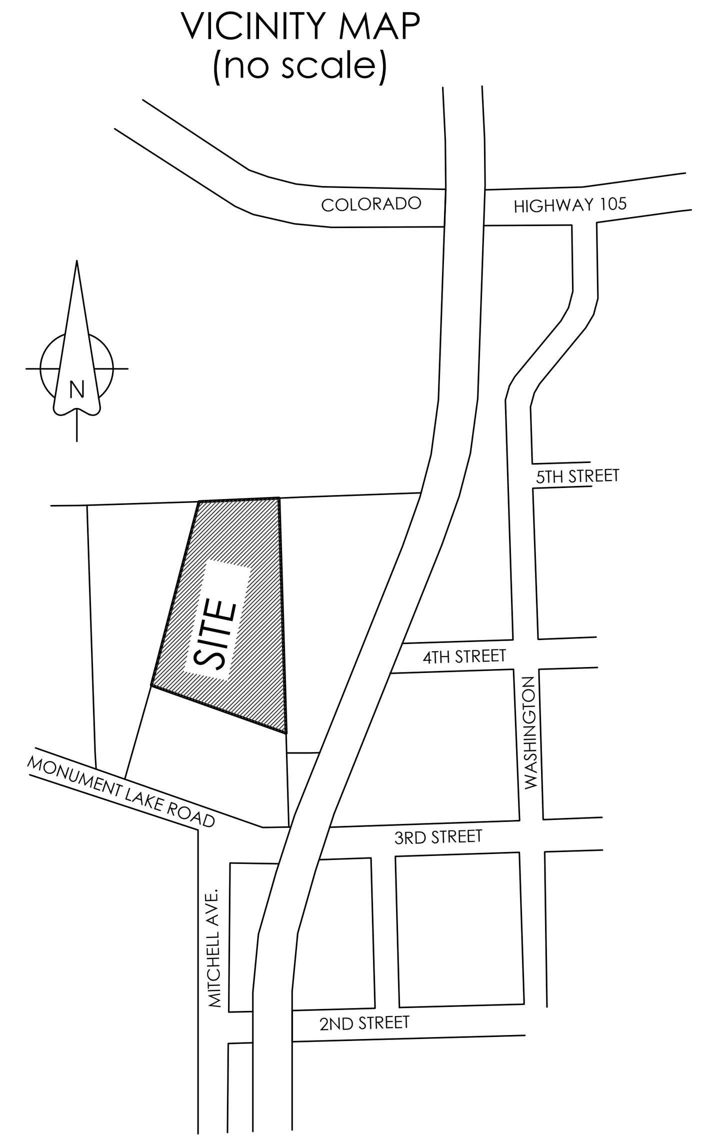
$S_s = 2.65$

Swale	Slope	Velocity	$\frac{V*S^{.17}}{(S_s-1)^{.66}}$	Riprap size From Eq
Swale A	4.00%	4.00	1.66	VL
Swale B	2.00%	5.70	2.11	VL
Swale C	4.00%	5.60	2.33	VL

11 Report Maps

Existing Condition Hydraulic Analysis Map (Map Pocket)
Proposed Condition Hydraulic Analysis Map (Map Pocket)





BENCHMARK

1" = 40' 1:480

EXISTING DRAINAGE SUMMARY TABLE

	POINT OF INTEREST/BASIN(S) BASIN(S)	AREA (AC)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)
	OSA1	4.05	7.6	16.6
	POND OUTFLOW	4.05	2.8	12.1
	A1	1.42	0.7	3.4
DP 1	A1 + POND OUTFLOW	5.47	3.5	15.5
	A2	0.32	0.2	1.0
	DP1 + A2	5.79	3.7	16.3
	B1	2.15	2.0	6.1
TOTAL	DP1 + A2 + B1	7.94	5.7	22.6

MVE INC. ENGINEERS, SURVEYORS
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REVISIONS
1. SITE CHANGES 9/27/2019

DESIGNED BY
DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

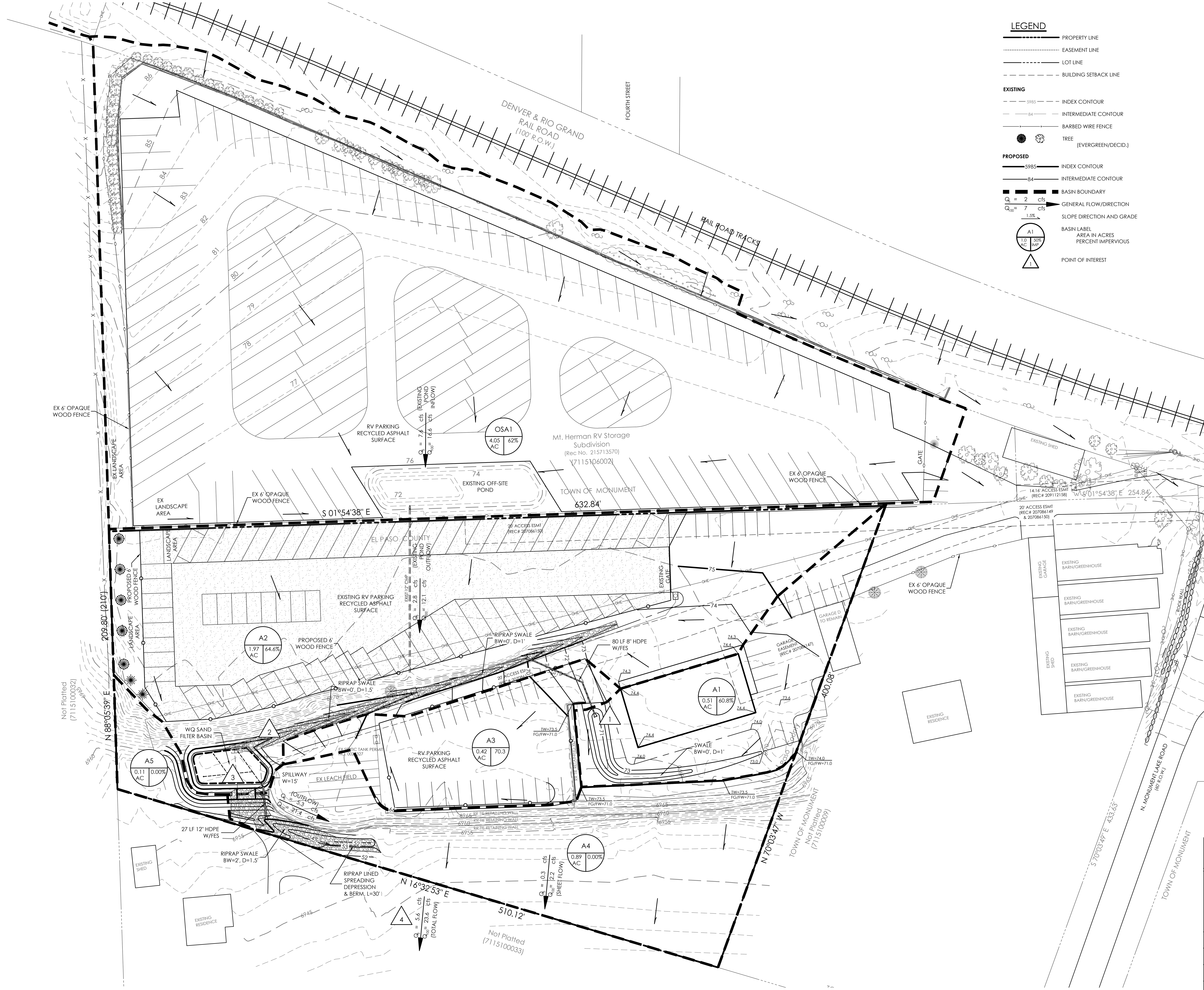
Monument Small Engine Storage

Existing Drainage Map

MVE PROJECT 61092
MVE DRAWING Ex-Drain-Map

October 24, 2019

SHEET 1 OF 1



LEGEND

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE
- BUILDING SETBACK LINE

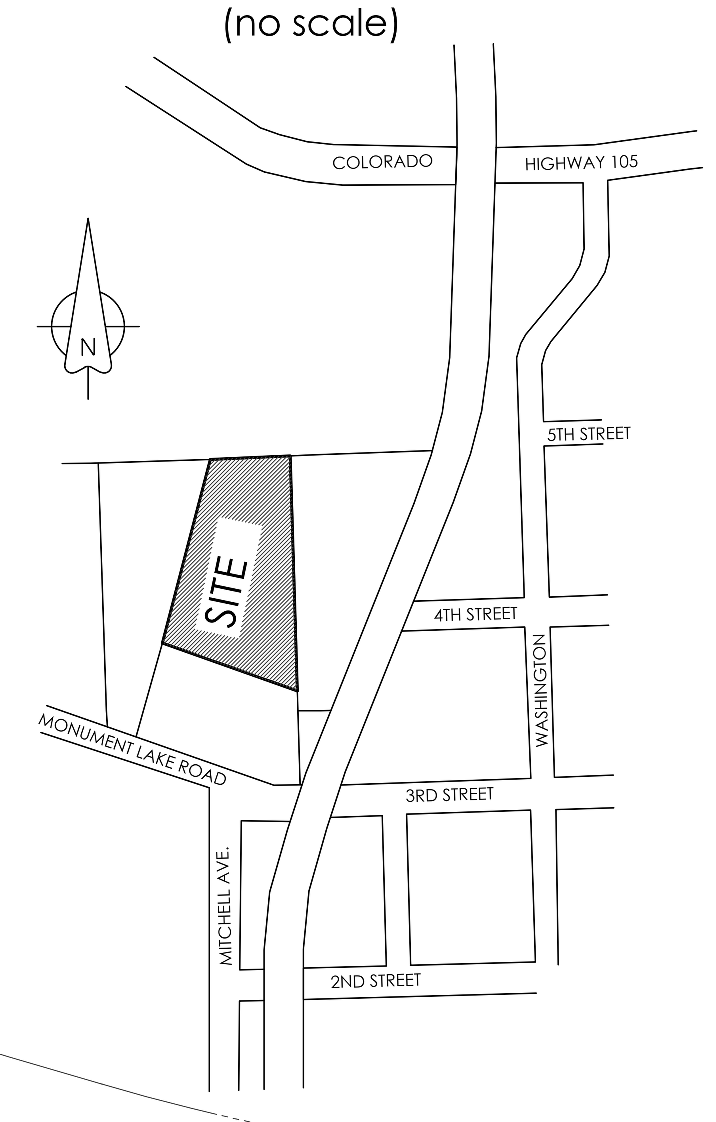
EXISTING

- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- BARBED WIRE FENCE
- TREE (EVERGREEN/DECID.)

PROPOSED

- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- GENERAL FLOW/DIRECTION
- SLOPE DIRECTION AND GRADE
- BASIN LABEL AREA IN ACRES PERCENT IMPERVIOUS
- POINT OF INTEREST

VICINITY MAP
(no scale)



BENCHMARK

1" = 40' 1:480

DEVELOPED DRAINAGE SUMMARY TABLE

POINT OF INTEREST/BASIN(S)	BASIN(S)	AREA (AC)	RUNOFF Q5 (CFS)	Q100 (CFS)
	OSA1	4.05	7.6	16.6
	POND OUTFLOW	4.05	2.8	12.1
DP 1	A1	0.51	0.9	2.0
	A2	1.97	4.3	9.2
DP 2	A1, A2, + POND OUTFLOW	6.53	7.4	22.0
	A3	0.42	0.9	2.0
DP 3 (IN)	A1, A2, A3 + POND OUTFLOW	6.95	8.2	23.7
DP 3 (OUT)	WQCV POND OUTFLOW	6.95	5.3	21.4
	A4	0.89	0.3	2.2
DP 4	DP3 (OUT) + A4	7.84	5.6	23.6
	A5	0.11	0.0	0.3

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Developed Drainage Map

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MVE DRAWING -PP-Drain-Map

October 24, 2019

SHEET 1 OF 1