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Preliminary & Final Drainage Report

Hansen Ranch Filing No. 1

Project Number 51421

August 28, 2019

Preliminary & Final Drainage Report

for

Hansen Ranch Filing No. 1

Project No. 51421

August 28, 2019

prepared for

Donald D. Cannella
1826 Labellezza Grove
Colorado Springs, CO 80919-3850
719.771.0022

prepared by

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51421 Final Drainage Report.odt

Statements and Acknowledgments

Engineer's Statement

This report and plan for the drainage design of Hansen Ranch Filing No. 1 was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

____ ____________

Charles C. Crum, P.E. Colorado No. 13348 Date
For and on Behalf of MVE, Inc.

Developer's Statement

Donald D. Cannella hereby certifies that the drainage facilities for Hansen Ranch Filing No. 1 shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Hansen Ranch Filing No. 1, guarantee that final drainage design review will absolve Donald D. Cannella and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

____ ____________

Donald D. Cannella Date

1826 Labellezza Grove

Colorado Springs, CO 80919-3850

City of Colorado Springs Statement

Filed in accordance with Section 7.7.906 of the Code of the City of Colorado Springs, 2001, as amended.

____ ____________

for the City Engineer Date
City of Colorado Springs

Conditions:

Contents

Preliminary & Final Drainage Report

The purpose of this Preliminary & Final Drainage Report is to identify drainage patterns and quantities within and affecting the proposed Hansen Ranch Filing No. 1, single family residential subdivision site. The report discusses the drainage characteristics along with the associated drainage design for the site and presents storm water management solutions for the the project. The report and included maps present results of the final hydrologic and drainage facility sizing and analyses. The report recommends drainage improvements to the site and identifies drainage requirements relative to the proposed development. This report has been prepared and submitted in accordance with the requirements of the City of Colorado Springs Development approval process. This report is applicable to the Zone Change, PUD Development Plan, and Final Plat development applications being made for the site. An Appendix is included with this report with pertinent calculations and data used in the drainage analysis.

1 General Location and Description

1.1 Location

The Hansen Ranch Filing No. 1 project is located in unplatted and recently annexed property known as the Villani Annexation (City Planning File No. CPC A 16-00112). The site is located within the NE 1/4 of the SW 1/4 of Section 7, Township 13 South, Range 65 West of the 6th Principal Meridian in the City of Colorado Springs, Colorado. The property is located east of the Tutt Boulevard, north of Dublin Boulevard, and south of Wolf Ridge Road. The site has existing address of 6795 Templeton Gap Road and El Paso County Tax ID number of 53073-00-007. A **Vicinity Map** is included in the Appendix.

A City of Colorado Springs subdivision known as Dublin North Kwan Parcel Filing No. 8, zoned PUD AO (Planned Unit Development with Airport Overlay) is adjacent on the north and east sides of the site. Tract F, Dublin North Kwan Parcel Filing No. 8, a 50 ft wide strip, is also adjacent along the entire south side of the site. The City subdivisions of Dublin North Filing No. 4 (zoned PUD AO) and Dublin North Filing No. 6 (zoned PUD AO) are located south of Tract F. Lot 15, AA Subdivision (zoned RR-5), located in El Paso County, is adjacent to the southwest side of Tract F. Tutt Boulevard/Templeton Gap Road is adjacent to the southwest corner of the site. An unplatted tract of land, also located within the City of Colorado Springs, is adjacent to the west side of the site.

There are no significant drainage features on, adjacent or near the site. The site is located in the Cottonwood Creek Major Drainage Basin. The site is not located within a Stream side Overlay zone.

1.2 Description of Property

The Hansen Ranch Filing No. 1 (Site) encompasses 12.90± acres and is zoned Planned Unit Development, Airport Overlay (PUD AO) with a proposed Single Family (detached) use. The site is currently undeveloped and vegetated with native grasses and weeds. Small elm trees in fair to good condition are also present. The existing vegetation covers approximately 85% of the Site's ground surface. All ground cover is in fair to good condition. Tutt Boulevard exists adjacent to the southwest corner of the Site with curb, gutter and pavement improvements and utilities. Wolf Ridge Road is to the north of the Site and will be connected by Dillenger Lane from the Site. There are no storm drain facilities that currently exist in the site or run through the site. The eastern borrow ditch from the vacated Templeton Road right of way exists along the western side of the Site and routes a minimal amount of storm water flow from the terminus of the south side of said Dillenger Lane.

The Site slopes downward from the northeast corner to the southeast corner at existing slopes that range from 2% to 5%. The steeper slopes exist in the northwestern quadrant of the Site. Storm runoff from the site drains southwesterly towards the southwest corner of the Site and exits at the western portion of the southern Site boundary. All storm water flows exit the Site in this area and flow across said Tract F, Dublin North Kwan Parcel Filing No. 8. and onto Lot 15, AA Subdivision.

According to the National Resource Conservation Service, the soil in the Hansen Ranch Filing No. 1 site is made up of Blakeland Loamy Sand complex (map unit 8), contained in Hydrologic Soil Group A. The Blakeland component of this soil is deep and well drained. Permeability is rapid, surface runoff is medium to rapid, and the hazard of erosion is moderate. A portion of the Soil Map and data tables from the National Cooperative Soil Survey and relevant Official Soil Series Descriptions (OSD) are included in the **Appendix**.[1 2]

The current Flood Insurance Study of the region includes a Flood Insurance Rate Map (FIRM), effective on December 7, 2018.[3] The proposed subdivision is included in Community Panel Numbers 08041C0537 G of the Flood Insurance Rate Maps for El Paso County and Incorporated Areas. No portion of the site lies within FEMA designated Special Flood Hazard Areas (SFHA's). An excerpt of the current FEMA Flood Insurance Rate Maps with the site delineated is included in the **Appendix**.

The site consists of an existing un-platted parcel and will be re-platted. Sixty-six (66) new lots will be created with this project and the Site will be developed with City streets and utilities. Access will be from Tutt Boulevard at the southwest and Wolf Ridge Road at the southwest and northwest corners of the property. All site drainage will be directed to a proposed private Full Spectrum Extended Detention Basin (FS EDB) adjacent to the southerly edge of the site within the western portion of the Site. The site will have utility services extended from the existing mains of said Tutt Boulevard and Wolf Ridge Road.

2 Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

The Hansen Ranch Filing No. 1, Site is located on the easterly edge of the Cottonwood Creek Major Drainage Basin (FOFO4000), which drains to Fountain Creek. The Cottonwood Creek Major Drainage Basin contains properties in both City of Colorado Springs and unincorporated El Paso County jurisdictions. The basin is a studied basin with an approved and operative Drainage Basin Planning Study (DBPS). The Basin stretches for approximately 17 miles on the east side of Colorado Springs and drains from northeast to southwest into Fountain Creek at a point just north of the crossing of Interstate 25 and US Highway 85-87. A copy of the City's Drainage Basin Planning Study Inventory Map showing the site location within the Basin is included in the **Appendix**. [4]

The Drainage Basin Planning Study for the Cottonwood Creek Basin was completed in 2000 by Ayers Associates.[5] There are not drainage improvements noted in the DBPS for the site or downstream to Cottwood Creek.

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

This Site was also previously examined in the Preliminary/Final Drainage Report for Dublin North Kwan Parcel Filing No. 8 by Terra Nova Engineering, Inc. and dated September 2014 & Revised November 2015 as an undeveloped basin flowing to Tutt Boulevard. No other drainage reports for any of the adjacent properties are pertinent to drainage on this site.

2.2 Basin Description

The site contains no significant ridges, hills, valleys, gullies, or streams. The Site is separated into two existing on-site sub-basins labeled EX-A1 & EX-A2. There is only one off-site drainage sub-basin labeled OS A and located in said Tract F, Dublin North Kwan Parcel Filing No. 8 with storm water flowing westerly and touching a very small portion of our Site's southern boundary. This off-site basin passes through the Site along the southern boundary line. The existing condition of the on-site property is stable and vegetated for the two on-site drainage basins. The majority of the flows are directed to the southwesterly corner of the site and then drains southerly off-site. The drainage sub-basins are shown on the included **Existing Drainage Map**.

Off-site sub-basin OS A, located at the south edge of the site, consists of said Tract F. The Tract is vacant and not well vegetated. The storm water from this basin flows overland to a swale flowing westerly ultimately encroaching into the Site's southern edge for a small distance. These flows will be allowed to pass through the Site's southern boundary.

Sand Creek Major Drainage Basin is adjacent to the Cottonwood Creek Major Basin touching on the Site's eastern and northern boundaries. A copy of the Drainage Map – Proposed Conditions for Dublin North Kwan Parcel Filing No. 8 along with the Preliminary and Final Drainage Report statements on Pages 10 & 11 is included for readers reference. The off-site storm water flows from Templeton Gap right of way are collected at the intersection of Wolf Ridge Road extension via a 18" flared end section and routed southerly in a public 18" pipe and directed toward an existing 6' D-10-R sump inlet located behind a curb in open space. The Drainage map and statements are included from said Preliminary and Final Drainage Report.

Existing on-site sub-basin EX-A1 is composed of the majority of the Site. The storm water flows overland through the vegetated site southwesterly towards the southwest corner of the Site and exits along the western portion of the southern Site boundary. Existing on-site sub-basin EX-A2 is composed of a smaller portion of the Site adjacent to sub-basin OS A. The storm water flows combine with the swale flow from sub-basin OS A and overland flow of EX-A1. These combined storm water flows exit the Site in this area and flow across said Tract F southerly onto the existing Lot 15, AA Subdivision into a natural lagoon area. The Dublin North Kwan Parcel Filing No. 8 Preliminary and Final Drainage Report states under Design Point 12 of said report that these flows in historic condition flow to Tutt boulevard and M.V.E., Inc. has the opinion they do not. They flow to a natural lagoon area on Lot 15, AA Subdivision.[6]

3 Drainage Design Criteria

3.1 Development Criteria Reference

This *Preliminary & Final Drainage Report for Hansen Ranch Filing No. 1* has been prepared according to the report guidelines presented in the *City of Colorado Springs Drainage Criteria Manual* (DCM)[7]. The hydrologic analysis is based on a collection of data from the DCM, the NCSS Web Soil Survey[8], Topographic mapping by Polaris Surveying, Inc. for the project site, proposed plan layout by M.V.E., Inc., property boundary information provided by Polaris Surveying, Inc. and proposed grading an drainage system layout developed by MVE, Inc.

6 Kwan No. 8
7 DCM Section 4.3 and Section 4.4
8 WSS

3.2 Hydrologic Criteria

For this Preliminary & Final Drainage Report, the Rational Method as described in the *City of Colorado Springs Drainage Criteria Manual* has been used for all Storm Runoff calculations, as the development and all sub-basins are less than 130 acres in area. “Colorado Springs Rainfall Intensity Duration Frequency” curves, Figure 6-5 in the DCM, was used to obtain the design rainfall values; a copy is included in the **Appendix**. The “Overland (Initial) Flow Equation” (Eq. 6-8) in the DCM, and Manning's equation with estimated depths were used in time of concentration calculations. “Runoff Coefficients for Rational Method”, Table 6-6 in the DCM, was utilized as a guide in estimating runoff coefficient and Percent Impervious values; a copy is included in the **Appendix**. Peak runoff discharges were calculated for each drainage sub-basin for both the 5-year storm event and the 100-year storm event with the Rational Method formula, (Eq. 6-5) in the DCM.[9]

The private Full Spectrum Extended Detention Basin (FS EDB) was sized and designed according to the procedures and tools presented by the Urban Drainage and Flood Control District's Urban Storm Drainage Criteria Manuals Volume 2 and Volume 3 as adopted by City of Colorado Springs.[10] [11] Public storm drain inlets were also sized and analyzed using Urban Drainage and Flood Control design worksheets. The hydraulic grade lines of the public storm main system was determined using Urban Drainage and Flood Control District's UD-Sewer Program.

4 Drainage Facility Design

4.1 General Concept

The intent of the drainage concept presented in this Preliminary & Final Drainage Report for the Hansen Ranch Filing No. 1 project is to provide adequate, safe and appropriate storm drainage with storm detention and water quality treatment in accordance with City of Colorado Springs Drainage Criteria. The existing drainage conditions and the proposed drainage concept is described in more detail below. Input data and results for all calculations are included in the **Appendix**. Drainage maps of existing and proposed conditions are also included in the **Appendix**.

4.2 Sub-Basin Specific Details

4.2.1 Existing Conditions

Existing off-site sub-basin OS A contains 0.89 acres. These flows combine with on-site sub-basin EX-A2 which contains 0.51 acres and will be allowed to pass through our site on the Site southern boundary. The storm water from these basins flow overland to a swale which flows westerly and ultimately encroaches into the Site's southern edge for a small distance. These sub-basins, containing 2% - 5% slopes generate storm runoff peak flows of Q_5 = 0.4 cfs and Q_{100} = 3.1 cfs (existing flows) at **Design Point EX-DP-1**.

Existing on-site sub-basin EX-A1 contains 12.38 acres of land. The sub-basin slopes downward from the northeast corner towards the southwest at existing slopes that range from 2% to 5%. The steeper slopes exist in the northeastern quadrant of the Site. These flows combine with Design Point EX-DP-1 which contains 1.40 acres. These sub-basins generate storm runoff discharges of Q_5 = 3.8 cfs and Q_{100} = 28.1 cfs (existing flows) and exits at the western portion of the southern Site boundary at **Design Point EX-DP-2**.

4.2.2 Proposed Conditions

Design Point No. 1 (DP 1) Developed sub-basin A1 is 2.03 acres in area and located in the northern portion of the site. The sub-basin will contain single family residential lots with houses, paved drives, & landscaping, and paved streets, curb, gutter, & sidewalks. Sub-basin A1 accepts no off-site storm water flow. Sub-basin A1 produces peak discharges of Q_5 = 3.7 cfs and Q_{100} = 8.2 cfs (developed flows). These storm water flows travel overland through the single family residential lots to the

9 DCM
10 UDFCD V2
11 UDFCD V3

paved streets and continue as gutter flow on the northeastern side of Dillenger Lane and the southern side of Finley Way to their intersection which is **DP 1**. The flows continue south in sub-basin H1 to **DP 3**.

Design Point No. 2 (DP 2) Developed sub-basin G1 is 1.78 acres in area and located in the western portion of the site. The sub-basin contains single family residential lots with houses, paved drives, & landscaping, and paved streets, curb, gutter, & sidewalks. Sub-basin G1 accepts no off-site storm water flow. Sub-basin G1 produces peak discharges of Q_5 = 3.5 cfs and Q_{100} = 7.6 cfs (developed flows). These storm water flows travel overland through the single family residential lots to the paved street and continue as shallow channel flow on the western side of Dillenger Lane to a public City of Colorado Springs 6' D-10-R Inlet in sump condition situated at **DP 2**. Should this inlet overflow due to blockage the flows will pond in the street until they overflow into the private Full Spectrum Extended Detention (FS EDB) by over-topping the southern curb of Finley Way at Dillenger Lane close to **DP 6**.

Design Point No. 3 (DP 3) Developed sub-basin H1 is 0.75 acres in area and located in the western portion of the site. The sub-basin contains single family residential lots with houses, paved drives, landscaping, paved streets, curb, gutter, and sidewalks. Sub-basin H1 produces peak discharges of Q_5 = 1.6 cfs and Q_{100} = 3.5 cfs (developed flows). These storm water flows travel overland through the single family residential lots to the paved street, combine with DP 1 storm water flows and continue as shallow channel flow on the eastern side of Dillenger Lane to a public City of Colorado Springs 8' D-10-R Inlet in sump condition situated at **DP 3**. The combined flows at **DP 3** entering the inlet are Q_5 = 5.1 cfs and Q_{100} = 11.3 cfs. These flows join the public 18" pipe flows from **DP 2** and the combined flows of Q_5 = 8.6 cfs and Q_{100} = 18.9 cfs continue via a public 24" pipe to **DP 7**. Should this inlet overflow due to blockage the flows will pond in the street until they overflow into the private FS EDB by over-topping the southern curb of Finley Way at Dillenger Lane close to **DP 6**.

Design Point No. 4 (DP 4) Developed sub-basins B1 – 0.88 acres in area, C1 – 1.05 acres in area, and D1 – 1.23 acres in area, are located in the central portion of the site. The sub-basins contain single family residential lots with houses, paved drives, landscaping, paved streets, curb, gutter, and sidewalks. Sub-basins C1, D1, and E1 produce a combined peak discharge of Q_5 = 5.6 cfs and Q_{100} = 12.4 cfs (developed flow). Sub-basin B1 storm water travels overland through the single family residential lots to the paved street and continue as shallow channel flow on the western and northern side of Finley Way. Sub-basins C1 and D1 storm water travels overland through the single family residential lots to the paved street and continue as shallow channel flow in Gigi Court. The storm water flows from sub-basins B1, C1, & D1 combine as gutter flow at the intersection of Finley Way and Gigi Court which is **DP 4**.

Design Point No. 5 (DP 5) Developed sub-basin E1 is 1.10 acres in area and located in the central portion of the site. The sub-basin contains single family residential lots with houses, paved drives, landscaping, paved streets, curb, gutter, and sidewalks. Sub-basin E1 produces peak discharges of Q_5 = 1.9 cfs and Q_{100} = 4.2 cfs (developed flows). These storm water flows travel overland through the single family residential lots to the paved street and continue as shallow channel flow on the northern side of Finley Way combining with storm water flows from **DP 4** for a combined peak discharge of Q_5 = 7.6 cfs and Q_{100} = 16.6 cfs (developed flow) collected in a public City of Colorado Springs 14' D-10-R Inlet in sump condition situated at **DP 5**. These combined flows at **DP 5** continue via a public 24" pipe to DP 6. Should this sump inlet overflow due to blockage the flows will pond in the street until they overflow into the private FS EDB by over-topping the southern curb of Finley Way close to **DP 6**.

Design Point No. 6 (DP 6) Developed sub-basin F1 is 2.60 acres in area and located in the eastern and southeastern portion of the site. The sub-basin contains single family residential lots with houses, paved drives, landscaping, paved streets, curb, gutter, and sidewalks. Sub-basin F1 accepts no off-site storm water flow. Sub-basin F1 produces peak discharges of Q_5 = 4.3 cfs and Q_{100} = 9.4 cfs (developed flows). These storm water flows travel overland through the single family residential lots to the paved street and continue as gutter flow on the eastern and southern side of Finley Way to a public City of Colorado Springs 6' D-10-R Inlet in sump condition situated at **DP 6**. These flows join the public 24" pipe flows from **DP 5** and the combined flow of Q_5 = 11.9 cfs and Q_{100}

= 26.0 cfs continue via a public 30” pipe to **DP 7**. Should this sump inlet overflow due to blockage the flows will pond in the street until they overflow into the private FS EDB by over-topping the southern curb of Finley Way at **DP 6**.

Design Point No. 7 (DP 7) Developed flows from DP 3 and DP 5 enter the concrete forebay via public 18” and 30” pipes for a combined flow of Q_5 = 18.8 cfs and Q_{100} = 41.4 cfs and enter the FS EDB at **DP 7**.

Design Point No. 8 (DP 8) Developed on-site sub-basins K1 – 0.66 acres in area, and off-site sub basin OS1 – 0.71 acres in area are located in the southern portion of the site. K1 sub-basin contains single family residential lots with houses, paved drives, and landscaping. OS1 sub-basin is vacant and not well vegetated. K1 and OS1 produce a combined peak discharge of Q_5 = 1.3 cfs and Q_{100} = 4.0 cfs (developed flow). Sub-basin K1 storm water travels overland through the single family residential lots to a swale and continues as shallow channel flow in sub-basin OS1 where the developed flows enter concrete forebay via a rip-rap swale to the private FS EDB at **DP 8**.

Design Point No. 9 (DP 9)

Flows from the entire site are collected in the proposed private Full Spectrum Extended Detention (FS EDB) Basin at DP 9. The combined flows of sub-basins A1, B1, C1, D1, E1, F1, G1, H1, J1, K1, and OS1 are Q_5 = 20.5 cfs and Q_{100} = 47.5 cfs (developed flow). These flows are treated and detained in the private FS EDB. The FS EDB will release flows of Q_5 = 0.4 cfs and Q_{100} = 7.4 cfs. Flows exit the pond by way of a private 12” RC Pipe and flow across said Tract F southerly onto the existing Lot 15, AA Subdivision into a natural lagoon area. Overflows in excess of the 100 year flow exit the pond by way of the 25' wide emergency spillway on the south side of the pond centered on said public 12” RC Pipe and flow into said existing natural lagoon area south of the site. The pond outflow works will consist of a 25' wide concrete spreading basin with baffle blocks to reduce velocities and return discharge the pond outflows to sheet flow.

4.3 Drainage Facilities

The proposed grading of the single family residential lots with houses, paved drives, landscaping, paved streets, curb, gutter, and sidewalks will direct the developed drainage runoff flows resulting from all pervious areas to the proposed private FS EDB. The basin will be a private facility, owned and maintained by the Hansen Ranch Home Owners Association. Calculations for the drainage facilities are included in the **Appendix** of this report.

The public storm drain inlets located in Hansen Ranch Filing No.1 City right of ways will be Colorado Springs Type D-10-R Inlets. The inlets were sized using the UDFCD standards worksheets containing the characteristics of the chosen inlet type. The drain piping connecting inlets and leading from the inlet to the pond forebays will be public and reinforced concrete storm pipe (RC Pipe).

Hydraulic Grade Line calculations are provided for all of the drain pipes. UD Sewer 2009 Version 1.4.0 (May 2014) was used for the computation of the piping hydraulic grade lines in this report. The program uses the energy-based Standard Step method in computing the hydraulic profile of the proposed storm drain system. The program uses Manning's equation to determine head losses due to friction. Calculations are included in the **Appendix** for readers reference.

Said private FS EDB will be maintained by the Hansen Ranch Home Owners Association. The inlets and storm pipes are public facilities and will be maintained by the City of Colorado Springs.

The private Full Spectrum Extended Detention Basin (FS EDB) will be constructed in accordance with City of Colorado Springs drainage criteria. The private FS EDB has been designed utilizing the UD – Detention, Version 3.07 (February 2017). The watershed area used was 13.72 acres with the watershed imperviousness of 57.5% as determined in the Combined Sub-Basin Runoff Calculations (DP9) worksheet for sub-basins A1, B1, C1, D1, E1, F1, G1, H1, J1, K1, and OS1, which is included in the Appendix. The total required detention volume was calculated to be 1.451 acre-feet as calculated with the Detention Basin Stage-Storage Table Builder with a Basin ID of Pond 1 in the Appendix. These basins are represented by DP 7, DP 8, and sub-basin J1. The referenced percent imperviousness is derived from values for various land use/land cover types contained in DCM Table 6-6, and the combined basin imperviousness calculation for DP 9 which are included in the **Appendix**. The FS-EDB will have concrete outlet box, micro-pool, concrete trickle channels, concrete forebays and a 11' wide gravel access road. The side slopes of the FS-EDB embankment will be 3:1 due to area constraints imposed by the required street access location connecting to Tutt Blvd and milder side slopes would make the facility exceedingly narrow and difficult to maintain. The capacity of said private Full Spectrum Extended Detention Basin (FS EDB) will be not less than 1.451 acre-feet to accept the required Water Quality Capture Volume (WQCV) of 0.261 acre-feet, Excess Urban Runoff Volume (EURV) of 0.685 acre-feet, and 100-year Detention Volume for the developed Hansen Ranch Filing No. 1. Overflows will pass through a concrete weir with a bottom width 25' and 3:1 side slopes at 1' of depth to a rip-rap (Type VL) lined emergency spillway from the pond. The spillway will discharge into a 3' wide by 25' long and 0.5' deep with five 1' high by 2' wide barrier blocks to evenly disperse the outlet flows southerly onto the adjacent tract. Calculations for the rip-rap are included for readers reference in the Appendix. Detailed design of this drainage facility will be provided with Construction Documents for the site.

4.4 Water Quality Enhancement Best Management Practices

The Hansen Ranch Filing No. 1 site will be developed with the proposed private FS EDB as required by City of Colorado Springs for developments having disturbed area more than 1 acre. The private FS EDB provides the required water quality treatment and included Water Quality Capture Volume (WQVC). Additionally, an Erosion Control Plan will be included with the Construction Plans for the site and will include construction BMP's for prevention of downstream sedimentation from construction on the site.

4.4.1 Four Step Process

The City of Colorado Springs Drainage Criteria Manual Volume 2 (DCM v2) requires the consideration of a “Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long term source controls”.[12] The Four Step Process is incorporated in the project and the elements are discussed below.

1) Runoff reduction practices for this project are a feature of the dwelling density and the open space requirements of this development. The dwelling density of each lot provides ample opportunity for a high level of Minimized Directly Connected Impervious Areas (MDCIA). Each individual residential lot in the subdivision will drain to grassed areas that reduce runoff that reduce the requirement for Water Quality Capture Volume in all sub-basins. Also the site features reserved pervious open space (Tract B in southwest corner), further reducing flows. The IRF worksheet for the site is included in the Appendix.

2) The project includes water quality treatment facility with Water Quality Capture Volume in the form of the proposed private Full Spectrum Extended Detention Basin (FS EDB). The private FS EDB is placed in the appropriate location to intercept the flows prior to the entering the downstream drainage ways.

3) The site is located in the Cottonwood Creek Drainage Basin. However, infrastructure has been constructed which directs flows to Sand Creek. Flows from this site enter the property located south of the site and are routed overland to Vickie Lane, These flows are intercepted by storm inlets in Vickie Lane and conveyed in storm drain pipelines leading to Tutt Boulevard and then continure flowing south to Sand Creek. All drainage paths on the site will be stabilized with appropriate landscape cover to prevent erosion of the site following development. All pipe outfalls from the site to the private Full Spectrum Extended Detention Basin (FS EDB) will discharge onto concrete forebay with barrier blocks. The private FS EDB emergency overflow spillway will be rip-rap lined. The normal outflows from the private FS EDB enter the private 12” RC Pipe storm drain which has a concrete level spreader at the outlet for energy dissipation, outlet protection and stabilization.

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4) This residential project contains no designated outdoor storage areas or storage of potentially harmful substances. No potentially harmful substances will be stored outdoors. No Site Specific or Other Source Control BMP's are required.

A Grading, Erosion and Stormwater Quality Control Plan for the construction of the site will be prepared at the time of Construction Drawing preparation. The Construction Drawings will contain the detailed design of the drainage facilities. The plans will be prepared in accordance with the provisions of the City of Colorado Springs Engineering Division's Drainage Criteria Manual Volume 2[13].

5 Drainage Improvement Opinion of Probable Costs

5.1 Private Non-reimbursable Permanent BMP Improvements

Probable costs for Hansen Ranch Filing No. 1 Private non-reimbursable Permanent BMP Improvements are listed below:

Item	Quantity	Unit	Unit Cost	Cost
FS EDB Excavation	1	EA	$5,525	$5,525
Concrete Outlet Structure	1	EA	$4,500	$4,500
Concrete Forebay	2	EA	$2,600	$5,200
Concrete Trickle Channel	288	LF	$19	$5,472
Concrete Spreading Basin at outfall	1	EA	$3,500	$3,500
12” HDPE Pipe	27	LF	$25	$675
Type VL Rip-Rap	66	CY	$112	$7,392
10% Engineering Contingency				$3,226
TOTAL				**$35,490.00**

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5.2 Public Non Reimbursable Drainage Improvements

Probable costs for Hansen Ranch Filing No. 1 Public non reimbursable Drainage Improvements are listed below:

Item	Quantity	Unit	Unit Cost	Cost
City Inlet 6' D-10-R	1	EA	$3,900	$3,900
City Inlet 8' D-10-R	1	EA	$5,200	$5,200
City Inlet 14' D-10-R	1	EA	$3,800	$3,800
18” RC Pipe	70	LF	$36	$2,520
24” RC Pipe	95	LF	$48	$4,560
30” RC Pipe	12	LF	$60	$720
10% Engineering Contingency				$2,070
TOTAL				**$2**

6 Drainage Fees

The Hansen Ranch Filing No. 1 development is located within the Cottonwood Creek Major Drainage Basin. Drainage fees are due for this project which is 12.90 Acres. These fees will are due at time of subdivision platting.

Drainage Fee/Acre	12.888 Acres @ $13,923.00 / Acre =	$179,439.62
Bridge Fee/Acre	12.888 Acres @ $ 1,130.00 / Acre =	14,563.44
Surcharge/Acre	12.888 Acres @ $ 723.00 / Acre =	9,318.02
	Grand Total =	$203,321.08

7 Conclusion

This Preliminary & Final Drainage Report for the Hansen Ranch Filing No. 1 development at presents a drainage concept that includes recommendation for proposed site improvements will direct, control, and treat storm drainage runoff. The proposed development of said project is in general conformance with all previously filed reports which include this area and will not negatively impact the adjacent properties and surrounding developments.

References

NRCS Web Soil Survey. United States Department of Agriculture, Natural Resources Conservation Service ("http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx", accessed October 2016).

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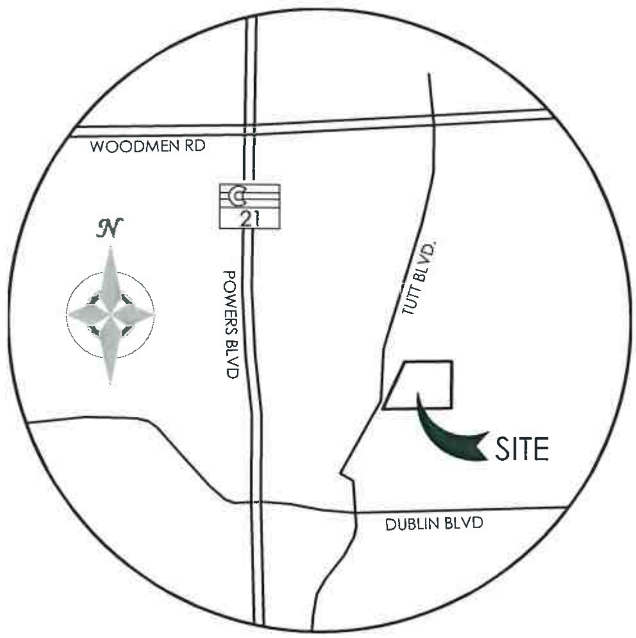
Urban Storm Drainage Criteria Manual: Volume 2, Structures, Storage, and Recreation. Urban Drainage and Flood Control District (Denver, Colorado : , January 2016).

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

Appendices

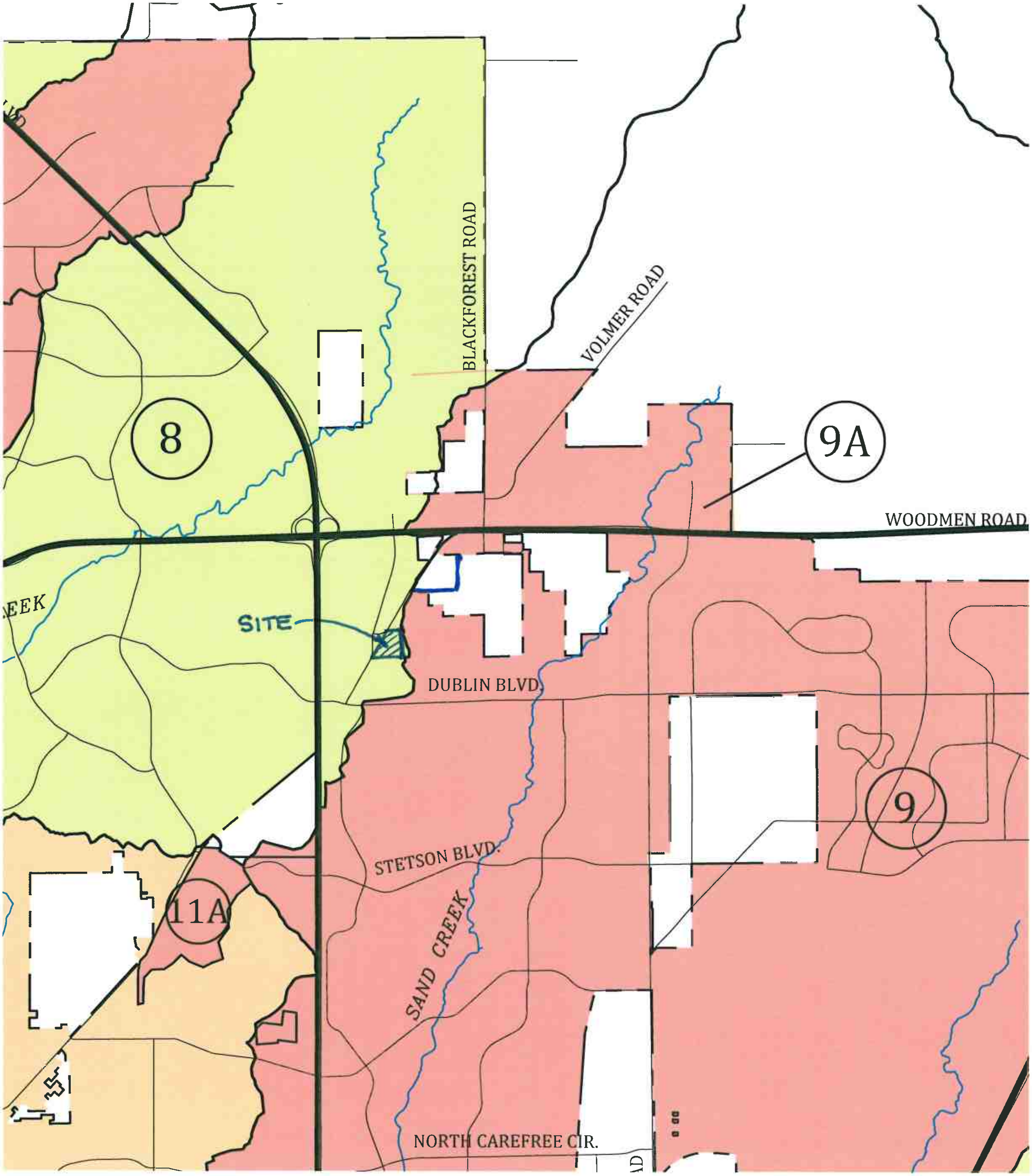
1 General Maps and Supporting Data

Vicinity Map
Portion of City Major Basin Delineation Map
Portion of Flood Insurance Rate Map
Soil Type map and Tables
Official Soil Series Descriptions
Hydrologic Soil Group Map and Tables



VICINITY MAP

NOT TO SCALE


BLACKFOREST ROAD
VOLMER ROAD
8
9A
WOODMEN ROAD
EEK
SITE
DUBLIN BLVD.
9
STETSON BLVD.
11A
SAND CREEK
NORTH CAREFREE CIR.

BASIN NUMBER	BASIN NAME
1	SMITH CREEK
2	BLACK SQUIRREL CREEK
3	MONUMENT BRANCH
4	MIDDLE TRIBUTARY
5	KETTLE CREEK
6	ELKHORN
7	PINE CREEK
8	COTTONWOOD CREEK
9	SAND CREEK
9A	UPPER SAND CREEK
10	PULPIT ROCK
11	NORTH SHOOKS RUN TEMPLETON GAP BASIN
11A	SHOOKS RUN NORTH TEMPLETON GAP BASIN A
11B	ADDENDUM NORTH SHOOKS RUN TEMPLETON GAP BASIN
12	UNSTUDIED MISCELLANEOUS BASIN
13	SHOOKS RUN
14	SPRING CREEK
15	PETERSON FIELD
16	JIMMY CAMP CREEK
17	LITTLE JOHNSON RESERVOIR
18	WINDMILL GULCH
19	BIG JOHNSON RESERVOIR CREWS GULCH
20	UNSTUDIED

BASIN NUMBER	BASIN NAME
21	UNSTUDIED
22	DOUGLAS CREEK
23	DRY CREEK
24	ROCKRIMMON NORTH
25	ROCKRIMMON SOUTH
26	POPES BLUFF
27	CAMP CREEK
28	BLACK CANYON
29	BALANCED ROCK
30	COLUMBIA ROAD
31	MESA DRAINAGE BASIN
32	WEST FORK JIMMY CAMP CREEK
33	NINETEENTH STREET
34	WESTSIDE BASIN
35	MIDLAND BASIN
36	TWENTY-FIRST STREET SOUTH
37	BEAR CREEK
38	MONUMENT CREEK
39	SOUTHWEST AREA UPPER CHEYENNE CREEK, CHEYENNE RUN, AND
40	STRATTON BASIN
41	FISHERS CANYON
42	SOUTH PINE CREEK
43	FOUNTAIN CREEK
44	ROSWELL

National Flood Hazard Layer FIRMette

FEMA

38°56'2.78"N

1:6,000

Legend

51421 ENG.

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/7/2019 at 12:10:04 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Map Scale: 1:1,830 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 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 3, 2014—Jun 17, 2014

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	12.8	100.0%
Totals for Area of Interest		**12.8**	**100.0%**

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

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be necessary when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, the provision of undisturbed nesting cover is vital and should be included in plans for habitat development. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for use as homesites. Shallow excavation is severely limited because cut banks cave in. This sandy soil requires special management practices to reduce water erosion and soil blowing. Capability subclasses IIIe, irrigated, and IVe, nonirrigated.

7—Bijou sandy loam, 3 to 8 percent slopes. This deep, well drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown sandy loam about 4 inches thick. The subsoil is brown or grayish brown sandy loam about 24 inches thick. The substratum is pale brown loamy coarse sand.

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

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

Almost all areas of this soil are used for range.

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

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

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

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, by properly managing livestock grazing, and by reseeding range where needed.

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

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

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

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

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

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

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

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

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

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

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

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

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

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

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

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

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

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

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

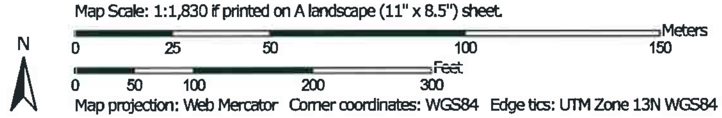
Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and low available water capacity are the main limitations to the establishment of trees and shrubs. The soils are so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained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

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

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

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

Map Scale: 1:1,830 if printed on A landscape (11" x 8.5") sheet.



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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 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 3, 2014—Jun 17, 2014

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
8	Blakeland loamy sand, 1 to 9 percent slopes	A	12.8	100.0%
Totals for Area of Interest			**12.8**	**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

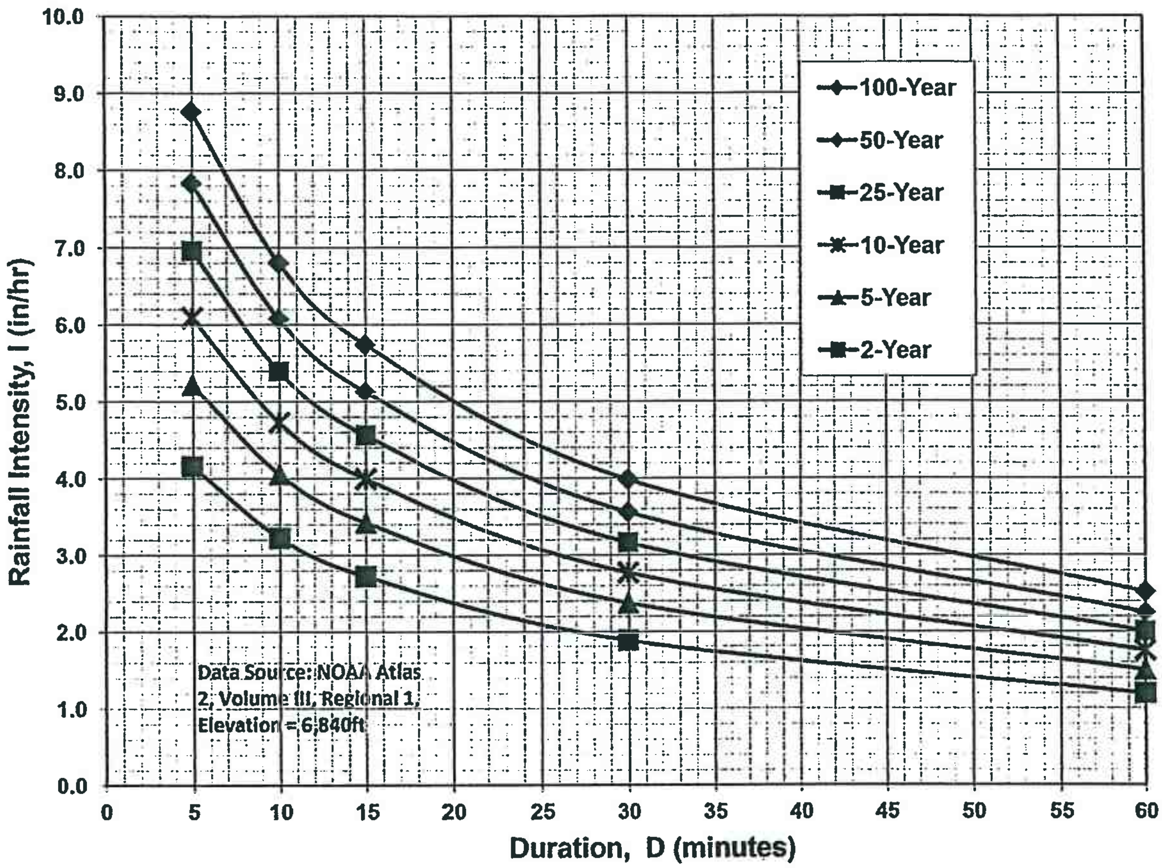
Component Percent Cutoff: None Specified

Tie-break Rule: Higher

2 Hydrologic Calculations

City of Colorado Springs DCM Runoff Coefficients – Table 6-6
Colorado Springs DCM Rainfall Intensity Duration Frequency – Figure 6-5
Sub-Basin Time of Concentration – Form SF-1
5-yr Sub-Basin and Combined Flows – Form SF-2
100-yr Sub-Basin and Combined Flows – Form SF-2
Sub-Basin Calculations

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

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

Job No.: **51421**

Project: **Hansen Ranch**

Date: **7/2/2019 21:22**

Calcs By: **TJW**

Checked By:

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

Sub-Basin	Sub-Basin Data				Overland			Shallow Channel				Channelized				t_c Check		
	Area (Acres)	C_5	C_{100}/CN	% Imp.	L_0 (ft)	S_0 (%)	t_i (min)	L_{0t} (ft)	S_{0t} (ft/ft)	v_{0sc} (ft/s)	t_t (min)	L_{0c} (ft)	S_{0c} (ft/ft)	v_{0c} (ft/s)	t_c (min)	L (min)	$t_{c,alt}$ (min)	t_c (min)
EX-A1	12.38	0.08	0.35	0%	100	6%	10.2	300	0.043	1.5	3.4	596	0.025	3.8	2.6	996	15.5	15.5
EX-A2	0.51	0.08	0.35	0%	90	6%	9.9	0	0.000	0.0	0.0	0	0.000	0.0	0.0	90	10.5	9.9
OS A	0.89	0.08	0.35	0%	100	4%	11.7	300	0.043	1.5	3.4	110	0.045	2.5	0.7	510	12.8	12.8
A1	2.03	0.45	0.59	65%	100	4%	7.8	61	0.016	0.9	1.1	210	0.017	2.6	1.3	371	12.1	10.2
B1	0.88	0.45	0.59	65%	58	2%	7.5	0	0.000	0.0	0.0	570	0.025	2.5	3.8	628	13.5	11.3
C1	1.05	0.45	0.59	65%	47	17%	3.2	299	0.023	1.1	4.7	104	0.014	2.2	0.8	450	12.5	8.6
D1	1.23	0.45	0.59	65%	47	17%	3.2	266	0.023	1.1	4.2	166	0.018	2.4	1.1	479	12.7	8.5
E1	1.10	0.45	0.59	65%	87	2%	8.3	274	0.038	1.4	3.3	0	0.000	0.0	0.0	361	12.0	11.6
F1	2.60	0.45	0.59	65%	100	3%	8.2	0	0.000	0.0	0.0	1005	0.022	3.1	5.5	1105	16.1	13.7
G1	1.78	0.45	0.59	65%	72	4%	6.2	82	0.024	1.1	1.3	392	0.042	4.9	1.3	546	13.0	8.8
H1	0.75	0.45	0.59	65%	59	5%	5.3	0	0.000	0.0	0.0	410	0.043	4.1	1.7	469	12.6	6.9
J1	0.94	0.11	0.37	4%	59	5%	8.0	0	0.000	0.0	0.0	410	0.043	2.8	2.5	469	12.6	10.5
K1	0.66	0.45	0.59	65%	100	2%	10.3	390	0.040	1.4	4.7	0	0.000	0.0	0.0	490	12.7	12.7
OS1	0.71	0.08	0.35	0%	55	9%	6.6	490	0.043	1.4	5.6	0	0.000	0.0	0.0	545	13.0	12.2

Job No.: **51421**
Project: **Hansen Ranch**
Design Storm: **5-Year Storm** *(20% Probability)*
Jurisdiction: **DCM**

Date: **7/2/2019 21:22**
Calcs By: **TJW**
Checked By:

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

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
	Sub-	Area		t_c	CA	I5	Q5	t_c	CA	I5	Q5	Slope	Length	Q	Q	Slope	Mnngs	Length	D_{Pipe}	Length	v_{0sc}	t_t
DP	Basin	(Acres)	C5	(min)	(Acres)	(in/hr)	(cfs)	(min)	(Acres)	(in/hr)	(cfs)	(%)	(ft)	(cfs)	(cfs)	(%)	n	(ft)	(in)	(ft)	(ft/s)	(min)
	EX-A2	0.51	0.08	9.9	0.04	4.14	0.2															
	OS A	0.89	0.08	12.8	0.07	3.75	0.3															
EX-DP1	EX-A2,OS A	1.40	0.08					12.8	0.11	3.75	0.4											
	EX-A1	12.38	0.08	15.5	0.99	3.47	3.4															
EX-DP2	EX-DP1,OS A	13.77	0.08					15.5	1.10	3.47	3.8											
DP-1	A1	2.03	0.45	10.2	0.91	4.10	3.7															
DP-2	G1	1.78	0.45	8.8	0.80	4.32	3.5															
	H1	0.75	0.45	6.9	0.34	4.68	1.6															
DP-3	A1,H1	2.78	0.45					10.2	1.25	4.10	5.1											
	B1	0.88	0.45	11.3	0.40	3.95	1.6															
	C1	1.05	0.45	8.6	0.47	4.35	2.0															
	D1	1.23	0.45	8.5	0.55	4.37	2.4															
DP-4	B1,C1,D1	3.16	0.45					11.3	1.42	3.95	5.6											
	E1	1.10	0.45	11.6	0.49	3.90	1.9															
DP-5	DP-4,E1	4.25	0.45					11.3	1.91	3.95	7.6											
DP-6	F1	2.60	0.45	13.7	1.17	3.66	4.3															
DP-7	DP-5,F1	11.41	0.45					13.7	5.13	3.66	18.8											
	K1	0.66	0.45	12.7	0.30	3.77	1.1															
	OS1	0.71	0.08	12.2	0.06	3.83	0.2															
DP-8	K1,OS1	1.37	0.26					12.7	0.36	3.77	1.3											
	J1	0.94	0.11	10.5	0.11	4.06	0.4															
DP-9	DP-7,DP-8	13.72	0.41					13.7	5.60	3.66	20.5											

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

Job No.: **51421**
Project: **Hansen Ranch**
Design Storm: **100-Year Storm** *(1% Probability)*
Jurisdiction: **DCM**

Date: **7/2/2019 21:22**
Calcs By: **TJW**
Checked By:

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

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
DP	Sub-Basin	Area (Acres)	C100	t_c (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	t_c (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	v_{0sc} (ft/s)	t_t (min)
	EX-A2	0.51	0.35	9.9	0.18	6.95	1.2															
	OS A	0.89	0.35	12.8	0.31	6.30	2.0															
EX-DP1	EX-A2,OS A	1.40	0.35					12.8	0.49	6.30	3.1											
	EX-A1	12.38	0.35	15.5	4.33	5.82	25.2															
EX-DP2	EX-DP1,OS A	13.77	0.35					15.5	4.82	5.82	28.1											
DP-1	A1	2.03	0.59	10.2	1.20	6.88	8.2															
DP-2	G1	1.78	0.59	8.8	1.05	7.25	7.6															
	H1	0.75	0.59	6.9	0.44	7.85	3.5															
DP-3	A1,H1	2.78	0.59					10.2	1.64	6.88	11.3											
	B1	0.88	0.59	11.3	0.52	6.63	3.5															
	C1	1.05	0.59	8.6	0.62	7.31	4.5															
	D1	1.23	0.59	8.5	0.72	7.34	5.3															
DP-4	B1,C1,D1	3.16	0.59					11.3	1.86	6.63	12.4											
	E1	1.10	0.59	11.6	0.65	6.55	4.2															
DP-5	DP-4,E1	4.25	0.59					11.3	2.51	6.63	16.6											
DP-6	F1	2.60	0.59	13.7	1.53	6.15	9.4															
DP-7	DP-5,F1	11.41	0.59					13.7	6.73	6.15	41.4											
	K1	0.66	0.59	12.7	0.39	6.33	2.5															
	OS1	0.71	0.35	12.2	0.25	6.43	1.6															
DP-8	K1,OS1	1.37	0.47					12.7	0.64	6.33	4.0											
	J1	0.94	0.37	10.5	0.35	6.82	2.4															
DP-9	DP-7,DP-8	13.72	0.56					13.7	7.72	6.15	47.5											

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

Sub-Basin OS A Runoff Calculations

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	38,562	0.89	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**38,562**	**0.89**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	38562								
	-								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	510	22	-	-	-	-	
Initial Time	100	4	0.040	-	11.7	12.8	DCM Eq. 6-8
Shallow Channel	300	13	0.043	1.5	3.4	-	DCM Eq. 6-9
Channelized	110	5	0.045	2.5	0.7	-	V-Ditch
				t_c	**12.8**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.00	3.75	4.38	5.01	5.63	6.30
Runoff (cfs)	0.1	**0.3**	0.6	1.1	1.5	**2.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.6	1.1	1.5	**2.0**

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

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

Notes

Sub-Basin Ex-A2 Runoff Calculations

Job No.:	**51421**	Date:		**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**	
		Checked by:		
Jurisdiction	**DCM**	Soil Type	**A**	
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**	

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	22,340	0.51	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**22,340**	**0.51**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	22340								

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	90	5	-	-	-	-	
Initial Time	90	5	0.056	-	9.9	10.5	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**9.9**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.30	4.14	4.83	5.52	6.21	6.95
Runoff (cfs)	0.0	**0.2**	0.4	0.7	1.0	**1.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.2**	0.4	0.7	1.0	**1.2**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Combined Sub-Basin Runoff Calculations (EX DP 1)

Includes Basins OS A EX-A2

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	60,902	1.40	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**60,902**	**1.40**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OS A	-	510	22	-	-	-	-	12.8
Channelized-1									
Channelized-2									
Channelized-3									
Total			510	22					

t_c (min) **12.8**

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	3.00	3.75	4.38	5.01	5.63	6.30
Site Runoff (cfs)	0.08	**0.42**	0.92	1.75	2.36	**3.08**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**0.4**	-	-	-	**3.1**

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

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

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Sub-Basin Ex-A1 Runoff Calculations

Job No.:	51421	Date:		7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW	
		Checked by:		
Jurisdiction	DCM	Soil Type	A	
Runoff Coefficient	Surface Type	Urbanization	Urban	

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Pasture/Meadow	539,065	12.38	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**539,065**	**12.38**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	539065								

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	996	34	-	-	-	-	
Initial Time	100	6	0.060	-	10.2	15.5	DCM Eq. 6-8
Shallow Channel	300	13	0.043	1.5	3.4	-	DCM Eq. 6-9
Channelized	596	15	0.025	3.8	2.6	-	V-Ditch
				t_c	**15.5**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.77	3.47	4.05	4.63	5.20	5.82
Runoff (cfs)	0.7	**3.4**	7.5	14.3	19.3	**25.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.7	**3.4**	7.5	14.3	19.3	**25.2**

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

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

Notes

Combined Sub-Basin Runoff Calculations (EX DP 2)

Includes Basins OS A EX-A1 EX-A2

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Pasture/Meadow	599,967	13.77	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**599,967**	**13.77**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-A1	-	996	34	-	-	-	-	15.5
Channelized-1									
Channelized-2									
Channelized-3									
Total			996	34					

t_c (min) **15.5**

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.77	3.47	4.05	4.63	5.20	5.82
Site Runoff (cfs)	0.76	**3.82**	8.36	15.93	21.50	**28.07**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**3.8**	-	-	-	**28.1**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Sub-Basin A1 Runoff Calculations (DP 1)

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
1/8 Acre or less	88,490	2.03	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**88,490**	**2.03**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**
	88490								

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	371	8	-	-	-	-	
Initial Time	100	4	0.035	-	7.8	12.1	DCM Eq. 6-8
Shallow Channel	61	1	0.016	0.9	1.1	-	DCM Eq. 6-9
Channelized	210	4	0.017	2.6	1.3	-	C&G
				t_c	**10.2**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.27	4.10	4.78	5.46	6.14	6.88
Runoff (cfs)	2.7	**3.7**	4.8	6.0	7.1	**8.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.7	**3.7**	4.8	6.0	7.1	**8.2**

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

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

Notes

Sub-Basin G1 Runoff Calculations (DP 2)

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
1/8 Acre or less	77,434	1.78	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**77,434**	**1.78**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**

77434

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft — C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	546	22	-	-	-	-	
Initial Time	72	3	0.042	-	6.2	13.0	DCM Eq. 6-8
Shallow Channel	82	2	0.024	1.1	1.3	-	DCM Eq. 6-9
Channelized	392	17	0.042	4.9	1.3	-	C&G
				t_c	**8.8**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.45	4.32	5.04	5.76	6.48	7.25
Runoff (cfs)	2.5	**3.5**	4.4	5.5	6.6	**7.6**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.5	**3.5**	4.4	5.5	6.6	**7.6**

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

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

Notes

Sub-Basin H1 Runoff Calculations

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
1/8 Acre or less	32,620	0.75	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**32,620**	**0.75**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**
	32620								
	-								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	469	21	-	-	-	-	
Initial Time	59	3	0.051	-	5.3	12.6	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	410	18	0.043	4.1	1.7	-	C&G
				t_c	**6.9**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.73	4.68	5.45	6.23	7.01	7.85
Runoff (cfs)	1.1	**1.6**	2.0	2.5	3.0	**3.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.1	**1.6**	2.0	2.5	3.0	**3.5**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Combined Sub-Basin Runoff Calculations (DP 3)

Includes Basins A1 H1

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
1/8 Acre or less	121,110	2.78	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**121,110**	**2.78**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	A1	-	371	8	-	-	-	-	10.2
Channelized-1									
Channelized-2									
Channelized-3									
Total			371	8					

t_c (min) **10.2**

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.27	4.10	4.78	5.46	6.14	6.88
Site Runoff (cfs)	3.73	**5.12**	6.51	8.20	9.74	**11.28**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**5.1**	-	-	-	**11.3**

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

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

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Sub-Basin B1 Runoff Calculations

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
1/8 Acre or less	38,406	0.88	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**38,406**	**0.88**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**

38406
-

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	628	16	-	-	-	-	
Initial Time	58	1	0.017	-	7.5	13.5	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	570	15	0.025	2.5	3.8	-	C&G

t_c 11.3 min.

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.15	3.95	4.61	5.27	5.93	6.63
Runoff (cfs)	1.1	**1.6**	2.0	2.5	3.0	**3.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.1	**1.6**	2.0	2.5	3.0	**3.5**

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

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

Notes

Z:\51421\Calcs\Hydrology\51421-Runoff Spreadsheet.xlsm
B1

Sub-Basin C1 Runoff Calculations

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
1/8 Acre or less	45,583	1.05	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**45,583**	**1.05**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**
	45583								

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft — C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	450	17	-	-	-	-	
Initial Time	47	8	0.170	-	3.2	12.5	DCM Eq. 6-8
Shallow Channel	299	7	0.023	1.1	4.7	-	DCM Eq. 6-9
Channelized	104	2	0.014	2.2	0.8	-	C&G
				t_c	**8.6**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.47	4.35	5.08	5.80	6.53	7.31
Runoff (cfs)	1.5	**2.0**	2.6	3.3	3.9	**4.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.5	**2.0**	2.6	3.3	3.9	**4.5**

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

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

Notes

Sub-Basin D1 Runoff Calculations

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
1/8 Acre or less	53,486	1.23	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**53,486**	**1.23**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**
	53486								

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	479	17	-	-	-	-	
Initial Time	47	8	0.170	-	3.2	12.7	DCM Eq. 6-8
Shallow Channel	266	6	0.023	1.1	4.2	-	DCM Eq. 6-9
Channelized	166	3	0.018	2.4	1.1	-	C&G
				t_c	**8.5 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.49	4.37	5.10	5.83	6.56	7.34
Runoff (cfs)	1.8	**2.4**	3.1	3.9	4.6	**5.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.8	**2.4**	3.1	3.9	4.6	**5.3**

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

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

Notes

Combined Sub-Basin Runoff Calculations (DP 4)

Includes Basins B1 C1 D1

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
1/8 Acre or less	137,475	3.16	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**137,475**	**3.16**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	B1	-	628	16	-	-	-	-	11.3
Channelized-1									
Channelized-2									
Channelized-3									
Total			628	16					

t_c (min) **11.3**

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.15	3.95	4.61	5.27	5.93	6.63
Site Runoff (cfs)	4.08	**5.61**	7.13	8.98	10.66	**12.35**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**5.6**	-	-	-	**12.4**

DCM I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.647	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Sub-Basin E1 Runoff Calculations

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
1/8 Acre or less	47,733	1.10	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**47,733**	**1.10**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**
	47733								

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	361	13	-	-	-	-	
Initial Time	87	2	0.023	-	8.3	12.0	DCM Eq. 6-8
Shallow Channel	274	11	0.038	1.4	3.3	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	C&G

t_c **11.6 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.11	3.90	4.55	5.20	5.85	6.55
Runoff (cfs)	1.4	**1.9**	2.4	3.1	3.7	**4.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.4	**1.9**	2.4	3.1	3.7	**4.2**

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

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

Notes

Combined Sub-Basin Runoff Calculations (DP 5)

Includes Basins B1 C1 D1 E1

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
1/8 Acre or less	185,208	4.25	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**185,208**	**4.25**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	B1	-	628	16	-	-	-	-	11.3
Channelized-1									
Channelized-2									
Channelized-3									
Total			628	16					

t_c (min) **11.3**

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.15	3.95	4.61	5.27	5.93	6.63
Site Runoff (cfs)	5.50	**7.56**	9.60	12.09	14.36	**16.64**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**7.6**	-	-	-	**16.6**

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

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

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Sub-Basin F1 Runoff Calculations (DP 6)

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
1/8 Acre or less	113,191	2.60	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**113,191**	**2.60**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**
	113191								
	-								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,105	26	-	-	-	-	
Initial Time	100	3	0.030	-	8.2	16.1	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	1,005	23	0.022	3.1	5.5	-	C&G
				t_c	**13.7 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.92	3.66	4.27	4.88	5.49	6.15
Runoff (cfs)	3.1	**4.3**	5.4	6.9	8.1	**9.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	3.1	**4.3**	5.4	6.9	8.1	**9.4**

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

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

Notes

Combined Sub-Basin Runoff Calculations (DP 7)

Includes Basins A1 B1 C1 D1 E1 F1 G1 H1

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
1/8 Acre or less	496,943	11.41	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**496,943**	**11.41**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	F1	-	1,105	26	-	-	-	-	13.7
Channelized-1									
Channelized-2									
Channelized-3									
Total			1,105	26					

t_c (min) **13.7**

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.92	3.66	4.27	4.88	5.49	6.15
Site Runoff (cfs)	13.68	**18.80**	23.88	30.08	35.72	**41.38**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**18.8**	-	-	-	**41.4**

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

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

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Sub-Basin K1 Runoff Calculations

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
1/8 Acre or less	28,959	0.66	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**28,959**	**0.66**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**

28959

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	490	17	-	-	-	-	
Initial Time	100	2	0.015	-	10.3	12.7	DCM Eq. 6-8
Shallow Channel	390	16	0.040	1.4	4.7	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	C&G

t_c 12.7 min.

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	3.01	3.77	4.40	5.02	5.65	6.33
Runoff (cfs)	0.8	**1.1**	1.4	1.8	2.1	**2.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.8	**1.1**	1.4	1.8	2.1	**2.5**

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

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

Notes

Sub-Basin OS1 Runoff Calculations

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	30,830	0.71	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**30,830**	**0.71**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	30830								

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	545	26	-	-	-	-	
Initial Time	55	5	0.091	-	6.6	13.0	DCM Eq. 6-8
Shallow Channel	490	21	0.043	1.4	5.6	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	Trap Ditch

t_c **12.2 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.06	3.83	4.47	5.10	5.74	6.43
Runoff (cfs)	0.0	**0.2**	0.5	0.9	1.2	**1.6**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.2**	0.5	0.9	1.2	**1.6**

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

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

Notes

Combined Sub-Basin Runoff Calculations (DP 8)

Includes Basins K1 OS1

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
1/8 Acre or less	28,959	0.66	0.41	0.45	0.49	0.54	0.57	0.59	65%
Pasture/Meadow	30,830	0.71	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**59,789**	**1.37**	**0.21**	**0.26**	**0.31**	**0.39**	**0.43**	**0.47**	**31.5%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	K1	-	490	17	-	-	-	-	12.7
Channelized-1									
Channelized-2									
Channelized-3									
Total			490	17					
								t_c (min)	12.7

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.01	3.77	4.40	5.02	5.65	6.33
Site Runoff (cfs)	0.86	**1.34**	1.90	2.69	3.34	**4.05**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**1.3**	-	-	-	**4.0**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Sub-Basin J1 Runoff Calculations

Job No.:	51421	Date:	7/2/2019 21:22
Project:	Hansen Ranch	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	A
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Lawns	39,170	0.90	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	1,632	0.04	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**40,802**	**0.94**	**0.05**	**0.11**	**0.18**	**0.28**	**0.33**	**0.37**	**4.0%**

40802
-

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

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

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	469	21	-	-	-	-	
Initial Time	59	3	0.051	-	8.0	12.6	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	410	18	0.043	2.8	2.5	-	C&G

t_c 10.5 min.

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.24	4.06	4.74	5.42	6.09	6.82
Runoff (cfs)	0.2	**0.4**	0.8	1.4	1.9	**2.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.4**	0.8	1.4	1.9	**2.4**

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

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

Notes

Combined Sub-Basin Runoff Calculations (DP 9)

Includes Basins A1 B1 C1 D1 E1 F1 G1 H1 J1 K1 OS1

Job No.:	**51421**	Date:	**7/2/2019 21:22**
Project:	**Hansen Ranch**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**A**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
1/8 Acre or less	525,902	12.07	0.41	0.45	0.49	0.54	0.57	0.59	65%
Pasture/Meadow	30,830	0.71	0.02	0.08	0.15	0.25	0.3	0.35	0%
Lawns	39,170	0.90	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	1,632	0.04	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**597,534**	**13.72**	**0.37**	**0.41**	**0.45**	**0.51**	**0.54**	**0.56**	**57.5%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	F1	-	1,105	26	-	-	-	-	13.7
Channelized-1									
Channelized-2									
Channelized-3									
Total			1,105	26					

t_c (min) **13.7**

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.92	3.66	4.27	4.88	5.49	6.15
Site Runoff (cfs)	14.67	**20.49**	26.45	33.96	40.64	**47.46**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**20.5**	-	-	-	**47.5**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

3 Hydraulic Calculations

IRF Worksheet
FS EDB design calculations (UD-BMP)
FS EDB design calculations (UD-Detention)
Rip-Rap Calculations
Storm Inlet Calculations
Storm Drain HGL Calculations

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer: TJW
Company: M.V.E., Inc.
Date: August 27, 2019
Project: 51421 - Hansen Ranch
Location: Pond 1

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	A1	B1	C1	D1	E1	F1	G1	H1	J1	K1	OS1			
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand			
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	2.030	0.880	1.050	1.230	1.100	2.600	1.780	0.750	0.940	0.660	0.710			
Directly Connected Impervious Area (DCIA, acres)	0.380	0.170	0.200	0.230	0.210	0.490	0.330	0.140	0.040	0.120	0.000			
Unconnected Impervious Area (UIA, acres)	1.000	0.430	0.520	0.610	0.540	1.280	0.880	0.370	0.000	0.330	0.000			
Receiving Pervious Area (RPA, acres)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.000	0.000			
Separate Pervious Area (SPA, acres)	0.650	0.280	0.330	0.390	0.350	0.830	0.570	0.240	0.400	0.210	0.710			
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C	C	C	C	C	C	C	V	C	C			

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	2.030	0.880	1.050	1.230	1.100	2.600	1.780	0.750	0.940	0.660	0.710			
Directly Connected Impervious Area (DCIA, %)	18.7%	19.3%	19.0%	18.7%	19.1%	18.8%	18.5%	18.7%	4.3%	18.2%	0.0%			
Unconnected Impervious Area (UIA, %)	49.3%	48.9%	49.5%	49.6%	49.1%	49.2%	49.4%	49.3%	0.0%	50.0%	0.0%			
Receiving Pervious Area (RPA, %)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	53.2%	0.0%	0.0%			
Separate Pervious Area (SPA, %)	32.0%	31.8%	31.4%	31.7%	31.8%	31.9%	32.0%	32.0%	42.6%	31.8%	100.0%			
A_R (RPA / UIA)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
I_a Check	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000			
f / I for WQCV Event:	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2			
f / I for 5-Year Event:	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5			
f / I for 100-Year Event:	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4			
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00			
IRF for 5-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
IRF for 100-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	68.0%	68.2%	68.6%	68.3%	68.2%	68.1%	68.0%	68.0%	4.3%	68.2%	0.0%			
Effective Imperviousness for WQCV Event:	68.0%	68.2%	68.6%	68.3%	68.2%	68.1%	68.0%	68.0%	4.3%	68.2%	0.0%			
Effective Imperviousness for 5-Year Event:	68.0%	68.2%	68.6%	68.3%	68.2%	68.1%	68.0%	68.0%	4.3%	68.2%	0.0%			
Effective Imperviousness for 100-Year Event:	68.0%	68.2%	68.6%	68.3%	68.2%	68.1%	68.0%	68.0%	4.3%	68.2%	0.0%			
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	N/A	0.0%	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	1.1%	0.1%	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	60.2%
Total Site Effective Imperviousness for WQCV Event:	60.2%
Total Site Effective Imperviousness for 5-Year Event:	60.2%
Total Site Effective Imperviousness for 100-Year Event:	60.2%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer: TJW
Company: M.V.E., Inc.
Date: June 17, 2019
Project: 51421-Hansen Ranch
Location:

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 57.5 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.575
C) Contributing Watershed Area	Area = 13.720 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: ○ Water Quality Capture Volume (WQCV) ◉ Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)	V_{DESIGN} = 0.261 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$ = 0.255 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$ = ____ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One: ◉ A ○ B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 0.946 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 7.8 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 3.00 ft / ft DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	concrete forebay with concrete baffles

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	TJW
Company:	M.V.E., Inc.
Date:	June 18, 2019
Project:	51421-Hansen Ranch
Location:	

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.008 ac-ft
B) Actual Forebay Volume	V_F = 0.008 ac-ft
C) Forebay Depth (D_F = 18 inch maximum)	D_F = 12.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 42.40 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 0.85 cfs
E) Forebay Discharge Design	Choose One ○ Berm With Pipe ◉ Wall with Rect. Notch ○ Wall with V-Notch Weir (flow too small for berm w/ pipe)
F) Discharge Pipe Size (minimum 8 inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 5.5 in DP 7
6. Trickle Channel	
A) Type of Trickle Channel	Choose One ◉ Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One ◉ Orifice Plate ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.41 inches
E) Total Outlet Area	A_{ot} = 9.10 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: TJW
Company: M.V.E., Inc.
Date: June 18, 2019
Project: 51421-Hansen Ranch
Location:

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.008 ac-ft
B) Actual Forebay Volume	V_F = 0.008 ac-ft
C) Forebay Depth (D_F = 18 inch maximum)	D_F = 12.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 4.10 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 0.08 cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe; ◉ Wall with Rect. Notch; ○ Wall with V-Notch Weir — (flow too small for berm w/ pipe)
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 2.7 in — DP 8
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ◉ Concrete; ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One: ◉ Orifice Plate; ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.41 inches
E) Total Outlet Area	A_{ot} = 9.10 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: TJW
Company: M.V.E., Inc.
Date: June 17, 2019
Project: 51421-Hansen Ranch
Location:

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 33.3 cu ft
C) Initial Surcharge Provided Above Micropool	V_s = 3.3 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 306 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 432 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3.14 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 65.68 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: TJW
Company: M.V.E., Inc.
Date: June 17, 2019
Project: 51421-Hansen Ranch
Location:

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	Concrete overflow weir-wall with rip-rap lining
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	0.13 TOO STEEP (< 3)
11. Vegetation	Choose One ○ Irrigated ◉ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	gravel access drive at 10% max slope, 11' wide

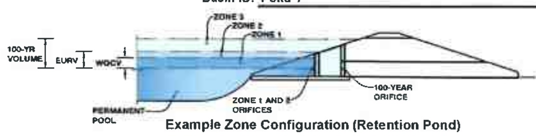
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: 51421-Hansen Ranch

Basin ID: Pond 1



Example Zone Configuration (Retention Pond)

Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	EDB			
Watershed Area =	13.72	acres		
Watershed Length =	1,070	ft		
Watershed Slope =	0.033	ft/ft		
Watershed Imperviousness =	57.50%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.261	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.946	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.648	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.849	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.039	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.275	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.553	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.877	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.4 in.) =	2.836	acre-feet	3.40	inches
Approximate 2-yr Detention Volume =	0.612	acre-feet		
Approximate 5-yr Detention Volume =	0.803	acre-feet		
Approximate 10-yr Detention Volume =	0.973	acre-feet		
Approximate 25-yr Detention Volume =	1.180	acre-feet		
Approximate 50-yr Detention Volume =	1.308	acre-feet		
Approximate 100-yr Detention Volume =	1.451	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.261	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.685	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.505	acre-feet
Total Detention Basin Volume =	1.451	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	

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Surchrge=6855.65	--	0.33	--	--	--	10	0.000	3	0.000
WQCV=6856.96	--	1.70	--	--	--	18,214	0.418	12,305	0.282
	--	1.90	--	--	--	18,720	0.430	15,993	0.367
	--	2.10	--	--	--	19,229	0.441	19,975	0.459
	--	2.30	--	--	--	19,740	0.453	23,872	0.548
	--	2.50	--	--	--	20,252	0.465	27,871	0.640
EL=6858.0	--	2.70	--	--	--	20,858	0.479	31,982	0.734
	--	2.90	--	--	--	21,375	0.491	36,205	0.831
EURV=6858.46	--	3.10	--	--	--	21,895	0.503	40,532	0.930
	--	3.30	--	--	--	22,417	0.515	44,963	1.032
	--	3.50	--	--	--	22,942	0.527	49,499	1.136
EL=6859.0	--	3.70	--	--	--	23,554	0.541	54,149	1.243
	--	3.90	--	--	--	24,083	0.553	58,913	1.352
100 YR=6859.40	--	4.10	--	--	--	24,615	0.565	63,782	1.464
SPILLWAY=6859.40	--	4.30	--	--	--	25,148	0.577	68,759	1.578
	--	4.50	--	--	--	22,683	0.521	73,542	1.688
EL=6860.0	--	4.70	--	--	--	26,308	0.604	78,441	1.801
	--	4.90	--	--	--	26,846	0.616	83,757	1.923
	--	5.10	--	--	--	27,390	0.629	89,180	2.047
	--	5.30	--	--	--	27,935	0.641	94,713	2.174
	--	5.50	--	--	--	28,482	0.654	100,355	2.304
EL=6860.5	--	5.70	--	--	--	29,120	0.669	106,115	2.436
	--		--	--	--				
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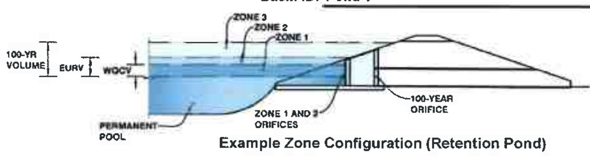
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: 51421-Hansen Ranch

Basin ID: Pond 1



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.64	0.261	Orifice Plate
Zone 2 (EURV)	3.14	0.685	Orifice Plate
'one 3 (100-year)	4.08	0.505	Weir&Pipe (Restrict)
		1.451	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 =	3.14	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.60	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	1.05	2.09					
Orifice Area (sq. inches)	1.55	3.24	4.31					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.14	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.92	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.92	N/A	feet
Overflow Grate Open Area % =	81%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.14	N/A	feet
Over Flow Weir Slope Length =	2.92	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.79	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	6.91	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.45	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	12.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	12.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.79	N/A	ft^2
Outlet Orifice Centroid =	0.50	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.08	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	25.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

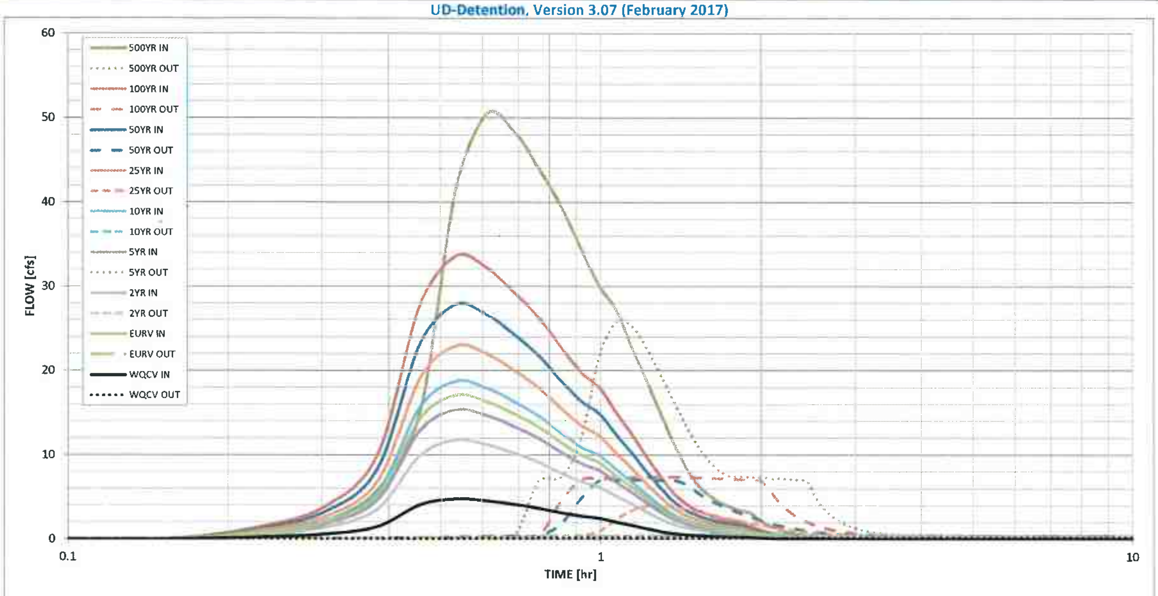
Spillway Design Flow Depth=	0.56	feet
Stage at Top of Freeboard =	5.64	feet
Basin Area at Top of Freeboard =	0.66	acres

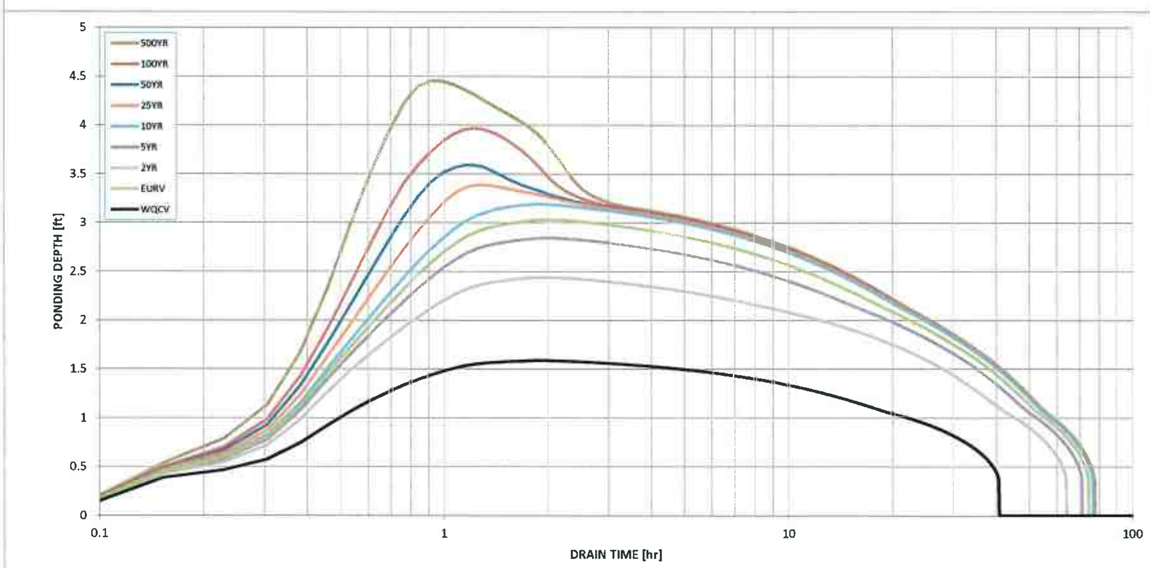
Routed Hydrograph Results

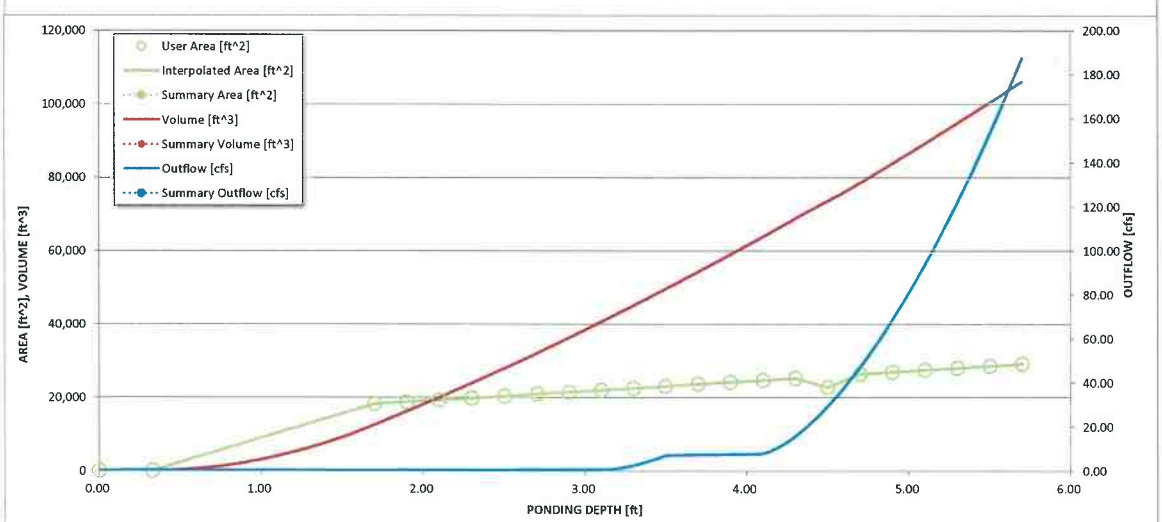
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.40
Calculated Runoff Volume (acre-ft) =	0.261	0.946	0.648	0.849	1.039	1.275	1.553	1.877	2.836
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.260	0.945	0.648	0.848	1.038	1.275	1.552	1.876	2.835
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.01	0.03	0.22	0.54	1.30
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.1	0.2	0.4	3.1	7.4	17.9
Peak Inflow Q (cfs) =	4.8	17.1	11.7	15.3	18.7	22.9	27.8	33.6	50.5
Peak Outflow Q (cfs) =	0.1	0.4	0.3	0.4	0.7	4.0	7.0	7.4	25.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.5	4.0	9.5	2.3	1.0	1.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.5	0.9	1.0	1.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	66	58	63	67	66	64	62	55
Time to Drain 99% of Inflow Volume (hours) =	40	71	62	68	73	73	72	71	69
Maximum Ponding Depth (ft) =	1.59	3.03	2.44	2.84	3.19	3.39	3.59	3.97	4.46
Area at Maximum Ponding Depth (acres) =	0.38	0.50	0.46	0.49	0.51	0.52	0.53	0.56	0.53
Maximum Volume Stored (acre-ft) =	0.239	0.890	0.607	0.802	0.976	1.074	1.184	1.386	1.662

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			

DP 8
RUNDOWN

Figure 13-12c. Emergency Spillway Protection

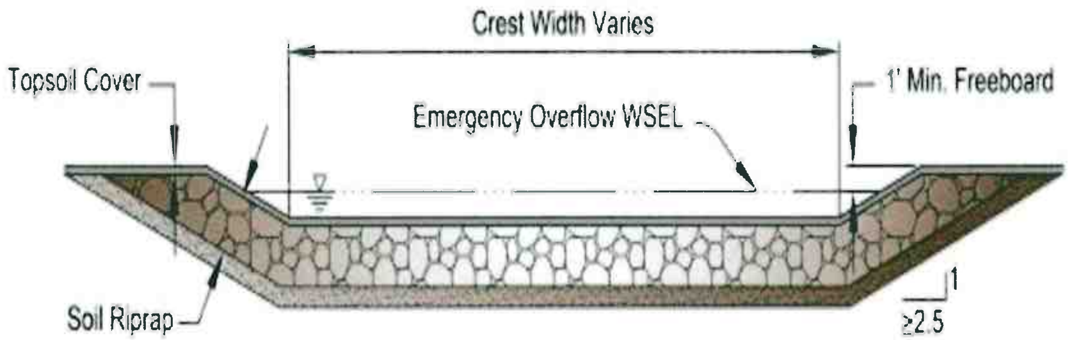
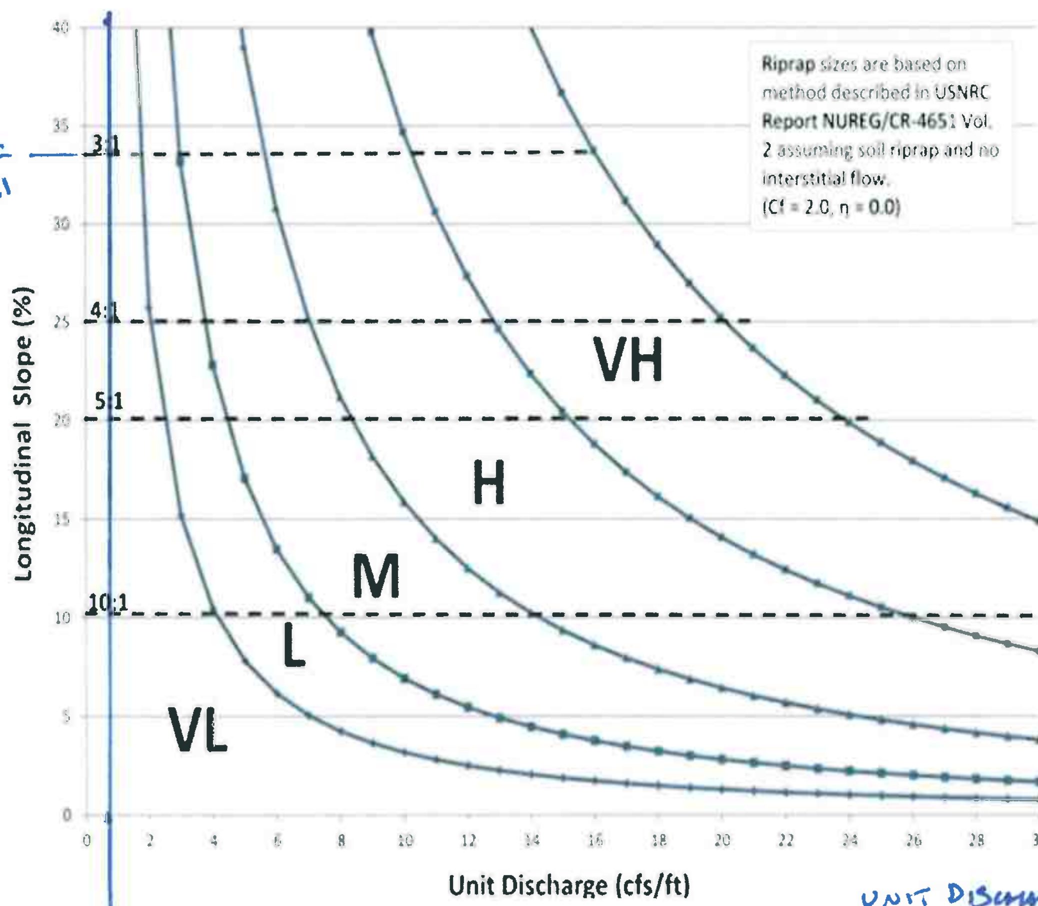


Figure 13-12d. Riprap Types for Emergency Spillway Protection

Q_{100} = 4.1 cfs
W = 6.0'
S = 3:1



S = 3:1

0.7 cfs/ft

Unit discharge = 4.1/6 = 0.7 cfs/ft

Type VL Riprap

DP 9
Spillway

Figure 13-12c. Emergency Spillway Protection

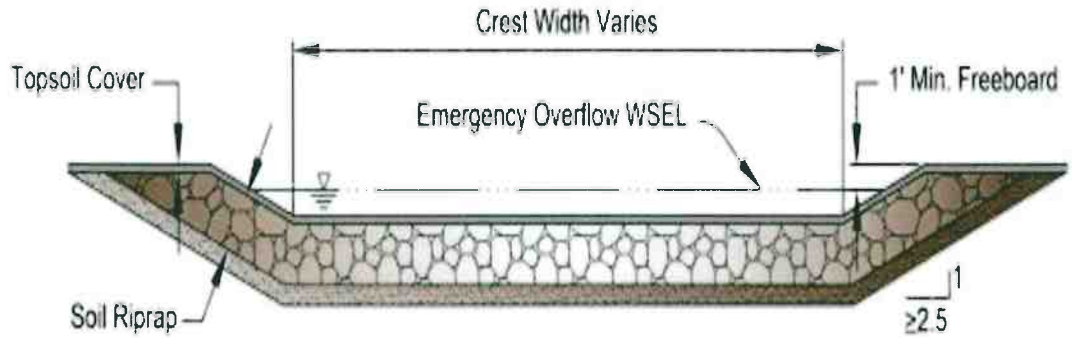
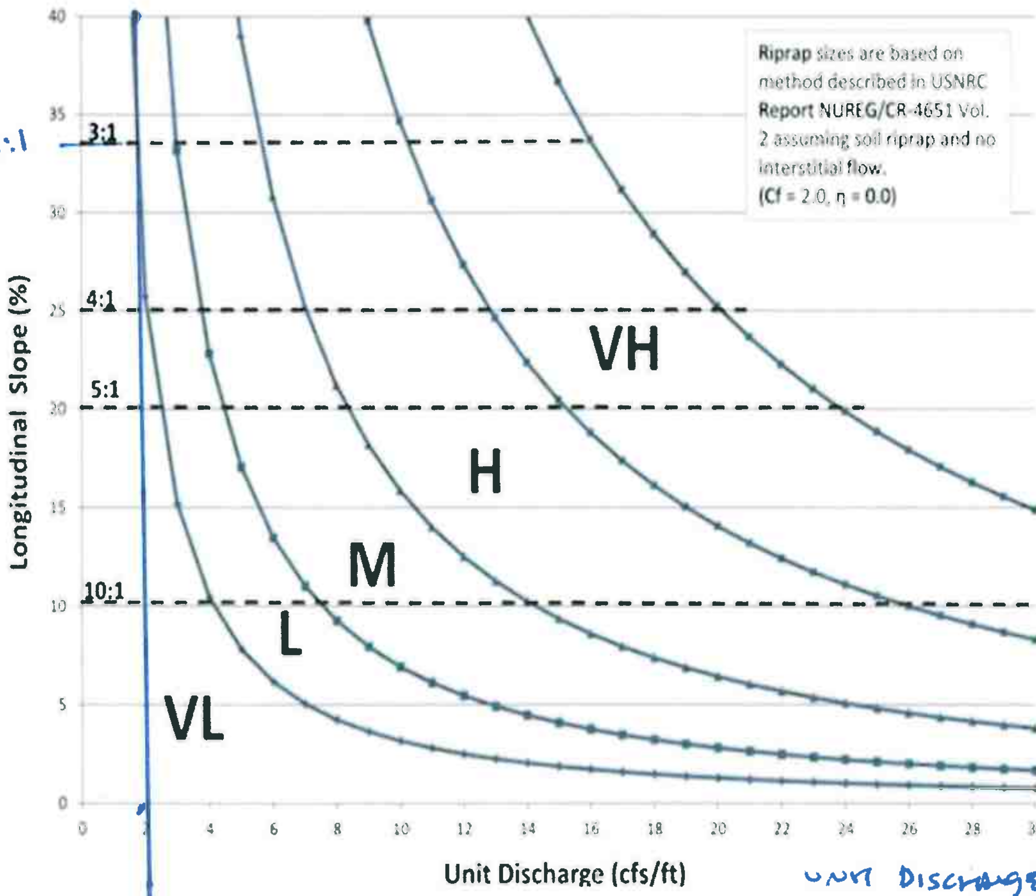


Figure 13-12d. Riprap Types for Emergency Spillway Protection

Q100 = 48.6 cfs
w = 25'
S = 3:1



UNIT DISCHARGE = 48.6/25 = 1.9 cfs/ft

TYPE VL RIP-RAP

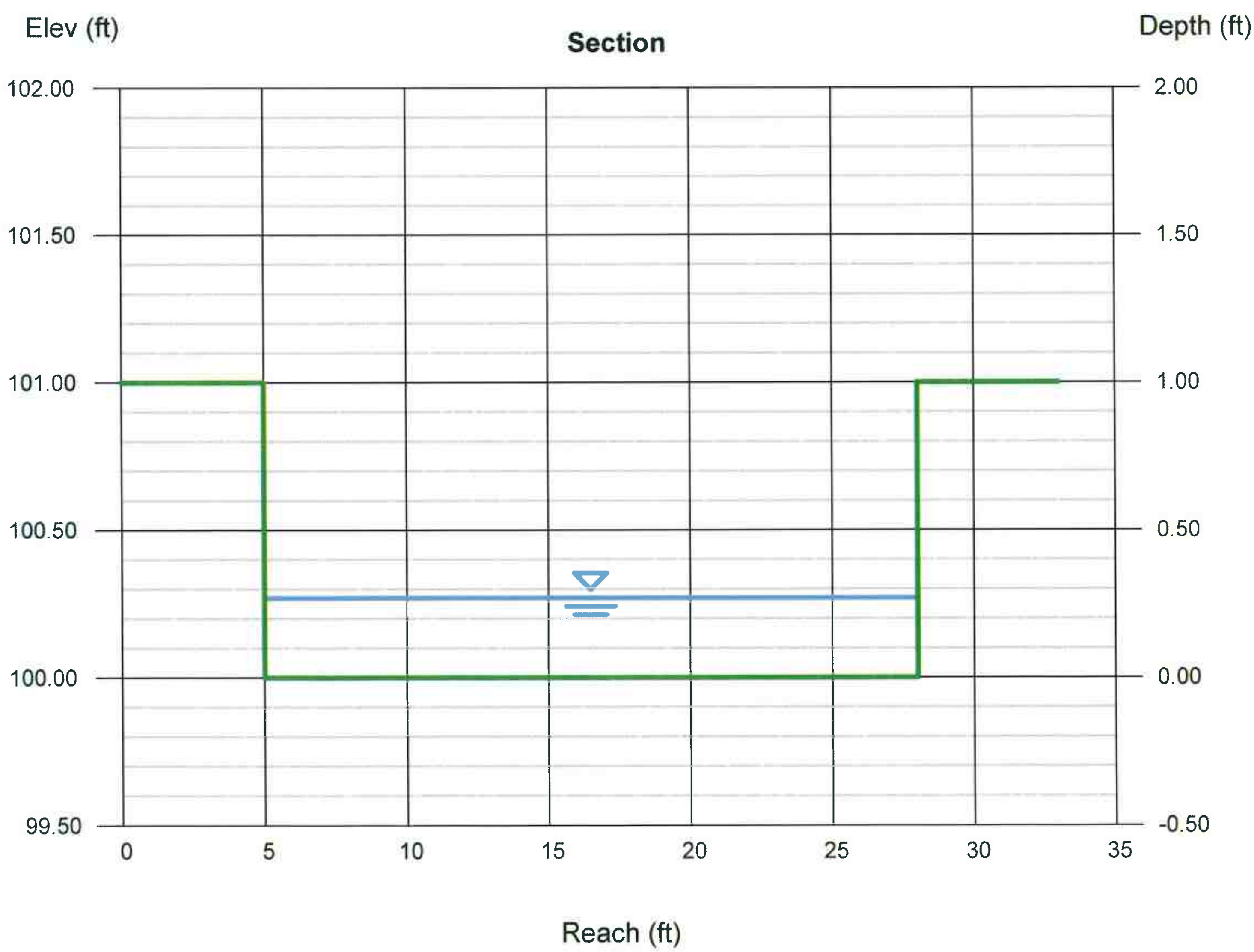
Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. | Tuesday, Sep 3 2019

DP/9
D/S OF LEVEL SPREADER

51421 - Level Spreader Sheet Flow

Rectangular		**Highlighted**	
Bottom Width (ft)	= 23.00	Depth (ft)	= 0.27
Total Depth (ft)	= 1.00	Q (cfs)	= 7.400
		Area (sqft)	= 6.21
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 1.19
Slope (%)	= 0.50	Wetted Perim (ft)	= 23.54
N-Value	= 0.035	Crit Depth, Yc (ft)	= 0.15
		Top Width (ft)	= 23.00
Calculations		EGL (ft)	= 0.29
Compute by:	Known Q		
Known Q (cfs)	= 7.40		



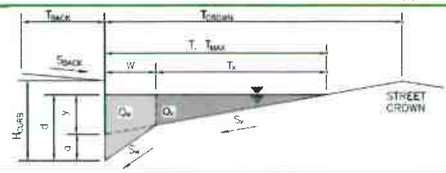
Version 4.05 Released March 2017

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

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

Project: **51421 - Hansen Ranch**

Inlet ID: **Inlet DP2**



2

Gutter Geometry (Enter data in the blue cells)

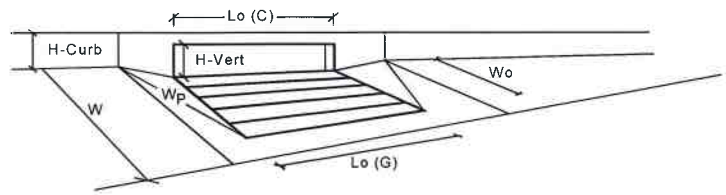
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	7.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	15.8	ft
Gutter Width	W =	0.83	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.100	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	15.8	15.8	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.6	7.8	inches
Check boxes are not applicable in SUMP conditions				

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet: Colorado Springs D-10-R	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1.5	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.6	7.8	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	0.83	0.83	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.30	0.57	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.54	0.92	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	4.5	11.6	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.5	7.6	cfs

Version 4.05 Released March 2017

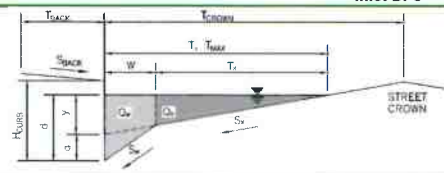
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: 51421 - Hansen Ranch

Inlet ID: Inlet DP3

3



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	7.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	15.8	ft
Gutter Width	W =	0.83	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.100	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

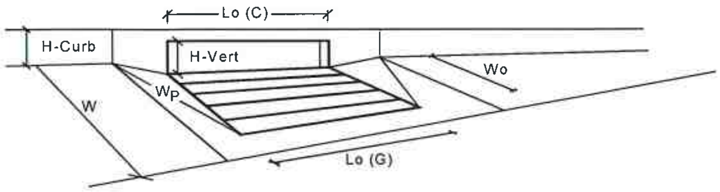
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	15.8	15.8	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.6	7.8	inches
Check boxes are not applicable in SUMP conditions				

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	cfs

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017

3



			MINOR	MAJOR	
Design Information (Input)	Colorado Springs D-10-R		MINOR	MAJOR	
Type of Inlet		Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	2.0	2	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	4.6	7.8	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	0.83	0.83	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	0.30	0.57	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.46	0.79	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	0.92	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	N/A	N/A	
			MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		Q_a =	**5.6**	**15.8**	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK\ REQUIRED}$ =	5.1	11.3	cfs

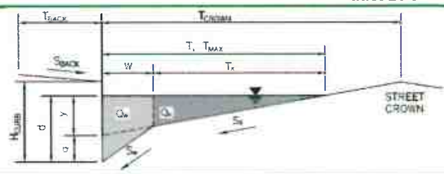
Version 4.05 Released March 2017

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

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

Project: 51421 - Hansen Ranch

Inlet ID: Inlet DP5



5

Gutter Geometry (Enter data in the blue cells)

Description	Parameter	Value	Units
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	7.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	15.8	ft
Gutter Width	W =	0.83	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.100	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

Description	Parameter	Minor Storm	Major Storm	Units
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	15.8	15.8	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.6	7.8	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Description	Parameter	Minor Storm	Major Storm	Units
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017

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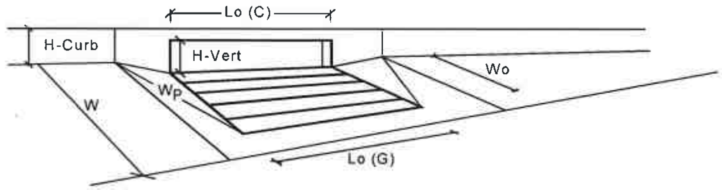


Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Colorado Springs D-10-R)	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3.5	4	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.6	7.8	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	0.83	0.83	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.30	0.57	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.43	0.74	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.71	0.91	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	7.7	25.7	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	7.6	16.6	cfs

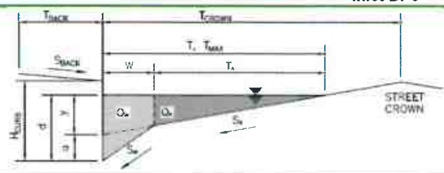
Version 4.05 Released March 2017

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

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

Project: 51421 - Hansen Ranch

Inlet ID: Inlet DP6



6

Gutter Geometry (Enter data in the blue cells)

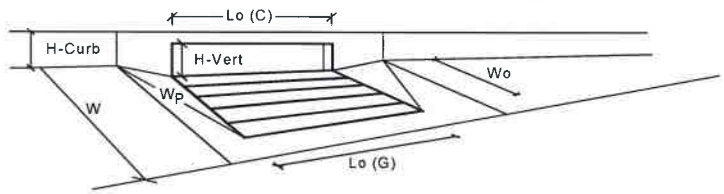
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	7.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	15.8	ft
Gutter Width	W =	0.83	ft
Street Transverse Slope	S_X =	0.100	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	15.8	15.8	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.6	7.8	inches
Check boxes are not applicable in SUMP conditions				

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Colorado Springs D-10-R)	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1.5	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.6	7.8	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	0.83	0.83	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.31	0.58	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.54	0.92	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**4.8**	**12.0**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.3	9.4	cfs

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 7/3/2019 8:36:16 AM	**UDSewer Results Summary** **Project Title:** 51421 - Hansen Ranch **Project Description:** West Line - 5yr

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

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

Rational Method Constraints

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

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 0.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
Pond	6856.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe 1	6861.83	8.60	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe 2	6861.83	3.50	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
Pond	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Pipe 1	0.00	0.00	0.00	0.00	5.10	0.00	0.00	0.00	8.60	Surface Water Present (Downstream)
Pipe 2	0.00	0.00	0.00	0.00	3.50	0.00	0.00	0.00	3.50	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Pipe 1	94.40	6856.38	0.8	6857.14	0.013	1.06	0.00	CIRCULAR	24.00 in	24.00 in
Pipe 2	35.00	6857.65	0.5	6857.82	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
Pipe 1	20.29	6.46	12.55	5.18	10.91	6.19	1.31	Supercritical	8.60	0.00	
Pipe 2	7.45	4.21	8.56	4.22	8.68	4.15	0.97	Subcritical	3.50	0.00	

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

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
Pipe 1	8.60	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
Pipe 2	3.50	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

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

Grade Line Summary:

Tailwater Elevation (ft): 0.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)

Pipe 1	6856.38	6857.14	0.00	0.00	6857.29	6858.19	6857.89	0.71	6858.60
Pipe 2	6857.65	6857.82	0.00	0.00	6858.36	6858.55	6858.64	0.18	6858.81

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

Excavation Estimate:

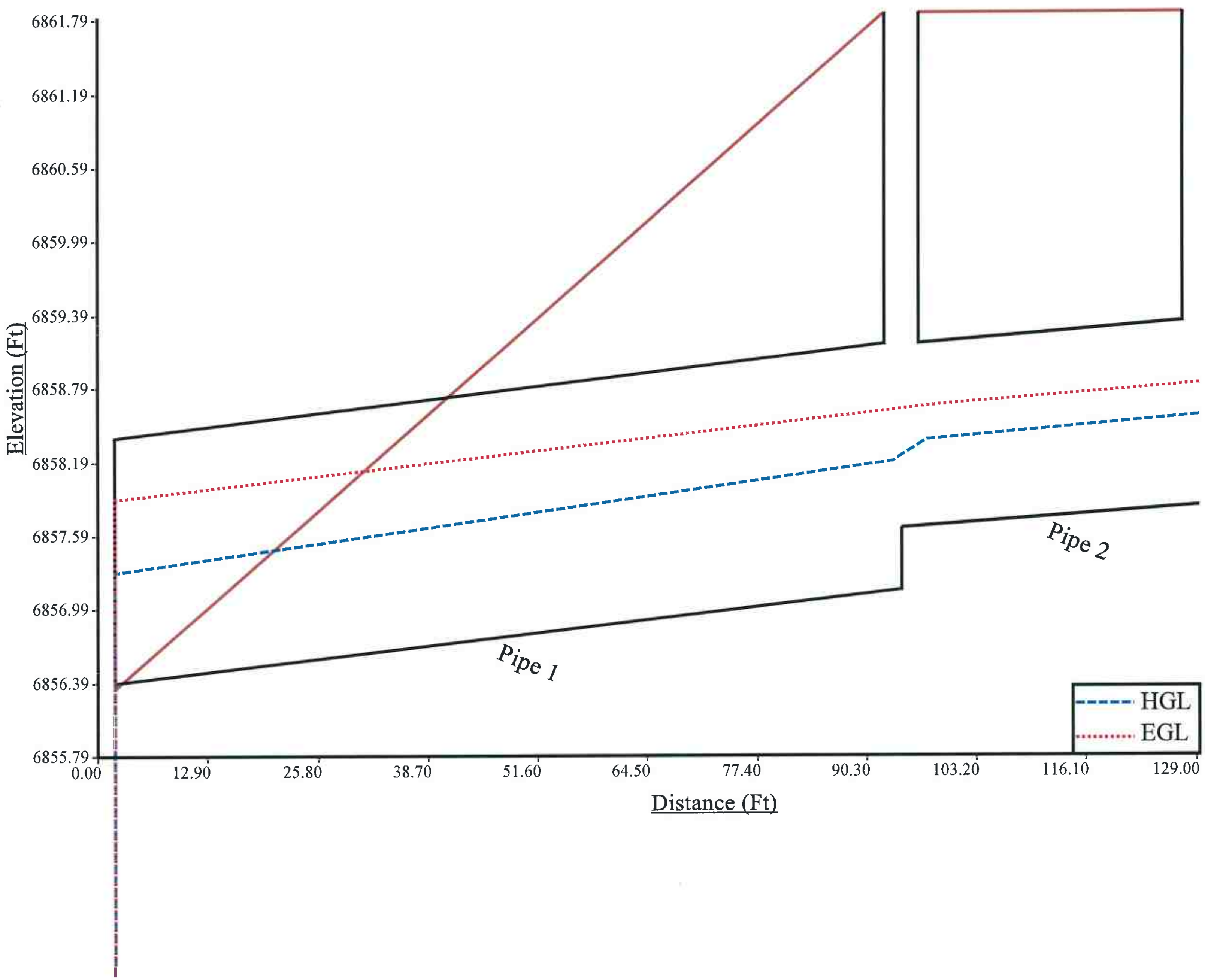
The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
Pipe 1	94.40	3.00	4.00	5.50	0.00	0.54	0.00	8.38	5.27	2.44	59.50	Sewer Too Shallow
Pipe 2	35.00	2.50	4.00	4.92	7.87	4.73	2.48	7.52	4.55	2.30	32.08	

Total earth volume for sewer trenches = 92 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

West



6861.79
6861.19
6860.59
6859.99
6859.39
6858.79
6858.19
6857.59
6856.99
6856.39
6855.79
Elevation (Ft)
0.00
12.90
25.80
38.70
51.60
64.50
77.40
90.30
103.20
116.10
129.00
Distance (Ft)
Pipe 1
Pipe 2
HGL
EGL

Program:
UDSEWER Math Model
Interface 2.1.1.4
Run Date:
7/3/2019 8:37:59 AM

UDSewer Results Summary

Project Title: 51421 - Hansen Ranch
Project Description: West Line - 100yr

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

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

Rational Method Constraints

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

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 2.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
Pond	6856.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe 1	6861.83	18.90	11.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe 2	6861.83	7.60	7.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
Pond	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Pipe 1	0.00	0.00	0.00	0.00	11.30	0.00	0.00	0.00	18.90	Surface Water Present (Downstream)
Pipe 2	0.00	0.00	0.00	0.00	7.60	0.00	0.00	0.00	7.60	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Pipe 1	94.40	6856.38	0.8	6857.14	0.013	1.06	0.00	CIRCULAR	24.00 in	24.00 in
Pipe 2	35.00	6857.65	0.5	6857.82	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
Pipe 1	20.29	6.46	18.77	7.17	18.34	7.34	1.05	Supercritical	18.90	0.00	
Pipe 2	7.45	4.21	18.00	4.30	18.00	4.30	0.00	Pressurized	7.60	35.00	

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

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
Pipe 1	18.90	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
Pipe 2	7.60	CIRCULAR	18.00 in	18.00 in	21.00 in	21.00 in	18.00 in	18.00 in	1.77	Existing height is smaller than the suggested height. Existing width is smaller than the suggested width. Exceeds max. Depth/Rise

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

Grade Line Summary:

Tailwater Elevation (ft): 2.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		

Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
Pipe 1	6856.38	6857.14	0.00	0.00	6857.91	6858.70	6858.75	0.75	6859.50
Pipe 2	6857.65	6857.82	0.01	0.00	6859.23	6859.41	6859.52	0.18	6859.70

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

Excavation Estimate:

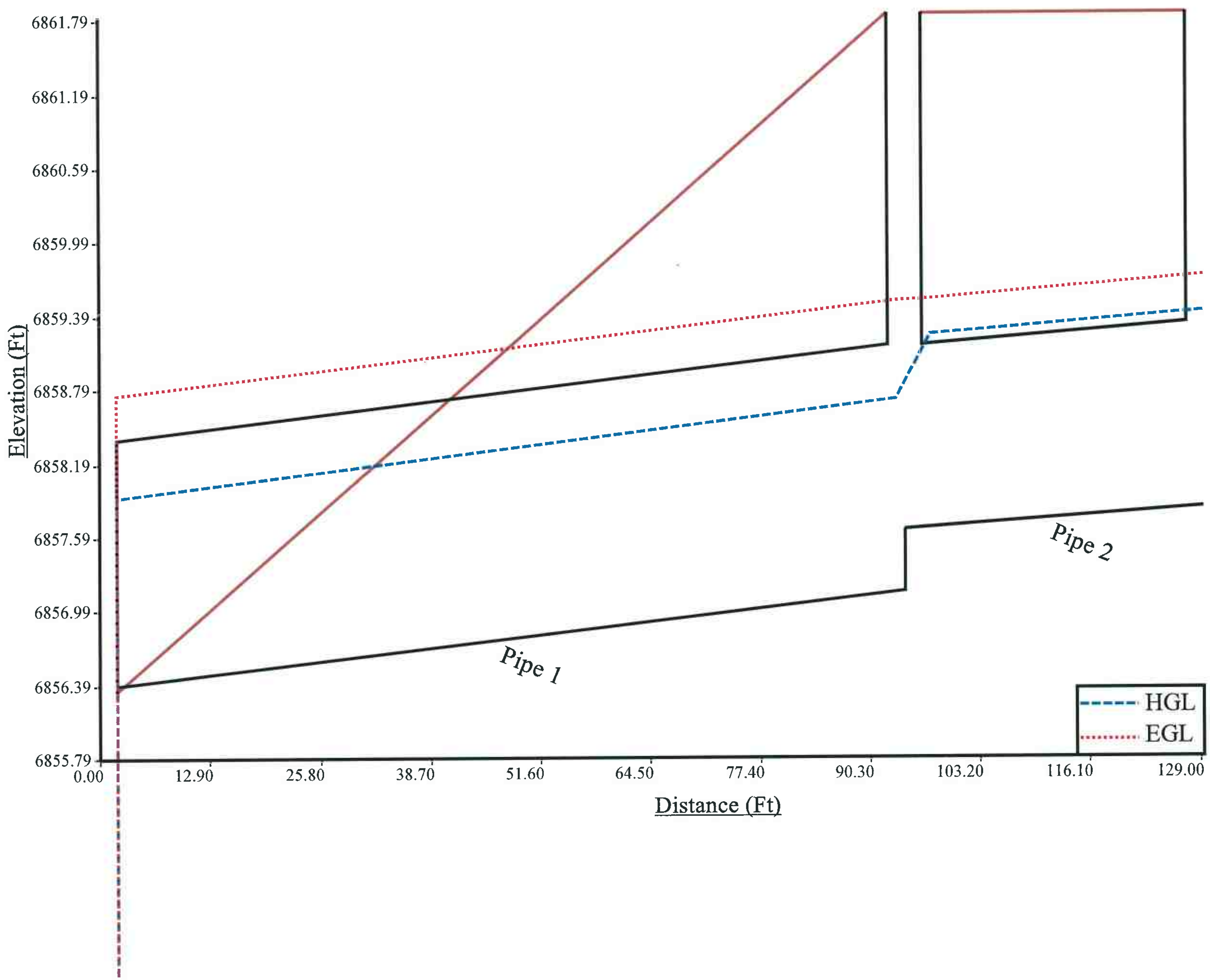
The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
Pipe 1	94.40	3.00	4.00	5.50	0.00	0.54	0.00	8.38	5.27	2.44	59.50	Sewer Too Shallow
Pipe 2	35.00	2.50	4.00	4.92	7.87	4.73	2.48	7.52	4.55	2.30	32.08	

Total earth volume for sewer trenches = 92 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

West



Elevation (Ft)
6861.79
6861.19
6860.59
6859.99
6859.39
6858.79
6858.19
6857.59
6856.99
6856.39
6855.79
0.00
12.90
25.80
38.70
51.60
64.50
77.40
90.30
103.20
116.10
129.00
Distance (Ft)
Pipe 1
Pipe 2
HGL
EGL

Program: UDSEWER Math Model Interface 2.1.1.4	UDSewer Results Summary
Run Date: 7/3/2019 8:39:40 AM	Project Title: 51421 - Hansen Ranch Project Description: East Line - 5yr

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

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

Rational Method Constraints

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

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 0.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
Pond	6856.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe 1	6861.78	11.90	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe 2	6861.78	7.60	7.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
Pond	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Pipe 1	0.00	0.00	0.00	0.00	4.30	0.00	0.00	0.00	11.90	Surface Water Present (Downstream)
Pipe 2	0.00	0.00	0.00	0.00	7.60	0.00	0.00	0.00	7.60	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Pipe 1	12.00	6856.34	2.3	6856.62	0.013	0.00	0.00	CIRCULAR	30.00 in	30.00 in
Pipe 2	35.00	6857.62	1.0	6857.97	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
Pipe 1	62.37	12.71	13.88	5.36	8.88	9.79	2.36	Supercritical	11.90	0.00	
Pipe 2	10.53	5.96	12.81	5.65	11.33	6.49	1.27	Supercritical	7.60	0.00	

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

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
Pipe 1	11.90	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
Pipe 2	7.60	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

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

Grade Line Summary:

Tailwater Elevation (ft): 0.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)

Pipe 1	6856.34	6856.62	0.00	0.00	6857.24	6857.78	6858.12	0.10	6858.22
Pipe 2	6857.62	6857.97	0.01	0.00	6858.56	6859.04	6859.22	0.32	6859.53

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

Excavation Estimate:

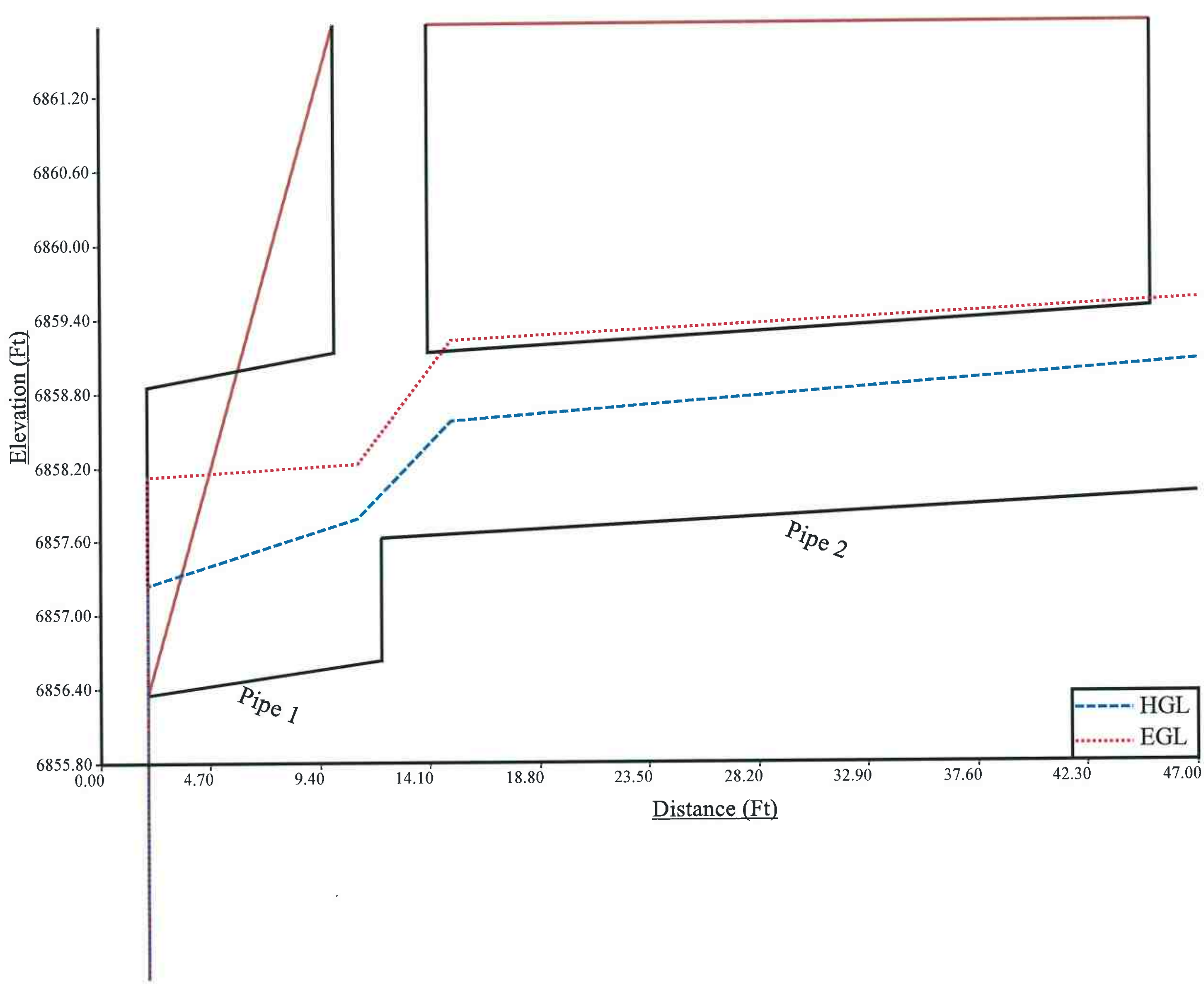
The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**
Pipe 1	12.00	3.50	6.00	6.08	0.00	0.79	0.00	8.82	5.95	2.37	9.53	Sewer Too Shallow
Pipe 2	35.00	2.50	4.00	4.92	7.82	4.70	2.45	7.12	4.35	2.10	31.00	

Total earth volume for sewer trenches = 41 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

East



Elevation (Ft)
6861.20
6860.60
6860.00
6859.40
6858.80
6858.20
6857.60
6857.00
6856.40
6855.80
0.00
4.70
9.40
14.10
18.80
23.50
28.20
32.90
37.60
42.30
47.00
Distance (Ft)
Pipe 1
Pipe 2
HGL
EGL

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 7/3/2019 8:41:03 AM	**UDSewer Results Summary** **Project Title:** 51421 - Hansen Ranch **Project Description:** East Line - 100yr

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

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

Rational Method Constraints

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

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 2.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
Pond	6856.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe 1	6861.78	26.00	9.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe 2	6861.78	16.60	16.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
Pond	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Pipe 1	0.00	0.00	0.00	0.00	9.40	0.00	0.00	0.00	26.00	Surface Water Present (Downstream)
Pipe 2	0.00	0.00	0.00	0.00	16.60	0.00	0.00	0.00	16.60	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Pipe 1	12.00	6856.34	2.3	6856.62	0.013	0.00	0.00	CIRCULAR	30.00 in	30.00 in
Pipe 2	35.00	6857.62	1.0	6857.97	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
Pipe 1	62.37	12.71	20.85	7.14	13.51	12.13	2.30	Supercritical	26.00	0.00	
Pipe 2	10.53	5.96	18.00	9.39	18.00	9.39	0.00	Pressurized	16.60	35.00	

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

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
Pipe 1	26.00	CIRCULAR	30.00 in	30.00 in	24.00 in	24.00 in	30.00 in	30.00 in	4.91	
Pipe 2	16.60	CIRCULAR	18.00 in	18.00 in	24.00 in	24.00 in	18.00 in	18.00 in	1.77	Existing height is smaller than the suggested height. Existing width is smaller than the suggested width. Exceeds max. Depth/Rise

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

Grade Line Summary:

Tailwater Elevation (ft): 2.00

	Invert Elev.	Downstream Manhole Losses	HGL	EGL

Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
Pipe 1	6856.34	6856.62	0.00	0.00	6857.75	6858.36	6859.04	0.11	6859.15
Pipe 2	6857.62	6857.97	0.07	0.00	6859.12	6859.99	6860.49	0.87	6861.36

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

Excavation Estimate:

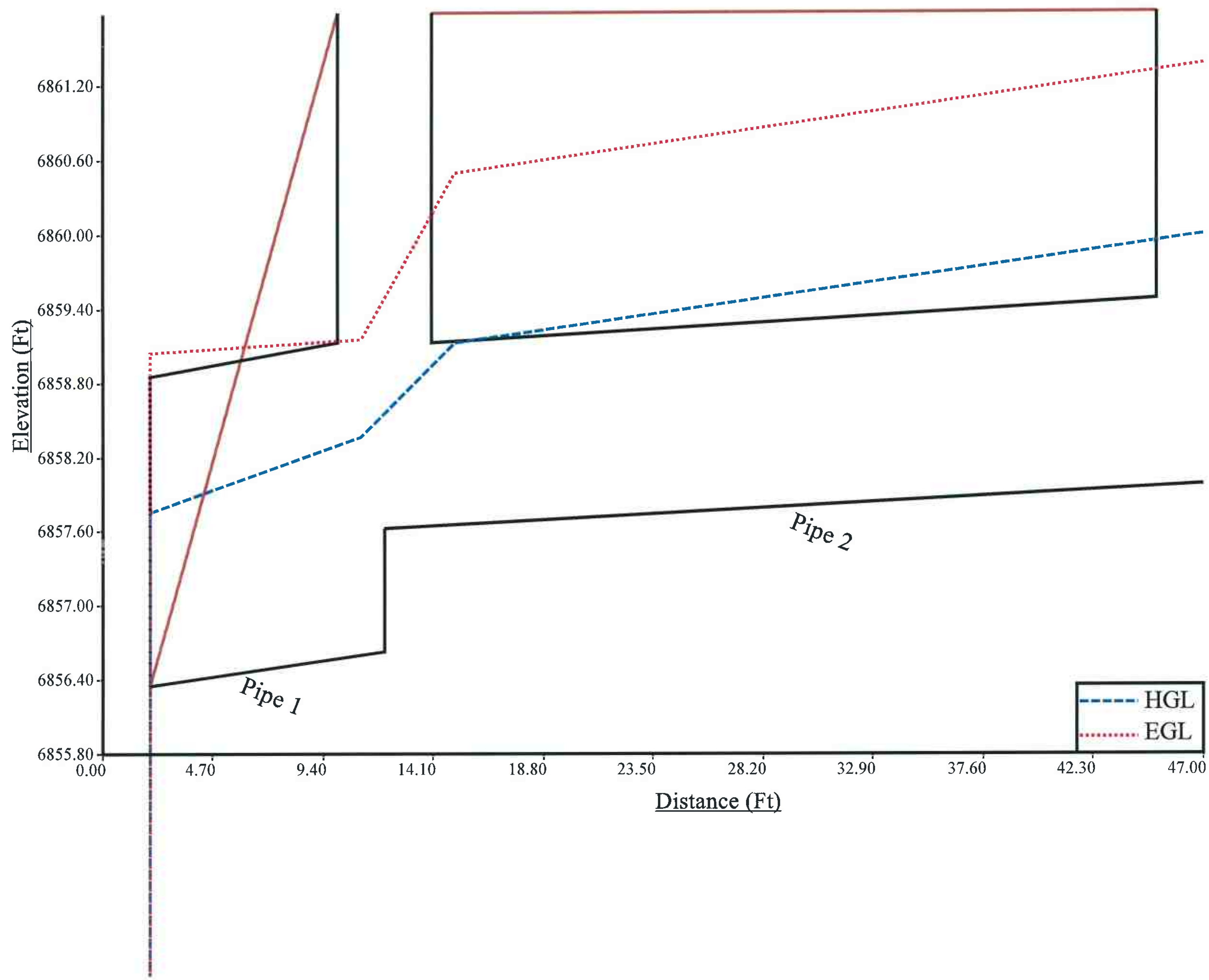
The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
Pipe 1	12.00	3.50	6.00	6.08	0.00	0.79	0.00	8.82	5.95	2.37	9.53	Sewer Too Shallow
Pipe 2	35.00	2.50	4.00	4.92	7.82	4.70	2.45	7.12	4.35	2.10	31.00	

Total earth volume for sewer trenches = 41 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

East



Elevation (Ft)
6861.20
6860.60
6860.00
6859.40
6858.80
6858.20
6857.60
6857.00
6856.40
6855.80
0.00
4.70
9.40
14.10
18.80
23.50
28.20
32.90
37.60
42.30
47.00
Distance (Ft)
Pipe 1
Pipe 2
HGL
EGL

4 Drainage Maps

Existing Conditions Drainage Map	(Map Pocket)
Proposed Conditions Drainage Map	(Map Pocket)

EXISTING DRAINAGE SUMMARY TABLE

POINT OF INTEREST/ Q100 BASIN(S)		AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	(CFS)
	EX-A2	0.51	9.9	0.2	1.2
	OS A	0.89	12.8	0.3	2.0
EX-DP-1	EX-A2, OS A	1.40	12.8	0.4	3.1
	EX-A1	12.38	15.5	3.4	25.2
EX-DP-2	EX-A1, EX-A2, OS A	13.77	15.5	3.8	28.1

FLOODPLAIN STATEMENT:

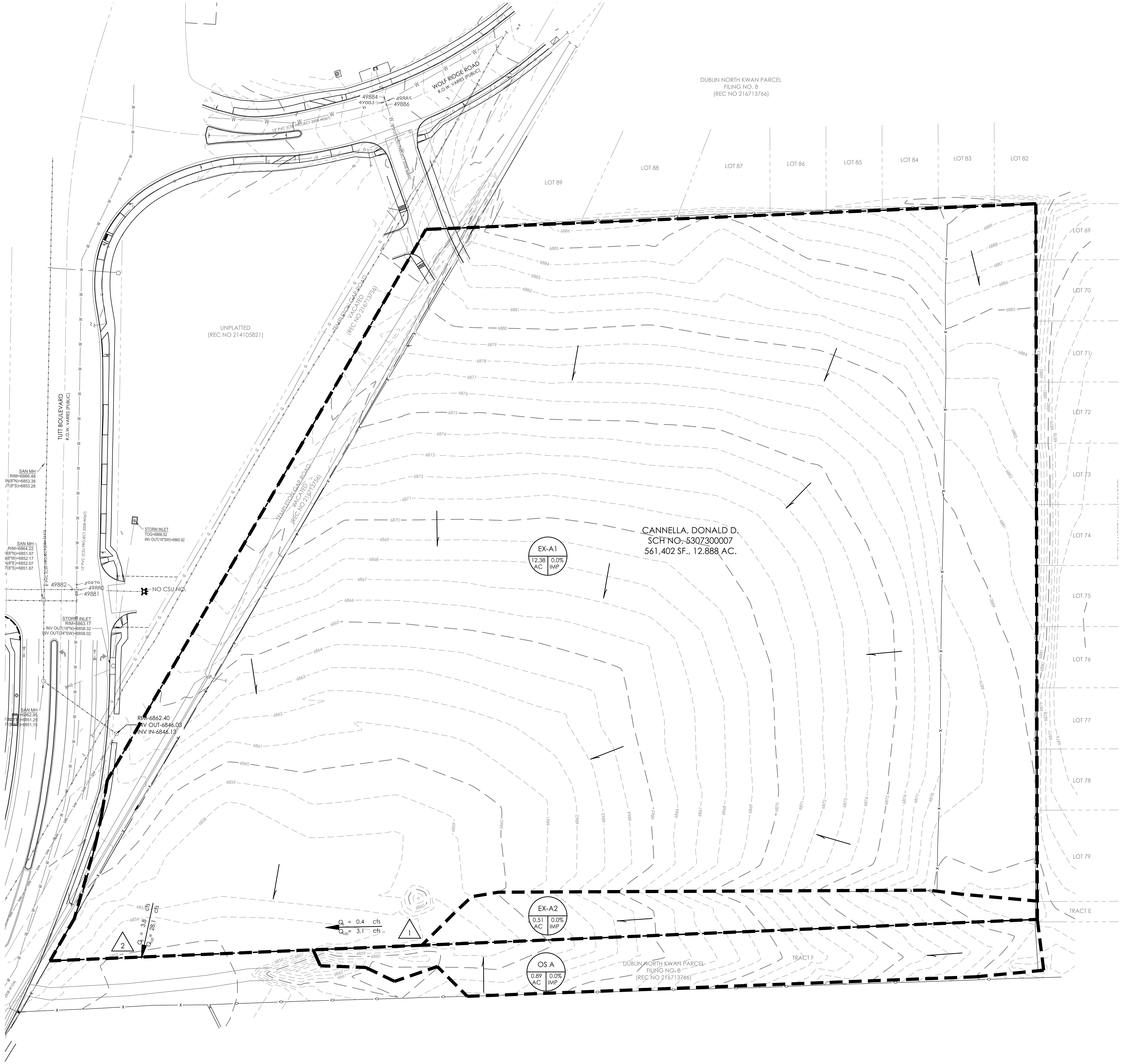
NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAP (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBER 08041C0737G, EFFECTIVE DECEMBER 7, 2018.

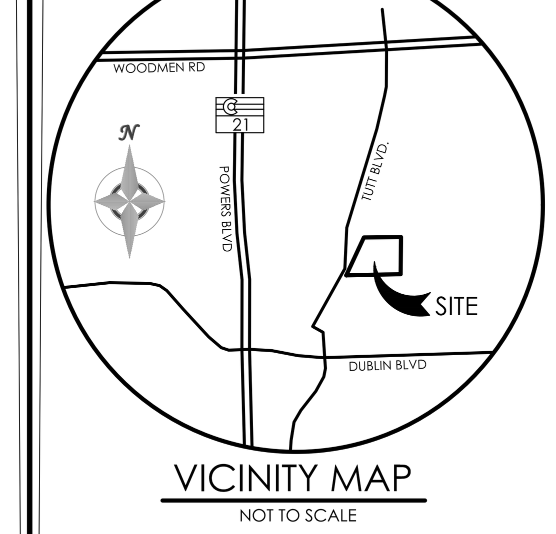
LEGEND

PROPERTY LINE
EASEMENT LINE
LOT LINE

EXISTING
INDEX CONTOUR
INTERMEDIATE CONTOUR

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





VICINITY MAP
NOT TO SCALE

BENCHMARK

1" = 50' 1:600

MVE INC.
ENGINEERS, SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

REVISIONS

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

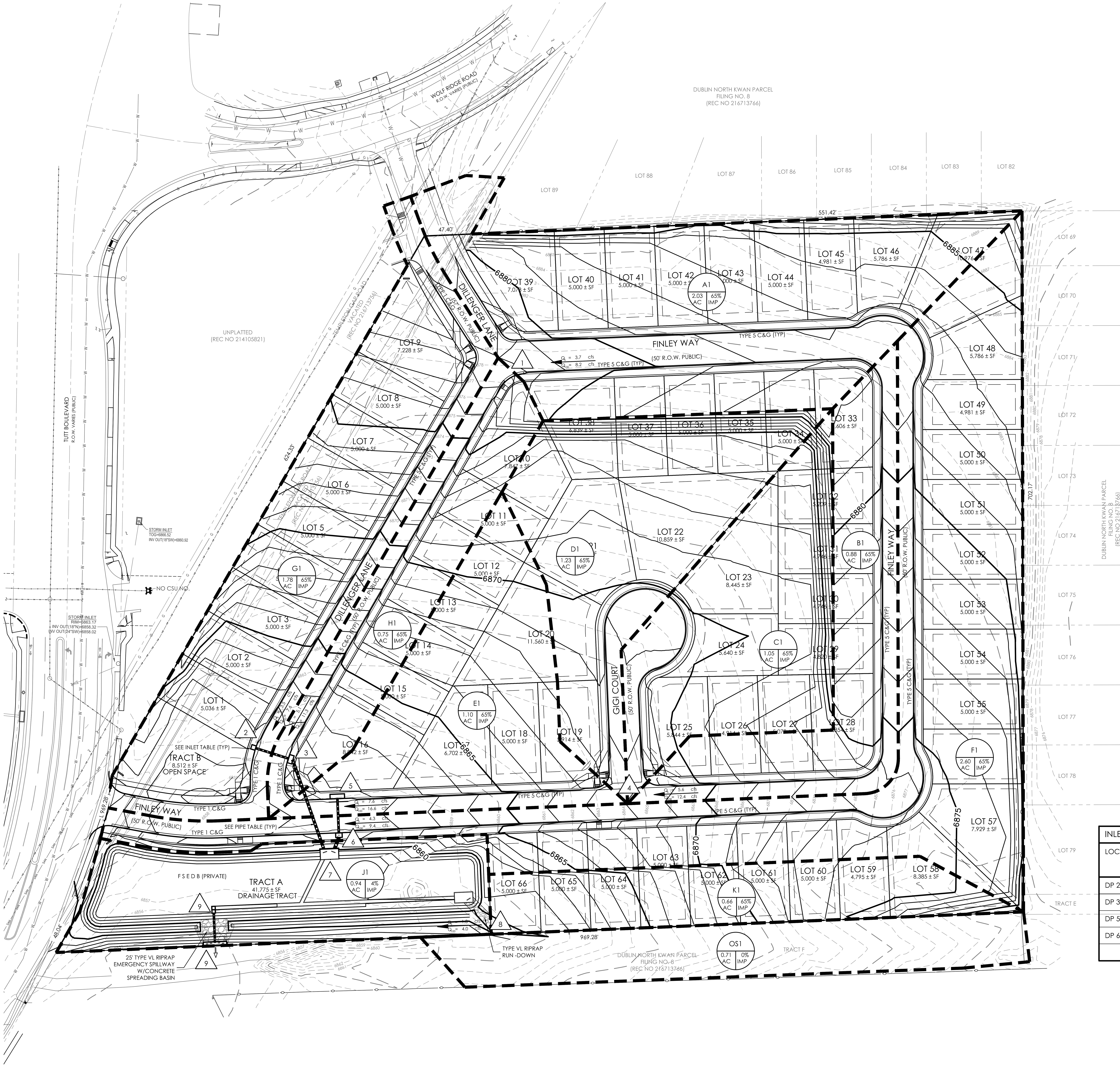
HANSEN RANCH

DRAINAGE MAP
EXISTING
CONDITIONS

MVE PROJECT 51421
MVE DRAWING EX-DM

JULY 1, 2019

SHEET 1 OF 1



FLOODPLAIN STATEMENT:

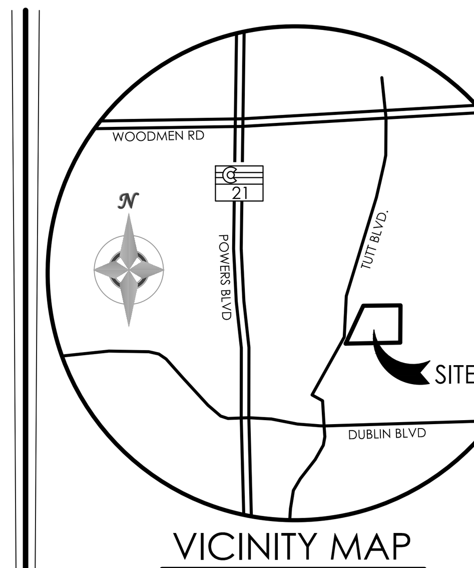
NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAP (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBER 08041C0737G, EFFECTIVE DECEMBER 7, 2018.

LEGEND

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE

EXISTING
- INDEX CONTOUR
- INTERMEDIATE CONTOUR

PROPOSED
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- GENERAL FLOW/DIRECTION
- SLOPE DIRECTION AND GRADE
- BASIN LABEL: AREA IN ACRES, PERCENT IMPERVIOUS
- POINT OF INTEREST
- F S E D B (PUBLIC) — FULL SPECTRUM DETENTION BASIN (PUBLIC)
- STORMWATER PIPE (PUBLIC)
- STORMWATER INLET (PUBLIC)
- RIP RAP (PUBLIC)



VICINITY MAP
NOT TO SCALE

1" = 50' 1:600

BENCHMARK

DEVELOPED DRAINAGE BASIN SUMMARY TABLE					
DESIGN POINT	BASIN(S)	AREA (AC)	Tc (MIN)	RUNOFF Q5	RUNOFF Q100
DP-1	A1	2.03	10.2	3.7	8.2
DP-2	G1	1.78	8.8	3.5	7.6
	H1	0.75	6.9	1.6	3.5
DP-3	A1,H1	2.78	10.2	5.1	11.3
	B1	0.88	11.3	1.6	3.5
	C1	1.05	8.6	2.0	4.5
	D1	1.23	8.5	2.4	5.3
DP-4	B1,C1,D1	3.16	11.3	5.6	12.4
	E1	1.10	11.6	1.9	4.2
DP-5	DP-4, E1	4.25	11.3	7.6	16.6
DP-6	F1	2.60	13.7	4.3	9.4
DP-7	DP-2,DP-3,DP-5,DP-6	11.41	13.7	18.8	41.4
	K1	0.66	12.7	1.1	2.5
	OS1	0.71	12.2	0.2	1.6
DP-8	K1, OS1	1.37	12.7	1.3	4.0
	J1	0.94	10.5	0.4	2.4
DP-9 (IN)	DP-7, DP-8, J1	13.72	13.7	20.5	47.5
DP-9 (OUT)	OUTFLOW			0.4	7.4

REVISIONS

INLET TABLE						
LOCATION	SIZE & SIZE	OWNER	CAPTURE Q5 (cfs)	CAPTURE Q100(cfs)	BYPASS Q5 (cfs)	BYPASS Q100(cfs)
DP 2	D-10-R, L=4'	PUBLIC	3.5	7.6	0.0	0.0
DP 3	D-10-R, L=8'	PUBLIC	5.1	11.3	0.0	0.0
DP 5	D-10-R, L=14'	PUBLIC	7.6	16.6	0.0	0.0
DP 6	D-10-R, L=6'	PUBLIC	4.3	9.4	0.0	0.0

PIPE TABLE					
LOCATION	SIZE	MATERIAL	OWNER	Q5 (cfs)	Q100(cfs)
DP 2 TO DP 3	18"	RCP	PUBLIC	3.5	7.6
DP 3 TO FS EDB	24"	RCP	PUBLIC	8.6	18.9
DP 5 TO DP 6	18"	RCP	PUBLIC	7.6	16.6
DP 6 TO FS EDB	30"	RCP	PUBLIC	11.9	26.0

MVE INC. ENGINEERS / SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

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

HANSEN RANCH

DRAINAGE MAP PROPOSED CONDITIONS

MVE PROJECT 51421
MVE DRAWING PP-DM

JULY 1, 2019

SHEET 1 **OF** 1