Westwood

Final Drainage Report

Grazing Yak Solar

El Paso County, Colorado

April 2019 *(Revised June 2019)*

COLORADO LICENSED
BRENDAN DEAN MILLER
44186
PROFESSIONAL ENGINEER
06/26/2019

Prepared For:

Mortenson construction

Drainage Reports

Design 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.

6/26/2019

Brendan Miller, P.E. # 44186 Date

Owner/Developer's Statement:

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

6/27/2019

Alsey Davidson
Grazing Yak Solar, LLC Date
700 Universe Blvd
Juno Beach, FL 33408

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.

Approved
by Jeff Rice
El Paso County Planning and Community Development
on behalf of Elizabeth Nijkamp, Engineering Review Manager
07/01/2019 2:30:28 PM

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

Conditions: Developer shall verify detention basin outlet requirements with the State Engineer prior to construction. Any design revisions to meet State requirements shall be reflected on as-built plans.

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Final Drainage Report for

Grazing Yak Solar

Prepared for:
Mortenson Construction
700 Meadow Lane North
Minneapolis, MN 55422

Prepared by:
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Project Number: 0021201.00
Date: 6/26/2019

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I. GENERAL LOCATION AND DESCRIPTION

A. Site Location

This Final Drainage Report has been prepared on behalf of Grazing Yak Solar, LLC for the development of the proposed Grazing Yak Solar Project, referred to as "The Project". The Project would consist of a 35 megawatt (MW) utility scale photovoltaic solar facility and underground collection line that would encompass approximately 317 acres in El Paso County (EPC), Colorado. The solar array site, referred to as "The Site", is located to the east of the intersection of McQueen Road and Washington Road, approximately 4 miles southeast of the Town of Calhan on private, agricultural land. Rural residences and agricultural land surround the Site, as well as the Golden West Wind Energy Center located to the north, west, and south. The Site is located on 272-acres in Section 29, Township 12 South, Range 61 West of the 6th Principal Meridian, El Paso County, Colorado. A vicinity map for the site can be found in Appendix A.

B. Description of Property

The Site is flat to gently rolling, at elevations ranging from approximately 6,830 to 6,735 feet. The site has naturally occurring slopes ranging from 2 to 10 percent and is currently agricultural land. Surface runoff is to the north, south and east. Runoff from the northern portion of the site flows north overland through multiple conveyances. These flows continue north under Washington through a culvert and eventually into Horse Creek. Flows from the central portion of the site flow toward the drainage that bisects the site. Runoff travels east of the project through an unnamed drainage and eventually into Horse Creek. Flows from the southeast portion of the site flow southeast into an unnamed drainage and eventually into Horse Creek. The proposed improvements to the site consist of a 35 megawatt (MW) photovoltaic solar array, inverters, dirt and gravel access paths, and other necessary ancillary features. The soils vary throughout the site and include mainly Trackton sandy loam, (Hydrologic soil group A), Truckton-Bresser complex (Hydrologic soil group A), Bresser sandy loam (Hydrologic soil group B) and Ascalon sandy loam (Hydrologic soil group B). A soils map has been provided and can be found in Appendix A. The project area contains areas of ponding and channelized water. The site grading does not attempt to get rid of this as the water is expected to percolate or evaporate within 72 hours based on the onsite A and B soils.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Drainage Basins

The existing drainage patterns for the major basin will follow the historic patterns. Grazing Yak will drain north, east and south through drainage ways and culverts and eventually discharging into Horse Creek. The Horse Creek drainage basin in El Paso County is unstudied, with no fees. Horse Creek flows to the east and is part of the Arkansas River basin. The site falls within Zone X, as shown on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panels 08041C0650 G and 0841C0625 G. A copy of the FIRM maps can be found in Appendix A.

B. Minor Drainage Basins

Minor Drainage Basins for Grazing Yak Solar Project have been delineated per the layout of the solar arrays. The developed minor basins will include driven steel pile mounted solar arrays with native ground beneath and dirt and gravel access roads constructed of re-compacted soil and Class 5 Gravel respectively. An Extended Detention Basin for the site will be designed to mitigate the increase in runoff. The basin will be privately owned and maintained. Overall, the proposed drainage patterns for the sub-basins will follow the historic patterns prior to development. For sub-basins within the site, runoff will drain to the north, south and east.

Basin (A1) consists of dirt access paths, a portion of the solar array and offsite undeveloped land. Runoff generated in this basin will flow northeast toward the western property line of the project site. The runoff flows northeast, into the unnamed drainage bisecting the site. This runoff is conveyed through the site and eventually into Horse Creek. The improvements have negligible impact on runoff rates.

Basin (A2) consists of dirt access paths, a portion of the solar array and offsite undeveloped land. Runoff generated in this basin will flow northeast toward the southern property line of the project site. The runoff flows east and northeast, into the unnamed drainage bisecting the site. This runoff is conveyed through the site and eventually into Horse Creek. The improvements have negligible impact on runoff rates.

Basin (A3) consists of dirt access paths, a portion of the solar array and offsite undeveloped land. Runoff generated in this basin will flow north and east toward the existing stock pond located in the unnamed drainage within the project site. The runoff exits the stock pond into the unnamed drainage bisecting the site and travels northeast. This runoff leaves the site at the eastern boundary and eventually into Horse Creek in large events. The improvements within this basin have negligible impact on runoff rates. This basin was analyzed for capacity at multiple event intervals. A Flo2D Model was generated to analyze the stock pond overflow condition utilizing the same input data as above. The output of this analysis is included in Appendix A. This analysis runs in a similar fashion to HEC-HMS but is more automated in the input of basin delineation and soil types by using USGS and USDA data rather than relying on manual input of data. The results of this analysis are that in the 50 and 100 year events, some flow is expected to overtop or breach the dam. The peak flow rate in this condition was calculated at 83 cfs based on the basin and spillway geometry. In the 100 year event, spillover begins coincident with the event peak at approximately 40 minutes and reaches a peak 1 hour and 21 minutes later at 2 hours and 1 minute after the peak. As a result, this creates a significant time shift between the breach and the peak in the basin downstream, Basin A4. In the 50 year event this delay is longer.

Basin (A4) consists of gravel access paths, dirt access paths, and a portion of the solar array. Runoff generated in this basin will flow north and south into the unnamed drainage and a sand filter basin (SF) respectively within the project site. The basin is sized to provide a minimum 10% reduction in predevelopment flows plus flows generated by the increase in imperviousness for the total site. Due to physical constraints, the reduction is significantly more resulting in over-detention of the runoff. However, the design does not exceed the maximum retention time allowed. Runoff is discharged from the basin into the unnamed drainage and conveyed to the eastern property line. This runoff leaves the site at the eastern boundary and eventually into Horse Creek as described below in Section III. As shown in the rational spreadsheets in Appendix A, without the basin in place, this results in an increase of 1.4cfs in basin A4 and an increase of 0.6cfs in basin D1. All other basins have no or negligible increase in flows. Due to physical constraints, A4 is used to mitigate all increases across the site, so the minimum mitigation throughout the site is 2.1cfs (due to rounding error). The addition of the detention facility reduces this discharge by far greater than 2.1cfs, which is the total increase from the site when including both basins A4 and D1 in the 100-year event.

Without accounting for a breached dam condition at A3, the outlet structure restricts flows to approximately 21 cfs from the existing peak of about 82cfs, a 74% decrease. During 25-year and smaller events, no breach is anticipated to occur and therefore acts exactly as calculated. For larger events, because of the aforementioned time shift in the peak flow, the basin will essentially act as a stand-alone basin with no upstream flows coming from Basins A1-A3 until hour at least hour 2 in the 100-year event. At this time, flows are being discharged through the grate structure at a rate higher than new flows are entering the basin from within the limits of Basin A4.

For the breached condition, the aforementioned Flo2D model was used in combination with Hydraflow Express CAD modeling, to size culverts to pass this flow. The combination of culverts will restrict peak flows to 85cfs (slightly greater than the 83cfs peak in the breached condition). In this condition, the 21cfs peak flows calculated through the basin outlet during the peak of the 100 year event (see UD-Detention Worksheet) will also be active. This results in a total peak discharge rate of 106 cfs versus the existing

100 year discharge of 165 cfs (83 cfs breach flow plus the existing basin A4 discharge of 82 cfs, assuming a similar time of concentration). This will result in an approximately 36% reduction in peak flow in the 100-year event.

Therefore in both scenarios (breached and un-breached upstream stock pond), the peak runoff will be less than the existing condition.

Basin (B1) consists of dirt access paths and a portion of the solar array. Runoff generated in this basin will flow to the south east offsite and eventually into Horse Creek. Flowrates or flow patterns within this basin will not be affected by this development. The improvements have negligible impact on runoff rates.

Basin (B2) consists of dirt access paths and a portion of the solar array. Runoff generated in this basin will flow to the south east offsite and eventually into Horse Creek. Flowrates or flow patterns within this basin will not be affected by this development. The improvements have negligible impact on runoff rates.

Basin (C1) consists of dirt access paths and a portion of the solar array. Runoff generated in this basin flows will travel north through multiple small conveyances towards the northern property line, under Washington road through a culvert and eventually into Horse Creek. Flowrates or flow patterns within this basin will not be affected by this development. The improvements have negligible impact on runoff rates.

Basin (D1) consists of gravel access paths, a portion of the solar array and undeveloped land. The increase in imperviousness is being mitigated in the basin in Basin A4. Runoff generated in this basin flows will travel north along the proposed site access road towards Washington Rd. Flows are conveyed under Washington road through a culvert and eventually into Horse Creek. The improvements increase runoff by 0.7cfs, which is mitigated in basin A4. Flows from both Basin D1 and A4 are discharged into Horse Creek and therefore the combined flow is decreased.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

This Conceptual Drainage Report is in accordance with El Paso County Drainage Criteria Manual and the Urban Drainage and Flood Control District (UDFCD) Storm Drainage Criteria Manual. These manuals were used as a basis of design for the site. All applicable tables, figures, and charts from the referenced reports and criteria manuals used in the drainage design of the site can be found in Appendix B. The report analyzes the minor (5-year) and major (100-year) storm events.

B. Drainage Studies, Master Plans, and Site Constraints

A previous drainage study (Conceptual Drainage Report for Grazing Yak Solar Project) was completed for the project on October 23, 2018 and revised on January 16, 2019. There are no master plans or site constraints for this development.

C. Hydrology

All the basins within the site were less than 160 acres thus the Rational Method was used to determine the flow rates for various basins within the site. The sub-basins were delineated based on the existing topography for the project. Flow rates for each basin can be found in Appendix A. The impervious panels are going to be pole mounted with the ground underneath them to remain vegetated. The main access from Washington Road to just south of the unnamed drainage will be constructed with Class 5 Gravel. The remaining site access paths will be constructed as recompacted dirt to promote infiltration back into the ground. The intensity-frequency curves used in the Rational

Method calculations were taken from the El Paso County Drainage Criteria Manual. All drainage facilities were analyzed and designed for both the minor (5-year) and major (100-year) storm events. Time of concentration calculations were used to determine the rainfall intensity. These calculations also can be found in Appendix A. There are three different locations of where offsite water will flow onto the project boundary. All three of these locations will continue to follow existing drainage patterns and will be allowed onsite. As mentioned above, an additional Flo2D analysis was done to account for the existing stock pond and verify appropriate assumptions were made.

D. Hydraulics

Hydraulic calculations for the basin sizing were based on UDFCD design spreadsheets. Street and inlet capacity will not be necessary for this development. Two access road crossings were required for the project: one for the basin and one above the 100-year depth to allow upstream dam flows to bypass above the basin full-level. The bypass has been sized as 5 parallel culverts each capable of bypassing 17CFS for a total of 85CFS. This is in addition the basin outlet below this level that will continue to discharge at the 100 year rate for the lower basin, once the bypass event ends. The calculations for these can be seen in Appendix B. Note that this bypass is only utilized in the 50 and 100 year events where the stock pond is in a breached condition. Any event where a breach does not occur will discharge as is shown in the UDFCD spreadsheet, regardless of the size event since all flows downstream of the existing stock pond are accounted for in its sizing.

E. Water Quality Enhancement (including Four Step Process)

The Project will require gravel access paths to a small portion of the site for access year-round. The remaining access paths will be constructed of recompacted dirt. The overall project design intent is to minimize changes to drainage patterns, ground conditions and general impacts to the maximum extent feasible, utilizing natural vegetation.

The Project will employ runoff reduction practices such as allowing sheet flow across grass buffers and minimizing the increased imperviousness to 2% total for the site post construction. The site consists of Type A & B soils, allowing for optimal infiltration throughout the site. The proposed water quality facility for the site was designed as a Sand Filter (SF) Basin which incorporates a structure that release flows for the water quality capture volume (WQCV) and the 100-year storm event. The design of this structure can be found in Appendix A utilizing the design spreadsheet included in Urban Drainage.

The SF is located in an area with a NRCS Type A soil designation. This is located to receive the sheet flow runoff from the basin containing a majority of the increased imperviousness. The total area of increased imperviousness (approximately 3.2 acres of this 86 acre area) will create a minimal impact to the natural drainage such that stabilization beyond protection at the outlet will not be necessary. The natural drainage way will be protected from sediment discharge, introduction of contaminants and other site operations during construction activities in conformance with El Paso County GEC requirements and MS4 permit. During construction, this outlet will be blocked and pumps will be utilized to remove discharge.

The Four Step Process was utilized in the design as follows:

Step 1 – Employ Runoff Reduction Practices – As previously stated, ground disturbance and installation of impervious structures was minimized to the largest extent possible. This effort included reducing gravel on lesser-traveled sections of roadway in an effort to minimize impacts. Some gravel roadway was still needed to accommodate traffic during construction and maintenance. In addition, areas that only need temporary improvement, such as the laydown yard and trenching areas, are proposed to be returned to their pre-construction condition once construction is complete. As a result, only narrow areas of imperviousness will be in place with large grass buffers below the solar racking, which accounts for a majority of the site area. In addition, the entire low-lying wash areas have been left undisturbed to a large extent. A large majority of the impervious surfaces will flow through grassy areas prior to reaching the site outfall to further mitigate potential runoff impacts.

Step 2 – Stabilize Drainageways - With the exception of the detention pond, the existing larger drainageways on the site were left in their current state. Minor grading is utilized in across more minor low areas, but this is used to reduce slopes to accommodate solar racking, not increase them. As a result, the portion of these drainageways that are impacted will become more gently sloping than in their natural condition. These areas will be reseeded and returned to a similar state as in the existing condition. No drainageways are proposed to become more channelized than in the existing condition.

Step 3 – Provide Water Quality Capture Volume – A Sand Filter Basin is proposed to mitigate the impact to the 2% of the site area that will have increased imperviousness due to the development. This design is included in this report and on the construction and GEC plans.

Step 4 – Consider Need for Industrial and Commercial BMPs – A separate Laydown area has been designated for the storage of fuel and other materials during construction. A written SWMP (Stormwater Management Plan) and GEC (Grading and Erosion Control) Plan have been developed for the site. A written SPCC (Spill Prevention, Control and Countermeasure) Plan is in the process of being developed for the site to be implemented at mobilization to the site. A solid waste handling/recycling program will also be implemented as part of the housekeeping best management practices.

IV. STORMWATER MANAGEMENT FACILITY DESIGN

A. Stormwater Conveyance Facilities

The general concept for the drainage design is to maintain the historic drainage patterns and release rates to the largest extent feasible. This approach reduces the impacts to existing wash and ultimately Horse Creek. No public infrastructure is proposed within this site. A basin will be added near the outfall of the site to allow for a dry road crossing and as part of the outlet structure and culvert installed under the crossing. This is utilized as a method of metering output from the proposed basin described in more detail below. The inlet structure is designed per the UFCD manual to include an orifice plate and a grate inlet at the top of the WQCV elevation. A 21” culvert will extend from the box under the road to the discharge point. In addition, additional culverts will be installed above the 100-year ponding elevation to serve as a bypass for flows entering as a result of a breached condition of the upstream dam.

B. Stormwater Storage Facilities

Basin A4 SF pond sizing calculations can be found in the Appendix. This basin will be created by lowering the grade at the basin location. In addition, the top foot of this area is to the de-compacted at the end of construction to ensure percolation into the soil. Since these are Type A soils, percolation rates will conservatively drain at a rate sufficient to drain the entire 27” deep basin in 72 hours (at a rate of 0.375 inches/hour, which is less than should be anticipated for these soils based on the geotechnical analysis). In addition, weep holes in the outlet structure will ensure the basin depth drains in approximately 50 hours even with no percolation. This volume should be maintained regularly to ensure no clogging of the outlet structure occurs.

The SF mitigates the increase of runoff generated by the gravel access roads and small electrical equipment pads throughout the site. Runoff generated by the access roads will flow into the EDB through a combination of sheet flow from the south and flows entering from the adjacent channelized bypass to the north. The basin provides a WQCV volume of 0.163 acre-feet and a minimum 100-year volume of 1.420 acre feet (at stage 2.33, or an elevation of 6737.00) and will release below historic runoff rates. The basin will have a two stage discharge due to the relatively small volume being captured from a large site in addition to any infiltration that happens through the sand filter bed. The WQCV volume will be discharged through an orifice plate with three 1-1/2” orifices each vertically spaced 6” above the bottom one, which has an invert that matches the basin invert. Flows above this will be discharged over a weir and through a pair of standard CDOT grates totaling a nominal 3.5’ x 6’ area at stage 1.75. Actual open

area and clogging are taken into account in the calculations. The box then discharges under the road through a 21" RCP culvert.
The UD-Detention spreadsheet was utilized for these calculations. Orifice holes and placement were based on the spreadsheet for the WQC Volume, which reaches a maximum depth of 1.75' which is the height of the grate weir. During the 10 and smaller events, flows will be discharged entirely through the orifice plate and sand filter basin. Since the volume through the grate exceeds the allowable discharge rate during large events, an orifice plate is typically used on the outlet culvert to restrict flows leaving the inlet box. The size of this orifice plate was calculated at 21" to maintain the proper window of discharge time for these larger events. In lieu of adding a steel orifice plate, a 21" culvert was used providing a 21" orifice opening. The flow rate through the culvert is restricted by the orifice flow rate since it is headwater controlled, and therefore the pipe itself acts as the orifice constriction. Additional calculations were performed outside of the spreadsheet to confirm that the orifice (headwall) controls the flow rate through the 21" pipe. Adding a steel plate with a 21" opening would be redundant and therefore was omitted from the design.

At the outlets of the pond on the downstream end of the aforementioned 21" culvert, riprap of will be placed with a D50 of a minimum of 6" and a minimum depth of 9" in order to reduce erosion from the outlet. The riprap has been sized based on an exit velocity of approximately 7.6 feet per second for the outlet.

In addition to the basin outlet, 5 x 24" culverts are to be installed at a height of 2.33' above the basin volume, which is higher than the 100-year capture volume. These are strictly intended to bypass flows from a breached condition from the upstream stock pond and therefore should only be active when there is additional volume entering the basin from the upstream area with negligible imperviousness that is not intended for treatment.

The entire 100 year event can be accepted and released by the basin with a peak water depth of 4.22' at an elevation of 6738.78. The road sits at 6740.00, offering additional freeboard above this depth. In an extreme event larger than this, overtopping of the road could occur. This basin has not been designed for this "Act-of-God" type event and road damage is anticipated in such an event. Instead this area behind the road crossing is intended to be drained via the five 24" culverts for all design events.

C. Water Quality Enhancement Best Management Practices

Water quality measures have been included in the design of the proposed EDBs. The basin will be designed to incorporate a structure that release flows for the water quality capture volume (WQCV) and the 100-year storm event. The basin also includes a micropool just upstream of the outfall structure.

D. Floodplain Modification

There will be no modification to the floodplain

E. Additional Permitting Requirements

No additional permitting will be required for this site.

F. General

All applicable tables, figures, and charts from the referenced reports and criteria manuals used in the drainage design of the site can be found in the Appendix. The site is not going to be platted at this time therefore no drainage fees are due.

REFERENCES

A. El Paso County Drainage Criteria Manual, Volumes 1 and 2.
B. Drainage Criteria Manual, Volumes 1, 2, & 3, Urban Drainage and Flood Control

District, June 2001, Revised June 2017.
C. El Paso County Engineering Criteria Manual

Appendix A

Hydrologic Calculations

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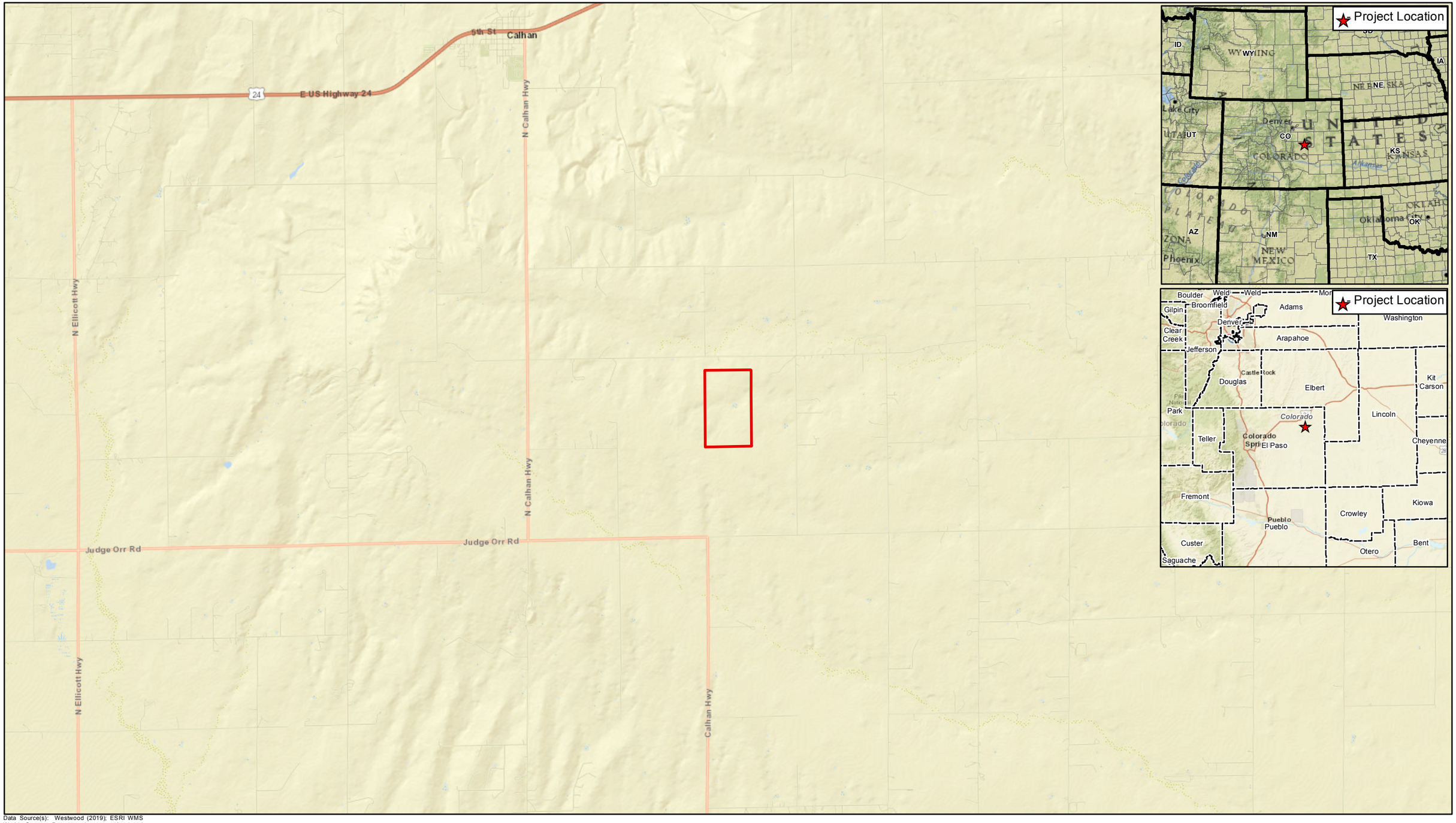


Data Source(s): Westwood (2019); ESRI WMS World Streets Basemap Imagery (Accessed 2019).

Grazing Yak Solar

El Paso County, Colorado

Legend

- Project Boundary
- County Boundary

N

0 1 Miles

Exhibit 1: Location Map

March 21, 2019

Westwood
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Map Document: N:\0021201.00\GIS\Hydro Exhibits\2019-03-21_GrazingYak_Ex1_LocationMap.mxd mshildreth 3/21/2019 11:12:35 AM

NOTES TO USERS

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

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

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

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

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

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

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

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

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

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

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

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

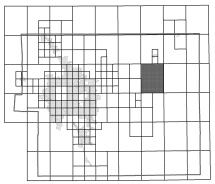
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this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

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

El Paso County Vertical Datum Offset Table

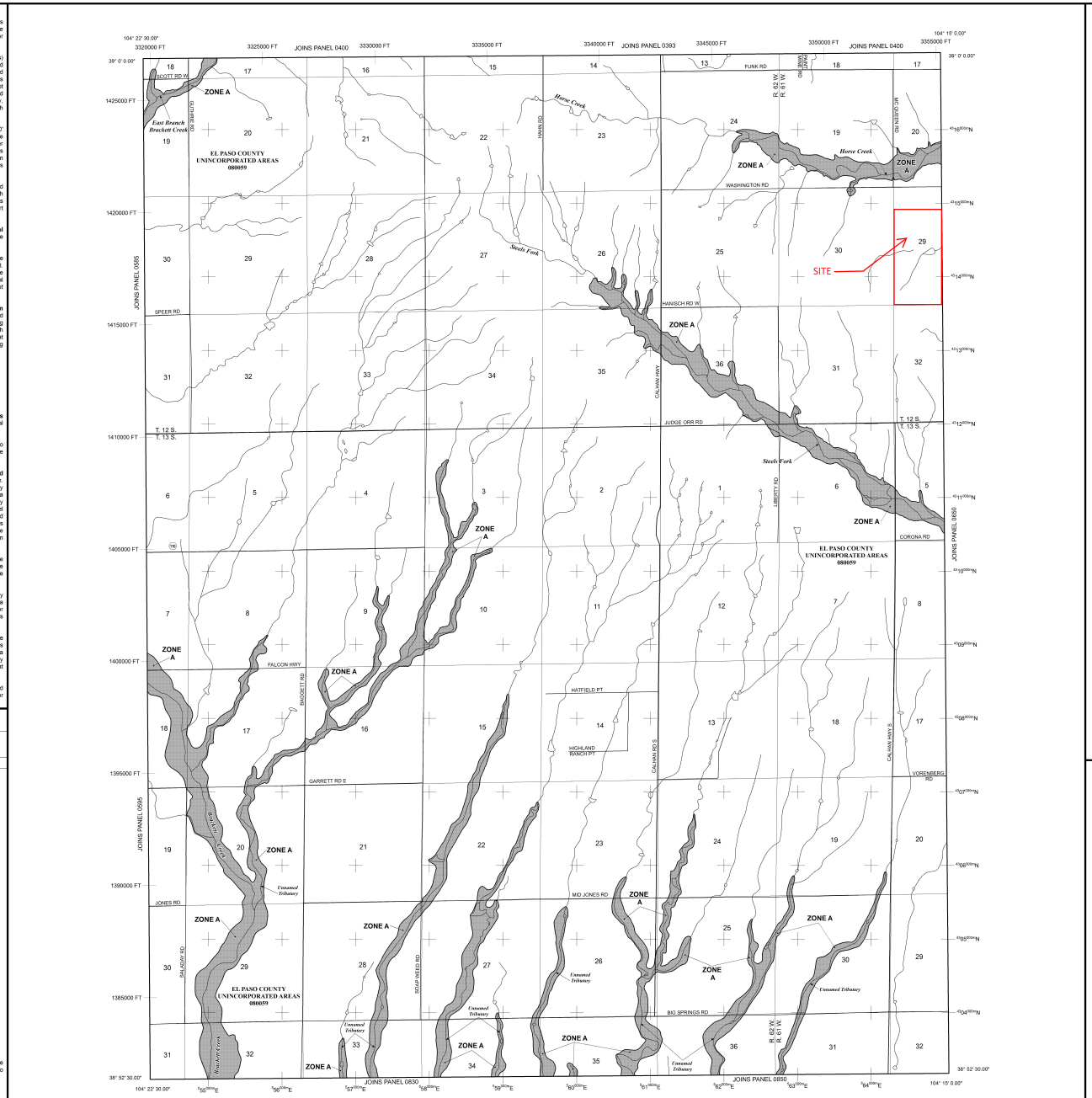
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



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

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

A — A	Cross section line
23 - - - 23	Transect line
97° 07' 30.00" 32° 22' 30.00"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT	5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

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

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

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

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

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

500 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0625G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO

AND INCORPORATED AREAS

PANEL 625 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0625	G

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

MAP NUMBER
08041C0625G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

NOTES TO USERS

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

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

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

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

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

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

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

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

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

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

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

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

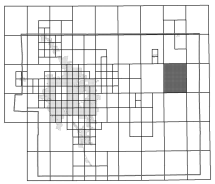
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this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

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

El Paso County Vertical Datum Offset Table

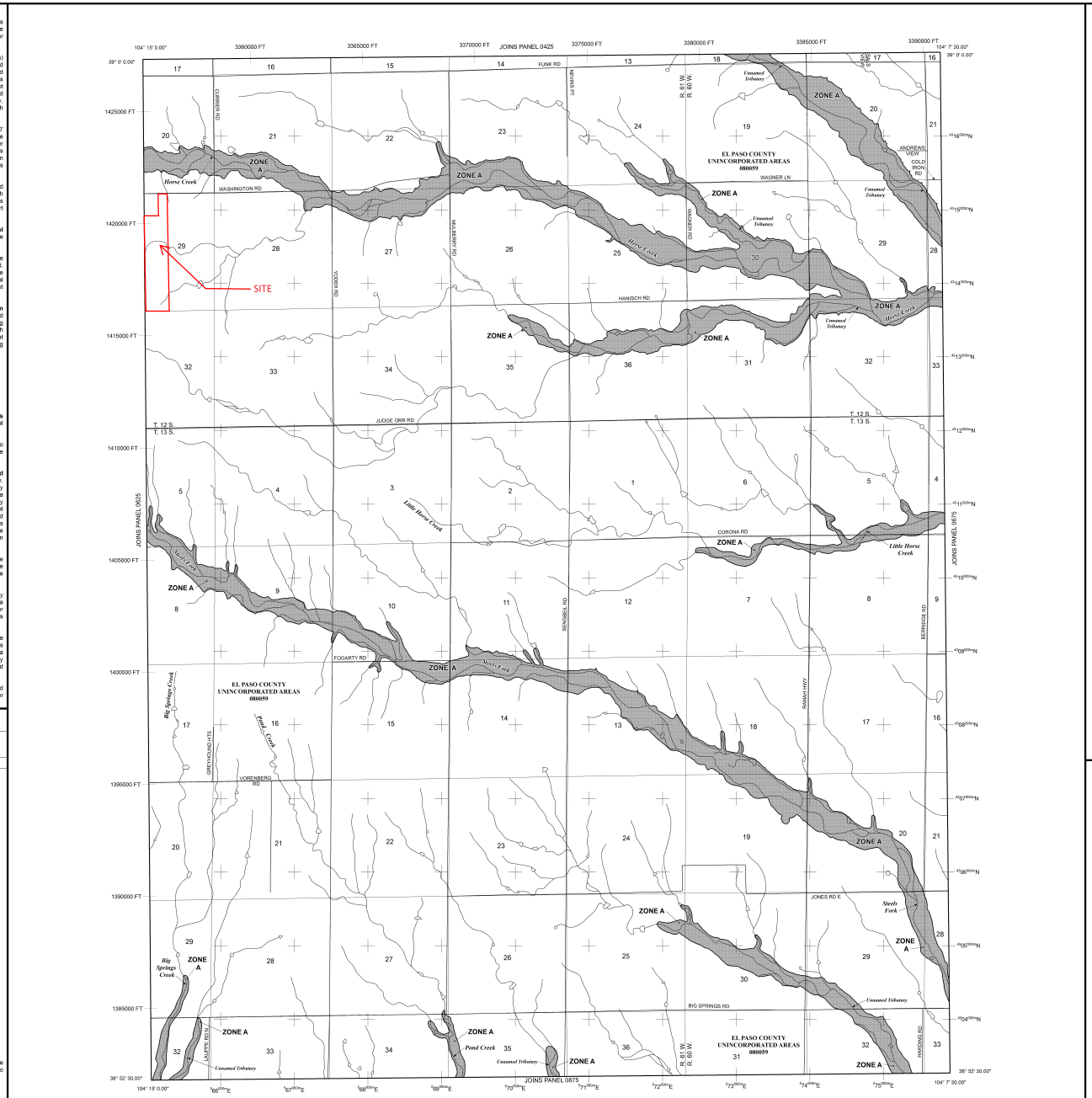
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



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

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



LEGEND

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

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• M1.5	River Mile

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

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
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1000 0 2000 4000 FEET

500 0 1000 2000 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0650G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 650 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0650	G

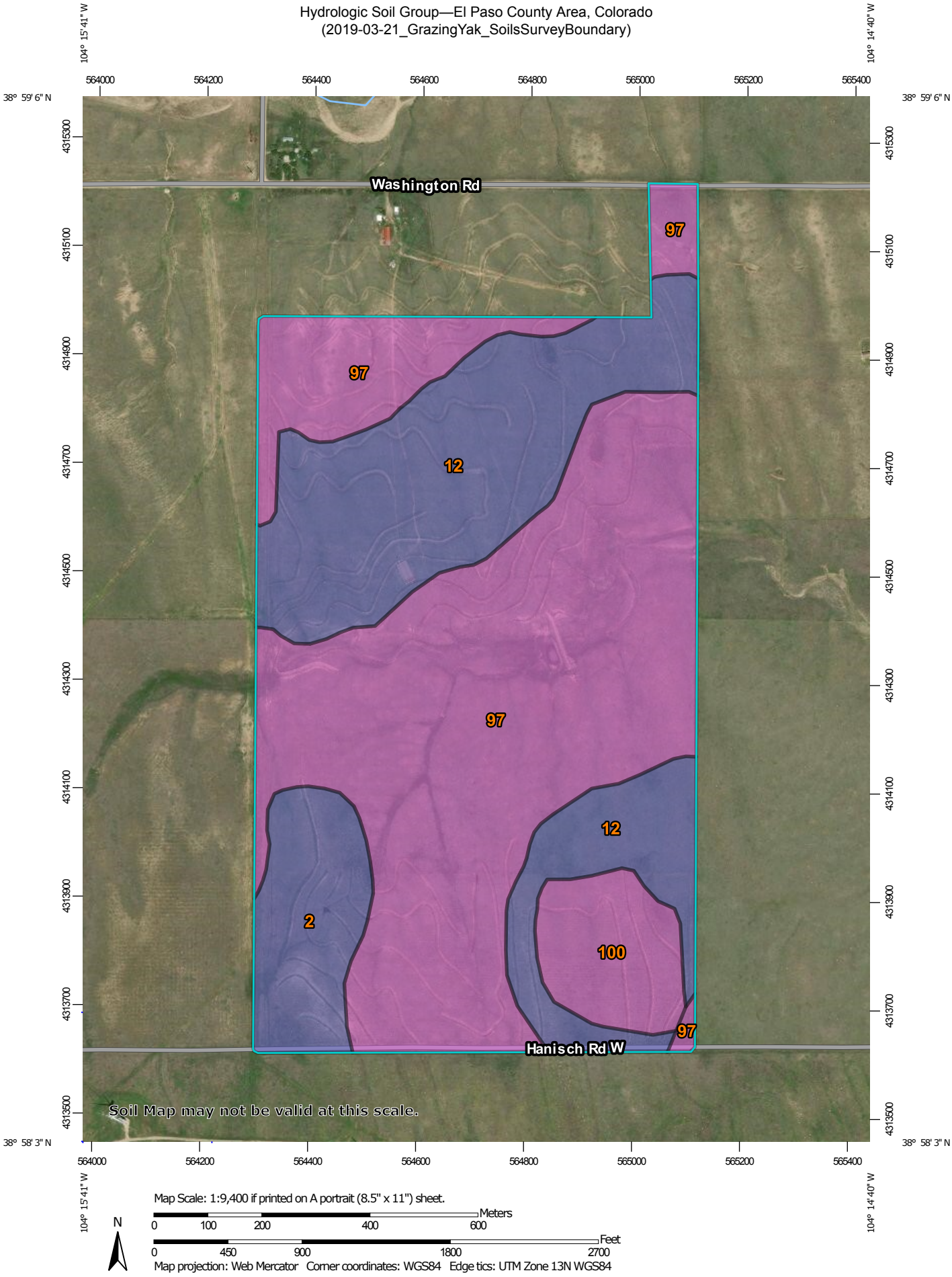
Notes to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0650G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Hydrologic Soil Group—El Paso County Area, Colorado
(2019-03-21_GrazingYak_SoilsSurveyBoundary)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Jun 7, 2016—Aug 17, 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
2	Ascalon sandy loam, 1 to 3 percent slopes	B	22.1	7.9%
12	Bresser sandy loam, cool, 3 to 5 percent slopes	B	82.9	29.6%
97	Truckton sandy loam, 3 to 9 percent slopes	A	158.5	56.5%
100	Truckton-Bresser complex, eroded	A	16.9	6.0%
Totals for Area of Interest			**280.4**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Grazing Yak Solar

Westwood Project #:21201 18-082

Prepared By: MSH

COMPOSITE BASIN - WEIGHTED "C" CALCULATIONS - Existing Conditions

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-3

	Residential							Lawns				
	Single Family			Multi-Unit				Clay Soil				
	0.25 acres	2.5 acres or larger	5 DU's/Ac 3,000 sf 2 story	(attached)	Roof	Streets: Paved	Gravel	2-7% Slope	>7% Slope	Historic		
% Imperv.	45.00%	12.00%	63.00%	75.00%	90.00%	100.00%	80.00%	2.00%	2.00%	2.00%		
											Total	Percent
BASIN	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Impervious**
A1										86.97	86.97	2.0%
A2										120.45	120.45	2.0%
A3										86.92	86.92	2.0%
A4										78.97	80.33	2.0%
Total A							**0.00**			**373.31**	**374.67**	**1.99%**
B1										3.82	3.82	2.0%
B2										5.60	5.60	2.0%
Total B										**9.42**	**9.42**	**2.0%**
C1										46.03	46.03	2.0%
Total C										**46.03**	**46.03**	**2.0%**
D1										5.12	5.68	1.8%
Total D							**0.00**			**5.12**	**5.68**	**1.80%**

Grazing Yak Solar

Westwood Project #:21201 18-082
Prepared By: MSH

COMPOSITE DEVELOPED BASIN -WEIGHTED "C" CALCULATIONS - Existing Conditions

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-4

i = % imperviousness/100 expressed as a decimal
C_A = Runoff coefficient for NRCS HSG A soils
C_B = Runoff coefficient for NRCS HSG B soils
C_{CD} = Runoff coefficient for NRCS HSG C and D soils.
Natural Resource Conservation Service (NRCS)

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group	Storm Return Period						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.84i^{1.124}$	$C_A = 0.85i+0.025$	$C_A = 0.78i+0.110$	$C_A = 0.65i+0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i+0.057$	$C_B = 0.63i+0.249$	$C_B = 0.56i+0.328$	$C_B = 0.47i+0.426$	$C_B = 0.37i+0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i+0.035$	$C_{C/D} = 0.74i+0.132$	$C_{C/D} = 0.56i+0.319$	$C_{C/D} = 0.49i+0.393$	$C_{C/D} = 0.41i+0.484$	$C_{C/D} = 0.32i+0.588$

Basin ID	% Imperv.	*i*	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
A1	2.0%	0.02	A	0.01	0.01	0.01	0.13	50.70	86.97	0.01	0.01	0.03	0.25
			B	0.01	0.01	0.07	0.44	36.27					
			C or D	0.01	0.05	0.15	0.49	0.00					
A2	2.0%	0.02	A	0.01	0.01	0.01	0.13	72.11	120.45	0.01	0.01	0.03	0.30
			B	0.01	0.01	0.07	0.56	48.34					
			C or D	0.01	0.05	0.15	0.49	0.00					
A3	2.0%	0.02	A	0.01	0.01	0.01	0.13	53.99	86.92	0.01	0.01	0.03	0.24
			B	0.01	0.01	0.07	0.44	32.88					
			C or D	0.01	0.05	0.15	0.49	0.05					
A4	2.0%	0.02	A	0.01	0.01	0.01	0.13	52.23	80.33	0.01	0.01	0.03	0.23
			B	0.01	0.01	0.07	0.44	28.10					
			C or D	0.01	0.05	0.15	0.49	0.00					
B1	2.0%	0.02	A	0.01	0.01	0.01	0.13	2.04	3.82	0.01	0.01	0.04	0.27
			B	0.01	0.01	0.07	0.44	1.78					
			C or D	0.01	0.05	0.15	0.49	0.00					
B2	2.0%	0.02	A	0.01	0.01	0.01	0.13	4.66	5.60	0.01	0.01	0.02	0.18
			B	0.01	0.01	0.07	0.44	0.94					
			C or D	0.01	0.05	0.15	0.49	0.00					
C1	2.0%	0.02	A	0.01	0.01	0.01	0.13	25.62	46.03	0.01	0.01	0.04	0.26
			B	0.01	0.01	0.07	0.44	20.41					
			C or D	0.01	0.05	0.15	0.49	0.00					
D1	1.8%	0.02	A	0.00	0.01	0.01	0.12	1.24	5.68	0.01	0.01	0.06	0.37
			B	0.01	0.01	0.07	0.43	4.32					
			C or D	0.01	0.05	0.15	0.49	0.12					

Grazing Yak Solar

Westwood Project #:21201 18-082

Prepared By: MSH

TIME OF CONCENTRATION CALCULATIONS - Existing Conditions

-REFERENCE UDFCD Vol.1 Section 2.4

NRCS Conveyance factors, K -REFERENCE UDFCD Vol.1 RUNOFF Table 6-2

SF-2

Heavy Meadow	2.50	Short Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Tillage/field	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

SUB-BASIN DATA			INITIAL / OVERLAND TIME			TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPER-VIOUS	USDCM Eq . 6-5	min.
A1	86.97	0.01	148	1.3	21.7	2623	2.4	5.00	0.8	54.7	76.4	2.0%		76.4
A2	120.45	0.01	300	1.7	28.8	3149	1.7	5.00	0.7	75.0	103.8	2.0%		103.8
A3	86.92	0.01	300	3.3	22.9	3203	2.4	5.00	0.8	66.7	89.6	2.0%		89.6
A4	80.33	0.01	300	3.7	22.2	3023	2.0	5.00	0.7	72.0	94.2	2.0%		94.2
B1	3.82	0.01	240	1.0	30.1	357	1.4	5.00	0.6	9.9	40.0	2.0%		40.0
B2	5.60	0.01	300	1.5	29.9	466	3.0	5.00	0.9	8.6	38.5	2.0%		38.5
C1	46.03	0.01	300	5.2	19.8	1517	1.6	5.00	0.6	42.1	61.9	2.0%		61.9
D1	5.68	0.01	529	0.9	47.7	1189	2.5	5.00	0.8	24.8	72.5	1.8%		72.5

Grazing Yak Solar

Westwood Project #:21201 18-082

Prepared By: MSH

RATIONAL METHOD PEAK RUNOFF - Existing Conditions

5-YR STORM

SF-3 *Rainfall Depth-Duration-Frequency (1-hr) =* **1.5**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	REMARKS
1	A1	86.97	0.01	76.4	0.74	1.28	0.9					
2	A2	120.45	0.01	103.8	1.01	1.03	1.0					
3	A3	86.92	0.01	89.6	0.72	1.15	0.8					
4	A4	80.33	0.01	94.2	0.63	1.11	0.7					
5	B1	3.82	0.01	40.0	0.03	1.97	1.4					
6	B2	5.60	0.01	38.5	0.04	2.02	0.1					
7	C1	46.03	0.01	61.9	0.40	1.48	0.6					
8	D1	5.68	0.01	72.5	0.06	1.33	0.1					

Grazing Yak Solar

Westwood Project #:21201 18-082

Prepared By: MSH

RATIONAL METHOD PEAK RUNOFF - Existing Conditions

100-YR STORM

SF-3 *Rainfall Depth-Duration-Frequency (1-hr) =* **2.52**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				
DESIGN POINT	DRAIN BASIN	AREA ac.	100yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	REMARKS
1	A1	86.97	0.25	76.4	22.16	2.16	47.8					
2	A2	120.45	0.30	103.8	36.13	1.74	62.8					
3	A3	86.92	0.24	89.6	21.12	1.93	40.8					
4	A4	80.33	0.23	94.2	18.78	1.86	35.0					
5	B1	3.82	0.27	40.0	1.03	3.32	1.4					
6	B2	5.60	0.18	38.5	0.99	3.40	3.4					
7	C1	46.03	0.26	61.9	12.10	2.49	30.2					
8	D1	5.68	0.37	72.5	2.09	2.24	4.7					

Grazing Yak Solar

Westwood Project #:21201 18-082

Prepared By: MSH

COMPOSITE BASIN - WEIGHTED "C" CALCULATIONS

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-3

	Residential							Lawns				
	Single Family			Multi-Unit				Clay Soil				
	0.25 acres	2.5 acres or larger	5 DU's/Ac 3,000 sf 2 story	(attached)	Roof	Streets: Paved	Gravel	2-7% Slope	>7% Slope	Historic		
% Imperv.	45.00%	12.00%	63.00%	75.00%	90.00%	100.00%	80.00%	2.00%	2.00%	2.00%		
											Total	Percent
BASIN	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Area**	**Impervious**
A1										86.97	86.97	2.0%
A2										120.45	120.45	2.0%
A3										86.92	86.92	2.0%
A4							1.36			78.97	80.33	3.3%
Total A							**1.36**			**373.31**	**374.67**	**2.28%**
B1										3.82	3.82	2.0%
B2										5.60	5.60	2.0%
Total B										**9.42**	**9.42**	**2.0%**
C1										46.03	46.03	2.0%
Total C										**46.03**	**46.03**	**2.0%**
D1							0.56			5.12	5.68	9.7%
Total D							**0.56**			**5.12**	**5.68**	**9.69%**

Grazing Yak Solar

Westwood Project #:21201 18-082
Prepared By: MSH

COMPOSITE DEVELOPED BASIN -WEIGHTED "C" CALCULATIONS

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-4

i = % imperviousness/100 expressed as a decimal
C_A = Runoff coefficient for NRCS HSG A soils
C_B = Runoff coefficient for NRCS HSG B soils
C_{CD} = Runoff coefficient for NRCS HSG C and D soils.
Natural Resource Conservation Service (NRCS)

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group	Storm Return Period						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.84i^{1.124}$	$C_A = 0.85i+0.025$	$C_A = 0.78i+0.110$	$C_A = 0.65i+0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i+0.057$	$C_B = 0.63i+0.249$	$C_B = 0.56i+0.328$	$C_B = 0.47i+0.426$	$C_B = 0.37i+0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i+0.035$	$C_{C/D} = 0.74i+0.132$	$C_{C/D} = 0.56i+0.319$	$C_{C/D} = 0.49i+0.393$	$C_{C/D} = 0.41i+0.484$	$C_{C/D} = 0.32i+0.588$

Basin ID	% Imperv.	*i*	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
A1	2.0%	0.02	A	0.01	0.01	0.01	0.13	50.70	86.97	0.01	0.01	0.03	0.25
			B	0.01	0.01	0.07	0.44	36.27					
			C or D	0.01	0.05	0.15	0.49	0.00					
A2	2.0%	0.02	A	0.01	0.01	0.01	0.13	72.11	120.45	0.01	0.01	0.03	0.30
			B	0.01	0.01	0.07	0.56	48.34					
			C or D	0.01	0.05	0.15	0.49	0.00					
A3	2.0%	0.02	A	0.01	0.01	0.01	0.13	53.99	86.92	0.01	0.01	0.03	0.24
			B	0.01	0.01	0.07	0.44	32.88					
			C or D	0.01	0.05	0.15	0.49	0.05					
A4	3.3%	0.03	A	0.01	0.01	0.01	0.14	52.23	80.33	0.01	0.01	0.04	0.24
			B	0.02	0.02	0.08	0.44	28.10					
			C or D	0.02	0.06	0.16	0.50	0.00					
B1	2.0%	0.02	A	0.01	0.01	0.01	0.13	2.04	3.82	0.01	0.01	0.04	0.27
			B	0.01	0.01	0.07	0.44	1.78					
			C or D	0.01	0.05	0.15	0.49	0.00					
B2	2.0%	0.02	A	0.01	0.01	0.01	0.13	4.66	5.60	0.01	0.01	0.02	0.18
			B	0.01	0.01	0.07	0.44	0.94					
			C or D	0.01	0.05	0.15	0.49	0.00					
C1	2.0%	0.02	A	0.01	0.01	0.01	0.13	25.62	46.03	0.01	0.01	0.04	0.26
			B	0.01	0.01	0.07	0.44	20.41					
			C or D	0.01	0.05	0.15	0.49	0.00					
D1	9.7%	0.10	A	0.04	0.04	0.05	0.19	1.24	5.68	0.05	0.06	0.12	0.41
			B	0.05	0.07	0.14	0.47	4.32					
			C or D	0.06	0.11	0.20	0.52	0.12					

Grazing Yak Solar

Westwood Project #:21201 18-082

Prepared By: MSH

TIME OF CONCENTRATION CALCULATIONS

-REFERENCE UDFCD Vol.1 Section 2.4

SF-2

NRCS Conveyance factors, K -REFERENCE UDFCD Vol.1 RUNOFF Table 6-2

Heavy Meadow	2.50	Short Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Tillage/field	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

SUB-BASIN DATA			INITIAL / OVERLAND TIME			TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPER-VIOUS	USDCM Eq . 6-5	min.
A1	86.97	0.01	148	1.3	21.7	2623	2.4	5.00	0.8	54.7	76.4	2.0%		76.4
A2	120.45	0.01	300	1.7	28.8	3149	1.7	5.00	0.7	75.0	103.8	2.0%		103.8
A3	86.92	0.01	300	3.3	22.9	3203	2.4	5.00	0.8	66.7	89.6	2.0%		89.6
A4	80.33	0.01	300	3.7	22.1	3023	2.0	5.00	0.7	72.0	94.1	3.3%		94.1
B1	3.82	0.01	240	1.0	30.1	357	1.4	5.00	0.6	9.9	40.0	2.0%		40.0
B2	5.60	0.01	300	1.5	29.9	466	3.0	5.00	0.9	8.6	38.5	2.0%		38.5
C1	46.03	0.01	300	5.2	19.8	1517	1.6	5.00	0.6	42.1	61.9	2.0%		61.9
D1	5.68	0.06	529	0.9	45.4	1189	2.5	5.00	0.8	24.8	70.2	9.7%		70.2

Grazing Yak Solar

Westwood Project #:21201 18-082

Prepared By: MSH

RATIONAL METHOD PEAK RUNOFF

5-YR STORM

SF-3 *Rainfall Depth-Duration-Frequency (1-hr) =* **1.5**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	REMARKS
1	A1	86.97	0.01	76.4	0.74	1.28	0.9					
2	A2	120.45	0.01	103.8	1.01	1.03	1.0					
3	A3	86.92	0.01	89.6	0.72	1.15	0.8					
4	A4	80.33	0.01	94.1	1.18	1.11	1.3					
5	B1	3.82	0.01	40.0	0.03	1.97	1.4					
6	B2	5.60	0.01	38.5	0.04	2.02	0.1					
7	C1	46.03	0.01	61.9	0.40	1.48	0.6					
8	D1	5.68	0.06	70.2	0.36	1.36	0.5					

Grazing Yak Solar

Westwood Project #:21201 18-082

Prepared By: MSH

RATIONAL METHOD PEAK RUNOFF

100-YR STORM

SF-3 *Rainfall Depth-Duration-Frequency (1-hr) =* **2.52**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				
DESIGN POINT	DRAIN BASIN	AREA ac.	100yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	REMARKS
1	A1	86.97	0.25	76.4	22.16	2.16	47.8					
2	A2	120.45	0.30	103.8	36.13	1.74	62.8					
3	A3	86.92	0.24	89.6	21.12	1.93	40.8					
4	A4	80.33	0.24	94.1	19.51	1.86	36.4					
5	B1	3.82	0.27	40.0	1.03	3.32	1.4					
6	B2	5.60	0.18	38.5	0.99	3.40	3.4					
7	C1	46.03	0.26	61.9	12.10	2.49	30.2					
8	D1	5.68	0.41	70.2	2.33	2.29	5.3					

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves[2] and should produce similar depth calculation results.

2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms**: Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

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

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

3.2 Time of Concentration

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

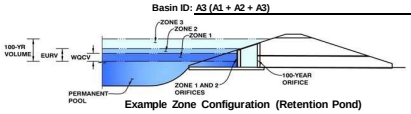
For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus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

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Grazing Yak

Basin ID: A3 (A1 + A2 + A3)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**No BMP**	Flood Control Only		
Watershed Area =	294.34	acres		
Watershed Length =	5,200	ft		
Watershed Slope =	0.017	ft/ft		
Watershed Imperviousness =	2.00%	percent		
Percentage Hydrologic Soil Group A =	30.0%	percent		
Percentage Hydrologic Soil Group B =	70.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.371	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.423	acre-feet		
2-yr Runoff Volume (P1 = 1 in.) =	0.211	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.32 in.) =	0.376	acre-feet	1.32	inches
10-yr Runoff Volume (P1 = 1.6 in.) =	2.277	acre-feet	1.60	inches
25-yr Runoff Volume (P1 = 2.02 in.) =	10.698	acre-feet	2.02	inches
50-yr Runoff Volume (P1 = 2.37 in.) =	16.923	acre-feet	2.37	inches
100-yr Runoff Volume (P1 = 2.74 in.) =	26.458	acre-feet	2.74	inches
500-yr Runoff Volume (P1 = 3.7 in.) =	48.450	acre-feet	3.70	inches
Approximate 2-yr Detention Volume =	0.193	acre-feet		
Approximate 5-yr Detention Volume =	0.349	acre-feet		
Approximate 10-yr Detention Volume =	1.818	acre-feet		
Approximate 25-yr Detention Volume =	3.103	acre-feet		
Approximate 50-yr Detention Volume =	3.325	acre-feet		
Approximate 100-yr Detention Volume =	5.227	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (EURV-WQCV) =	0.052	acre-feet	
Select Zone 2 Storage Volume (Optional) =		acre-feet	**Total detention volume is less than 100-year volume.**
Select Zone 3 Storage Volume (Optional) =		acre-feet	
Total Detention Basin Volume =	0.052	acre-feet	
Initial Surcharge Volume (ISV) =	user	ft^3	
Initial Surcharge Depth (ISD) =	user	ft	
Total Available Detention Depth (H_{total}) =	user	ft	
Depth of Trickle Channel (H_{TC}) =	user	ft	
Slope of Trickle Channel (S_{TC}) =	user	ft/ft	
Slopes of Main Basin Sides (S_{main}) =	user	H:V	
Basin Length-to-Width Ratio ($R_{L/W}$) =	user		
Initial Surcharge Area (A_{ISV}) =	user	ft^2	
Surcharge Volume Length (L_{ISV}) =	user	ft	
Surcharge Volume Width (W_{ISV}) =	user	ft	
Depth of Basin Floor (H_{FLOOR}) =	user	ft	
Length of Basin Floor (L_{FLOOR}) =	user	ft	
Width of Basin Floor (W_{FLOOR}) =	user	ft	
Area of Basin Floor (A_{FLOOR}) =	user	ft^2	
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3	
Depth of Main Basin (H_{MAIN}) =	user	ft	
Length of Main Basin (L_{MAIN}) =	user	ft	
Width of Main Basin (W_{MAIN}) =	user	ft	
Area of Main Basin (A_{MAIN}) =	user	ft^2	
Volume of Main Basin (V_{MAIN}) =	user	ft^3	
Calculated Total Basin Volume (V_{total}) =	user	acre-feet	

Depth Increment = 1 ft

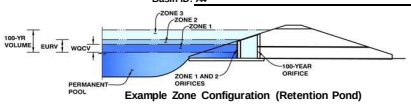
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	40	0.001		
	--	1.00	--	--	--	10,924	0.251	5,373	0.123
	--	2.00	--	--	--	20,739	0.476	21,106	0.485
	--	3.00	--	--	--	40,555	0.931	51,960	1.193
	--	4.00	--	--	--	64,265	1.475	104,370	2.396
	--	5.00	--	--	--	89,026	2.044	181,016	4.156
	--	6.00	--	--	--	115,746	2.657	283,402	6.506
	--	7.00	--	--	--	143,975	3.305	413,262	9.487
	--	7.50	--	--	--	178,461	4.097	493,871	11.338

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Grazing Yak Solar

Basin ID: A4



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF	
Watershed Area =	86.01	acres
Watershed Length =	3,300	ft
Watershed Slope =	0.024	ft/ft
Watershed Imperviousness =	3.34%	percent
Percentage Hydrologic Soil Group A =	60.0%	percent
Percentage Hydrologic Soil Group B =	39.0%	percent
Percentage Hydrologic Soil Groups C/D =	1.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.142	acre-feet
Excess Urban Runoff Volume (EURV) =	0.192	acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.101	acre-feet
5-yr Runoff Volume (P1 = 1.32 in.) =	0.168	acre-feet
10-yr Runoff Volume (P1 = 1.6 in.) =	0.538	acre-feet
25-yr Runoff Volume (P1 = 2.02 in.) =	2.017	acre-feet
50-yr Runoff Volume (P1 = 2.37 in.) =	3.356	acre-feet
100-yr Runoff Volume (P1 = 2.74 in.) =	5.801	acre-feet
500-yr Runoff Volume (P1 = 3.7 in.) =	11.779	acre-feet
Approximate 2-yr Detention Volume =	0.092	acre-feet
Approximate 5-yr Detention Volume =	0.156	acre-feet
Approximate 10-yr Detention Volume =	0.441	acre-feet
Approximate 25-yr Detention Volume =	0.744	acre-feet
Approximate 50-yr Detention Volume =	0.916	acre-feet
Approximate 100-yr Detention Volume =	1.598	acre-feet

Optional User Override 1-hr Precipitation

1.00	inches
1.32	inches
1.60	inches
2.02	inches
2.37	inches
2.74	inches
3.70	inches

Stage-Storage Calculation

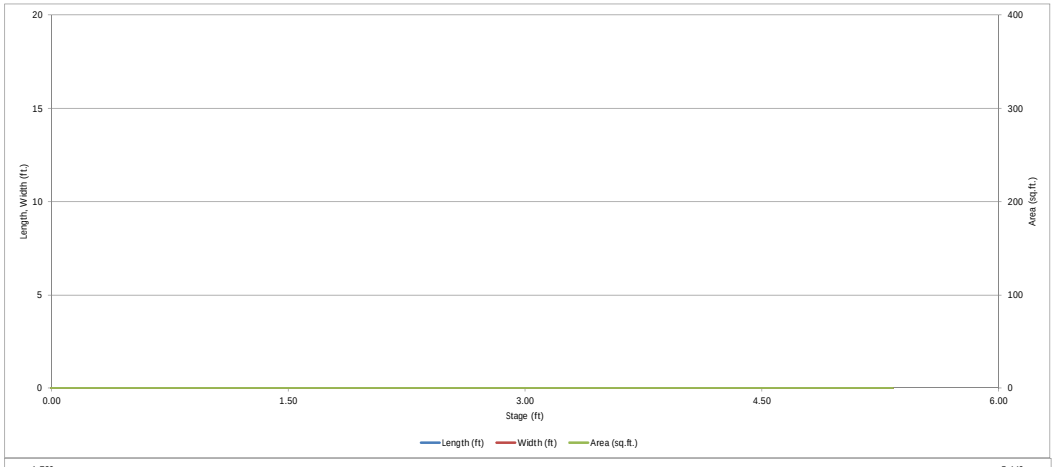
Zone 1 Volume (WQCV) =	0.142	acre-feet
Zone 2 Volume (100-year - Zone 1) =	1.456	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	1.598	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (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

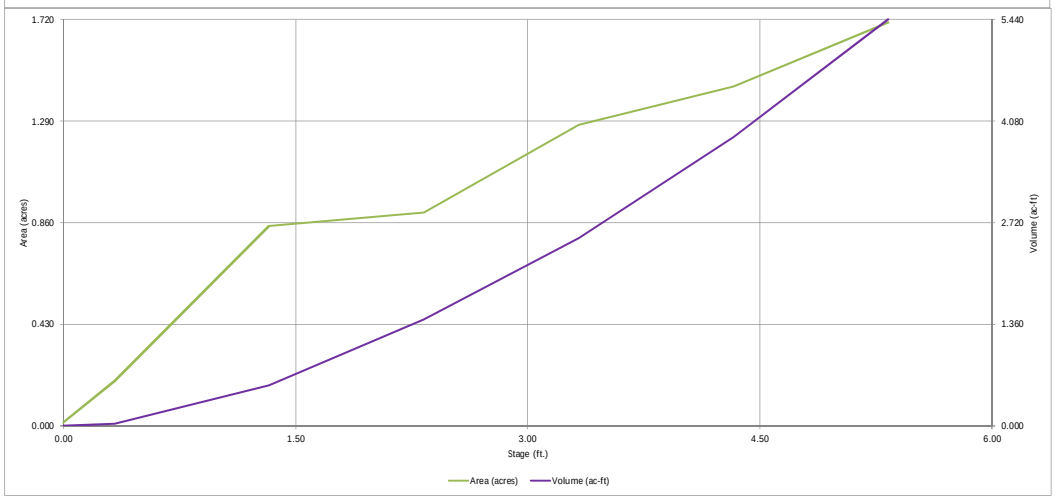
Depth Increment = 1 ft

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	--	--	--	640	0.015		
Bottom of WQCV	--	0.33	--	--	--	8,353	0.192	1,401	0.032
	--	1.33	--	--	--	36,793	0.845	23,690	0.544
Top of WQCV	--	2.33	--	--	--	39,378	0.904	62,142	1.427
	--	3.33	--	--	--	55,423	1.272	109,542	2.515
	--	4.33	--	--	--	62,524	1.435	168,516	3.869
	--	5.33	--	--	--	74,355	1.707	236,955	5.440

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

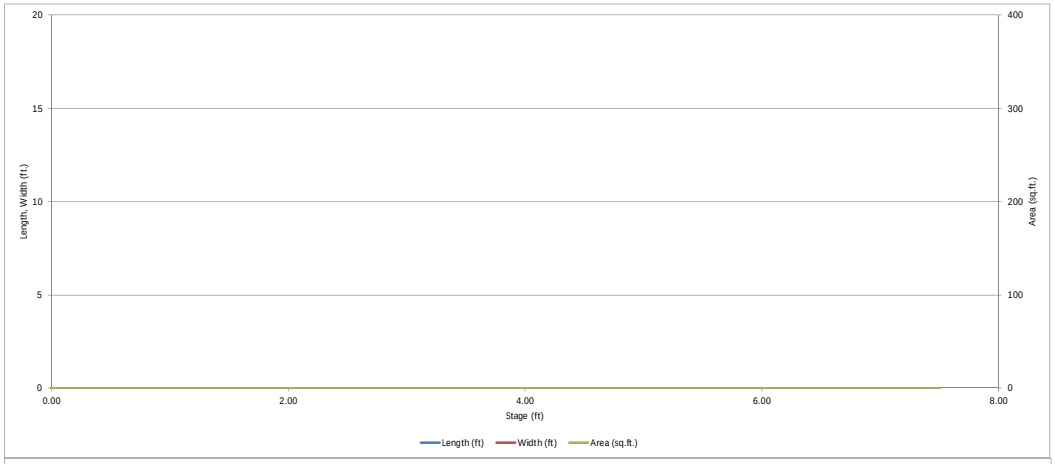
UD-Detention, Version 3.07 (February 2017)

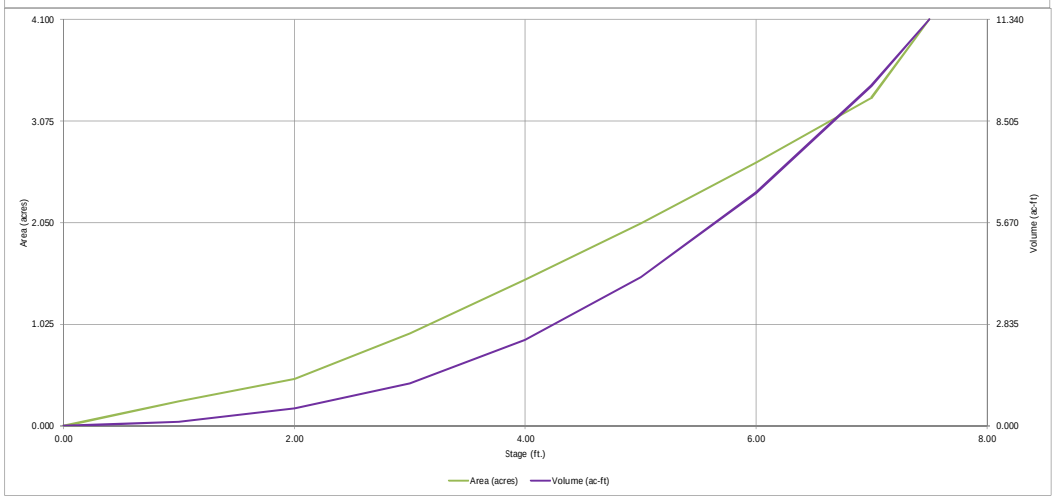




DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)





Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: **Grazing Yak**

Basin ID: **A4**

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.77	0.177	Orifice Plate
Zone 2 (100-year)	2.52	1.420	Weir&Pipe (Circular)
Zone 3			Not Utilized
		1.598	Total

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.75	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 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00					
Orifice Area (sq. inches)	1.77	1.77	1.77					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.75	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	5.58	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.35	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	1.75	N/A	feet
Over Flow Weir Slope Length =	3.35	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.44	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	13.09	N/A	ft^2
Overflow Grate Open Area w/ Debris =	6.54	N/A	ft^2

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

	Zone 2 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	21.00	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Circular	Not Selected	
Outlet Orifice Area =	2.41	N/A	ft^2
Outlet Orifice Centroid =	0.88	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.33	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	243.00	feet
Spillway End Slopes =	25.00	H:V
Freeboard above Max Water Surface =	2.00	feet

Calculated Parameters for Spillway

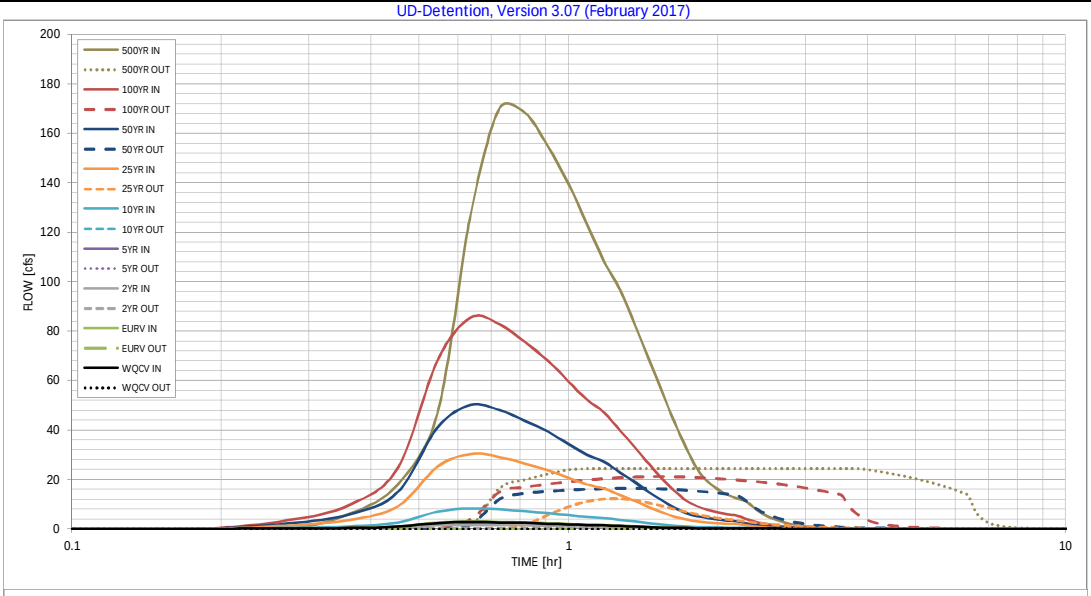
Spillway Design Flow Depth=	0.23	feet
Stage at Top of Freeboard =	7.56	feet
Basin Area at Top of Freeboard =	1.71	acres

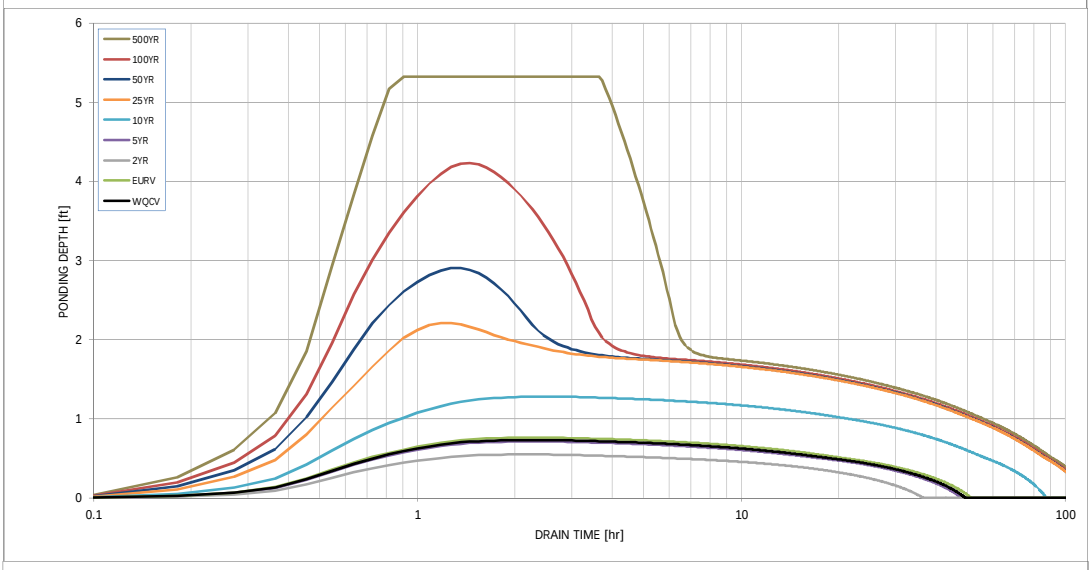
Routed Hydrograph Results

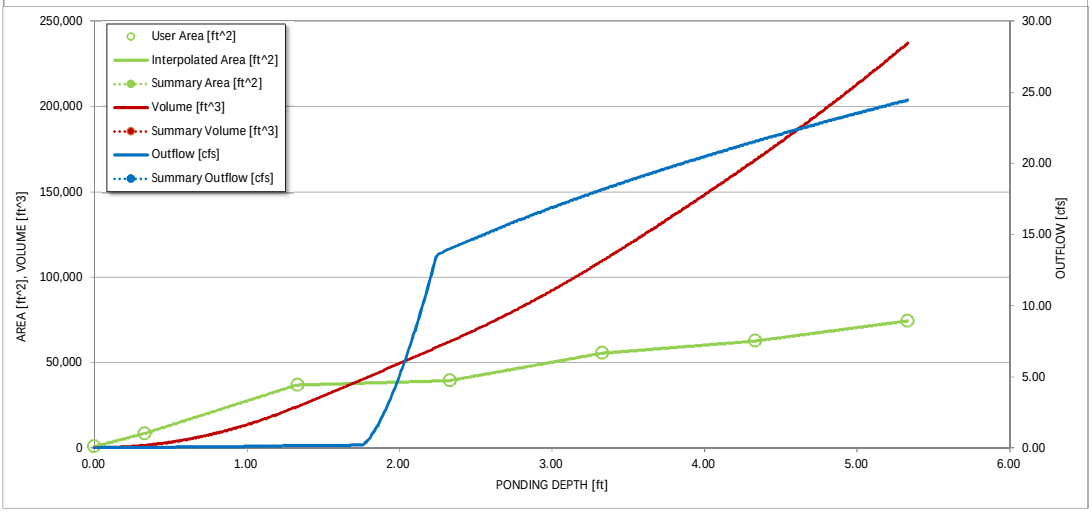
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.00	1.32	1.60	2.02	2.37	2.74	3.70
Calculated Runoff Volume (acre-ft) =	0.177	0.192	0.101	0.168	0.538	2.017	3.356	5.801	11.779
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.177	0.191	0.100	0.168	0.537	2.015	3.354	5.788	11.769
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.07	0.26	0.46	0.76	1.46
Predevelopment Peak Q (cfs) =	0.0	0.0	0.3	0.8	6.1	22.1	39.5	65.6	125.8
Peak Inflow Q (cfs) =	2.7	3.0	1.6	2.6	8.2	30.3	50.0	85.4	170.1
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	0.2	12.3	16.5	21.2	24.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.0	0.6	0.4	0.3	0.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.9	1.2	1.6	1.8
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) =	45	47	33	44	78	92	82	71	51
Time to Drain 99% of Inflow Volume (hours) =	47	49	35	46	83	106	101	94	83
Maximum Ponding Depth (ft) =	0.73	0.76	0.55	0.71	1.28	2.21	2.91	4.24	5.33
Area at Maximum Ponding Depth (acres) =	0.45	0.47	0.33	0.44	0.81	0.90	1.11	1.42	1.71
Maximum Volume Stored (acre-ft) =	0.163	0.177	0.089	0.154	0.511	1.319	2.002	3.726	5.440

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 Outlet Structure Design

Outflow Hydrograph Workbook Filename: _____

Storm Inflow Hydrographs UD-Detention, Version 3.07 (February 2017)

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.45 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:10:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:16:21	0.12	0.13	0.07	0.12	0.37	1.30	2.11	3.43	6.04
0.917	0:21:48	0.33	0.36	0.19	0.32	0.98	3.56	5.82	9.68	18.11
	0:27:15	0.85	0.92	0.49	0.81	2.52	9.13	14.93	24.84	46.55
	0:32:42	2.34	2.53	1.35	2.23	6.93	25.07	40.96	68.05	127.10
	0:38:09	2.73	2.95	1.57	2.60	8.20	30.28	50.04	85.41	170.14
	0:43:36	2.60	2.81	1.49	2.47	7.82	29.00	48.03	82.68	168.27
	0:49:03	2.36	2.55	1.35	2.25	7.12	26.40	43.71	75.51	154.85
	0:54:30	2.10	2.26	1.19	1.99	6.35	23.70	39.35	68.06	139.79
	0:59:57	1.79	1.94	1.02	1.71	5.48	20.61	34.36	59.68	123.26
	1:05:24	1.57	1.70	0.89	1.49	4.78	17.91	29.96	52.18	107.99
	1:10:51	1.42	1.53	0.80	1.35	4.33	16.24	27.09	46.98	96.58
	1:16:18	1.15	1.25	0.65	1.10	3.56	13.54	22.66	39.53	82.22
	1:21:45	0.93	1.01	0.52	0.88	2.91	11.17	18.75	32.82	68.46
	1:27:12	0.70	0.76	0.39	0.66	2.23	8.76	14.81	26.14	55.13
	1:32:39	0.51	0.55	0.28	0.48	1.66	6.67	11.40	20.28	43.13
	1:38:06	0.37	0.41	0.21	0.36	1.20	4.91	8.48	15.24	32.74
	1:43:33	0.29	0.32	0.16	0.28	0.93	3.73	6.38	11.36	24.13
	1:49:00	0.24	0.26	0.14	0.23	0.77	3.03	5.15	9.09	19.08
	1:54:27	0.21	0.22	0.12	0.20	0.65	2.56	4.34	7.64	15.97
	1:59:54	0.18	0.20	0.10	0.17	0.57	2.24	3.78	6.63	13.79
	2:05:21	0.17	0.18	0.09	0.16	0.52	2.01	3.38	5.92	12.27
	2:10:48	0.15	0.17	0.09	0.15	0.48	1.84	3.10	5.42	11.19
	2:16:15	0.11	0.12	0.06	0.11	0.35	1.36	2.30	4.08	8.66
	2:21:42	0.08	0.09	0.05	0.08	0.26	0.99	1.67	2.94	6.24
	2:27:09	0.06	0.07	0.03	0.06	0.19	0.73	1.23	2.18	4.63
	2:32:36	0.04	0.05	0.02	0.04	0.14	0.54	0.92	1.62	3.44
	2:38:03	0.03	0.03	0.02	0.03	0.10	0.39	0.67	1.19	2.55
	2:43:30	0.02	0.02	0.01	0.02	0.07	0.28	0.48	0.86	1.84
	2:48:57	0.01	0.02	0.01	0.01	0.05	0.20	0.35	0.62	1.33
	2:54:24	0.01	0.01	0.00	0.01	0.03	0.14	0.24	0.44	0.95
	2:59:51	0.01	0.01	0.00	0.00	0.02	0.09	0.15	0.29	0.63
	3:05:18	0.00	0.00	0.00	0.00	0.01	0.05	0.09	0.17	0.38
	3:10:45	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.08	0.19
	3:16:12	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.06
	3:21:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:27:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:32:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:38:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:43:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:48:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:54:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:59:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:16:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:21:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:27:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:32:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:37:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:43:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:48:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:54:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:59:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:16:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:21:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:27:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:32:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:37:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:43:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:48:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:54:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:59:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:05:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:10:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:16:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:21:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:26:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:32:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

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

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

Appendix B

Hydraulic Calculations

THE MAXIMUM DISCHARGE FROM CROSS SECTION 1 IS: 83.19 CFS AT TIME: 13.64 HOURS
THE TOTAL VOLUME OF DISCHARGE IS: 26.72 AF NOTE: HOUR 10.0 = HOUR 0 UD SS

HYDROGRAPH AND AVERAGE FLOODPLAIN HYDRAULICS FOR CROSS SECTION NO: 1

VELOCITY = AVERAGE CROSS SECTION VELOCITY = DISCHARGE DIVIDED BY AVERAGE DEPTH AND TOTAL WIDTH
RESOLVED VEL = AVERAGE OF THE SUM OF THE MAGNITUDE OF THE RESOLVED VELOCITY VECTORS FOR EACH CROSS SECTION ELEMENT
(FOR ONLY ONE CELL = RESOLVED VELOCITY VECTOR AND ALWAYS POSITIVE)

TIME (HRS)	TOPWID (FT)	DEPTH (FT)	WS ELEV (FT/FT)	VELOCITY (FPS)	RESOLVED VEL (FPS)	DISCHARGE (CFS)
0.10	0.00	0.00	0.00	0.00	0.00	0.00
0.20	0.00	0.00	0.00	0.00	0.00	0.00
0.30	0.00	0.00	0.00	0.00	0.00	0.00
0.40	0.00	0.00	0.00	0.00	0.00	0.00
0.50	0.00	0.00	0.00	0.00	0.00	0.00
0.60	0.00	0.00	0.00	0.00	0.00	0.00
0.70	0.00	0.00	0.00	0.00	0.00	0.00
0.80	0.00	0.00	0.00	0.00	0.00	0.00
0.90	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0.00	0.00	0.00	0.00	0.00	0.00
1.10	0.00	0.00	0.00	0.00	0.00	0.00
1.20	0.00	0.00	0.00	0.00	0.00	0.00
1.30	0.00	0.00	0.00	0.00	0.00	0.00
1.40	0.00	0.00	0.00	0.00	0.00	0.00
1.50	0.00	0.00	0.00	0.00	0.00	0.00
1.60	0.00	0.00	0.00	0.00	0.00	0.00
1.70	0.00	0.00	0.00	0.00	0.00	0.00
1.80	0.00	0.00	0.00	0.00	0.00	0.00
1.90	0.00	0.00	0.00	0.00	0.00	0.00
2.00	0.00	0.00	0.00	0.00	0.00	0.00
2.10	0.00	0.00	0.00	0.00	0.00	0.00
2.20	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00
2.40	0.00	0.00	0.00	0.00	0.00	0.00
2.50	0.00	0.00	0.00	0.00	0.00	0.00
2.60	0.00	0.00	0.00	0.00	0.00	0.00
2.70	0.00	0.00	0.00	0.00	0.00	0.00
2.80	0.00	0.00	0.00	0.00	0.00	0.00
2.90	0.00	0.00	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.00	0.00	0.00	0.00
3.10	0.00	0.00	0.00	0.00	0.00	0.00
3.20	0.00	0.00	0.00	0.00	0.00	0.00
3.30	0.00	0.00	0.00	0.00	0.00	0.00
3.40	0.00	0.00	0.00	0.00	0.00	0.00
3.50	0.00	0.00	0.00	0.00	0.00	0.00
3.60	0.00	0.00	0.00	0.00	0.00	0.00
3.70	0.00	0.00	0.00	0.00	0.00	0.00
3.80	0.00	0.00	0.00	0.00	0.00	0.00
3.90	0.00	0.00	0.00	0.00	0.00	0.00
4.00	0.00	0.00	0.00	0.00	0.00	0.00
4.10	0.00	0.00	0.00	0.00	0.00	0.00
4.20	0.00	0.00	0.00	0.00	0.00	0.00
4.30	0.00	0.00	0.00	0.00	0.00	0.00
4.40	0.00	0.00	0.00	0.00	0.00	0.00
4.50	0.00	0.00	0.00	0.00	0.00	0.00
4.60	0.00	0.00	0.00	0.00	0.00	0.00
4.70	0.00	0.00	0.00	0.00	0.00	0.00
4.80	0.00	0.00	0.00	0.00	0.00	0.00
4.90	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	0.00	0.00	0.00	0.00	0.00
5.10	0.00	0.00	0.00	0.00	0.00	0.00
5.20	0.00	0.00	0.00	0.00	0.00	0.00
5.30	0.00	0.00	0.00	0.00	0.00	0.00
5.40	0.00	0.00	0.00	0.00	0.00	0.00
5.50	0.00	0.00	0.00	0.00	0.00	0.00
5.60	0.00	0.00	0.00	0.00	0.00	0.00
5.70	0.00	0.00	0.00	0.00	0.00	0.00
5.80	0.00	0.00	0.00	0.00	0.00	0.00
5.90	0.00	0.00	0.00	0.00	0.00	0.00

6.00	0.00	0.00	0.00	0.00	0.00	0.00
6.10	0.00	0.00	0.00	0.00	0.00	0.00
6.20	0.00	0.00	0.00	0.00	0.00	0.00
6.30	0.00	0.00	0.00	0.00	0.00	0.00
6.40	0.00	0.00	0.00	0.00	0.00	0.00
6.50	0.00	0.00	0.00	0.00	0.00	0.00
6.60	0.00	0.00	0.00	0.00	0.00	0.00
6.70	0.00	0.00	0.00	0.00	0.00	0.00
6.80	0.00	0.00	0.00	0.00	0.00	0.00
6.90	0.00	0.00	0.00	0.00	0.00	0.00
7.00	0.00	0.00	0.00	0.00	0.00	0.00
7.10	0.00	0.00	0.00	0.00	0.00	0.00
7.20	0.00	0.00	0.00	0.00	0.00	0.00
7.30	0.00	0.00	0.00	0.00	0.00	0.00
7.40	0.00	0.00	0.00	0.00	0.00	0.00
7.50	0.00	0.00	0.00	0.00	0.00	0.00
7.60	0.00	0.00	0.00	0.00	0.00	0.00
7.70	0.00	0.00	0.00	0.00	0.00	0.00
7.80	0.00	0.00	0.00	0.00	0.00	0.00
7.90	0.00	0.00	0.00	0.00	0.00	0.00
8.00	0.00	0.00	0.00	0.00	0.00	0.00
8.10	0.00	0.00	0.00	0.00	0.00	0.00
8.20	0.00	0.00	0.00	0.00	0.00	0.00
8.30	0.00	0.00	0.00	0.00	0.00	0.00
8.40	0.00	0.00	0.00	0.00	0.00	0.00
8.50	0.00	0.00	0.00	0.00	0.00	0.00
8.60	0.00	0.00	0.00	0.00	0.00	0.00
8.70	0.00	0.00	0.00	0.00	0.00	0.00
8.80	0.00	0.00	0.00	0.00	0.00	0.00
8.90	0.00	0.00	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.00	0.00	0.00	0.00
9.10	0.00	0.00	0.00	0.00	0.00	0.00
9.20	0.00	0.00	0.00	0.00	0.00	0.00
9.30	0.00	0.00	0.00	0.00	0.00	0.00
9.40	0.00	0.00	0.00	0.00	0.00	0.00
9.50	0.00	0.00	0.00	0.00	0.00	0.00
9.60	0.00	0.00	0.00	0.00	0.00	0.00
9.70	0.00	0.00	0.00	0.00	0.00	0.00
9.80	0.00	0.00	0.00	0.00	0.00	0.00
9.90	0.00	0.00	0.00	0.00	0.00	0.00
10.00	0.00	0.00	0.00	0.00	0.00	0.00
10.10	0.00	0.00	0.00	0.00	0.00	0.00
10.20	0.00	0.00	0.00	0.00	0.00	0.00
10.30	0.00	0.00	0.00	0.00	0.00	0.00
10.40	0.00	0.00	0.00	0.00	0.00	0.00
10.50	0.00	0.00	0.00	0.00	0.00	0.00
10.60	0.00	0.00	0.00	0.00	0.00	0.00
10.70	0.00	0.00	0.00	0.00	0.00	0.00
10.80	0.00	0.00	0.00	0.00	0.00	0.00
10.90	0.00	0.00	0.00	0.00	0.00	0.00
11.00	0.00	0.00	0.00	0.00	0.00	0.00
11.10	0.00	0.00	0.00	0.00	0.00	0.00
11.20	0.00	0.00	0.00	0.00	0.00	0.00
11.30	0.00	0.00	0.00	0.00	0.00	0.00
11.40	0.00	0.00	0.00	0.00	0.00	0.00
11.50	0.00	0.00	0.00	0.00	0.00	0.00
11.60	0.00	0.00	0.00	0.00	0.00	0.00
11.70	0.00	0.00	0.00	0.00	0.00	0.00
11.80	0.00	0.00	0.00	0.00	0.00	0.00
11.90	0.00	0.00	0.00	0.00	0.00	0.00
12.00	579.90	0.01	6757.53	0.05	0.06	0.23
12.10	579.90	0.01	6757.54	0.06	0.07	0.45
12.20	579.90	0.01	6757.54	0.07	0.08	0.52
12.30	579.90	0.01	6757.54	0.07	0.08	0.53
12.40	579.90	0.01	6757.54	0.06	0.08	0.53
12.50	579.90	0.01	6757.54	0.06	0.08	0.52
12.60	546.76	0.01	6757.54	0.06	0.07	0.39
12.70	480.49	0.01	6757.54	0.05	0.07	0.26
12.80	463.92	0.01	6757.54	0.03	0.06	0.18
12.90	447.35	0.03	6757.56	0.27	0.09	3.93
13.00	447.35	0.04	6757.57	1.04	0.17	20.65
13.10	447.35	0.06	6757.59	1.33	0.21	38.45
13.20	447.35	0.07	6757.60	1.60	0.22	52.32
13.30	447.35	0.10	6757.62	1.72	0.25	74.96
13.40	447.35	0.10	6757.63	1.76	0.25	81.13

13.50	447.35	0.10	6757.63	1.77	0.25	81.49
13.60	447.35	0.10	6757.63	1.78	0.25	82.69
13.70	447.35	0.10	6757.63	1.78	0.25	82.83
13.80	447.35	0.10	6757.63	1.77	0.25	81.66
13.90	447.35	0.10	6757.63	1.77	0.25	80.11
14.00	447.35	0.10	6757.62	1.75	0.25	77.72
14.10	447.35	0.10	6757.62	1.74	0.24	75.46
14.20	447.35	0.10	6757.62	1.74	0.24	76.16
14.30	447.35	0.10	6757.62	1.78	0.25	76.01
14.40	447.35	0.09	6757.62	1.75	0.24	73.64
14.50	447.35	0.09	6757.62	1.73	0.26	70.75
14.60	447.35	0.07	6757.60	1.85	0.24	59.11
14.70	447.35	0.07	6757.59	1.86	0.24	58.05
14.80	447.35	0.07	6757.28	1.57	0.23	52.38
14.90	447.35	0.07	6757.59	1.69	0.21	50.82
15.00	447.35	0.07	6757.59	1.70	0.23	50.36
15.10	430.78	0.07	6757.59	1.67	0.20	46.75
15.20	430.78	0.06	6757.59	1.78	0.22	48.93
15.30	430.78	0.07	6757.28	1.48	0.22	43.74
15.40	430.78	0.06	6757.59	1.58	0.21	42.22
15.50	430.78	0.06	6757.59	1.54	0.19	40.49
15.60	430.78	0.06	6757.58	1.51	0.19	39.02
15.70	430.78	0.06	6757.58	1.54	0.20	38.80
15.80	430.78	0.06	6757.27	1.33	0.22	36.12
15.90	430.78	0.06	6757.58	1.47	0.20	36.11
16.00	430.78	0.06	6757.58	1.39	0.18	33.77
16.10	430.78	0.06	6757.27	1.25	0.19	32.64
16.20	430.78	0.05	6757.58	1.35	0.18	31.73
16.30	430.78	0.05	6757.58	1.33	0.19	30.88
16.40	414.21	0.05	6757.58	1.38	0.18	30.21
16.50	414.21	0.05	6757.58	1.36	0.19	29.48
16.60	414.21	0.05	6757.58	1.34	0.17	28.60
16.70	414.21	0.05	6757.57	1.34	0.17	27.87
16.80	414.21	0.05	6757.57	1.32	0.17	27.10
16.90	414.21	0.05	6757.57	1.34	0.17	26.26
17.00	397.65	0.05	6757.26	1.29	0.18	25.71
17.10	397.65	0.05	6757.57	1.40	0.18	25.08
17.20	397.65	0.04	6757.57	1.38	0.16	24.43
17.30	397.65	0.04	6757.57	1.37	0.19	23.83
17.40	397.65	0.04	6757.57	1.36	0.17	23.26
17.50	397.65	0.04	6757.57	1.34	0.17	22.71
17.60	397.65	0.05	6757.25	1.22	0.17	22.13
17.70	397.65	0.04	6757.57	1.32	0.17	21.65
17.80	397.65	0.04	6757.56	1.31	0.15	21.22
17.90	397.65	0.04	6757.56	1.30	0.15	20.75
18.00	397.65	0.04	6757.56	1.30	0.15	20.48
18.10	397.65	0.04	6757.56	1.31	0.14	18.55
18.20	397.65	0.04	6757.25	1.21	0.15	18.04
18.30	397.65	0.04	6757.24	1.20	0.15	17.59
18.40	397.65	0.03	6757.56	1.31	0.14	17.18
18.50	397.65	0.03	6757.56	1.30	0.15	16.86
18.60	364.51	0.03	6757.56	1.42	0.15	16.55
18.70	364.51	0.03	6757.56	1.42	0.13	16.26
18.80	364.51	0.03	6757.56	1.41	0.14	15.98
18.90	364.51	0.03	6757.55	1.41	0.15	15.66
19.00	364.51	0.03	6757.55	1.41	0.14	15.33
19.10	364.51	0.03	6757.24	1.29	0.14	14.94
19.20	364.51	0.03	6757.55	1.40	0.15	14.53
19.30	364.51	0.03	6757.55	1.39	0.15	14.22
19.40	364.51	0.03	6757.55	1.38	0.13	13.84
19.50	364.51	0.03	6757.24	1.26	0.13	13.50
19.60	364.51	0.03	6757.56	0.97	0.14	11.39
19.70	364.51	0.04	6756.87	0.81	0.14	11.20
19.80	364.51	0.03	6757.56	0.95	0.12	10.97
19.90	364.51	0.03	6757.56	0.95	0.13	10.77
20.00	364.51	0.03	6757.24	0.87	0.14	10.55
20.10	364.51	0.03	6757.24	0.86	0.14	10.39
20.20	364.51	0.03	6757.24	0.86	0.13	10.16
20.30	364.51	0.03	6757.55	0.93	0.14	9.93
20.40	364.51	0.03	6757.55	0.92	0.12	9.72
20.50	364.51	0.03	6757.55	0.92	0.12	9.55
20.60	364.51	0.03	6757.24	0.84	0.12	9.31
20.70	364.51	0.03	6757.55	0.91	0.13	9.20
20.80	364.51	0.03	6757.55	0.91	0.12	9.03
20.90	364.51	0.03	6757.24	0.83	0.12	8.92

21.00	364.51	0.03	6757.24	0.83	0.13	8.69
21.10	364.51	0.03	6757.55	0.93	0.12	9.86
21.20	347.94	0.03	6757.24	0.91	0.12	10.05
21.30	347.94	0.04	6756.86	1.18	0.15	14.64
21.40	347.94	0.03	6757.56	1.02	0.13	11.27
21.50	347.94	0.03	6757.24	0.92	0.14	10.74
21.60	347.94	0.03	6757.24	0.91	0.14	10.25
21.70	347.94	0.03	6757.24	0.89	0.12	9.76
21.80	347.94	0.03	6757.55	0.96	0.13	9.31
21.90	347.94	0.03	6756.86	0.79	0.13	8.88
22.00	347.94	0.03	6757.55	0.94	0.12	8.54
22.10	347.94	0.03	6757.24	0.86	0.13	8.38
22.20	347.94	0.03	6757.55	0.93	0.11	8.34
22.30	347.94	0.03	6756.86	0.78	0.13	8.36
22.40	347.94	0.03	6757.55	0.93	0.12	8.37
22.50	347.94	0.03	6757.24	0.86	0.12	8.34
22.60	347.94	0.03	6757.55	0.94	0.12	8.29
22.70	347.94	0.03	6757.24	0.86	0.13	8.30
22.80	347.94	0.03	6757.24	0.63	0.11	6.42
22.90	347.94	0.03	6757.55	0.70	0.10	7.08
23.00	347.94	0.03	6757.55	0.71	0.11	7.19
23.10	347.94	0.03	6757.55	0.69	0.10	6.81
23.20	347.94	0.03	6757.24	0.63	0.11	6.62
23.30	347.94	0.03	6757.24	0.62	0.11	6.51
23.40	347.94	0.03	6757.55	0.67	0.10	6.41
23.50	347.94	0.03	6756.86	0.56	0.11	6.30
23.60	347.94	0.03	6757.24	0.61	0.11	6.21
23.70	347.94	0.03	6757.55	0.66	0.11	6.11
23.80	347.94	0.03	6757.55	0.66	0.10	6.03
23.90	347.94	0.03	6757.55	0.65	0.10	5.96
24.00	347.94	0.03	6756.86	0.54	0.10	5.88
24.10	347.94	0.03	6756.86	0.54	0.10	5.81
24.20	314.80	0.03	6756.86	0.60	0.10	5.74
24.30	314.80	0.03	6756.86	0.60	0.10	5.66
24.40	298.23	0.03	6756.86	0.63	0.10	5.60
24.50	281.67	0.03	6756.86	0.67	0.12	5.65
24.60	265.10	0.03	6756.86	0.71	0.11	5.63
24.70	248.53	0.03	6756.86	0.76	0.10	5.63
24.80	215.39	0.03	6756.86	0.88	0.11	5.63
24.90	215.39	0.03	6756.86	0.88	0.11	5.61
25.00	215.39	0.03	6756.86	0.88	0.10	5.63
25.10	198.82	0.03	6756.48	0.86	0.11	5.61
25.20	198.82	0.03	6756.86	0.95	0.11	5.60
25.30	182.25	0.03	6756.86	1.04	0.12	5.61
25.40	182.25	0.03	6756.86	1.04	0.09	5.58
25.50	165.69	0.03	6756.86	1.14	0.09	5.59
25.60	165.69	0.03	6756.86	1.15	0.10	5.61
25.70	165.69	0.03	6756.86	1.14	0.09	5.61
25.80	165.69	0.03	6756.86	1.14	0.09	5.59
25.90	165.69	0.03	6756.86	1.15	0.11	5.62
26.00	165.69	0.03	6756.86	1.15	0.08	5.62
26.10	165.69	0.03	6756.15	1.05	0.11	5.66
26.20	165.69	0.03	6756.86	1.15	0.09	5.63
26.30	165.69	0.03	6756.15	1.05	0.11	5.72
26.40	165.69	0.03	6757.16	1.08	0.09	6.12
26.50	165.69	0.03	6756.48	1.07	0.13	5.95
26.60	165.69	0.04	6755.84	0.83	0.13	5.79
26.70	165.69	0.04	6756.39	0.93	0.10	5.62
26.80	165.69	0.04	6756.65	0.81	0.12	5.47
26.90	165.69	0.03	6756.86	1.13	0.12	5.32
27.00	165.69	0.03	6757.47	0.90	0.14	5.19
27.10	165.69	0.03	6757.47	0.89	0.12	5.05
27.20	165.69	0.03	6757.15	0.99	0.14	4.92
27.30	165.69	0.03	6757.47	0.87	0.12	4.79
27.40	165.69	0.04	6757.07	0.76	0.12	4.66
27.50	165.69	0.03	6756.14	0.85	0.14	4.54
27.60	165.69	0.03	6756.85	1.05	0.14	4.42
27.70	165.69	0.03	6756.85	1.04	0.13	4.30
27.80	165.69	0.03	6756.39	0.83	0.11	4.19
27.90	165.69	0.03	6757.65	0.72	0.13	4.08
28.00	165.69	0.03	6756.42	0.71	0.13	3.97
28.10	165.69	0.03	6757.47	0.80	0.13	3.87
28.20	149.12	0.03	6757.65	0.77	0.11	3.77
28.30	149.12	0.03	6756.39	0.87	0.13	3.67
28.40	149.12	0.03	6757.47	0.86	0.12	3.58

28.50	149.12	0.04	6756.72	0.65	0.12	3.50
28.60	149.12	0.03	6757.65	0.74	0.12	3.40
28.70	149.12	0.03	6757.65	0.73	0.12	3.32
28.80	149.12	0.03	6756.38	0.83	0.12	3.25
28.90	149.12	0.03	6756.72	0.62	0.12	3.17
29.00	149.12	0.03	6757.65	0.71	0.12	3.10
29.10	149.12	0.03	6757.46	0.81	0.12	3.04
29.20	149.12	0.02	6756.75	0.80	0.11	2.97
29.30	149.12	0.02	6755.82	0.66	0.11	2.27
29.40	132.55	0.02	6756.82	0.55	0.09	1.26
29.50	132.55	0.02	6757.64	0.56	0.09	1.36
29.60	132.55	0.02	6756.70	0.50	0.09	1.39
29.70	132.55	0.03	6757.14	0.42	0.10	1.41
29.80	132.55	0.02	6757.65	0.58	0.11	1.44
29.90	132.55	0.03	6757.14	0.43	0.11	1.47
30.00	132.55	0.03	6758.17	0.63	0.13	2.83

Culvert Report

un 6 2019Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

24-inch CMP

Invert Elev Dn (ft)	=	1.33
Pipe Length (ft)	=	50.00
Slope (%)	=	2.00
Invert Elev Up (ft)	=	2.33
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.016
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

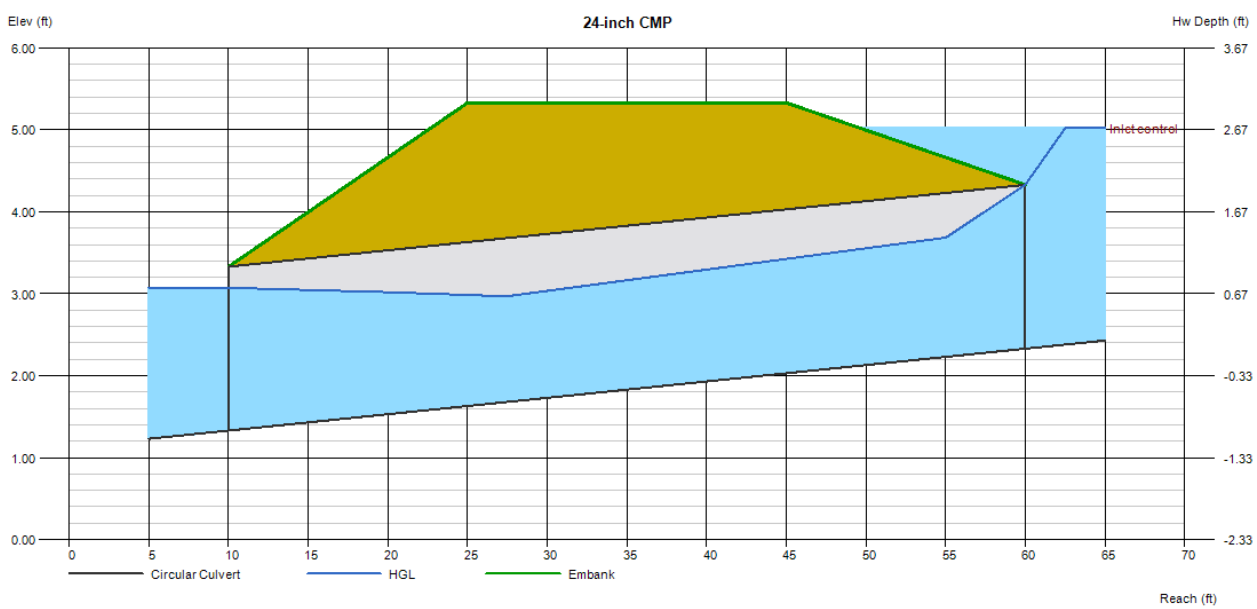
Top Elevation (ft)	=	5.33
Top Width (ft)	=	20.00
Crest Width (ft)	=	200.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	20.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	17.00
Qpipe (cfs)	=	17.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.85
Veloc Up (ft/s)	=	6.80
HGL Dn (ft)	=	3.07
HGL Up (ft)	=	3.81
Hw Elev (ft)	=	5.02
Hw/D (ft)	=	1.35
Flow Regime	=	Inlet Control



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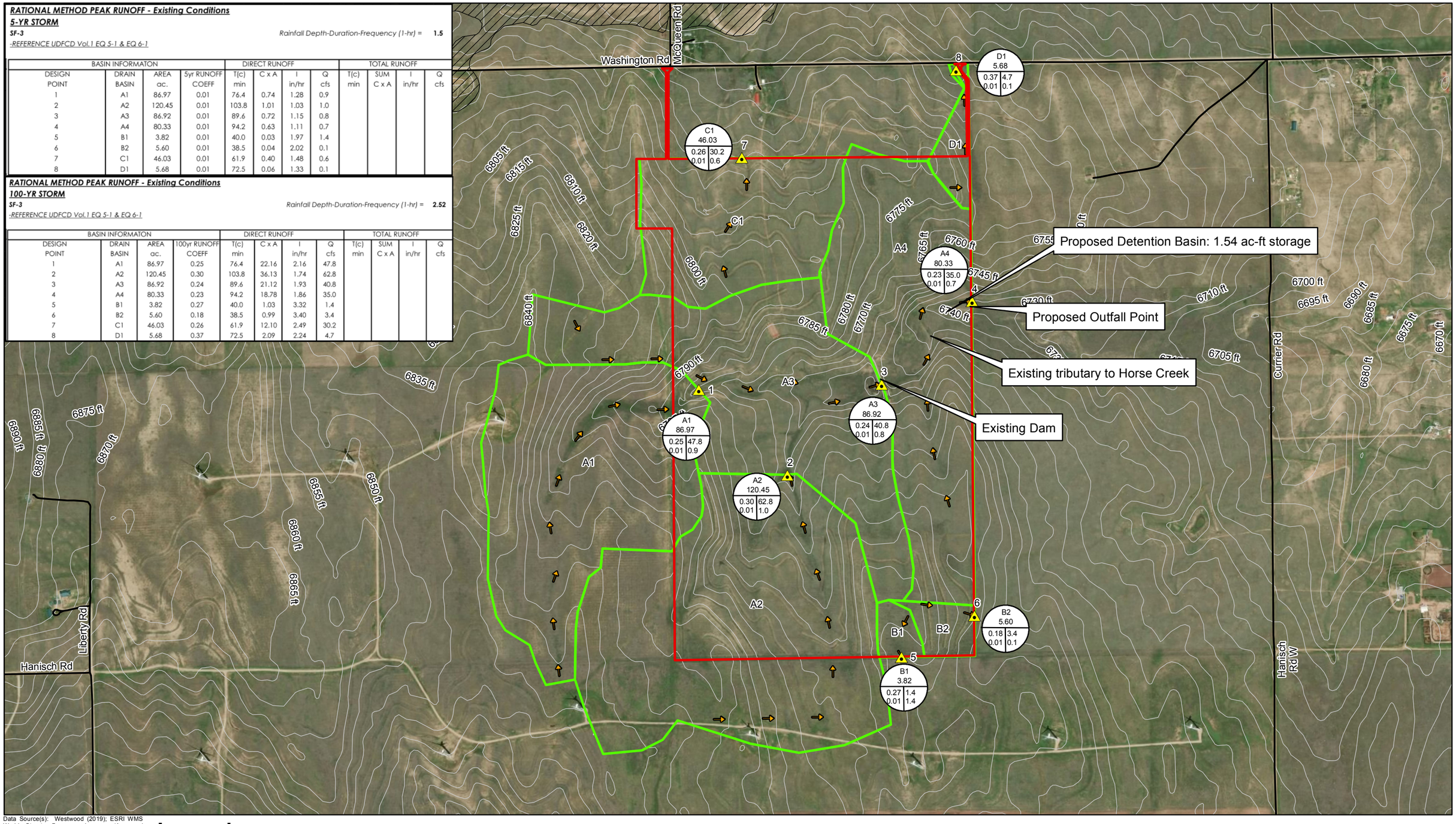
RATIONAL METHOD PEAK RUNOFF - Existing Conditions
5-YR STORM
SF-3 — *Rainfall Depth-Duration-Frequency (1-hr) =* **1.5**
-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs
1	A1	86.97	0.01	76.4	0.74	1.28	0.9				
2	A2	120.45	0.01	103.8	1.01	1.03	1.0				
3	A3	86.92	0.01	89.6	0.72	1.15	0.8				
4	A4	80.33	0.01	94.2	0.63	1.11	0.7				
5	B1	3.82	0.01	40.0	0.03	1.97	1.4				
6	B2	5.60	0.01	38.5	0.04	2.02	0.1				
7	C1	46.03	0.01	61.9	0.40	1.48	0.6				
8	D1	5.68	0.01	72.5	0.06	1.33	0.1				

RATIONAL METHOD PEAK RUNOFF - Existing Conditions
100-YR STORM
SF-3 — *Rainfall Depth-Duration-Frequency (1-hr) =* **2.52**
-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	100yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs
1	A1	86.97	0.25	76.4	22.16	2.16	47.8				
2	A2	120.45	0.30	103.8	36.13	1.74	62.8				
3	A3	86.92	0.24	89.6	21.12	1.93	40.8				
4	A4	80.33	0.23	94.2	18.78	1.86	35.0				
5	B1	3.82	0.27	40.0	1.03	3.32	1.4				
6	B2	5.60	0.18	38.5	0.99	3.40	3.4				
7	C1	46.03	0.26	61.9	12.10	2.49	30.2				
8	D1	5.68	0.37	72.5	2.09	2.24	4.7				



Data Source(s): Westwood (2019); ESRI WMS World Streets Basemap Imagery (Accessed 2019).

Legend

- Project Boundary
- County Boundary
- Drainage Areas
- FEMA Zone A
- FEMA Zone AE
- 5' Contours
- Flow Path
- Existing Road
- Drainage Point

ID
Acreage
C 100 | Q 100
C 5 | Q 5
(cfs)

N

0 — 800 Feet

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Grazing Yak Solar

El Paso County, Colorado

Existing Drainage Plan

June 04, 2019

Map Document: N:\0021201.00\GIS\Hydro Exhibits\2019-06-04_GrazingYak_Ex1_Ex_DrainagePlan.mxd MJHildreth 6/4/2019 1:17:12 PM

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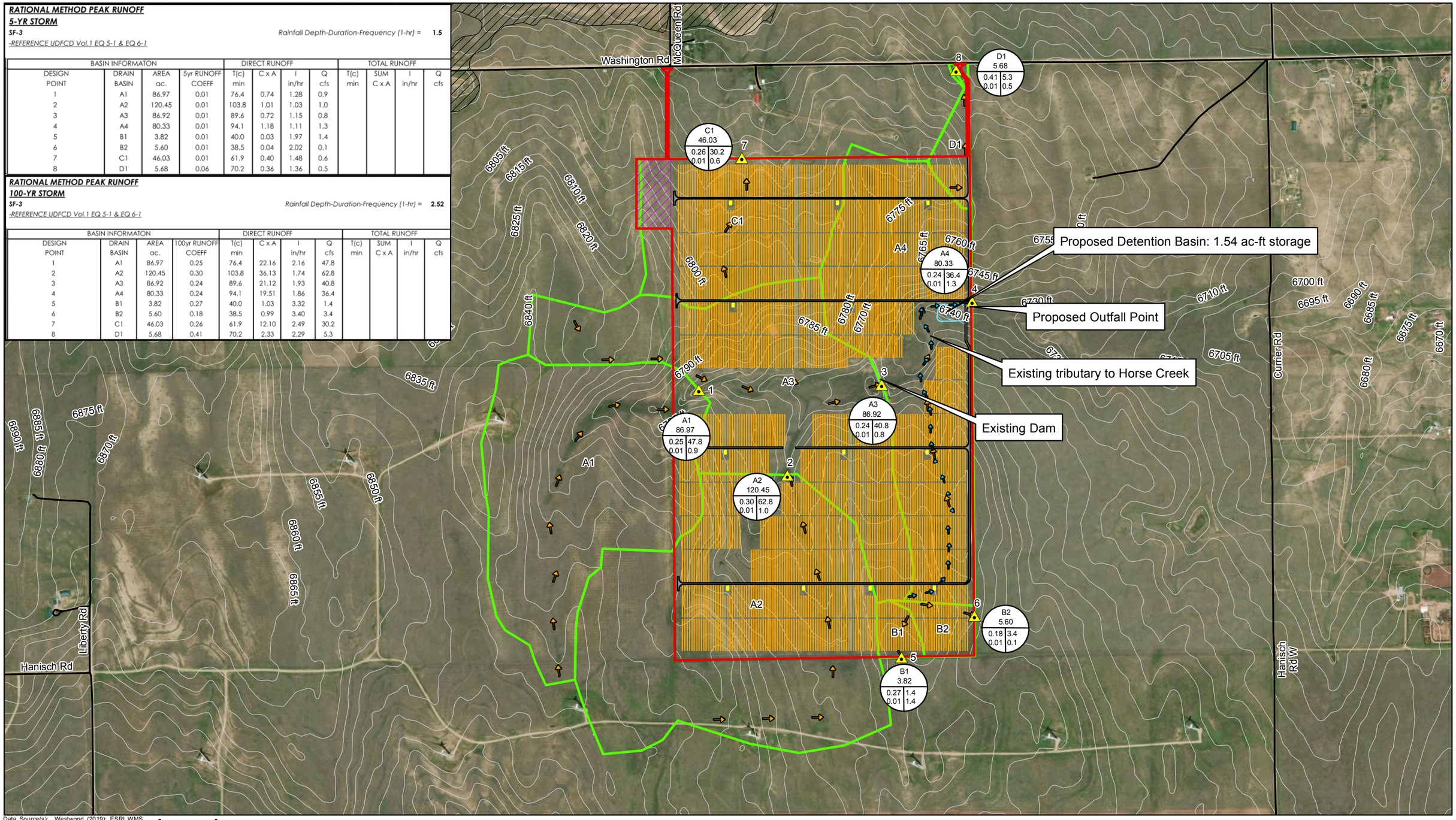
RATIONAL METHOD PEAK RUNOFF
5-YR STORM
SF-3 — Rainfall Depth-Duration-Frequency (1-hr) = **1.5**
-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs
1	A1	86.97	0.01	76.4	0.74	1.28	0.9				
2	A2	120.45	0.01	103.8	1.01	1.03	1.0				
3	A3	86.92	0.01	89.6	0.72	1.15	0.8				
4	A4	80.33	0.01	94.1	1.18	1.11	1.3				
5	B1	3.82	0.01	40.0	0.03	1.97	1.4				
6	B2	5.60	0.01	38.5	0.04	2.02	0.1				
7	C1	46.03	0.01	61.9	0.40	1.48	0.6				
8	D1	5.68	0.06	70.2	0.36	1.36	0.5				

RATIONAL METHOD PEAK RUNOFF
100-YR STORM
SF-3 — Rainfall Depth-Duration-Frequency (1-hr) = **2.52**
-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	100yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs
1	A1	86.97	0.25	76.4	22.16	2.16	47.8				
2	A2	120.45	0.30	103.8	36.13	1.74	62.8				
3	A3	86.92	0.24	89.6	21.12	1.93	40.8				
4	A4	80.33	0.24	94.1	19.51	1.86	36.4				
5	B1	3.82	0.27	40.0	1.03	3.32	1.4				
6	B2	5.60	0.18	38.5	0.99	3.40	3.4				
7	C1	46.03	0.26	61.9	12.10	2.49	30.2				
8	D1	5.68	0.41	70.2	2.33	2.29	5.3				



Data Source(s): Westwood (2019); ESRI WMS World Streets Basemap Imagery (Accessed 2019).

Legend

- Project Boundary
- County Boundary
- Gravel Road
- Array Outline
- Inverter
- Drainage Areas
- FEMA Zone A
- FEMA Zone AE
- Detention Basin
- Temporary Laydown Yard
- 5' Contours
- Flow Path
- Existing Road
- Time of Concentration Path
- Drainage Point

ID
Acreage
C 100 | Q 100
C 5 | Q 5
(cfs)

N

0 800 Feet

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Grazing Yak Solar

El Paso County, Colorado

Proposed Drainage Plan

June 04, 2019

Map Document: N:\0021201.00\GIS\Hydro Exhibits\2019-06-04_GrazingYak_Ex1_Proposed_DrainagePlan.mxd MJHilderth 6/4/2019 1:15:29 PM