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

Final Drainage Report

Freedom Springs

Project No. 61090

November 8, 2018

PCD File No.: PPR-18-040

Final Drainage Report

for

Freedom Springs
Multifamily Residential Community

Project No. 61090

November 8, 2018

prepared for

Freedom Springs, LP
444 S. Campbell Avenue
Springfield, MO 65806
417.720.1577

prepared by

MVE, Inc.
1903 Lelaray Street, Suite 200
Colorado Springs, CO 80909
719.635.5736

61090-Freedom Springs-Final Drainage Report.odt

Statements and Acknowledgments

Engineer's Statement

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

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

Developer's Statement

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

Printed Name: Date
Title:
Freedom Springs, LP
444 S. Campbell Avenue
Springfield, MO 65806

El Paso County

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

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

Contents

Final Drainage Report

The purpose of this Final Drainage Report is to identify drainage patterns and quantities within and affecting the proposed Freedom Springs project located in Lot 2, Western Hills Filing No. 2. This project is the development of the existing platted lot having an area of approximately 3.87± Acres with a multi-family use. The report will “identify specific solutions to problems on-site and off-site resulting from the proposed project.[1] The report and included maps present results of hydrologic and drainage facilities analyses. The report will discuss the recommended drainage improvements to the site and identify drainage requirements relative to the proposed project. This report has been prepared and submitted in accordance with the requirements of the El Paso County land development approval process. An Appendix is included with this report with pertinent calculations and graphs used in the drainage analyses and design.

1 General Location and Description

1.1 Location

The proposed Freedom Springs site is located within the southeast one-quarter of Section 7, Township 14 South, Range 65 west of the 6th principal meridian in El Paso County, Colorado. The 3.87± acre site is situated on the north side of Western Drive, east of Hathaway Drive and west of Dale Road. The proposed site is platted as Lot 2, Western Hills Filing No. 2 in 1994. A **Vicinity Map** is included in the **Appendix**.

The unplatted property to the southwest of the site contains a manufacturing facility and is zoned M (Industrial). The property to the northwest of the site, platted as a portion of Aerospace Gardens, is zoned R-4 (Planned Development) and used as multi-family residential. A Multi-family residential property, zoned R-4, and platted as Lots 1 and 3, Block 1, Western Hills Subdivision and Lot 1 Western Hills Subdivision Filing No. 2 is adjacent to the site on the north. Western Drive, a paved public road with concrete curb and gutter in a 60 foot right-of-way, borders the site along the south. A golf course, platted as Lot 1, Cimarron Southeast Filing No. 2B is adjacent to Western Drive on the northeast. Vacant commercial lots, platted as Lot 1, Cimarron Southeast Filing No. 2C, is adjacent to the Western Drive on the southwestern side.

1.2 Description of Property

The Freedom Springs project contains 3.87± acres and is zoned R-4 (Planned Development), which is an obsolete county zone. The property contains no structures, but has a paved access road in and easement and various utilities with easements.

The site is covered with native prairie grasses and weeds in good condition. There are also sparse trees around the site. The existing site topography slopes to the south towards Western Drive with grades that range from 1% to 6% with isolated areas of up to 20%.

There are no major drainageways in the Freedom Springs site. All storm runoff flows south or southeast to Western Drive that collects the flows and conveys it to the northeast. There is no storm drain system in the Western Drive or or the surrounding area. The site is located in the Sand Creek

1 DCM

Major Drain Basin. The flows from the site continue northeast in Western Drive and eventually enters the East Fork of Sand Creek, continuing southwest.

According to the National Resource Conservation Service, the dominant soil in the immediate area of the Freedom Springs site is Blakeland loamy sand (map unit 8). The Blakeland loamy sand is typically deep and somewhat excessively drained. Permeability is rapid, surface runoff is slow, and the hazard of erosion is moderate. Blakeland loamy sand is classified as being part of Hydrologic Soil Group A.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**.[2] [3]

The current Flood Insurance Study of the region includes Flood Insurance Rate Maps (FIRMs), effective March 17, 1997. [4] [5] The project site is included in Community Panel Number 08041C0754 F of the FIRMs for El Paso County, Colorado. No portion of the site lies within FEMA designated Special Flood Hazard Areas (SFHAs). An excerpt of the current **FEMA Flood Insurance Rate Maps** with the site delineated is included in the **Appendix**.

A new multi-family residential facility will be constructed on the site. The proposed building and parking area will be located on the western side if the site. The development will include a new building, parking lot, landscaping and recreational open area. Also, the east side of the site will be improved with a new Full Spectrum Sand Filter Basin (FS SFB) which will collect, detain and treat the flows from the new development.

2 Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

Freedom Springs site is located in the Sand Creek Major Drainage Basin (FOFO4000) on the east side of Colorado Springs, which 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. The site is located in the southeastern portion of the Sand Creek Major Drainage Basin, in the East Fork sub-area and eventually drains into the East Fork of Sand Creek. A copy of a portion of the **"*Drainage Area Identification Study*" map**, showing the site location within the Basin is included in the **Appendix**. [6]

The Drainage Basin Planning Study for the Sand Creek Major Drainage Basin was completed in 1996 by Kiowa Engineering Corporation.[7] The site is contained within sub-basin 3, located just upstream of Design Point No. 3, as indicated in the 1996 report. There are not drainage improvements noted in the DBPS for the site.

A drainage report for Western Hills Subdivision was prepared in 1971 by G.L. Williams and Partners, LTD. No other drainage reports for this or any of the adjacent properties were available for review during the course of preparing this drainage report .

2.2 Sub-Basin Description

2.2.1 Existing Drainage Patterns (Off-Site)

Off-site drainage flows enter the north edge of the Freedom Springs property from two off-site drainage basins located north of the site. The hydrologic analyses used in the drainage design of the proposed subdivision considered the existing Land Use Conditions of the offsite sub-basins. The off-site drainage sub-basins are depicted on the included **Existing Drainage Basin Map**.

2 WSS
3 OSD
4 FIS
5 FIRM, Map No. 08041C0754 F
6 Drain. Area Ident. Study
7 1996 DBPS

Existing off-site sub-basin OS1 is located north of the western portion of the site (west of the existing paved access drive), and contains an existing multi-family residential development. The basin runoff flows south towards the site and enters exiting sub-basin A1 by way of the existing paved access drive. These flows continue to drain south towards Western Drive in the sub-basin A1, but remain mostly separated from sub-basin A1 runoff. The flows enter Western Drive and flow northeast in the street.

Existing off-site sub-basin OS2 is located north of the eastern portion of the site (west of the existing paved access drive). The sub-basin contains a part of the existing multi-family residential development, including the clubhouse and swimming pool area. The basin runoff flows southeast towards the site and enters exiting sub-basin B1 by overland sheet flow. These flows enter the site and join other flows generated in sub-basing B1 and continue to drain southeast towards Western Drive.

2.2.2 Existing Drainage Patterns (On-Site)

The site is mostly undeveloped, except for the existing paved access drive that extends north from Western Drive to the existing multi-family development north of the site. The entire site drains from north to south and southeast to Western Drive. However, the existing paved drive conveys most of the offsite flows from existing off-site sub-basing OS1 to Western Drive. All off-site and on-site runoff reaches Western Drive and travels northeast in the existing concrete curb and gutter. There is no storm drain in Western Drive adjacent to the site, but two storm drain inlets located northeast of the site collect storm flows which drain into the pond adjacent to the south side of Western Drive. The existing drainage patterns for the site are described by two on-site basins. The drainage sub-basins are shown on the included **Existing Drainage Map**.

Existing sub-basin A1 is located on the western side of the site and contains open field (meadow) and paved access drive along the east side of the basin. Sub-basin A1 accepts the flows form off-site sub-basin OS1. These offsite flows travel south through the site, mostly contained in the paved drive, to Western Drive on the south. Storm runoff from sub-basin A1 also flows south to Western Drive and enters the street. Once in the street, all the flows from OS1 and A1 travel northeast in the street.

Existing sub-basin B1 contains the eastern portion of the property and contains grassed field (meadow) and trees. The basin accepts the sheet flow from off-site sub-basin OS2 on the north. The combined flows from drain toward Western Drive on the southeast, joining the flows from from OS1, A1, and other off-site flows in the street. The combined flows continue northeast in the street to an off-site inlet that drains into the existing pond located on the south side of Western Drive. These flows eventually reach the east fork of sand creek and continue to the southeast in the creek.

3 Drainage Design Criteria

3.1 Development Criteria Reference

This Final Drainage Report for Freedom Springs has been prepared according to the report guidelines presented in the latest edition of *El Paso County Drainage Criteria Manual* (DCM)[8]. The County has also adopted portions of the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, especially concerning the calculation of rainfall runoff flow rates.[9] [10] The hydrologic analysis is based on a collection of data from the DCM, the NRCS Web Soil Survey[11], Existing topographic data and proposed site plan by by Land Development Consultants, Inc.

3.2 Hydrologic Criteria

For this Final Drainage Report, the Rational Method as described in the D*rainage Criteria Manual* has been used for all Storm Runoff calculations, as the development and all sub-basins are less than

8 DCM Section 4.3 and Section 4.4
9 CS DCM Vol 1
10 CS DCM Vol 2
11 WSS

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.[12]

The Water Quality Control Volume procedure, Section 3.3 of the *Urban Drainage and Flood Control District Drainage Criteria Manual, Volume 3* (UDFCD) was used for water quality volume calculations with the aid of the worksheet “UD-BMP_v3.06” spreadsheet developed by the Urban Drainage and Flood Control District.[13] [14] Full Spectrum Detention utilizing the Excess Urban Runoff Volume (EURV) concept was sized and storm routing calculations were performed in accordance with *Urban Drainage and Flood Control District Drainage Criteria Manual, Volume 2 using* the aid of the detention design spreadsheet, “UD-Detention_v3.07”, developed by the Urban Drainage and Flood Control District. [15] [16]

4 Drainage Facility Design

4.1 General Concept

The intent of the drainage concept presented in this Final Drainage Report is to maintain the existing drainage patterns & quantities on the site. Major and minor storm flows will continue to be safely conveyed through the site and downstream. The runoff from all developed areas will drain to the proposed Full Spectrum Sand Filter Basin (FS SFB). A proposed private on-site storm drain system will collect the flow from the various developed on-site sub-basin and convey them to the proposed FS SFB. The developed flows will be detained and released to Western Drive at flow rates less than the calculated existing flow rates.

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

4.2 Specific Details

4.2.1 Existing Hydrologic Conditions

The off-site drainage area north of the western portion of the site, sub-basin OS1, contains the existing adjacent multi-family residential development known as Western Hills Apartments. The sub-basin is 2.84 acres in area and drains southerly towards the northeast corner of existing on-site sub-basin A1 at the paved access drive that extends from Western Drive. Basin OS1 generates peak storm runoff discharges of Q_5 = 4.7 cfs and Q_{100} = 10.4 cfs (existing flows). These flows continue south through sub-basin A1 to Western Drive.

Existing off-site sub-basin OS2 is located north of the eastern portion of the site and also contains a portion of existing Western Hills Apartments. The sub-basin is 0.57 acres in area and drains southeasterly towards the northeast corner of the site with peak discharges of Q_5 = 1.1 cfs and Q_{100} = 2.5 cfs (existing flows). These flows enter existing on-site sub-basin B1 and continue southeast towards Western Drive.

Existing on-site sub-basin A1 is 2.72 acres in area and comprises the western portion of the site, containing the existing paved access drive and open field area. The sub-basin accepts the offsite flows from sub-basin OS1 as described above. Sub-basin A1 produces peak discharges of Q_5 = 1.7 cfs and Q_{100} = 7.2 cfs (existing flows) which drain southerly towards Western Drive. The combined

12 DCM
13 UDFCDV.3
14 UDFCD
15 UDFCD V.2
16 UDFCD

flow rate of the runoff from sub-basins OS1 and A1 are Q_5 = 6.2 cfs and Q_{100} = 17.0 cfs (existing flows). These flows enter Western all along the street frontage, however concentrated flows, mostly from off-site sub-basin OS1, enter the street at the existing drive connection. The combined flows of continue northeast in the street.

Existing sub-basin B1 (1.16 acres) is comprised of the east side of the site, east of the existing paved access drive. The sub-basin accepts the off-site sheet flows from sub-basin OS2. Sub-basin B1 contains open field area and drains southeast towards Western Drive. The peak discharges generated by sub-basin B1 are Q_5 = 0.4 cfs and Q_{100} = 2.8 cfs (existing flow), which joins with the off-site flows for combined peak discharges of Q_5 = 1.4 cfs and Q_{100} = 5.0 cfs (existing flow). These flows enter Western Drive and are directed to the northeast in street.

The existing combined total flows entering Western Drive from the off-site and on-site basins are Q_5 = 7.6 cfs and Q_{100} = 22.0 cfs (existing flow).

Western Drive an existing public 39 ft wide, paved street with concrete curb on both sides in a 60' right-of-way. The roadway drains to the northeast and does not contain a storm drain system adjacent to the site. However, there are two curb inlets located approximately 110 feet to the northeast of the site. The inlets drain street flows to the existing pond adjacent to the south side of the road.

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

4.2.2 Proposed Hydrologic Conditions

The off-site drainage basin, OS1 (2.84 acres), will continue to drain south toward the site as in existing conditions. The discharges are Q_5 = 4.7 cfs and Q_{100} = 10.4 cfs (proposed flow), which drain to the north edge of the site and into proposed sub-basins H1.

Proposed sub-basin H1 (0.45 acres) consists of the north edge of the site together with with the improved access drive to Western Drive. This sub-basin will accept the flows from off-site sub-basin OS1, which will continue south in the access drive to Western Drive as in existing conditions. Sub-basin H1 will produce runoff at peak flow rates of Q_5 = 1.6 cfs and Q_{100} = 3.1 cfs (proposed flow), which drains to the access drive and then south towards Western Drive. The combined discharges of sub-basins OS1 and H1 are Q_5 = 5.7 cfs and Q_{100} = 12.3 cfs (proposed flow). A proposed single Type 16 combination inlet at Design Point 4 (DP4) will collect the developed 100-year discharge from on-site sub-basin H1 of 3.1 cfs and allow the existing offsite flows from sub-basin OS1 to continue to flow by and reach Western Drive as in existing conditions. The collected flows will be carried to the proposed FS SFB located east of the access drive.

Proposed sub-basin A1 (0.63 acres) will consist of the paved parking area on the south side of the proposed building. The discharges generated by A1 are Q_5 = 2.7 cfs and Q_{100} = 4.9 cfs (proposed flow), which drain southerly in the parking lot to a proposed double Type 16 combination inlet in sump condition at DP1. The collected storm runoff will be conveyed to the proposed FS SFB in the proposed private storm drain line.

Proposed sub-basin B1 (0.17 acres) is parking lot area located east of sub-basin A1. Sub-basin B1 drains to a proposed single Type 16 combination inlet in sump condition at DP2 with peak discharges of Q_5 = 0.7 cfs and Q_{100} = 1.3 cfs (proposed flow). The inlet will collect up to the 100-year flows and the flows will be conveyed to the FS SFB in the storm drain system.

Proposed sub-basin C1 (0.11 acres) is comprised of the parking, drive and landscape area located north of sub-basin B1. The discharges from sub-basin C1 are Q_5 = 0.4 cfs and Q_{100} = 0.8 cfs (proposed flows) which drain south to DP3, being the location of a proposed single Type 16 combination inlet on grade. The proposed inlet will collect flows of Q_5 = 0.3 cfs and Q_{100} = 0.5 cfs and bypass flows of Q_5 = 0.1 cfs and Q_{100} = 0.3 cfs to sub-basin H1.

Proposed sub-basin D1 (0.36 acres) consists of the proposed building footprint on the western side of the site. The sub-basin generates storm runoff peak discharges of Q_5 = 1.4 cfs and Q_{100} = 2.6 cfs (proposed flows). Building roof drains will direct all flows to the underground drainage system and then to the FS SFB.

Proposed sub-basin E1 (0.17 acres) will consist of the recreation yard on the north side of the building. The discharges generated by E1 are Q_5 = 0.1 cfs and Q_{100} = 0.5 cfs (proposed flow), which drain to a low point in the center of the basin (DP5). A proposed grated area inlet in sump condition will collect the flows which will be conveyed to the proposed FS SFB in the proposed private storm drain line.

Proposed sub-basin F1 (0.17 acres) is also part of the recreation yard on the north side of the building. Sub-basin F1 drains to a proposed area inlet in sump condition at DP6 with peak discharges of Q_5 = 0.3 cfs and Q_{100} = 0.8 cfs (proposed flow). The inlet will collect up to the 100-year flows and the flows will be conveyed to the FS SFB in the storm drain system.

Proposed sub-basin G1 (0.58 acres) contains open landscape area and the proposed FS SFB located on the east side of the existing paved access drive at DP7. The discharges from sub-basin G1 are Q_5 = 0.2 cfs and Q_{100} = 1.3 cfs (proposed flows) which drain south into the FS SFB at DP7. The pond also collects the flows from sub-basins A1, B1, C1, D1, E1, F1, G1 and H1. The combined peak discharges of all in-flowing basins are Q_5 = 7.2 cfs and Q_{100} = 15.2 cfs (proposed flow). The proposed FS SFB will treat and detain the developed flows and release them to Western drive by way of a outlet pipe and County Standard curb opening with steel cover. The released flows are Q_5 = 0.2 cfs and Q_{100} = 1.1 cfs (proposed flow).

Proposed sub-basin J1 (0.46 acres) is comprised of open yard and landscape area adjacent to Western Drive on the westerly side of the site. The proposed landscaping will consist of trees, shrubs in wood mulch, and non-irrigated native grass. The basin will drain south by sheet flow into Western Drive as this area does in the existing condition. Sub-basin J1 produces peak runoff discharges of Q_5 = 0.1 cfs and Q_{100} = 1.1 cfs (proposed flows).

Proposed sub-basin M1 (0.13 acres) consists of narrow landscape area on the west edge of the site. The area drains westerly into the adjacent site and generates storm runoff peak discharges of Q_5 = 0.1 cfs and Q_{100} = 0.4 cfs (proposed flows). Most of the area of this sub-basin historically drains into the site to the southeast. In the developed condition, this area will drain offsite to the west and then south to Western Drive. The area of this basin is minor, is landscaped pervious area, and results in runoff of negligible magnitude. The flows leaving the site from this basin will not present problems for the adjacent or downstream properties.

The off-site drainage basin, OS2 (0.57 acres), will continue to drain southeast toward the site as in existing conditions. The discharges are Q_5 = 1.1 cfs and Q_{100} = 2.5 cfs (proposed flow), which drain onto the site into proposed sub-basins L1.

Proposed sub-basin L1 (0.45 acres) consists of open landscape area along the east edge of the site. Grading contours will remain the same as existing conditions. Sub-basin L1 will continue to accept the off-site flows from sub-basin OS2. The discharges generated by L1 are Q_5 = 0.1 cfs and Q_{100} = 1.1 cfs (proposed flow), which drain to the southeast towards Western Drive. The combined flows of OS2 and L1 are Q_5 = 1.1 cfs and Q_{100} = 3.3 cfs (proposed flow), which enter Western Drive along the street frontage by sheet flow.

Proposed sub-basin K1 (0.15 acres) is the south edge of the eastern portion of the site. This basin consist of the landscaped area between the proposed FS SFB and Western Drive which drains southwest into the street. Proposed peak runoff discharges from this basin are Q_5 = 0.1 cfs and Q_{100} = 0.4 cfs (proposed flow).

The combined total developed flows entering Western Drive from the off-site and on-site basins are Q_5 = 4.7 cfs and Q_{100} = 14.1 cfs (proposed flow). These flows represent a decrease of 2.9 cfs in the 5-year rainfall event and a decrease of 7.9 cfs in the 100-year event. The flows that enter Western Drive will continue to drain northeast in the the street to the existing inlets located northeast of the site.

4.2.3 Proposed Drainage Facilities

The proposed on-site storm drain system will be owned and maintained by Freedom Springs. The pipe system will be 6”, 12” and 18” HDPE material. The proposed inlets will be Type 16 combination inlets with concrete boxes and adjustable steel grate and curb openings. The area inlet will be PVC and non-traffic bearing located in landscaped areas. The proposed pipe system discharges into the Full Spectrum Sand Filter Basin, which is designed to detain the WQCV, EURV and 100-year developed runoff volumes. The proposed FS Sand Filter Basin has storage volume of 0.281 acre-feet. The facility is located in Type A soils and will be full-infiltration type. The EURV and 100-year flows will be regulated by a concrete outlet box with steel orifice plate and outlet pipe. The facility will have an emergency spillway with 6' bottom width discharging to Western Drive and protected by riprap lining.

4.3 Erosion Control

During future construction, best management practices (BMP's) for erosion control will be employed based on the previously referenced City of Colorado Springs Drainage Criteria Manual Volume 2 and the Erosion Control Plan to minimize erosion from the site. The BMP's will remain in place until the site is stabilized with the new hard surfacing or landscape seeding, planting and cover materials. Also, BMP's will be utilized as deemed necessary by the contractor, engineer, owner, or County inspector and are not limited to the measures described on the Erosion Control Plan.

4.4 Water Quality Enhancement Best Management Practices

The Full Spectrum Sand Filter Basin described above will provide storage for the WQCV, EURV and developed 100-year runoff volume for the site. A Grading and Erosion Control Plan for the construction of the site has been prepared in accordance with the provisions of the County's Engineering Criteria Manual. Placement of construction stormwater BMP's will as required by the plan will limit soil erosion and deposition by stormwater flowing over the site.

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

1) Runoff Reduction Practices are employed in this project. Impervious surfaces have been reduced as much as practically possible. The parking lot contains landscape islands and the entire east side of the site will remain as pervious surface.

2) All drainage paths on the site are stabilized with pavement or appropriate landscape treatment. The Full Spectrum Sand Filter Basin will intercept flows from developed areas. Additionally, the pond outflow point will be stabilized with outlet protection.

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

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

The total area of the site is 3.87 acres. An existing paved access drive splits the lot into the east and west portions. All areas to be developed with impervious building or paved areas will be collected in the proposed storm drain inlets and directed to the proposed Full Spectrum Detention Sand Filter Basin (FSD SFB) on the west side of the site, except 0.08 acres of the existing paved access drive that is not possible to direct to the pond due to grade elevations. A total of 2.56 acres out of the 3.87 acres drains to the FSD SFB. Other areas of the site do not drain to the pond. Other than the 0.08 acres of existing paved area already discussed, these areas are unpaved pervious landscape areas of the site totaling 1.19 acres.

5 Opinion of Probable Cost for Drainage Facilities

There are no public drainage improvements associated with this project. Costs for the private non-reimbursable drainage improvements for this project are listed in the table below:

Freedom Springs Private Drainage Costs (Non-Reimbursable)				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
HDPE Storm Drain Pipe with Appurtenances	1040	LF	$45.00	$46,800
Type 16 Combination Inlets	4	EA	$3,800.00	$15,200
Sand Filter Basin (Full Spectrum)	1	EA	$10,500.00	$10,500
GRAND TOTAL				**$72,500.00**

6 Drainage and Bridge Fees

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

7 Conclusion

This Final Drainage Report presents existing and proposed drainage conditions for the proposed Freedom Springs project. The development will have negligible and inconsequential effects on the existing site drainage and drainage conditions downstream. Full Spectrum Detention and Water Quality treatment will be provided. A Permanent BMP Maintenance Agreement and Easement is being provided for this project. Also, an Operations and Maintenance Manual (O&M Manual) is being provided. The proposed project will not, with respect to stormwater runoff, negatively impact the adjacent properties and downstream properties.

References

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

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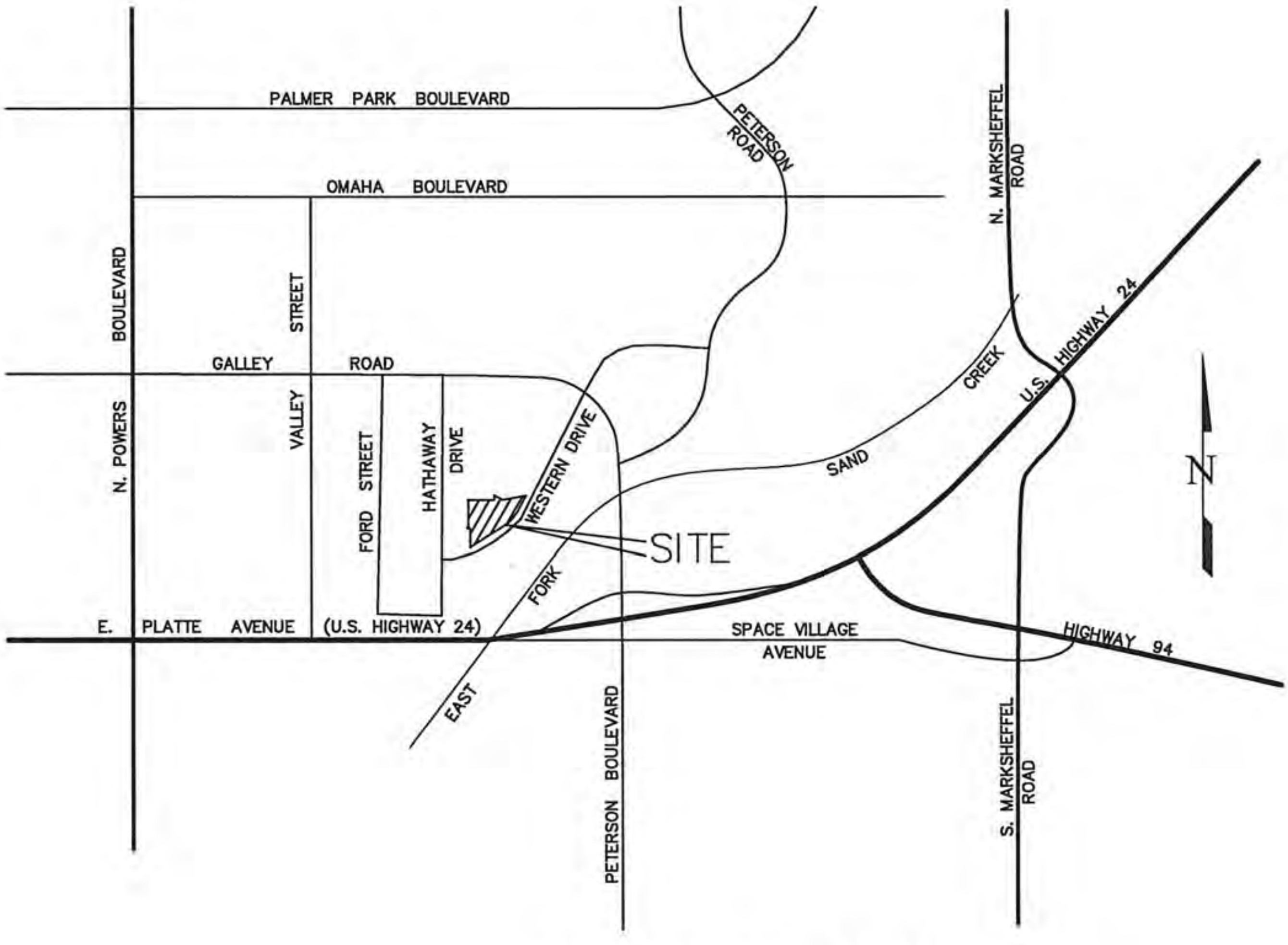
Detention Design Spreadsheet. Urban Drainage and Flood Control District ("http://www.udfcd.org/downloads/software/UD-Detention_v2.2.xls", accessed February 2017).

Appendices

8 General Maps and Supporting Data

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



VICINITY MAP

NO SCALE

APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 754 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

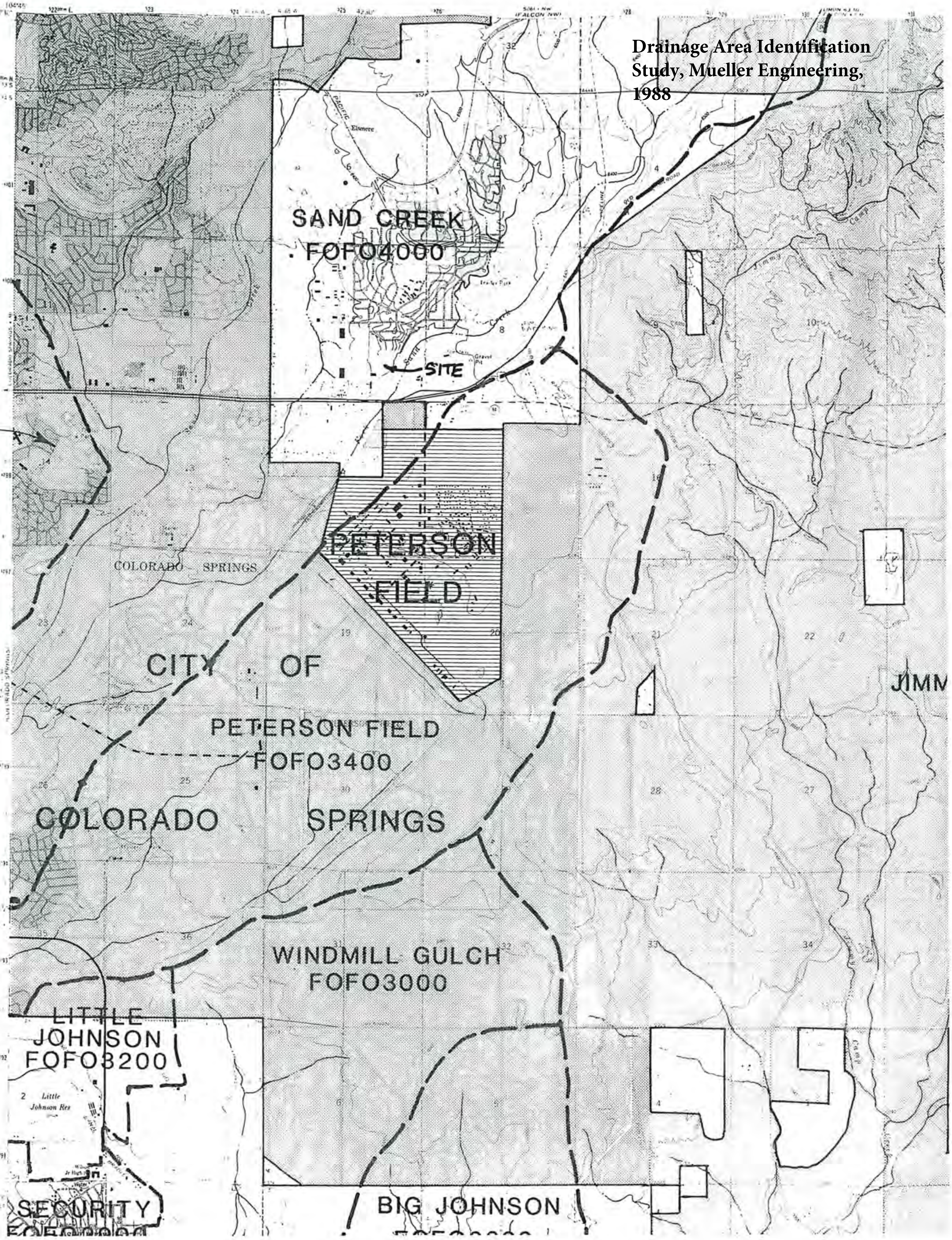
CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0754	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0754	F

MAP NUMBER
08041C0754 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov


Drainage Area Identification Study, Mueller Engineering, 1988
SAND CREEK
FOFO4000
SITE
K
PETERSON
FIELD
COLORADO SPRINGS
CITY OF
PETERSON FIELD
FOFO3400
COLORADO SPRINGS
WINDMILL GULCH
FOFO3000
LITTLE
JOHNSON
FOFO3200
SECURITY
BIG JOHNSON
JIMM

Soil Map—El Paso County Area, Colorado
(Freedom Springs)

Map Scale: 1:1,530 if printed on A portrait (8.5" x 11") sheet.

0 20 40 80 120 Meters

0 50 100 200 300 Feet

N

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

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

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

Date(s) aerial images were photographed: 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	10.9	99.9%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	0.0	0.1%
Totals for Area of Interest		**10.9**	**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.

Hydrologic Soil Group—El Paso County Area, Colorado
(Freedom Springs)

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

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Coordinate System: Web Mercator (EPSG:3857)

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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	10.9	99.9%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	A	0.0	0.1%
Totals for Area of Interest			**10.9**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

9 Hydrologic Calculations

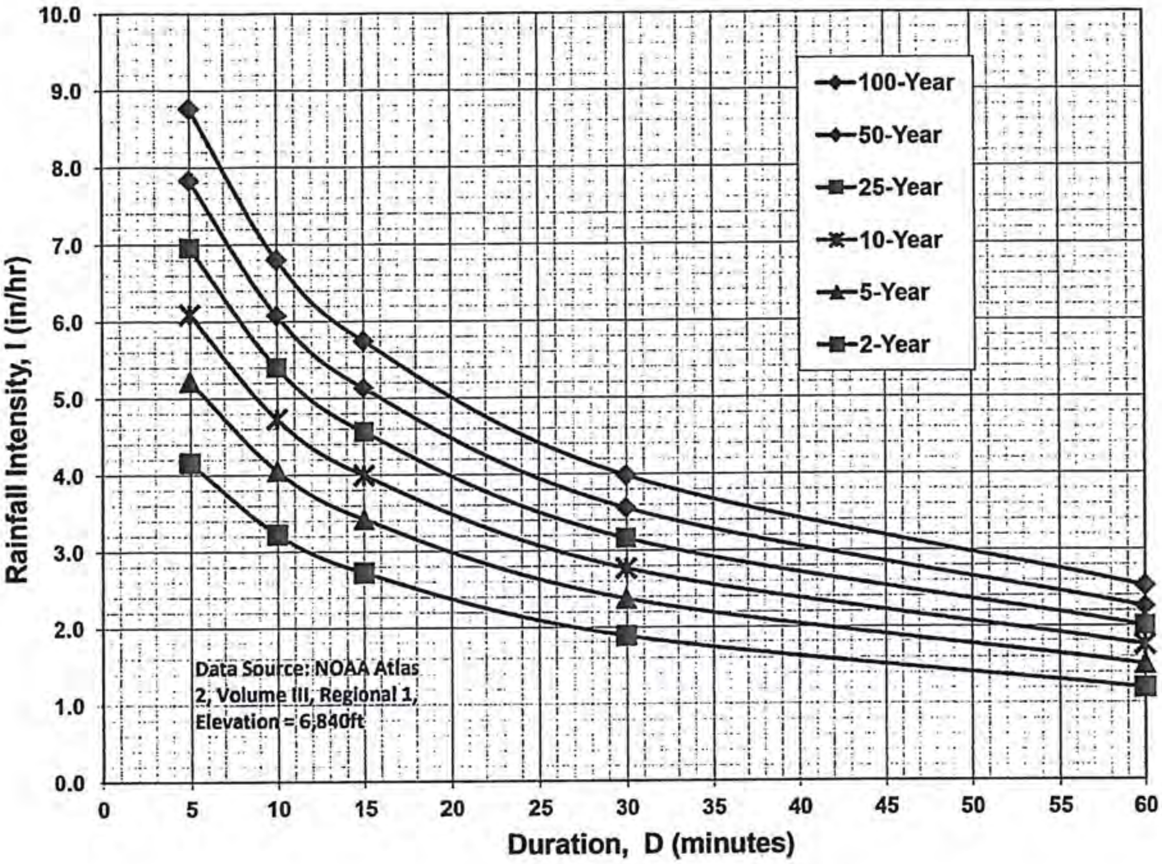
Runoff Coefficients and Percent Imperviousness Table 6-6
Colorado Springs Rainfall Intensity Duration Frequency Table 6-5
Hydrologic Calculations Summary Form SF-1 for Existing & Developed Conditions
Hydrologic Calculations Summary 5-yr Form SF-2 for Existing & Developed Conditions
Hydrologic Calculations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

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													
EXIST. OFFSITE	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
EXIST SITE & DEV. PART	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													
DEV.	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
EXIST	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
DEV	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
DEV	Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

Job No.: **61090**
Project: **Freedom Springs**

Date: **3/22/18 10:03**
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		t_c
	Area (Acres)	C_5	C_{100}/CN	% Imp.	L_0 (ft)	S_0 (%)	t_i (min)	L_{0t} (ft)	S_{0t} (ft/ft)	V_{0sc} (ft/s)	t_t (min)	L_{0c} (ft)	S_{0c} (ft/ft)	V_{0c} (ft/s)	t_c (min)	L (min)	$t_{c,alt}$ (min)	(min)
OS1	2.84	0.45	0.59	65%	95	1%	11.4	125	0.010	2.0	1.0	360	0.019	3.0	2.0	580	13.2	13.2
OS2	0.57	0.49	0.65	65%	100	1%	11.0	90	0.020	1.0	1.5	0	0.000	0.0	0.0	190	11.1	11.1
EX A1	2.72	0.17	0.41	11%	100	4%	11.2	265	0.009	0.7	6.5	0	0.000	0.0	0.0	365	12.0	12.0
EX B1	1.16	0.09	0.36	2%	100	3%	12.4	145	0.041	1.4	1.7	0	0.000	0.0	0.0	245	11.4	11.4
A1	0.63	0.85	0.92	94%	100	2%	3.9	35	0.014	2.4	0.2	160	0.011	2.0	1.3	295	11.6	5.5
B1	0.17	0.75	0.85	81%	100	8%	3.2	16	0.063	5.0	0.1	0	0.000	0.0	0.0	116	10.6	5.0
C1	0.11	0.70	0.81	76%	32	2%	3.1	0	0.000	0.0	0.0	128	0.057	2.5	0.9	160	10.9	5.0
D1	0.36	0.73	0.81	90%	30	1%	3.7	0	0.000	0.0	0.0	175	0.010	5.0	0.6	205	11.1	5.0
E1	0.17	0.20	0.44	14%	87	3%	10.7	0	0.000	0.0	0.0	0	0.000	0.0	0.0	87	10.5	10.5
F1	0.17	0.45	0.62	45%	87	2%	9.2	0	0.000	0.0	0.0	0	0.000	0.0	0.0	87	10.5	9.2
G1	0.58	0.08	0.35	0%	100	4%	11.7	160	0.063	1.8	1.5	0	0.000	0.0	0.0	260	11.4	11.4
H1	0.45	0.73	0.83	79%	65	2%	4.7	0	0.000	0.0	0.0	245	0.045	3.0	1.4	310	11.7	6.0
J1	0.46	0.08	0.35	0%	100	4%	11.7	25	0.080	2.0	0.2	0	0.000	0.0	0.0	125	10.7	10.7
K1	0.15	0.08	0.35	0%	33	11%	4.9	0	0.000	0.0	0.0	0	0.000	0.0	0.0	33	10.2	5.0
L1	0.45	0.08	0.35	0%	100	6%	10.5	140	0.068	1.8	1.3	0	0.000	0.0	0.0	240	11.3	11.3
M1	0.13	0.08	0.35	0%	32	9%	5.1	0	0.000	0.0	0.0	0	0.000	0.0	0.0	32	10.2	5.1

Job No.: 61090
Project: Freedom Springs
Design Storm: 5-Year Storm *(20% Probability)*
Jurisdiction: DCM

Date: 3/22/18 10:03
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)	C5	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	V_{Osc} (ft/s)	t_t (min)
Offsite																						
	OS1	2.84	0.45	13.2	1.28	3.71	4.7															
	OS2	0.57	0.49	11.1	0.28	3.98	1.1															
Existing																						
	EX A1	2.72	0.17	12.0	0.45	3.85	1.7															
	EX B1	1.16	0.09	11.4	0.11	3.94	0.4															
OS1+EX A1	OS1, EX A1	5.56	0.31					14.1	1.73	3.61	6.2											
OS2+EX B1	OS2, EX B1	1.72	0.21					11.4	0.36	3.94	1.4											
Developed																						
DP1	A1	0.63	0.85	5.5	0.54	5.02	2.7															
DP2	B1	0.17	0.75	5.0	0.13	5.17	0.7															
DP3	C1	0.11	0.70	5.0	0.08	5.17	0.4															
	D1	0.36	0.73	5.0	0.27	5.17	1.4															
DP5	E1	0.17	0.20	10.5	0.03	4.06	0.1															
DP6	F1	0.17	0.45	9.2	0.08	4.25	0.3															
	G1	0.58	0.08	11.4	0.05	3.93	0.2															
	H1	0.45	0.73	6.0	0.33	4.89	1.6															
	J1	0.46	0.08	10.7	0.04	4.03	0.1															
	K1	0.15	0.08	5.0	0.01	5.17	0.1															
	L1	0.45	0.08	11.3	0.04	3.94	0.1															
	M1	0.13	0.08	5.1	0.01	5.14	0.1															
OS2+L1	OS2, L1	1.02	0.29					11.4	0.29	3.94	1.1											
DP4	OS1, H1	3.29	0.49					14.4	1.61	3.58	5.7											
DP7	A1-H1	2.65	0.56					6.2	1.49	4.84	7.2											

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

Job No.: 61090
Project: Freedom Springs
Design Storm: 100-Year Storm *(1% Probability)*
Jurisdiction: DCM

Date: 3/22/18 10:03
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_{Osc} (ft/s)	t_t (min)
Offsite																						
	OS1	2.84	0.59	13.2	1.68	6.23	10.4															
	OS2	0.57	0.65	11.1	0.37	6.68	2.5															
Existing																						
	EX A1	2.72	0.41	12.0	1.12	6.47	7.2															
	EX B1	1.16	0.36	11.4	0.42	6.61	2.8															
OS1+EX A1	OS1, EX A1	5.56	0.50					14.1	2.80	6.06	17.0											
OS2+EX B1	OS2, EX B1	1.72	0.44					11.4	0.75	6.61	5.0											
Developed																						
DP1	A1	0.63	0.92	5.5	0.58	8.43	4.9															
DP2	B1	0.17	0.85	5.0	0.15	8.68	1.3															
DP3	C1	0.11	0.81	5.0	0.09	8.68	0.8															
	D1	0.36	0.81	5.0	0.30	8.68	2.6															
DP5	E1	0.17	0.44	10.5	0.07	6.81	0.5															
DP6	F1	0.17	0.62	9.2	0.11	7.14	0.8															
	G1	0.58	0.35	11.4	0.20	6.59	1.3															
	H1	0.45	0.83	6.0	0.37	8.21	3.1															
	J1	0.46	0.35	10.7	0.16	6.76	1.1															
	K1	0.15	0.35	5.0	0.05	8.68	0.4															
	L1	0.45	0.35	11.3	0.16	6.62	1.1															
	M1	0.13	0.35	5.1	0.05	8.63	0.4															
OS2+L1	OS2, L1	1.02	0.48					11.4	0.49	6.61	3.3											
DP4	OS1, H1	3.29	0.62					14.4	2.05	6.01	12.3											
DP7	A1-H1	2.65	0.71					6.2	1.87	8.13	15.2											

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

Sub-Basin OS1 Runoff Calculations

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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	123,800	2.84	0.41	0.45	0.49	0.54	0.57	0.59	65%
Combined	**123,800**	**2.84**	**0.41**	**0.45**	**0.49**	**0.54**	**0.57**	**0.59**	**65.0%**
	123800								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	580	9	-	-	-	-	
Initial Time	95	1	0.010	-	11.4	13.2	DCM Eq. 6-8
Shallow Channel	125	1	0.010	2.0	1.0	-	DCM Eq. 6-9
Channelized	360	7	0.019	3.0	2.0	-	C&G
				t_c	**13.2 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.96	3.71	4.33	4.95	5.57	6.23
Runoff (cfs)	3.5	**4.7**	6.0	7.6	9.0	**10.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	3.5	**4.7**	6.0	7.6	9.0	**10.4**

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

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

Notes

Sub-Basin OS2 Runoff Calculations

Job No.:	**61090**	Date:	**3/22/18 10:03**
Project:	**Freedom Springs**	Calcs by:	**TJW**
		Checked by:	**DRG**
Jurisdiction	**DCM**	Soil Type	**OS2**
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	24,712	0.57	0.45	0.49	0.54	0.59	0.62	0.65	65%
Combined	**24,712**	**0.57**	**0.45**	**0.49**	**0.54**	**0.59**	**0.62**	**0.65**	**65.0%**
	24712								

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	190	3	-	-	-	-	
Initial Time	100	1	0.010	-	11.0	11.1	DCM Eq. 6-8
Shallow Channel	90	2	0.020	1.0	1.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**11.1 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.18	3.98	4.64	5.31	5.97	6.68
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

Z:\61090\Calcs\Hydrology\61090 Runoff Spreadsheet.xlsm
OS2

Sub-Basin EX A1 Runoff Calculations

Job No.:	61090	Date:		3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW	
		Checked by:	DRG	
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	103,361	2.37	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	7,926	0.18	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	7,102	0.16	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**118,389**	**2.72**	**0.11**	**0.17**	**0.23**	**0.32**	**0.37**	**0.41**	**11.5%**
	118389								

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	365	6	-	-	-	-	
Initial Time	100	4	0.035	-	11.2	12.0	DCM Eq. 6-8
Shallow Channel	265	3	0.009	0.7	6.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**12.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.08	3.85	4.49	5.14	5.78	6.47
Runoff (cfs)	0.9	**1.7**	2.8	4.5	5.8	**7.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.9	**1.7**	2.8	4.5	5.8	**7.2**
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 EX B1 Runoff Calculations

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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	49,443	1.14	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	749	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	214	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**50,406**	**1.16**	**0.04**	**0.09**	**0.16**	**0.26**	**0.31**	**0.36**	**1.8%**

50406

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	245	9	-	-	-	-	
Initial Time	100	3	0.032	-	12.4	11.4	DCM Eq. 6-8
Shallow Channel	145	6	0.041	1.4	1.7	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch

t_c **11.4 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.14	3.94	4.59	5.25	5.91	6.61
Runoff (cfs)	0.1	**0.4**	0.9	1.6	2.1	**2.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.4**	0.9	1.6	2.1	**2.8**

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

Includes Basins OS1 EX A1

Job No.:	**61090**	Date:	**3/22/18 10:03**
Project:	**Freedom Springs**	Calcs by:	**TJW**
		Checked by:	**DRG**
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	123,800	2.84	0.41	0.45	0.49	0.54	0.57	0.59	65%
Pasture/Meadow	103,361	2.37	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	7,926	0.18	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	7,102	0.16	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**242,189**	**5.56**	**0.26**	**0.31**	**0.36**	**0.43**	**0.47**	**0.50**	**38.8%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OS1	-	580	9	-	-	-	-	13.2
Channelized-1	V-Ditch	1	296	12	10	1	2	5.5	0.9
Channelized-2						1			
Channelized-3									
Total			876	21					

1 = Man-made, Smooth, Straight

t_c (min) **14.1**

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)	2.88	3.61	4.21	4.82	5.42	6.06
Site Runoff (cfs)	4.23	**6.24**	8.51	11.59	14.17	**16.95**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**6.2**	-	-	-	**17.0**

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.

Combined Sub-Basin Runoff Calculations

Includes Basins OS2 EX B1

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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	24,712	0.57	0.41	0.45	0.49	0.54	0.57	0.59	65%
Pasture/Meadow	49,443	1.14	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	749	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	214	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**75,118**	**1.72**	**0.16**	**0.21**	**0.27**	**0.35**	**0.40**	**0.44**	**22.6%**

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 B1	-	245	9	-	-	-	-	11.4
Channelized-1						1			
Channelized-2						1			
Channelized-3									
Total			245	9					

t_c (min) **11.4**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.14	3.94	4.59	5.25	5.91	6.61
Site Runoff (cfs)	0.86	**1.44**	2.15	3.20	4.04	**4.97**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**1.4**	-	-	-	**5.0**

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 A1 Runoff Calculations

1

Job No.:	61090	Date:		3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW	
		Checked by:	DRG	
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.
Driveways & Walks	25,793	0.59	0.89	0.9	0.92	0.94	0.95	0.96	100%
Lawns	1,662	0.04	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**27,455**	**0.63**	**0.84**	**0.85**	**0.87**	**0.90**	**0.91**	**0.92**	**93.9%**

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft $\qquad C_v$ 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	295	4	-	-	-	-	
Initial Time	100	2	0.015	-	3.9	11.6	DCM Eq. 6-8
Shallow Channel	35	1	0.014	2.4	0.2	-	DCM Eq. 6-9
Channelized	160	2	0.011	2.0	1.3	-	C&G
				t_c	**5.5 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.00	5.02	5.86	6.69	7.53	8.43
Runoff (cfs)	2.1	**2.7**	3.2	3.8	4.3	**4.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.1	**2.7**	3.2	3.8	4.3	**4.9**

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 B1 Runoff Calculations

2

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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.
Driveways & Walks	6,096	0.14	0.89	0.9	0.92	0.94	0.95	0.96	100%
Lawns	1,386	0.03	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**7,482**	**0.17**	**0.73**	**0.75**	**0.78**	**0.81**	**0.83**	**0.85**	**81.5%**

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	116	9	-	-	-	-	
Initial Time	100	8	0.080	-	3.2	10.6	DCM Eq. 6-8
Shallow Channel	16	1	0.063	5.0	0.1	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	C&G
				t_c	**5.0 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.12	5.17	6.03	6.89	7.75	8.68
Runoff (cfs)	0.5	**0.7**	0.8	1.0	1.1	**1.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.5	**0.7**	0.8	1.0	1.1	**1.3**

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

Sub-Basin C1 Runoff Calculations

3

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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.
Driveways & Walks	3,650	0.08	0.89	0.9	0.92	0.94	0.95	0.96	100%
Lawns	1,169	0.03	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**4,819**	**0.11**	**0.68**	**0.70**	**0.73**	**0.77**	**0.79**	**0.81**	**75.7%**

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	160	8	-	-	-	-	
Initial Time	32	1	0.022	-	3.1	10.9	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	128	7	0.057	2.5	0.9	-	C&G
				t_c	**5.0 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.12	5.17	6.03	6.89	7.75	8.68
Runoff (cfs)	0.3	**0.4**	0.5	0.6	0.7	**0.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.3	**0.4**	0.5	0.6	0.7	**0.8**

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.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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.
Roofs	15,888	0.36	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**15,888**	**0.36**	**0.71**	**0.73**	**0.75**	**0.78**	**0.80**	**0.81**	**90.0%**

Basin Travel Time

Shallow Channel Ground Cover Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	205	2	-	-	-	-	
Initial Time	30	0	0.010	-	3.7	11.1	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	175	2	0.010	5.0	0.6	-	Pipe
				t_c	**5.0 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.12	5.17	6.03	6.89	7.75	8.68
Runoff (cfs)	1.1	**1.4**	1.6	2.0	2.3	**2.6**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.1	**1.4**	1.6	2.0	2.3	**2.6**
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 E1 Runoff Calculations

5

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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.
Driveways & Walks	1,047	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Lawns	6,356	0.15	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**7,403**	**0.17**	**0.14**	**0.20**	**0.26**	**0.35**	**0.39**	**0.44**	**14.1%**

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	87	3	-	-	-	-	
Initial Time	87	3	0.029	-	10.7	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	-	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	4.73	5.41	6.09	6.81
Runoff (cfs)	0.1	**0.1**	0.2	0.3	0.4	**0.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.1**	0.2	0.3	0.4	**0.5**

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 F1 Runoff Calculations

(6)

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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.
Driveways & Walks	3,305	0.08	0.89	0.9	0.92	0.94	0.95	0.96	100%
Lawns	4,102	0.09	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**7,407**	**0.17**	**0.41**	**0.45**	**0.49**	**0.56**	**0.59**	**0.62**	**44.6%**

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	87	2	-	-	-	-	
Initial Time	87	2	0.017	-	9.2	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	-	C&G

t_c **9.2 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.39	4.25	4.96	5.67	6.38	7.14
Runoff (cfs)	0.2	**0.3**	0.4	0.5	0.6	**0.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.3**	0.4	0.5	0.6	**0.8**

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

Job No.:	**61090**	Date:	**3/22/18 10:03**
Project:	**Freedom Springs**	Calcs by:	**TJW**
		Checked by:	**DRG**
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.**
Lawns	25,376	0.58	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**25,376**	**0.58**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

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	260	14	-	-	-	-	
Initial Time	100	4	0.040	-	11.7	11.4	DCM Eq. 6-8
Shallow Channel	160	10	0.063	1.8	1.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**11.4 min.**		

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	3.13	3.93	4.58	5.24	5.89	6.59
Runoff (cfs)	0.0	**0.2**	0.4	0.8	1.0	**1.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.2**	0.4	0.8	1.0	**1.3**

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

Sub-Basin H1 Runoff Calculations

Job No.:	**61090**	Date:	**3/22/18 10:03**
Project:	**Freedom Springs**	Calcs by:	**TJW**
		Checked by:	**DRG**
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.**
Driveways & Walks	15,473	0.36	0.89	0.9	0.92	0.94	0.95	0.96	100%
Lawns	4,028	0.09	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**19,501**	**0.45**	**0.71**	**0.73**	**0.76**	**0.80**	**0.82**	**0.83**	**79.3%**

Basin Travel Time

Shallow Channel Ground Cover Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	310	12	-	-	-	-	
Initial Time	65	1	0.015	-	4.7	11.7	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	245	11	0.045	3.0	1.4	-	C&G
				t_c	**6.0 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.90	4.89	5.71	6.52	7.34	8.21
Runoff (cfs)	1.2	**1.6**	1.9	2.3	2.7	**3.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.2	**1.6**	1.9	2.3	2.7	**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

Sub-Basin J1 Runoff Calculations

Job No.:	**61090**	Date:	**3/22/18 10:03**
Project:	**Freedom Springs**	Calcs by:	**TJW**
		Checked by:	**DRG**
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.
Lawns	20,091	0.46	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**20,091**	**0.46**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

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	125	6	-	-	-	-	
Initial Time	100	4	0.040	-	11.7	10.7	DCM Eq. 6-8
Shallow Channel	25	2	0.080	2.0	0.2	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch

t_c **10.7 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.22	4.03	4.70	5.37	6.04	6.76
Runoff (cfs)	0.0	**0.1**	0.3	0.6	0.8	**1.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.1**	0.3	0.6	0.8	**1.1**

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

Sub-Basin K1 Runoff Calculations

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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.
Lawns	6,322	0.15	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**6,322**	**0.15**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	33	4	-	-	-	-	
Initial Time	33	4	0.106	-	4.9	10.2	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	C&G

t_c 5.0 min.

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.12	5.17	6.03	6.89	7.75	8.68
Runoff (cfs)	0.0	**0.1**	0.1	0.3	0.3	**0.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.1**	0.1	0.3	0.3	**0.4**

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

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
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 L1 Runoff Calculations

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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.
Lawns	19,790	0.45	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**19,790**	**0.45**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

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	240	15	-	-	-	-	
Initial Time	100	6	0.055	-	10.5	11.3	DCM Eq. 6-8
Shallow Channel	140	10	0.068	1.8	1.3	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch

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	3.94	4.60	5.26	5.91	6.62
Runoff (cfs)	0.0	**0.1**	0.3	0.6	0.8	**1.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.1**	0.3	0.6	0.8	**1.1**

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

Sub-Basin M1 Runoff Calculations

Job No.:	**61090**	Date:	**3/22/18 10:03**
Project:	**Freedom Springs**	Calcs by:	**TJW**
		Checked by:	**DRG**
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.**
Lawns	5,771	0.13	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**5,771**	**0.13**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

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	32	3	-	-	-	-	
Initial Time	32	3	0.088	-	5.1	10.2	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**5.1**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.10	5.14	6.00	6.86	7.71	8.63
Runoff (cfs)	0.0	**0.1**	0.1	0.2	0.3	**0.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.1**	0.1	0.2	0.3	**0.4**

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

Includes Basins OS2 L1

Job No.:	61090	Date:	3/22/18 10:03
Project:	Freedom Springs	Calcs by:	TJW
		Checked by:	DRG
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	24,712	0.57	0.41	0.45	0.49	0.54	0.57	0.59	65%
Lawns	19,790	0.45	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**44,502**	**1.02**	**0.24**	**0.29**	**0.34**	**0.41**	**0.45**	**0.48**	**36.1%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OS2	-	190	3	-	-	-	-	11.1
Channelized-1	V-Ditch	2	76	12	2	1	2	4.0	0.3
Channelized-2						1			
Channelized-3									
Total			266	15					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **11.4**

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)	3.14	3.94	4.59	5.25	5.90	6.61
Site Runoff (cfs)	0.76	**1.15**	1.59	2.20	2.71	**3.26**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**1.1**	-	-	-	**3.3**

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.

Combined Sub-Basin Runoff Calculations

4

Includes Basins OS1 H1

Job No.:	**61090**	Date:	**3/22/18 10:03**
Project:	**Freedom Springs**	Calcs by:	**TJW**
		Checked by:	**DRG**
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	123,800	2.84	0.41	0.45	0.49	0.54	0.57	0.59	65%
Driveways & Walks	15,473	0.36	0.89	0.9	0.92	0.94	0.95	0.96	100%
Lawns	4,028	0.09	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**143,301**	**3.29**	**0.45**	**0.49**	**0.53**	**0.58**	**0.60**	**0.62**	**67.0%**

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	OS1	-	580	9	-	-	-	-	13.2
Channelized-1	C&G	Asphalt	286	12	10	1	0	4.0	1.2
Channelized-2						1			
Channelized-3									
Total			866	21					
								t_c (min)	**14.4**

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)	2.86	3.58	4.18	4.77	5.37	6.01
Site Runoff (cfs)	4.24	**5.75**	7.24	9.03	10.66	**12.32**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**5.7**	-	-	-	**12.3**
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.

Combined Sub-Basin Runoff Calculations

7

Includes Basins A1 B1 C1 D1 E1 F1 G1 H1

Job No.:	**61090**	Date:		**3/22/18 10:03**
Project:	**Freedom Springs**	Calcs by:	**TJW**	
		Checked by:	**DRG**	
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.**
Roofs	15,888	0.36	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	55,364	1.27	0.89	0.9	0.92	0.94	0.95	0.96	100%
Lawns	44,079	1.01	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**115,331**	**2.65**	**0.53**	**0.56**	**0.60**	**0.65**	**0.68**	**0.71**	**60.4%**

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	-	295	4	-	-	-	-	5.5
Channelized-1	Pipe	HDPE	119	5	5	1	0	5.9	0.3
Channelized-2	Pipe	HDPE	116	4	5	1	0	5.4	0.4
Channelized-3									
Total			530	12					
								t_c (min)	**6.2**

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)	3.86	4.84	5.65	6.46	7.26	8.13
Site Runoff (cfs)	5.45	**7.22**	9.01	11.19	13.10	**15.20**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**7.2**	-	-	-	**15.2**

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

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

10 Hydraulic Calculations

Inlet Calculations
Storm Drain Pipe Calculations
Detention Pond Calculations

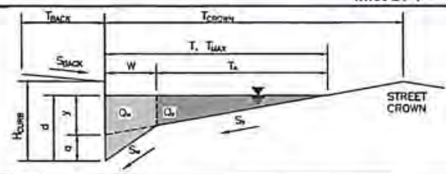
Version 4.05 Released March 2017

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

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

Project: Freedom Springs

Inlet ID: Inlet DP1



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	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} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.035	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} =	9.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	3.78	7.56	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.15	1.15	inches
Water Depth at Gutter Flowline	d =	4.93	8.71	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	7.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.556	0.296	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	SUMP	SUMP	cfs
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	11.5	11.5	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X TH}$ =	9.5	9.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.449	0.449	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X TH}$	$Q_{X TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	SUMP	SUMP	cfs
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		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

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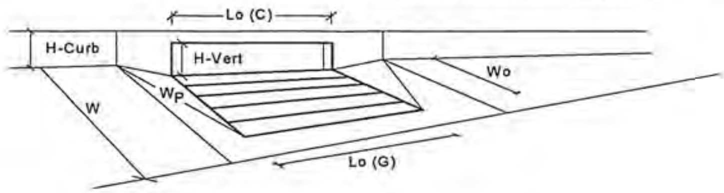


Design Information (Input)		MINOR	MAJOR	
Type of Inlet — Denver No. 16 Combination	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.9	6.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Warning 1 Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	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) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.434	0.523	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.25	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.58	0.71	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.58	0.71	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	3.6	6.2	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.7	4.9	cfs

Warning 1: Dimension entered is not a typical dimension for inlet type specified.

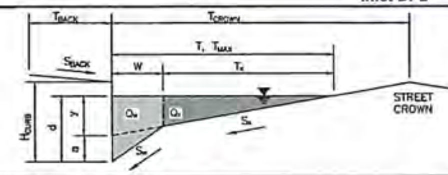
Version 4.05 Released March 2017

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

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

Project: Freedom Springs

Inlet ID: Inlet DP2



Gutter Geometry (Enter data in the blue cells)

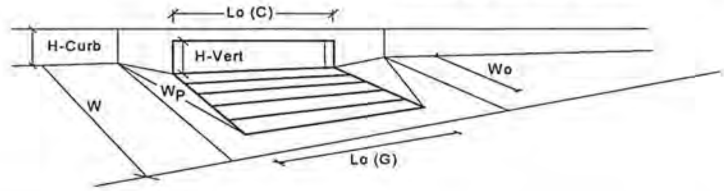
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.017	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} =	9.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	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 — Denver No. 16 Combination	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.4	5.3	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	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) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.308	0.461	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.12	0.27	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.53	0.82	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.53	0.82	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	0.9	2.9	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.7	1.3	cfs

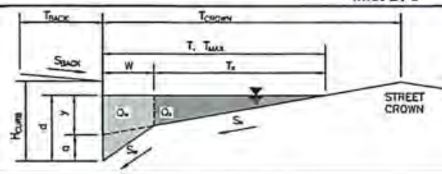
Version 4.05 Released March 2017

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

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

Project: Freedom Springs

Inlet ID: Inlet DP3



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	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} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.063	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 =	0.084	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} =	9.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

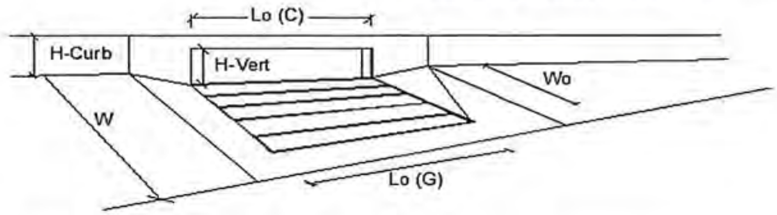
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	7.0	7.0	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet — Denver No. 16 Combination	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	0.3	0.5	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.1	0.3	cfs
Capture Percentage = Q_a/Q_o =	C% =	69	66	%

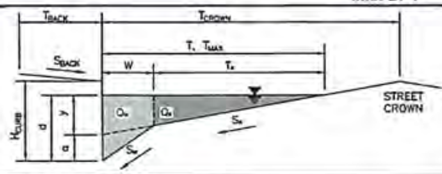
Version 4.05 Released March 2017

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

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

Project: Freedom Springs

Inlet ID: Inlet DP4



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	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} =	16.0	ft
Gutter Width	W =	2.00	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 =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.043	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} =	16.0	16.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

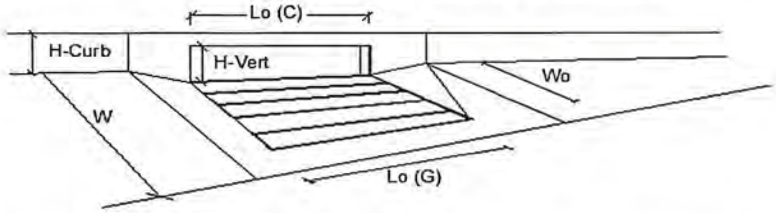
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	15.9	15.9	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

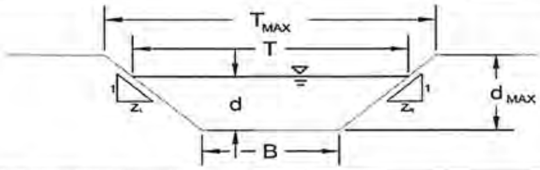
Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet — Denver No. 16 Combination	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	2.3	3.1	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	3.4	9.2	cfs
Capture Percentage = Q_a/Q_o =	C% =	40	25	%

AREA INLET IN A SWALE

Freedom Springs
Inlet DP5



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E	C	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0200	ft/ft
Bottom Width	B =	3.00	ft
Left Side Slope	Z1 =	20.00	ft/ft
Right Side Slope	Z2 =	20.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	13.00	23.00	feet
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	0.25	0.50	feet

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	0.3	1.4	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	0.25	0.50	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	0.1	0.5	cfs
Water Depth	d =	0.15	0.32	feet

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Version 4.05 Released March 2017

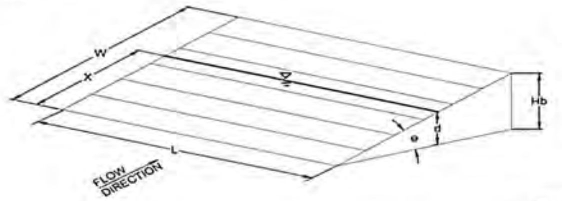
AREA INLET IN A SWALE

Freedom Springs

Inlet DP5

Inlet Design Information (Input)

Type of Inlet: User-Defined — Inlet Type = User-Defined

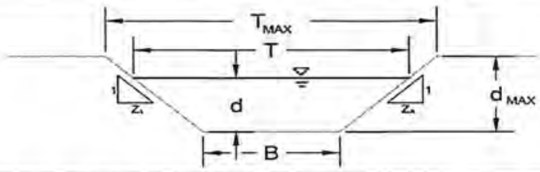


Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00	degrees
Width of Grate	W =	1.00	feet
Length of Grate	L =	1.00	feet
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	feet
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	N/A	
Orifice Coefficient	C_o =	0.64	
Weir Coefficient	C_w =	2.05	

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.15	0.32	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	0.4	1.0	cfs
	Bypassed Flow, Q_b =	0.0	0.0	cfs
	Capture Percentage = Q_a/Q_o = C%	100	100	%

AREA INLET IN A SWALE

Freedom Springs
Inlet DP6



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E	C	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0200	ft/ft
Bottom Width	B =	3.00	ft
Left Side Slope	Z1 =	20.00	ft/ft
Right Side Slope	Z2 =	20.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- (•) Non-Cohesive
- ( ) Cohesive
- ( ) Paved

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	16.00	23.00	feet
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	0.33	0.50	feet

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Top Width Criterion	Q_{allow} =	0.5	1.4	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	0.33	0.50	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	0.3	0.8	cfs
Water Depth	d =	0.26	0.40	feet

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

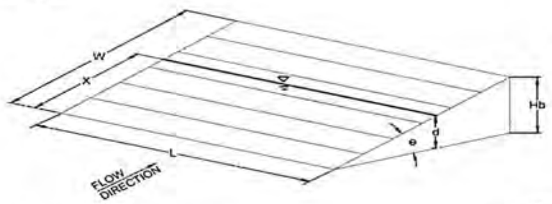
Version 4.05 Released March 2017

AREA INLET IN A SWALE

Freedom Springs
Inlet DP6

Inlet Design Information (Input)

Type of Inlet: User-Defined — Inlet Type = User-Defined



Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00	degrees
Width of Grate	W =	1.00	feet
Length of Grate	L =	1.00	feet
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	feet
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	N/A	
Orifice Coefficient	C_o =	0.64	
Weir Coefficient	C_w =	2.05	

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.26	0.40	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	0.8	1.1	cfs
	Bypassed Flow, Q_b =	0.0	0.0	cfs
	Capture Percentage = Q_a/Q_o = C%	100	100	%

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Wednesday, Mar 7 2018

Pipe from DP1 inlet to MH1

Circular

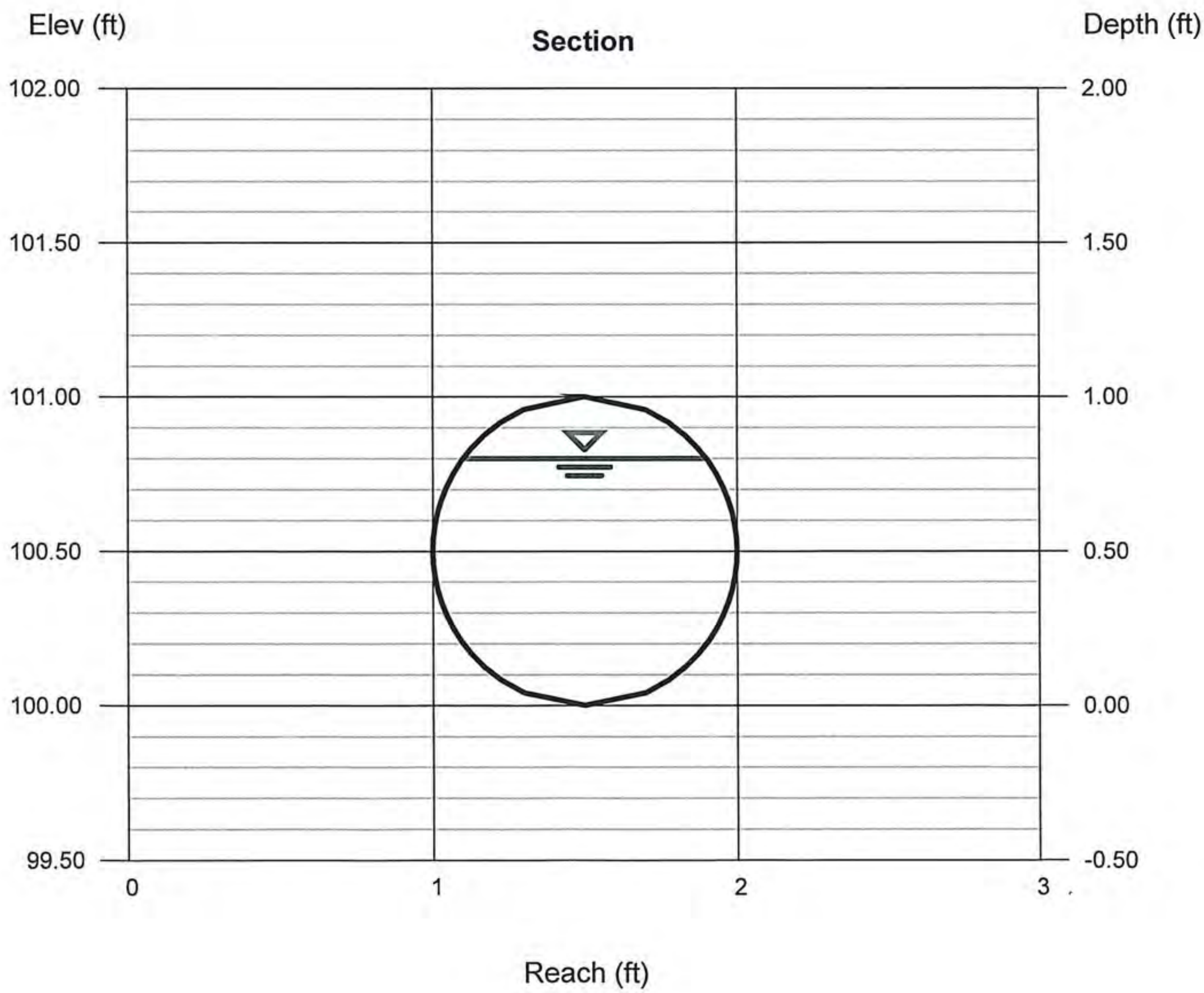
Diameter (ft)	= 1.00
Invert Elev (ft)	= 100.00
Slope (%)	= 2.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 4.90

Highlighted

Depth (ft)	= 0.80
Q (cfs)	= 4.900
Area (sqft)	= 0.67
Velocity (ft/s)	= 7.27
Wetted Perim (ft)	= 2.22
Crit Depth, Yc (ft)	= 0.92
Top Width (ft)	= 0.80
EGL (ft)	= 1.62



Channel Report

Pipe from DP2 inlet to MH1

Circular

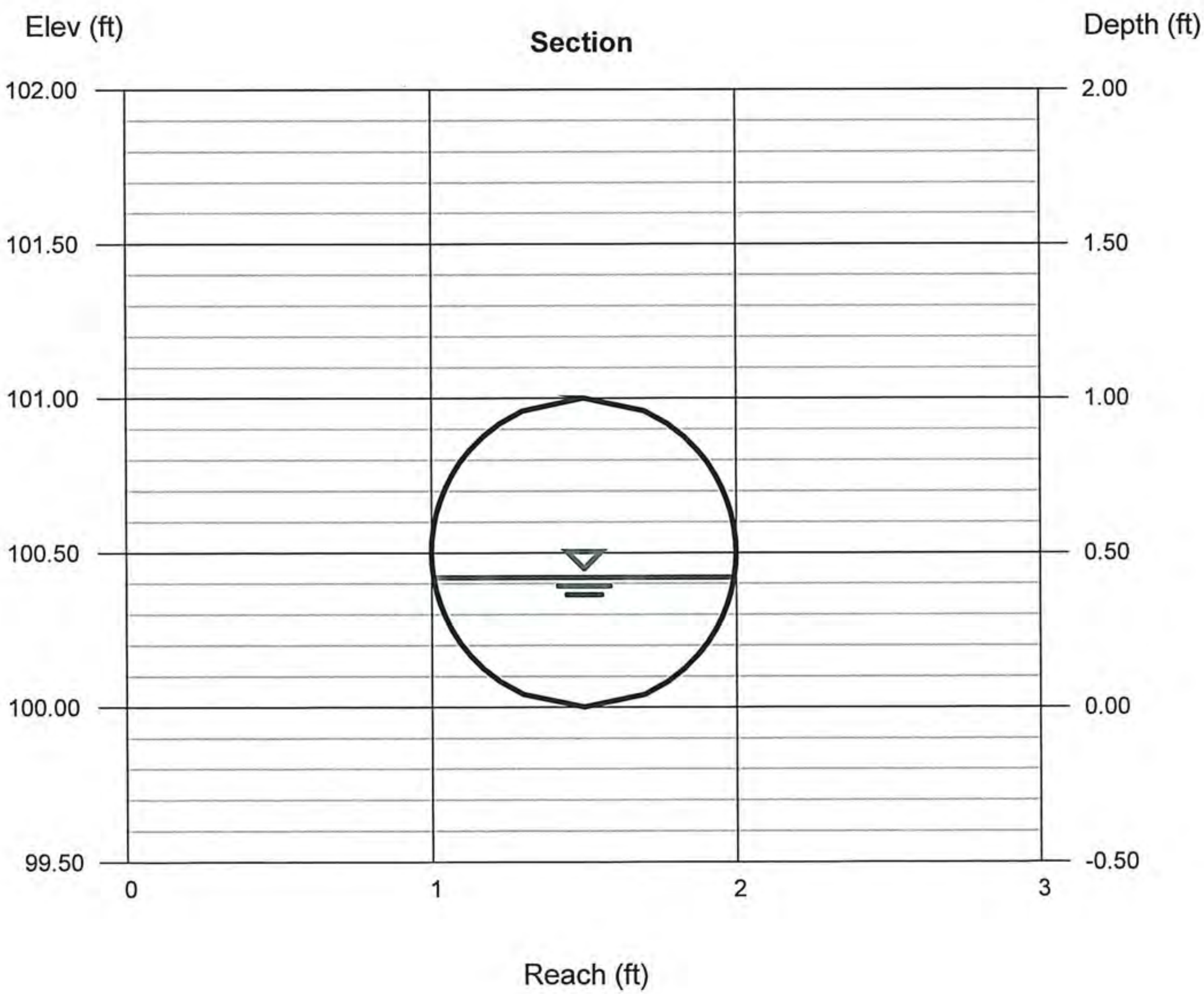
Diameter (ft)	= 1.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 1.30

Highlighted

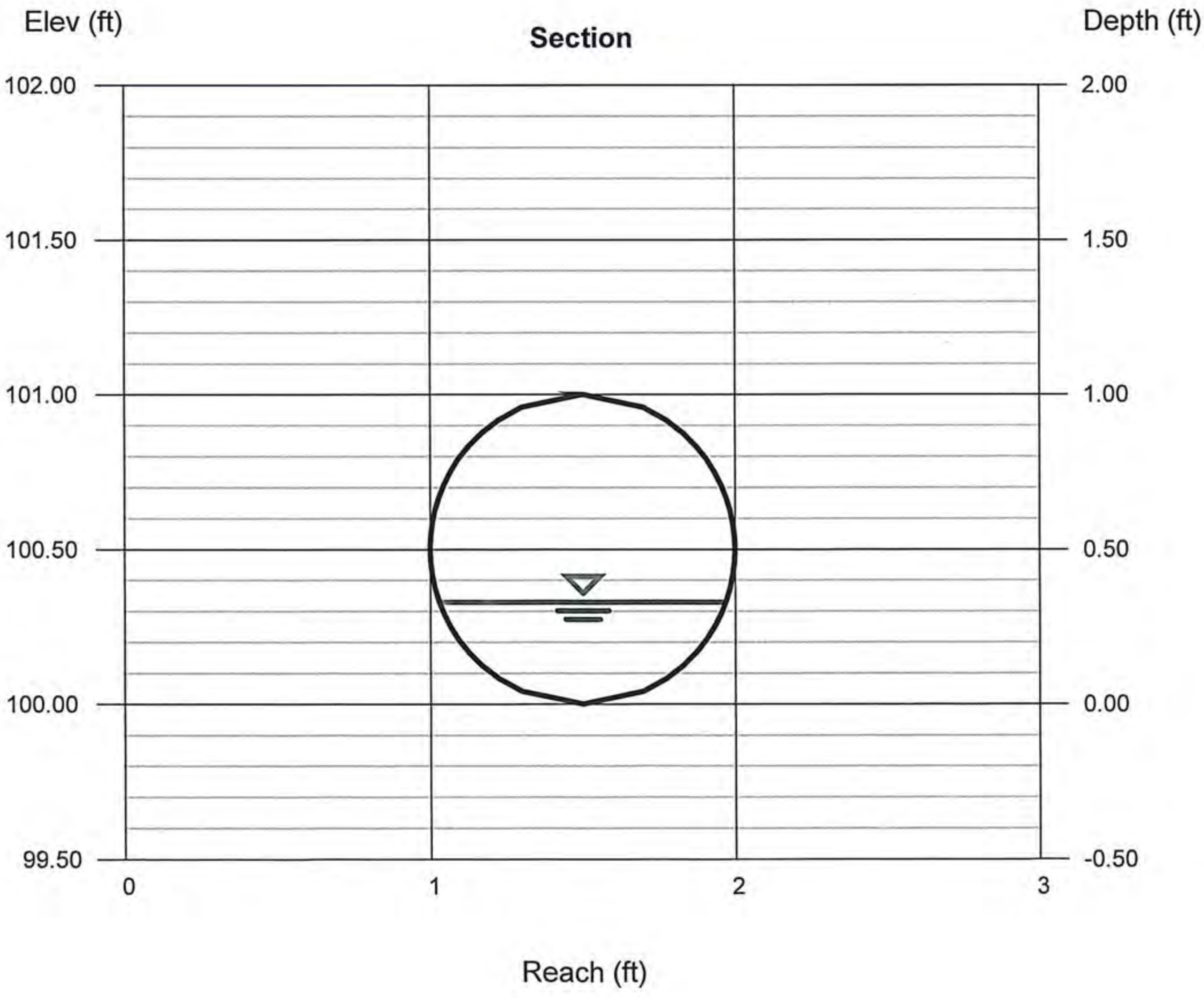
Depth (ft)	= 0.42
Q (cfs)	= 1.300
Area (sqft)	= 0.32
Velocity (ft/s)	= 4.12
Wetted Perim (ft)	= 1.41
Crit Depth, Yc (ft)	= 0.48
Top Width (ft)	= 0.99
EGL (ft)	= 0.68



Channel Report

Pipe from DP3 inlet to MH1

Circular		Highlighted	
Diameter (ft)	= 1.00	Depth (ft)	= 0.33
		Q (cfs)	= 0.800
		Area (sqft)	= 0.23
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 3.53
Slope (%)	= 1.00	Wetted Perim (ft)	= 1.22
N-Value	= 0.013	Crit Depth, Yc (ft)	= 0.38
		Top Width (ft)	= 0.94
Calculations		EGL (ft)	= 0.52
Compute by:	Known Q		
Known Q (cfs)	= 0.80		

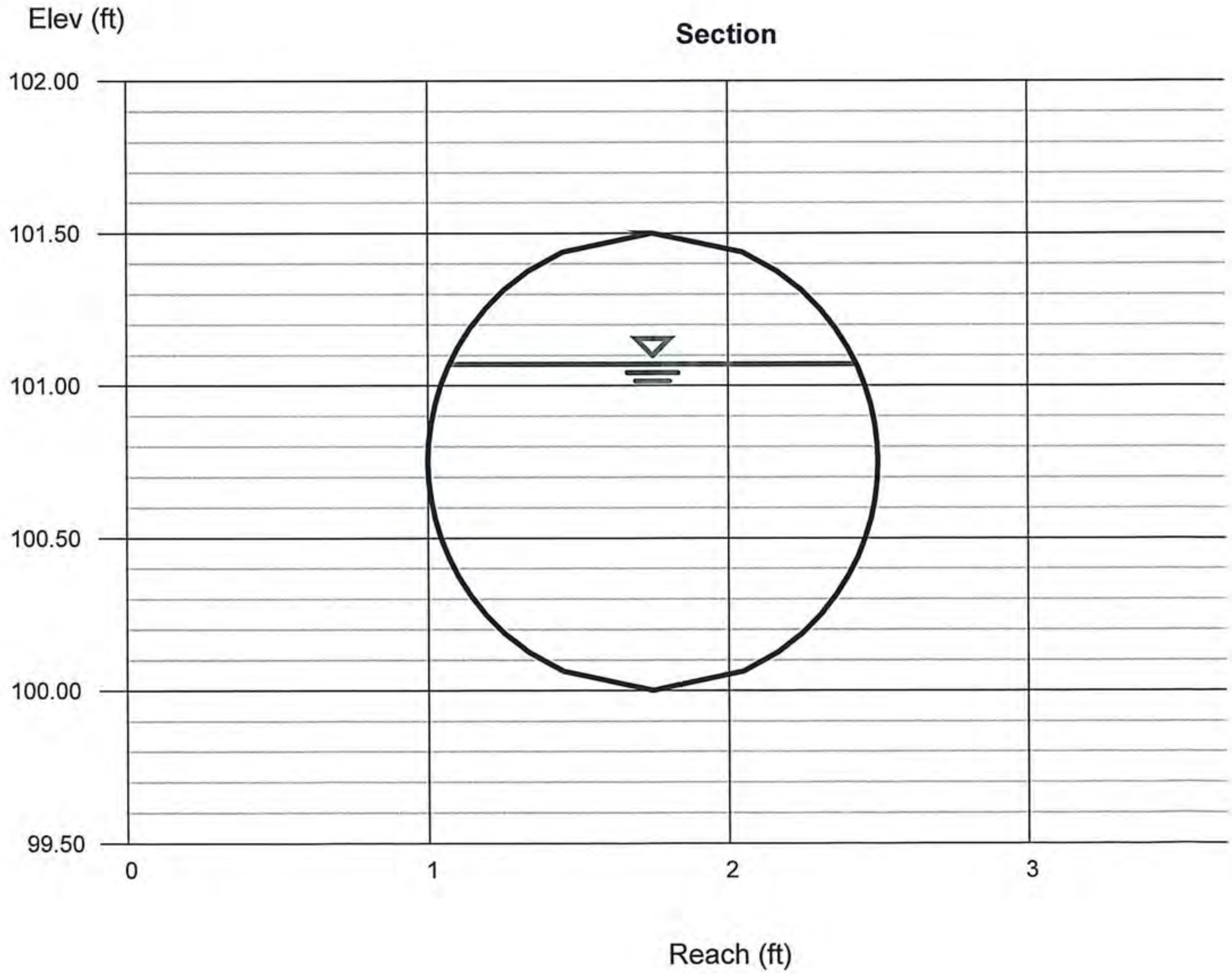


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Mar 7 2018

Pipe from MH1 to Pond

Circular		**Highlighted**	
Diameter (ft)	= 1.50	Depth (ft)	= 1.07
		Q (cfs)	= 12.70
		Area (sqft)	= 1.35
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 9.40
Slope (%)	= 2.00	Wetted Perim (ft)	= 3.02
N-Value	= 0.013	Crit Depth, Yc (ft)	= 1.34
		Top Width (ft)	= 1.35
Calculations		EGL (ft)	= 2.44
Compute by:	Known Q		
Known Q (cfs)	= 12.70		



Design Procedure Form: Sand Filter (SF)

Designer: TJW
Company: M.V.E., Inc.
Date: March 23, 2018
Project: Freedom Springs
Location: DP 7

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)	I_a = 61.8 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.618
C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time WQCV= $0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$	WQCV = 0.19 watershed inches
D) Contributing Watershed Area (including sand filter area)	Area = 97,781 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume V_{WQCV} = WQCV / 12 * Area	V_{WQCV} = 1,580 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = 1,543 cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = ______ cu ft
2. Basin Geometry	
A) WQCV Depth	D_{WQCV} = 2.5 ft
B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.	Z = 4.00 ft / ft
C) Minimum Filter Area (Flat Surface Area)	A_{Min} = 755 sq ft
D) Actual Filter Area	A_{Actual} = ______ sq ft
E) Volume Provided	V_T = ______ cu ft
3. Filter Material	Choose One ◉ 18" CDOT Class B or C Filter Material ○ Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One ○ YES ◉ NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = N/A ft
ii) Volume to Drain in 12 Hours	Vol_{12} = N/A cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = N/A in

Design Procedure Form: Sand Filter (SF)

Designer:	**TJW**
Company:	**M.V.E., Inc.**
Date:	**March 23, 2018**
Project:	**Freedom Springs**
Location:	**DP 7**

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6-7. Inlet / Outlet Works A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet	Outflows are small and will discharge to concrete channel to Western Drive Emergency spillway lined with rip rap to Western Drive

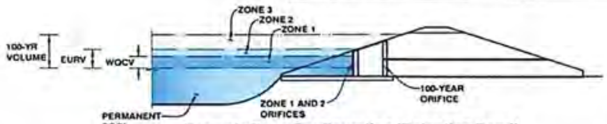
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Freedom Springs

Basin ID: Full Spectrum Sand Filter Basin - DP7



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF	
Watershed Area =	2.25	acres
Watershed Length =	430	ft
Watershed Slope =	0.036	ft/ft
Watershed Imperviousness =	61.80%	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 =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.036	acre-feet
Excess Urban Runoff Volume (EURV) =	0.170	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.117	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.152	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.186	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.226	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.272	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.326	acre-feet
500-yr Runoff Volume (P1 = 3.25 in.) =	0.464	acre-feet
Approximate 2-yr Detention Volume =	0.110	acre-feet
Approximate 5-yr Detention Volume =	0.144	acre-feet
Approximate 10-yr Detention Volume =	0.174	acre-feet
Approximate 25-yr Detention Volume =	0.210	acre-feet
Approximate 50-yr Detention Volume =	0.232	acre-feet
Approximate 100-yr Detention Volume =	0.256	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.25	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.036	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.133	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.086	acre-feet
Total Detention Basin Volume =	0.256	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Depth Increment = 0.25 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	3,208	0.074		
	--	0.25	--	--	--	3,500	0.080	804	0.018
WQCV=6301.46	--	0.50	--	--	--	3,818	0.088	1,715	0.039
	--	0.75	--	--	--	4,148	0.095	2,708	0.062
	--	1.00	--	--	--	4,505	0.103	3,786	0.087
	--	1.25	--	--	--	4,844	0.111	4,951	0.114
	--	1.50	--	--	--	5,214	0.120	6,204	0.142
EURV=6302.71	--	1.75	--	--	--	5,596	0.128	7,552	0.173
	--	2.00	--	--	--	6,011	0.138	8,999	0.207
	--	2.25	--	--	--	6,396	0.147	10,609	0.244
100 YR=6303.34	--	2.50	--	--	--	6,817	0.156	12,261	0.281
	--	2.75	--	--	--	7,250	0.166	14,019	0.322
	--	3.00	--	--	--	7,715	0.177	15,890	0.365
	--	3.25	--	--	--	8,151	0.187	17,873	0.410
	--	3.50	--	--	--	8,622	0.198	19,970	0.458
	--	3.75	--	--	--	9,105	0.209	22,186	0.509
	--	4.00	--	--	--	9,631	0.221	24,528	0.563
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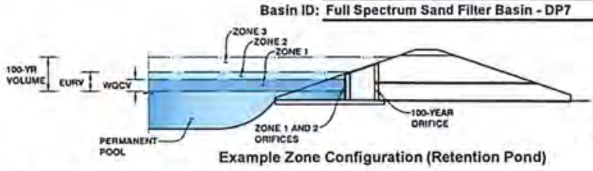
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Freedome Springs

Basin ID: Full Spectrum Sand Filter Basin - DP7



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.46	0.036	Filtration Media
Zone 2 (EURV)	1.72	0.133	Orifice Plate
Zone 3 (100-year)	2.34	0.086	Weir&Pipe (Restrict)
		0.256	Total

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

Underdrain Orifice Invert Depth =	2.00	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	0.97	inches

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.46	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.75	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	5.00	inches
Orifice Plate: Orifice Area per Row =	2.94	sq. inches (diameter = 1-15/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	2.042E-02	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)	0.46	0.89	1.32					
Orifice Area (sq. inches)	2.94	2.94	2.94					

	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 =	1.75	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 =	1.75	N/A	feet
Over Flow Weir Slope Length =	2.92	N/A	feet
Grate Open Area / 100-yr Orifice Area =	59.91	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 =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	2.10		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.12	N/A	ft^2
Outlet Orifice Centroid =	0.10	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.70	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	6.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

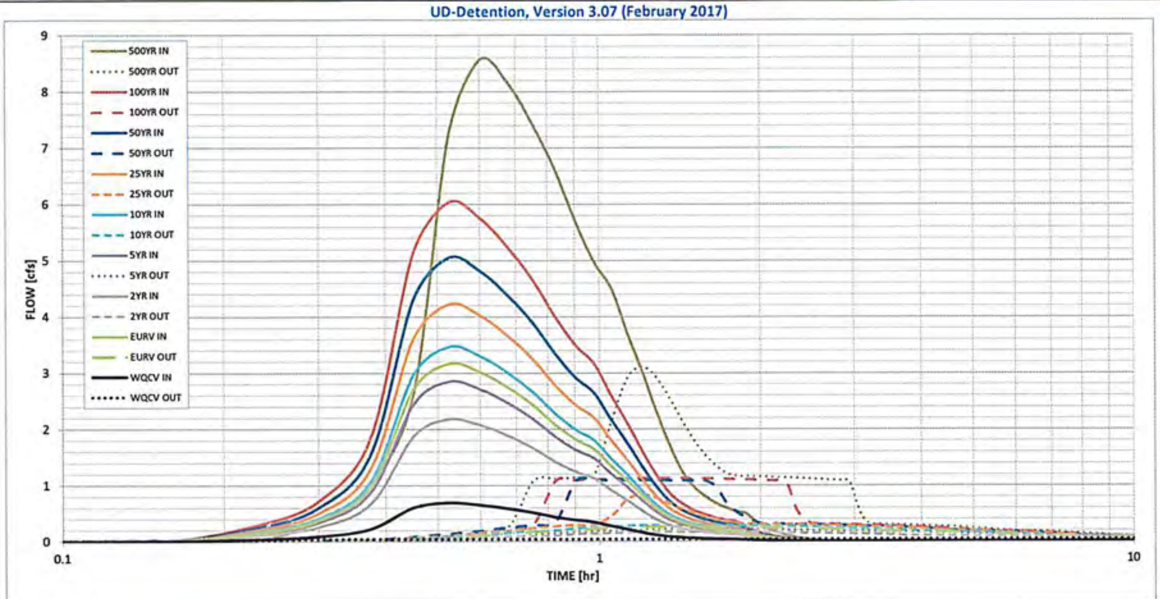
Spillway Design Flow Depth=	0.42	feet
Stage at Top of Freeboard =	3.92	feet
Basin Area at Top of Freeboard =	0.22	acres

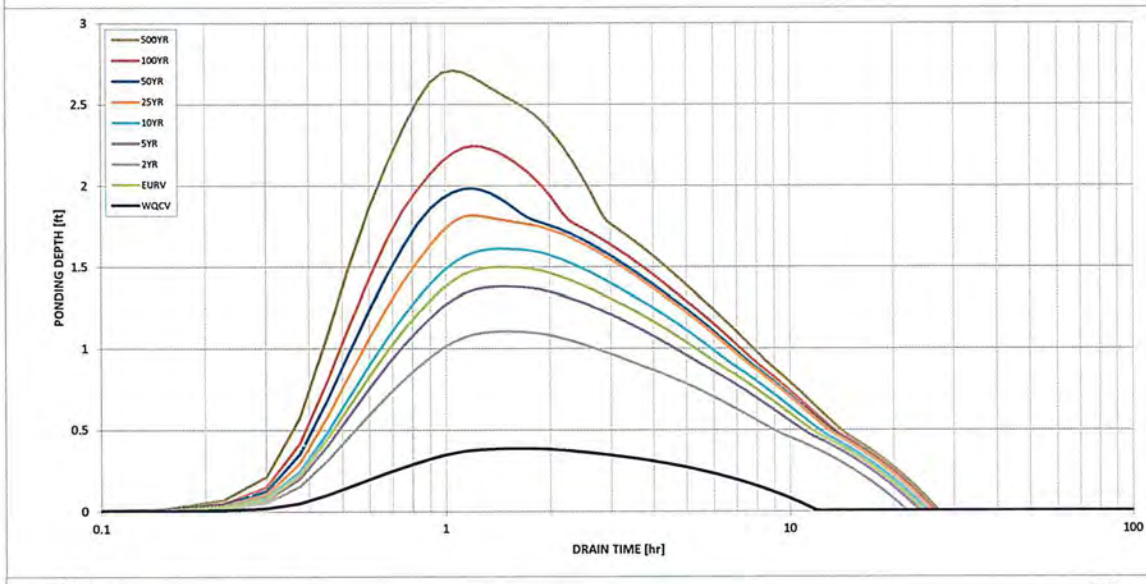
Routed Hydrograph Results

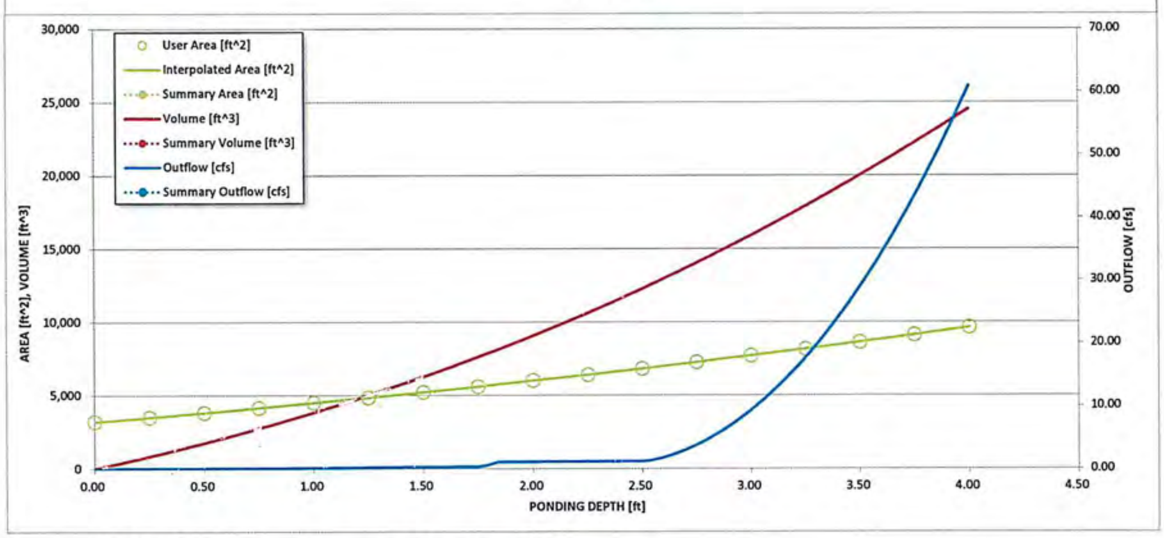
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.25
Calculated Runoff Volume (acre-ft) =	0.036	0.170	0.117	0.152	0.186	0.226	0.272	0.326	0.464
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.035	0.169	0.116	0.152	0.185	0.226	0.272	0.325	0.463
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.01	0.03	0.23	0.55	1.27
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.5	1.2	2.9
Peak Inflow Q (cfs) =	0.7	3.2	2.2	2.8	3.5	4.2	5.1	6.0	8.6
Peak Outflow Q (cfs) =	0.0	0.3	0.2	0.2	0.3	0.8	1.1	1.1	3.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	17.5	9.3	11.8	2.1	0.9	1.1
Structure Controlling Flow =	Filtration Media	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.1	0.1	0.1
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) =	12	23	21	22	23	24	23	23	22
Time to Drain 99% of Inflow Volume (hours) =	12	24	22	23	25	25	25	25	26
Maximum Ponding Depth (ft) =	0.38	1.50	1.11	1.38	1.61	1.82	1.98	2.24	2.71
Area at Maximum Ponding Depth (acres) =	0.08	0.12	0.11	0.12	0.12	0.13	0.14	0.15	0.16
Maximum Volume Stored (acre-ft) =	0.030	0.144	0.098	0.128	0.157	0.182	0.205	0.242	0.314

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



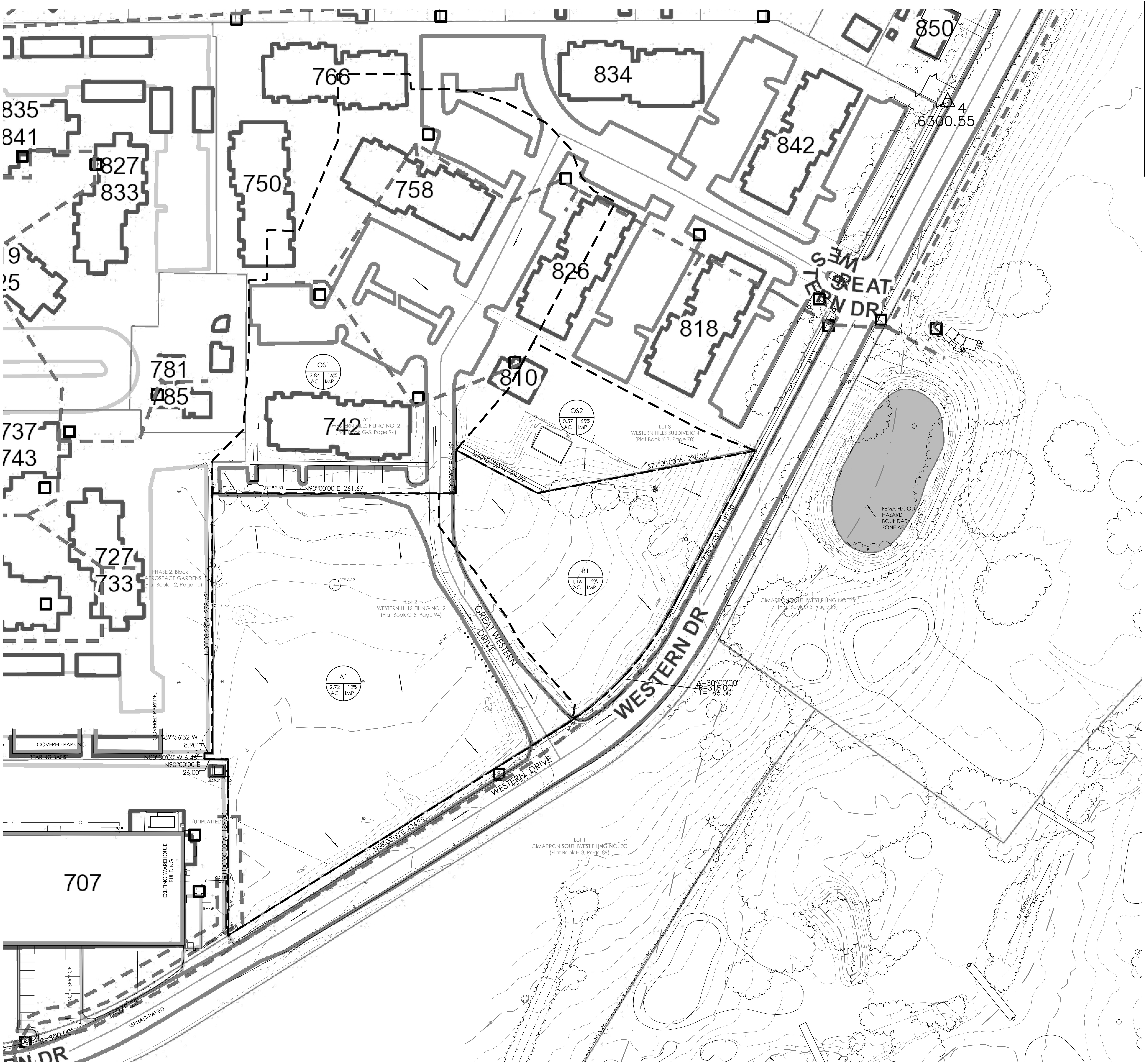


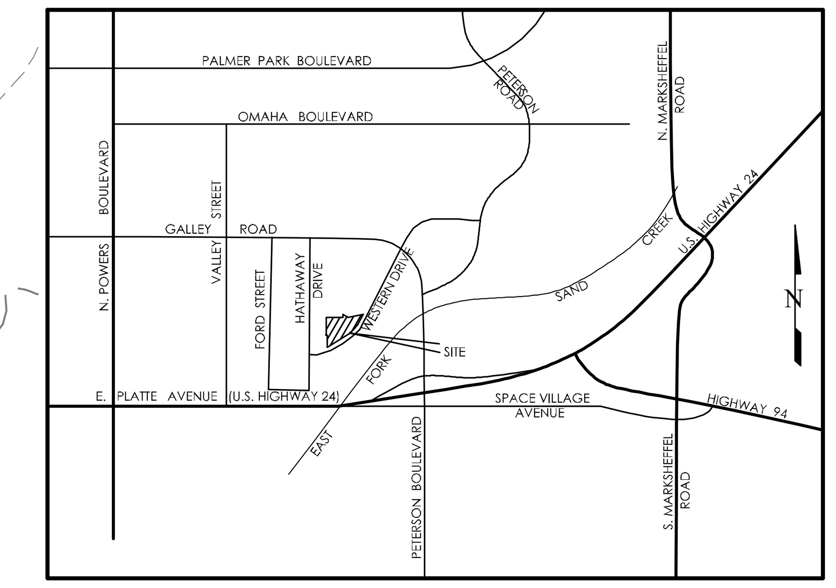


S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

11 Report Maps

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





VICINITY MAP
NO SCALE

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

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

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

N

1" = 50' 1:600

BENCHMARK

REVISIONS

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

EXISTING DRAINAGE SUMMARY TABLE

POINT OF INTEREST/BASIN(S) BASIN(S)	AREA (AC)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)
OS1	2.84	4.7	10.4
A1	2.72	1.7	7.2
OS2	0.57	1.1	2.5
B1	1.16	0.4	2.8
OS1+A1	5.56	6.2	17.0
OS2+B1	1.72	1.4	5.0
OS1,OS2,A1,B1	7.28	7.6	22.0

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DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

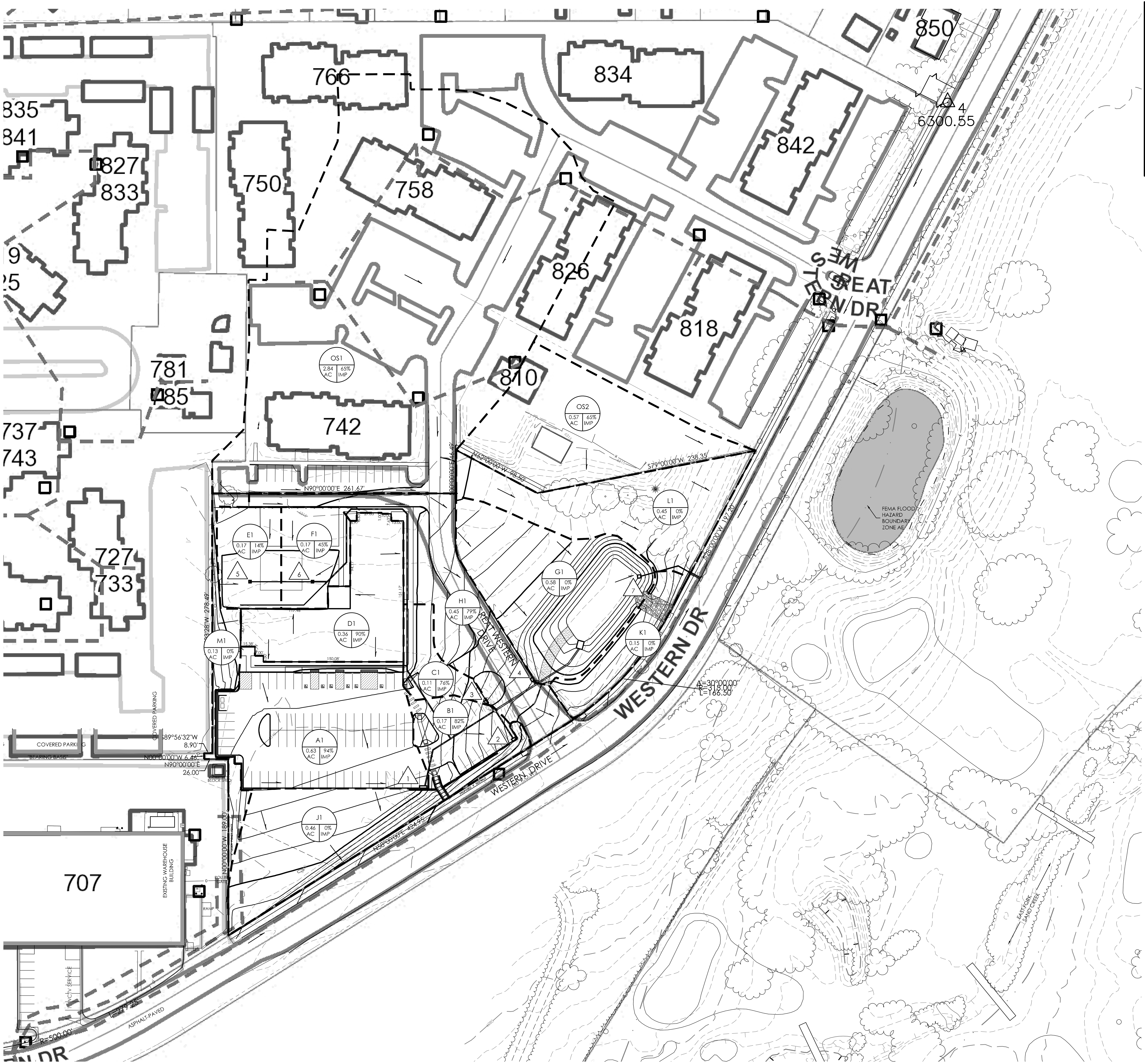
FREEDOM SPRINGS 734 WESTERN DRIVE

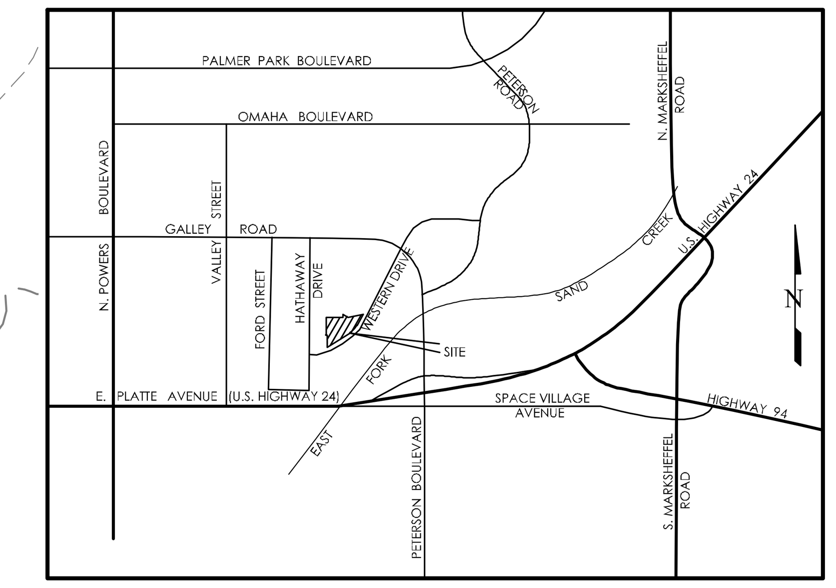
Existing Drainage Map

MVE PROJECT 61090
MVE DRAWING Ex-Drain-Map

November 8, 2018

SHEET 1 OF 1





VICINITY MAP
NO SCALE

BENCHMARK

LEGEND

PROPERTY LINE
EASEMENT LINE
LOT LINE
BUILDING SETBACK LINE

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

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

N

1" = 50' 1:600

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

REVISIONS

PROPOSED DRAINAGE SUMMARY TABLE

POINT OF INTEREST/BASIN(S) BASIN(S)		AREA (AC)	RUNOFF	
			Q5 (CFS)	Q100 (CFS)
	OS1	2.84	4.7	10.4
	H1	0.45	1.6	3.1
DP1	A1	0.63	2.7	4.9
DP2	B1	0.17	0.7	1.3
DP3	C1	0.11	0.4	0.8
DP4	OS1,H1	3.29	5.7	12.3
	D1	0.36	1.4	2.6
DP5	E1	0.17	0.1	0.5
DP6	F1	0.17	0.3	0.8
	G1	0.58	0.2	1.3
DP7	A1,B1,C1,D1,E1,F1,G1,H1	2.65	7.2	15.2
DP7	POND OUTFLOW	2.65	0.2	1.1
	J1	0.46	0.1	1.1
	K1	0.15	0.1	0.4
	M1	0.13	0.1	0.4
	OS2	0.57	1.1	2.5
	L1	0.45	0.1	1.1
	OS2,L1	1.02	1.1	3.3
	OS1,H1,A1,B1,C1,D1, E1, F1,G1,H1,J1, K1, OS2,L1	7.11	4.7	14.4

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

FREEDOM SPRINGS
734 WESTERN DRIVE

Proposed Drainage Map

MVE PROJECT 61090
MVE DRAWING Ex-Drain-Map

November 8, 2018

SHEET 1 OF 1