WWE
Wright Water Engineers, Inc.
2490 West 26th Ave., Suite 100A
Denver, Colorado 80211
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November 11, 2017

Via: Electronic Submittal

El Paso County
Engineering Division
200 South Cascade Avenue, Suite 100
Colorado Springs, CO 80903-2208

Re: **Drainage Letter Report for the Forest Lakes Metropolitan District Water Intake and Treatment Plant Project**

Wright Water Engineers, Inc. (WWE), on behalf of the Forest Lakes Metropolitan District (FLMD), has prepared this El Paso County Drainage Letter Report Letter to provide a summary of the anticipated drainage and water quality impacts resulting from the construction of the FLMD Water Intake and Treatment Plant Project. This letter report generally follows the El Paso County "Small Subdivision Drainage Report (Letter Report) Checklist" requirements.

Statements and Signatures

Design Engineer's Statement:

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

Hayes A. Lenhart, P.E. #46527

11/11/2017
Date

Owner/Developer's Statement:

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

Ann Nichols, District Manager
Forest Lakes Metropolitan District
2 North Cascade Avenue, Ste. 1280
Colorado Springs, CO 80903

11/12/17
Date

PCD Project No. PPR-17-043

*Prior to issuance of NTP, Engineer must submit an addendum to the final drainage report that address' the overflow from backwash basins.

El Paso County:

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

Approved *

By:Jennifer Irvine, County Engineer
Date:01/04/2018
El Paso County Department of Public Works

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

Conditions:

Name and Purpose of Report

The Forest Lakes Metropolitan District – Water Intake and Treatment Plant (FLMD WTP) Project includes the following construction and site development improvements:

- Construction of a 6,600 sq. ft. surface water treatment plant building and associated raw water intake structure which will deliver water from Bristlecone Reservoir to the treatment plant building.
- The building will house various water treatment systems designed to provide the FLMD with a drinking water supply.
- The project also includes site development improvements including an asphalt roadway, parking area and landscaping.

The development area associated with the water treatment plant (WTP) was included as part of the March 2016 “Preliminary & Final Drainage Report for Forest Lakes Filings 2A & 2B” prepared by Classic Consulting Engineers & Surveyors (2016 Forest Lakes Drainage Report). This previously approved drainage report is El Paso County Reference File no. PPR-06-042.

At the time of the development of the 2016 Forest Lakes Drainage Report, the proposed conditions associated with the FLMD water treatment plant had not yet been finalized. The purpose of this drainage letter report is to summarize the changes in drainage characteristics to the basins affected by the construction of the WTP and document that the regional stormwater treatment facilities being constructed as part of the Forest Lakes Filings 2A and 2B project will not be adversely impacted as a result of the additional surface runoff generated by the FLMD WTP site.

General Property Description

The FLMD WTP property is located in Monument, Colorado. The property area associated with the FLMD WTP makes up approximately 3.5 acres of a 113.85 acre parcel owned by the FLMD (El Paso County Tax Schedule No 7127000011). The project centroid is located at approximately 39° 3'43.27" North, 104°52'31.93" West. A site vicinity map is provided in Attachment A.

The WTP site will be located immediately east and adjacent to Bristlecone Reservoir. The raw water intake structure will be located approximately 1,800 feet west of the WTP and will house pumps and associated appurtenances to deliver raw water from the reservoir to the WTP.

Existing Drainage Characteristics

The proposed WTP is bound to the west by Bristlecone Reservoir which is fed by a perennial water way named Beaver Creek. Upstream of the reservoir, Beaver Creek flows generally from west to east. Downstream of the reservoir, Beaver Creek generally runs southeast and is tributary to Monument Creek. The WTP is bound on the east side by the Pinon Lake Tributary, an ephemeral channel which is tributary to Pinon Lake. The outlet of Pinon Lake flows into Beaver Creek downstream of Bristlecone Reservoir.

Existing surface runoff at the WTP site generally flows southeasterly and away from the reservoir. This surface water flows to either an existing 48" storm sewer pipe which delivers water to Pinion Lake or flows onto Long Valley Drive and into Pinon Lake. The western portion of the existing WTP site flows southwesterly and runs onto the existing Bristlecone Reservoir spillway.

The developed portion of the proposed WTP site lies within two existing basins associated with the 2016 Forest Lakes Drainage Report, basins EX-C and EX-D (shown in Attachment B). The majority of the WTP site lies within basin EX-D.

Basin EX-C, according to the 2016 Forest Lakes Drainage Report, is a 2.76 acre basin which drains a portion of the existing Forest Lakes Drive Roadway and portion of undeveloped land. An existing 15' Type-R at-grade inlet intercepts a portion of this runoff (Q_5 = 3.2 cfs and Q_{100}= 6.8 cfs) and an existing 18" RCP (Pipe 5) conveys it to a 48" storm sewer main. The existing 48" pipe contains a combined runoff rate of Q_5 = 26 cfs and Q_{100} = 177 cfs and currently daylights within the proposed Filing 2B parcel (Basin EX-E). This runoff continues into Pinon Lake without detention or water quality treatment as originally approved with the Filing No. 1 development and drainage plan. The runoff not intercepted by this existing at-grade inlet flows onto EX-D and which eventually drains into Pinon Lake.

Basin EX-D, according to the 2016 Forest Lakes Drainage Report, is a 13.5 acre basin which currently drains an undeveloped portion of the proposed Filing 2B site and is directly tributary to an off-site area that drains directly south along the western boundary into the Bristlecone Lake spillway rundown.
The existing drainage basin delineations associated with the WTP site from the 2016 Forest Lakes Drainage Report are provided in Attachment B.

The proposed raw water intake structure, which lies approximately 1,800 feet west of the WTP site is located on the banks of Bristlecone Reservoir above the reservoir's expected 100-year water surface elevation. All surface water in this area flows immediately south to the reservoir.

Proposed Drainage Characteristics

Changes to Developed Basin B and Basin D

As part of the 2016 Forest Lakes Drainage Report proposed drainage conditions were developed in consideration of the residential development sites for Filings 2A and 2B. The primary basins which are affected by the development of the WTP are developed Basins B and D. See Attachment B for an illustration of the developed condition drainage areas associated with Basins B and D as provided in the 2016 Forest Lakes Drainage Report. These proposed drainage basins did not include considerations for the impervious area resulting from the construction of the FLMD WTP.

Attachment E provides an illustration of the updated drainage basin delineations associated with the proposed FLMD WTP. There are three proposed drainage basins, Basin C, Basin D.1 and Basin D. Surface runoff from Basin D.1 will be routed to a new Bioretention Facility while surface runoff from Basins C and D will be routed in accordance with the 2016 Forest Lakes Drainage Report. As shown in Attachment C and Table 1, the total drainage area associated with developed Basins C and D have been reduced when compared to the 2016 Forest Lakes Drainage Report.

Table 1. Developed Basin Drainage Area Summary

Basin	Basin Area 2016 Forest Lakes Drainage Report (acres)	Basin Area with WTP Site (acres)
Basin C	2.76	2.63
Basin D	3.37	2.46
Basin D.1	NA	1.04
Total	6.13	6.13

While some additional impervious area has been added to Basins C and D the overall reduction in drainage area for these basin has resulted in a decrease to 100-year peak flow rates as calculated by the rational method. Table 2 provides a summary of the changes to the 100-year peak flow rates from Basins C and D. Therefore, no changes are necessary to the capacity of the drainage infrastructure which drain Basins C and D. Please see Attachment C for a more detailed summary of these calculations.

Table 2. Expected Changes in 100-year Runoff Rates to Developed Basins C and D

Basin	Basin Runoff Characteristics 2016 Forest Lakes Drainage Report		Basin Runoff Characteristics with WTP Site	
	Weighted C(100)	100-year Runoff (cfs)	Weighted C(100)	100-year Runoff (cfs) [1]
Basin C	0.52	9.32	0.54	9.11
Basin D	0.60	11.53	0.67	10.63

[1]No change in the basin time of concentration is required due to basin area changes resulting from the WTP construction

Developed Basin D.1

Basin Drainage Patterns

Localized surface runoff from the northwest and northeast areas of the site will be directed into a 1 foot deep triangular shaped riprap lined channel with 5H:1V side slopes. This channel will covey surface runoff directly into the WTP bioretention facility. Soils in the D.1 basin area consist of Hydrologic Soil Type B (see Attachment D for a NRCS Soils Report of the area). A summary of Basin D.1 land use areas and 100-yr runoff coefficients for use with the Rational Method for are provided in Table 3.

Table 3. Basin D.1 Land Use Areas and Associated 100-year Runoff Coefficients

Land Use Type			**100-yr Runoff Coefficient (C_{100})**
Impervious Areas			
Rooftop WTP	6614	sqft	0.81
Rooftop Well Building	875	sqft	0.81
Road	10954	sqft	0.96
Walk	562	sqft	0.96
Pervious Areas			
Lawn	26297	sqft	0.35
Total Area	45302	sqft	**Composite C_{100}** = 0.58
	1.04	acres	

100-Year Peak Runoff

The estimated 100-year peak runoff flow rate for basin D.1 using the Rational Method ($Q_{100} = C_{100}$ x I x A) is approximately 5.3 cfs (Q_{100}) based on a composite C_{100} value of 0.58, an estimated time of concentration of 5 minutes with a corresponding rainfall intensity of 8.8 in/hr (I), and a total area of 1.04 acres (A).

During the 100-year event the riprap lined channel is expected to flow at a depth of approximately 0.6 feet with approximately 0.4 feet of freeboard. The channel will be lined with riprap Type M (D_{50} = 12 inches) (See Attachment C for riprap sizing calculations). A riprap impact basin will be provided where the water flows into the bioretention facility to dissipate energy before spreading out into the bioretention facility.

Bioretention Facility

Runoff generated from Basin D.1 will be treated with an onsite bioretention facility which has been sized to treat the water quality capture volume and provide controlled release of the 100-yr event to a flow rate equal to 90% of the 100-yr pre-development surface runoff rate from Basin D.1. This bioretention facility will be owned and maintained by the Forest Lakes Metropolitan District.

The bioretention facility was sized in accordance with the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2. WWE utilized Urban Drainage and Flood Control District (UDFCD) design spreadsheets UD-Detention and UD-BMP to design the facility. Point precipitation frequency estimates for design of the bioretention facility were taken from The City of Colorado Springs Drainage Criteria Manual and are shown in Table 4. See Attachment C which provides the input and output for each UDFCD design spreadsheet. A summary of important design parameters associated with the bioretention facility are provided in Table 5.

Table 4. NOAA Atlas 14 One-Hour Point Precipitation Depths by Return Frequency

Return Frequency (years)	1 hour Point Precipitation Depth (inches)
2	1.19
5	1.50
10	1.75
25	2.00
50	2.25
100	2.52
500*	3.39

*Taken from NOAA atlas 14

Table 5. Select Bioretention Facility Design Parameters

Design Parameter	Required	Provided
Water Quality Capture Volume (WQCV)	0.013 ac-ft	0.013 ac-ft
WQCV Drain time	12 hours	12 hours
Excess Urban Runoff Volume (EURV)	0.031 ac-ft	0.031 ac-ft
EURV Drain time	24 to 44 hours	24 hours
Bioretention Filter Area	362 sqft	428 sqft
100-year Volume	0.084 ac-ft	0.084 ac-ft
100-year Ponding Depth	NA	2.85 ft
Freeboard provided above 100-year WSE	1 ft	1.1 ft
100-year peak release rate	1.1 cfs	1.1 cfs

The 18” diameter outfall pipe from the bioretention area will be directed to the east and connect into a 4’ diameter manhole. This manhole directs water south via an 18” RCP pipe and will connect into a proposed 24” diameter RCP pipe via a 4’ diameter manhole located south of the site. This 24” diameter RCP diameter pipeline is being constructed as part of the Forest Lakes Filing 2B project. This 24” RCP eventually ties into a new 48” diameter pipeline also being constructed as part of the Forest Lakes Filing 2B project which discharges directly into Pinion Lake, the original receiving water for this area as indicated in the 2016 Forest Lakes Drainage Report.

An emergency overflow spillway will also be provided to control release of events greater that the 100-yr event. This overflow will direct water via a rock weir overflow and onto Long Valley Drive. Surface water from Long Valley Drive discharges into Pinon Lake.

El Paso County 4-step Process for BMP Selection

The following provides a narrative summary of the BMP selection process for the FLMD Water Intake and Treatment Plant project in accordance with El Paso County Engineering Criteria Manual.

Step 1: Runoff Reduction Practices

Runoff reduction practices to minimize directly connected impervious areas were first integrated into the site. Curb and gutter was eliminated from the sites access road to promote overland flow onto and infiltration into pervious areas. All of the stormwater from the site will be collected via a riprap lined channel to promote infiltration. A grass swale was considered, however due to the natural steep topography of the site a grass swale was not practical due to potential flow velocity in the channel.

Step 2: Stabilize Drainageways

The primary drainage feature of the site is a riprap lined swale to prevent this drainage way from becoming a source of erosion and sediment to downstream waterways. Pervious areas will be seeded and vegetated to reduce the potential for surface erosion. No natural channels or drainageways are located on this site.

Step 3: Provide Water Quality Capture Volume

This site was designed with a bioretention system to provide the water quality capture volume. A bioretention facility was selected because the site is not expected to be a significant source of trash, debris, or pollutants. This water treatment plant facility will primarily be operated remotely and is not expected to generate a significate amount of traffic once in operation (<1ADT). The bioretention facility was also selected for aesthetic purposes as it is immediately adjacent to a local recreation site (Bristlecone Reservoir) and is at the entrance to the Forest Lakes Filing 2B residential development project.

Step 4: Consider Need for Industrial and Commercial BMPs

All chemicals and materials stored on this site will be indoors in designated chemical storage areas. Any chemical spills associated with this facility will occur inside the facility. Outdoor maintenance of equipment such as automobiles, or heavy equipment is not expected at this site, therefore no industrial or commercial BMPs were implemented.

Summary and Conclusions

In summary construction of the FLMD WTP will not adversely affect the drainage infrastructure or conditions outlined in the 2016 Forest Lakes Drainage Report. The WTP site will constructed

with a bioretention facility sized to treat the water quality capture volume and provide controlled release of the 100-yr event in accordance with El Paso County drainage criteria.

Sincerely,

WRIGHT WATER ENGINEERS, INC.

By _____
Hayes A. Lenhart, P.E.
Associate Water Resources Engineer

Reviewed By _____
Wayne F. Lorenz, P.E.
Chief Design Engineer

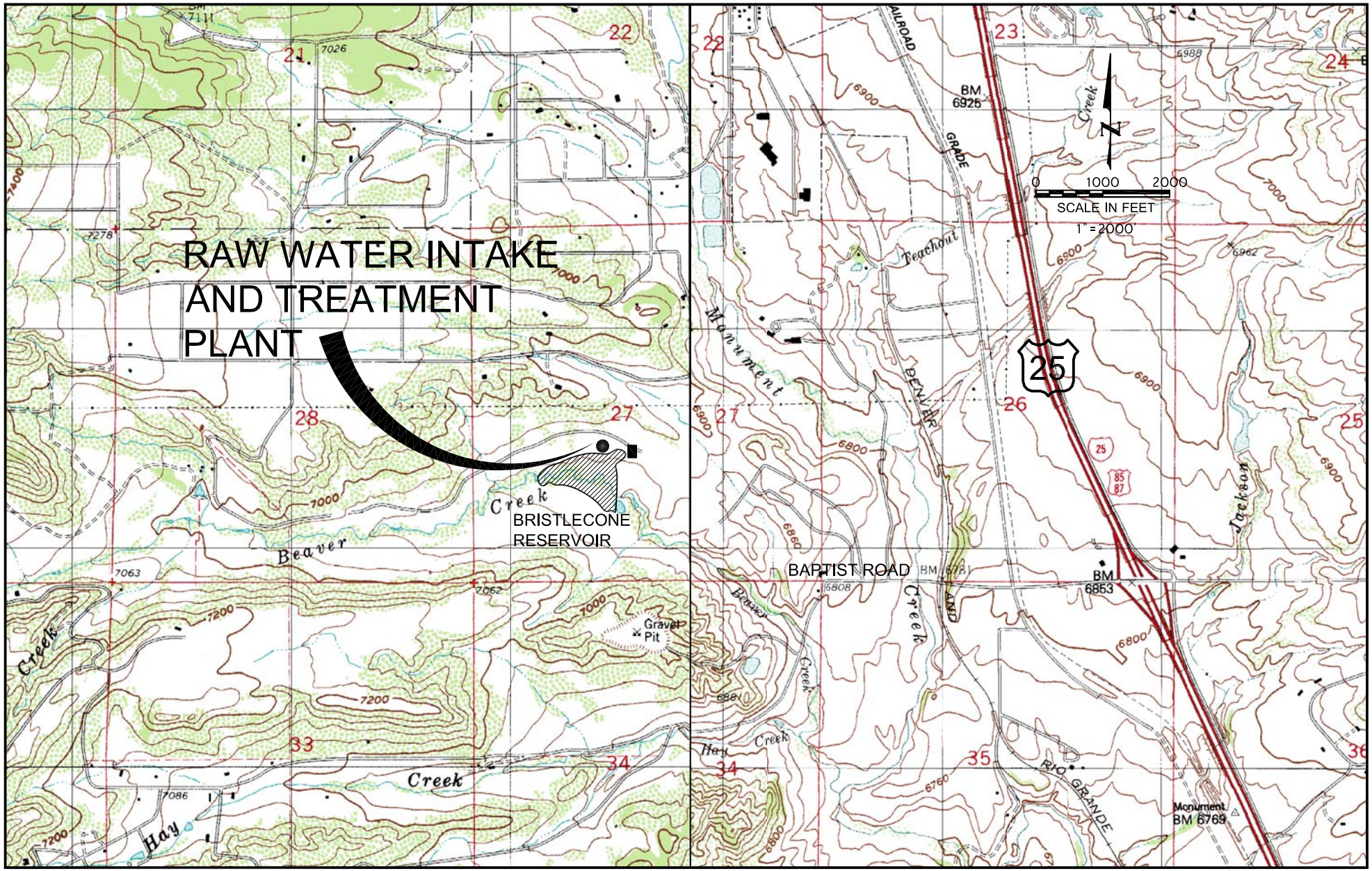
Attachments

Attachment A – Site Vicinity Map
Attachment B – 2016 Forest Lakes Drainage Report Existing and Developed Basin Delineations
Attachment C – Hydrologic and Hydraulic Calculation Sheets
Attachment D – Reference Information
Attachment E – Updated Basin Delineations with FLMD Water Treatment Plant

Z:\Project Files\02-03\031-090\031-090.300\Engineering\Site Development Plan - El Paso County\Drainage Letter\FLMD WTP - Drainage Letter Report.docx

Attachment A

Plot Date/Time: 04/17/2017, 01:58:51 PM; Z:\PROJECT FILES\02-03\031-090\031-090.300\CAD-GIS\CAD\01_CAD\B_WWE-DWGS\G1-G4 GENERAL SHEETS.DWG-FIGURE 1 - VICINITY MAP



WWE
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. 100A
DENVER, CO 80211
(303)480-1700

DESIGN	HAL
DETAIL	HAL
CHECK	WFL
DATE	4/17/2017
SCALE	AS SHOWN

FOREST LAKES METROPOLITAN DISTRICT WATER INTAKE AND TREATMENT PLANT

VICINITY MAP

FIGURE 1

Attachment B

BASIN RUNOFF SUMMARY		
BASIN	Q5 (CFS)	Q100 (CFS)
EX-A	3.5	8.4
EX-B	0.6	1.1
EX-C	3.3	9.3
EX-D	3.8	27.8
EX-E	3.5	25.4
EX-F	1.4	10.0
EX-H	2.8	20.6
EX-I	4.3	10.8
EX-J	3.7	7.8

DESIGN POINT SUMMARY			
DESIGN POINT	Q5 (CFS)	Q100 (CFS)	INLET SIZE
1	22.6	165.8	OFF-SITE RUNOFF
2	23.2	170.5	EX. TYPE D SUMP
3	3.5	8.4	EX. 5' SUMP
4	0.6	1.1	EX. 5' SUMP
5	3.3	9.3	EX. 15' AT-GRADE
6	29.8	192.4	SEDIMENT BASIN
7	30.7	199.0	PINON LAKE
8	3.8	27.8	BRISTLECONE LAKE
11	4.3	10.8	EX. 5' SUMP
12	3.7	7.8	EX. 5' SUMP

PIPE ROUTING		
PIPE/SIZE	Q5 (CFS)	Q100 (CFS)
1 ~ EX. 48"	23.2	170.5
2 ~ EX. 18"	3.5	8.4
3 ~ EX. 18"	3.9	9.1
4 ~ EX. 48"	24.8	174.2
5 ~ EX. 18"	3.2	6.8
6 ~ EX. 48"	25.9	176.5
14 ~ EX. 18"	4.3	10.8
15 ~ EX. 24"	7.9	18.3

N

100' 50' 0 100' 200'

SCALE: 1" = 100'

LEGEND

- EXISTING GROUND CONTOUR (5820)
- SITE BOUNDARY
- PROPOSED BASIN BOUNDARY
- PROP. DIRECTION OF DRAINAGE
- EXISTING STORM SEWER
- EXISTING STORM INLET
- BASIN IDENTIFIER / AREA IN ACRES (D / 1.41)
- PIPE RUN (1)
- DESIGN POINT (1)

OS-A 213.78 (1)
OS-B 6.09
EX-A 2.51
EX-I 2.58
EX-J 1.49
EX-B 0.16
EX-C 2.76
EX-D 13.53
EX-E 13.10
EX-BB 3.24
EX-CC 2.87
EX-F 6.10
EX-H 8.48

FOREST LAKES DRIVE
SITE BOUNDARY
BRISTLECONE LAKE
PINON LAKE

EXISTING 100-YR FEMA FLOODPLAIN PER JUNE 2004 LOMR

TRIBUTARY BASIN TO DP-29 PER "FINAL DRAINAGE REPORT FOR BAPTIST ROAD WEST," BY FELSBURG, HOLT & ULLEVIG & EPC STAFF DIRECTION

CLASSIC CONSULTING ENGINEERS & SURVEYORS SM
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FOREST LAKES FILING NO. 2A & 2B

FINAL DRAINAGE REPORT
EXISTING CONDITIONS

DESIGNED BY	MAL	SCALE		DATE	12/14/15
DRAWN BY	MAL	(H) 1"= 100'		SHEET	1 OF 2
CHECKED BY		(V) 1"= N/A		JOB NO.	1175.02

BASIN RUNOFF SUMMARY		
BASIN	Q5 (CFS)	Q100 (CFS)
A	3.5	8.4
B	0.6	1.1
C	3.3	9.3
D	4.9	11.5
E	6.5	13.3
F	0.6	2.2
G	7.6	15.8
H	1.8	3.5
I	4.3	10.8
J	2.2	4.9
K	11.3	25.9
L	2.6	5.2
M	0.4	2.6
V	7.2	28.4
W	3.0	9.1
X	6.1	15.8
OS-A	22.6	165.8
OS-B	2.0	15.0

DESIGN POINT SUMMARY			
DESIGN POINT	Q5 (CFS)	Q100 (CFS)	INLET SIZE
1	22.6	165.8	OFF-SITE RUNOFF
2	23.2	170.5	EX. TYPE D SUMP
3	3.5	8.4	EX. 5' SUMP
4	0.6	1.1	EX. 5' SUMP
5	3.3	9.3	EX. 15' AT-GRADE
6	5.2	14.3	5' SUMP
7	6.5	13.3	5' SUMP
8	0.6	2.2	TYPE D GRATED
9	7.6	15.8	10' SUMP
10	1.8	3.5	5' SUMP
11	4.3	10.8	EX. 5' SUMP
12	2.2	4.9	EX. 5' SUMP
13	11.3	25.9	15' SUMP
14	2.6	5.2	5' SUMP
15	36.2	83.5	POND 'A'
16	28.5	196.7	PINON LAKE

PIPE ROUTING		
PIPE/SIZE	Q5 (CFS)	Q100 (CFS)
1 ~ EX. 48"	23.2	170.5
2 ~ EX. 18"	3.5	8.4
3 ~ EX. 18"	3.9	9.1
4 ~ EX. 48"	24.8	174.2
5 ~ EX. 18"	3.2	6.8
6 ~ EX. 48"	25.9	176.5
7 ~ 24"	6.5	13.3
8 ~ 30"	10.7	25.6
9 ~ 18"	0.6	2.2
10 ~ 30"	11.1	27.1
11 ~ 24"	7.6	15.8
12 ~ 18"	1.8	3.5
13 ~ 36"	18.8	42.5
14 ~ 18"	4.3	10.8
15 ~ 24"	6.5	15.5
16 ~ 30"	11.3	25.9
17a ~ 24"	2.6	5.2
17b ~ 30"	13.8	30.6
18 ~ 42"	36.0	81.7
19 ~ 30"	0.7	36.0

CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799(Fax)

FOREST LAKES FILING NO. 2A & 2B

FINAL DRAINAGE REPORT
DEVLOPED CONDITIONS

DESIGNED BY	MAL	SCALE	DATE 12/14/15
DRAWN BY	MAL	(H) 1"= 100'	SHEET 1 OF 2
CHECKED BY		(V) 1"= N/A	JOB NO. 1175.02

Attachment C

WWE CALCULATION SHEET

Project:	FLMD WTP	Design:	HAL
Job. No.:	091-030.300	Check	JMN
Date:	09/08/17	***UPDATED:***	11/11/2017
Subject:	Comparison of 2016 Forest Lakes Drainage Report Developed Flows for Basins C and D with WTP Developed Flows		

Purpose: **Task 1: Determine the Increases to 2016 Forest Lakes Drainage Report Developed Flow Rates when the WTP Site is Included in Basin**

References: **1. Classic Consulting Engineers and Surveyors, 2016. "Preliminary & Final Drainage Report for Forest Lakes Filings 2A & 2B."**
2. WWE Construction Drawings. Issued for Bid Set. Forest Lakes Metropolitan District Water Intake and Treatment Plant Project. **REFERENCE**

Assumptions from Reference 1

Basin Runoff Coefficients by Land use **1**

Basin	Impervious Area / Streets		Single-Family Lots / Landscape	
	C(5)	C (100)	C(5)	C (100)
C	0.90	0.96	0.08	0.35
D	0.9	0.96	0.22	0.44

Basin Characteristics (Developed Conditions) **1**

Basin	Total Area (AC)	Impervious Area / Streets (AC)	Single-Family Lots / Landscape (AC)	Weighted C(5)	Weighted C(100)	Time of Concentration Tc (min)
C	2.76	0.79	1.97	0.31	0.52	12.1
D	3.37	1.03	2.34	0.43	0.60	16.2
Total =	6.13					

Basin Runoff Coefficient Summary (Developed Conditions) **1**

Basin	Total Area	5-yr Intensity (in/hr)	100-yr Intensity (in/hr)	5-year Runoff (cfs)	100-year runoff (cfs)
C	2.76	3.84	6.44	3.34	9.32
D	3.37	3.40	5.71	4.90	11.53

Task 1: Determine the Changes to 2016 Forest Lakes Drainage Report Developed Flow Rates when the WTP Site is Included in Basin

Basin D.1 Impervious Area

Rooftop WTP =	6614 sqft
Rooftop Well Bldg =	875 sqft
Road =	10954 sqft
Walk =	555 sqft

Basin D.1 Pervious Area

Pervious Area =	26304 sqft

Basin C Additional Impervious Area

Backwash Basin =	840 sqft

Basin D Additional Impervious Area

Backwash Basin =	840 sqft
Road =	1761 sqft
Transformer Pad =	106 sqft

Basin C and D Runoff Coefficients by Land use **1**

Basin	Impervious Area / Streets		Single-Family Lots / Landscape	
	C(5)	C (100)	C(5)	C (100)
C	0.90	0.96	0.08	0.35
D	0.9	0.96	0.22	0.44

Basin Characteristics (Developed Conditions W / WTP) **1,2**

Basin	Total Area (AC)	Previous Impervious Area / Streets (AC)	Additional Impervious Area / Streets (AC)	New Area Single-Family Lots / Landscape (AC)	Weighted C(5)	Weighted C(100)	Time of Concentration Tc (min)
C	2.63	0.79	0.02	1.82	0.33	0.54	12.10
D	2.46	1.03	0.06	1.37	0.52	0.67	16.20
D.1	1.04						
Total =	6.13						

Basin Runoff Coefficient Summary (Developed Conditions W / WTP) **1,2**

Basin	Total Area (AC)	5-yr Intensity (in/hr)	100-yr Intensity (in/hr)	5-year Runoff (cfs)	100-year runoff (cfs)
C	2.63	3.84	6.44	3.36	9.11
D	2.46	3.84	6.44	4.93	10.63

WWE CALCULATION SHEET

Project:	FLMD WTP	Design:	HAL
Job. No.:	091-030.300	Check:	JMN
Date:	09/16/17	***UPDATED:***	11/11/2017
Subject:	Calculate the Peak Flow Rate for the WTP Site Using Rational Method and Check Capacities of Drainage Infrastructure		

Purpose: **Task 1: Use Rational Method to Estimate the Peak Flow Rate from the WTP Site**
Task 2: Check Capacity of Drainage Channel

References:
1. May 2014 City of Colorado Spring Drainage Criteria Manual, Volume 1.
2. WWE Construction Drawings. Issued for Bid Set. Forest Lakes Metropolitan District Water Intake and Treatment Plant Project.
3. NRCS Web Soil Survey

REFERENCE

Assumptions

Hydrologic Soil Group = B **3**

Basin D.1 Characteristics **2**

Impervious Area		
Rooftop WTP	6614	sqft
Rooftop Well Bldg	875	sqft
Road	10954	sqft
Walk	555	sqft
Pervious Area		
Lawns	26304.4	sqft
Total Area	45302.4	sqft

Task 1: Use Rational Method to Estimate the Peak Flow Rate from the WTP Site

Task 1.1: Estimate Composite C Value

Land Use	100-yr Runoff Coefficient
Paved Areas	0.96
Roof Areas	0.81
Lawn	0.35

1

Composite C =	0.58

Task 1.2: Estimate Time of Concentration and Associated Rainfall Intensity

Assume Time of Concentration = 5 minutes **2**
100-yr Rainfall Intensity = 8.8 in/hr **3**

Task 1.3: Estimate 100-yr Peak Flow Rate Using Rational Method

Q_{100} =	5.3 cfs

WWE CALCULATION SHEET

Project:	FLMD WTP	Design:	HAL
Job. No.:	091-030.300	Check:	JMN
Date:	09/16/17	***UPDATED:***	11/11/2017
Subject:	Calculate the Peak Flow Rate for the WTP Site Using Rational Method and Check Capacities of Drainage Infrastructure		

WRIGHT WATER ENGINEERS, INC.

Purpose:

Task 1: Use Rational Method to Estimate the Peak Flow Rate from the WTP Site

Task 2: Check Capacity of Drainage Channel

References:

1. May 2014 City of Colorado Spring Drainage Criteria Manual, Volume 1.

2. WWE Construction Drawings. Issued for Bid Set. Forest Lakes Metropolitan District Water Intake and Treatment Plant Project.

3. NRCS Web Soil Survey

REFERENCE

Task 2: Check Capacity of Drainage Channel

Use Manning Equation to Determine Channel Depth at 5.2 cfs

Depth in Drainage Channel at 5.2 cfs **2**

Bottom Width	0	ft
Side Slope	5	H:1V
Slope	0.03	ft/ft
Manning's "n"	0.04	dimensionless
Depth	0.61	ft
Flow Area	1.84	sqft
Wetted Perimeter	6.19	ft
Hydraulic Radius	0.30	ft
Channel Flow =	5.3	cfs
Channel Velocity =	2.9	ft/s

Critical Flow Depth Calculation		
Bottom Width	0	ft
Side Slope	5	H:1V
Slope	0.03	ft/ft
Manning's "n"	0.04	dimensionless
Depth	0.59	ft
Flow Area	1.73	sqft
Wetted Perimeter	6.00	ft
Hydraulic Radius	0.29	ft
Top Width (T)	5.88	ft

Calculations:

Solve Following Equation for Equality Under 100-year Discharge Conditions by Solving for Critical Depth.

$$\frac{Q^2}{g} = 0.88 \qquad \frac{Q^2}{g} = \frac{A^3}{T}$$

$$\frac{A^3}{T} = 0.88$$

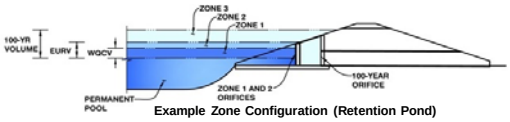
Critical Depth =	0.59	ft
Critical Velocity =	3.1	ft/s

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: FLMD - Water Treatment Plant, Monument CO

Basin ID: D.1



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	RG		
Watershed Area =	1.05	acres	
Watershed Length =	370	ft	
Watershed Slope =	0.038	ft/ft	
Watershed Imperviousness =	40.00%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	100.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Desired WQCV Drain Time =	12.0	hours	
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.013	acre-feet	
Excess Urban Runoff Volume (EURV) =	0.044	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	0.035	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.048	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.068	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	0.103	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.126	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.157	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.39 in.) =	0.235	acre-feet	3.39 inches
Approximate 2-yr Detention Volume =	0.032	acre-feet	
Approximate 5-yr Detention Volume =	0.045	acre-feet	
Approximate 10-yr Detention Volume =	0.062	acre-feet	
Approximate 25-yr Detention Volume =	0.070	acre-feet	
Approximate 50-yr Detention Volume =	0.073	acre-feet	
Approximate 100-yr Detention Volume =	0.084	acre-feet	

Optional User Override 1-hr Precipitation

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.013	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.031	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.040	acre-feet
Total Detention Basin Volume =	0.084	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 1 ft

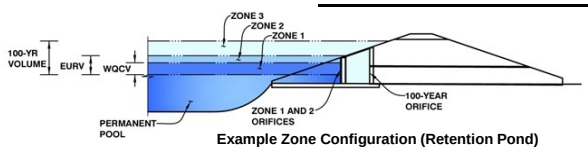
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	428	0.010		
EL = 6881	--	1.00	--	--	--	884	0.020	647	0.015
EL = 6882	--	2.00	--	--	--	1,441	0.033	1,804	0.041
EL= 6883	--	3.00	--	--	--	2,097	0.048	3,587	0.082
EL = 6884	--	4.00	--	--	--	2,855	0.066	6,063	0.139

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: FLMD - Water Treatment Plant, Monument CO

Basin ID: D.1



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.88	0.013	Filtration Media
Zone 2 (EURV)	2.07	0.031	Orifice Plate
Zone 3 (100-year)	3.03	0.040	Weir&Pipe (Restrict)
		0.084	Total

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

Underdrain Orifice Invert Depth =	1.92	ft (distance below the filtration media surface)	Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Diameter =	0.56	inches	Underdrain Orifice Centroid =	0.02	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.88	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	3.403E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.07	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.49	sq. inches (diameter = 3/4 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.88	1.28	1.67					
Orifice Area (sq. inches)	0.49	0.49	0.49					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.07	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.07	N/A	feet
Overflow Weir Front Edge Length =	2.50	N/A	feet	Over Flow Weir Slope Length =	2.50	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	40.76	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	2.50	N/A	feet	Overflow Grate Open Area w/o Debris =	4.38	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	2.19	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.11	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.10	N/A	feet
Restrictor Plate Height Above Pipe Invert =	2.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	0.68	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.40	feet
Spillway Crest Length =	2.00	feet	Stage at Top of Freeboard =	4.30	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.07	acres
Freeboard above Max Water Surface =	0.90	feet			

Calculated Parameters for Spillway

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	3.39
Calculated Runoff Volume (acre-ft) =	0.013	0.044	0.035	0.048	0.068	0.103	0.126	0.157	0.235
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.012	0.044	0.034	0.048	0.068	0.102	0.125	0.156	0.235
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.19	0.64	0.88	1.19	1.90
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.2	0.7	0.9	1.2	2.0
Peak Inflow Q (cfs) =	0.2	0.7	0.6	0.8	1.1	1.7	2.1	2.6	3.8
Peak Outflow Q (cfs) =	0.0	0.1	0.0	0.1	0.5	1.1	1.1	1.1	2.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.7	2.7	1.6	1.2	0.9	1.3
Structure Controlling Flow =	Filtration Media	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.2	0.2	0.2	0.2
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	24	24	23	22	22	19
Time to Drain 99% of Inflow Volume (hours) =	**12**	24	22	25	25	25	25	25	24
Maximum Ponding Depth (ft) =	0.73	1.87	1.60	1.97	2.15	2.25	2.46	2.85	3.29
Area at Maximum Ponding Depth (acres) =	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05
Maximum Volume Stored (acre-ft) =	0.010	0.038	0.030	0.041	0.047	0.050	0.058	0.075	0.097

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.06, November 2016) **Sheet 1 of 2**

Designer: **Designed By: HAL Check By:**
Company: **Wright Water Engineers, Inc. Denver, CO.**
Date: **September 25, 2017**
Project: **FLMD - WTP**
Location: **Monument , CO**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 40.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.400
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time ($WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$)	WQCV = 0.14 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 45,302 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = 543.15 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 8.8 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 4.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 362 sq ft
D) Actual Flat Surface Area	A_{Actual} = 428 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 2097 sq ft
F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$)	V_T = 922 cu ft
3. Growing Media	Choose One: (•) 18" Rain Garden Growing Media ( ) 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 = 1.7 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 543 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 5/9 in

Design Procedure Form: Rain Garden (RG)

Designer: Designed By: HAL Check By:
Company: Wright Water Engineers, Inc. Denver, CO.
Date: September 25, 2017
Project: FLMD - WTP
Location: Monument , CO

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. Inlet / Outlet Control A) Inlet Control	Choose One ○ Sheet Flow- No Energy Dissipation Required ◉ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ○ Seed (Plan for frequent weed control) ◉ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ◉ YES ○ NO **NO SPRINKLER HEADS ON FLAT SURFACE**

Notes:

Hydraulic Analysis Report

Project Data

Project Title: Forest Lakes Metropolitan District - WTP
Designer: HAL / JMN
Project Date: Thursday, September 21, 2017
Project Units: U.S. Customary Units

Channel Analysis: Channel Analysis

Notes: Riprap analysis for primary drainage channel through site.

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 5.0000 ft/ft
Side Slope 2 (Z2): 5.0000 ft/ft
Longitudinal Slope: 0.0300 ft/ft
Manning's n: 0.0400
Flow: 5.2000 cfs

Result Parameters

Depth: 0.6034 ft
Area of Flow: 1.8202 ft^2
Wetted Perimeter: 6.1531 ft
Hydraulic Radius: 0.2958 ft
Average Velocity: 2.8568 ft/s
Top Width: 6.0336 ft
Froude Number: 0.9166
Critical Depth: 0.5827 ft
Critical Velocity: 3.0629 ft/s
Critical Slope: 0.0361 ft/ft
Critical Top Width: 5.83 ft
Calculated Max Shear Stress: 1.1295 lb/ft^2
Calculated Avg Shear Stress: 0.5538 lb/ft^2

Riprap Analysis: Riprap Analysis

Notes:

Input Parameters

Riprap Type: Embankment Overtopping

Calculations will use either total or overbank discharges.

Total Discharge: 5.2 cfs

Embankment Slope: 4:1 H:V

Embankment Overtopping Length: 5 ft/s

Weir Flow Coefficient: 2.84

Riprap Sizing Equation Coefficient: 0.525 s^0.52/ft^0.04

Coefficient of Uniformity of the Riprap: 2.1

Coefficient of Uniformity = D60/D10

Porosity: 0.45

Angle of Repose: 42 degrees

Specific Gravity of Riprap: 2.65

Result Parameters

Overtopping Depth: 0.511851 ft

Depth determined from rectangular weir equation

Unit Discharge: 1.04 cfs

Slope: 0.25 ft/ft

Slope Angle: 14.0362 degrees

Smallest Possible Median Rock Size: 3.16629 in

Interstitial Velocity: 0.892378 ft/s

Average Velocity: 0.40157 ft/s

Thickness required for all flow to pass thru Riprap: 2.58984 ft

Allowable Flow Depth over the Riprap: 0.19911 ft

Manning's Roughness Coefficient (n): 0.0306974

Unit Discharge over Riprap using Manning's Equation: 1.64327 cfs/ft

Required Interstitial Flow through the Riprap: 0 cfs/ft

Flow Provided by a riprap thickness of 2*d50: 0.435034 cfs/ft

Thickness required for Flow: 2*d50

Riprap Class

Riprap Class Name: CLASS I

Riprap Class Order: 1

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 12 in

d85: 9 in

d50: 6.5 in

d15: 4.5 in

Name of Selected Channel: Channel Analysis

USE UDFCD TYPE M RIPRAP

Attachment D

United States Department of Agriculture

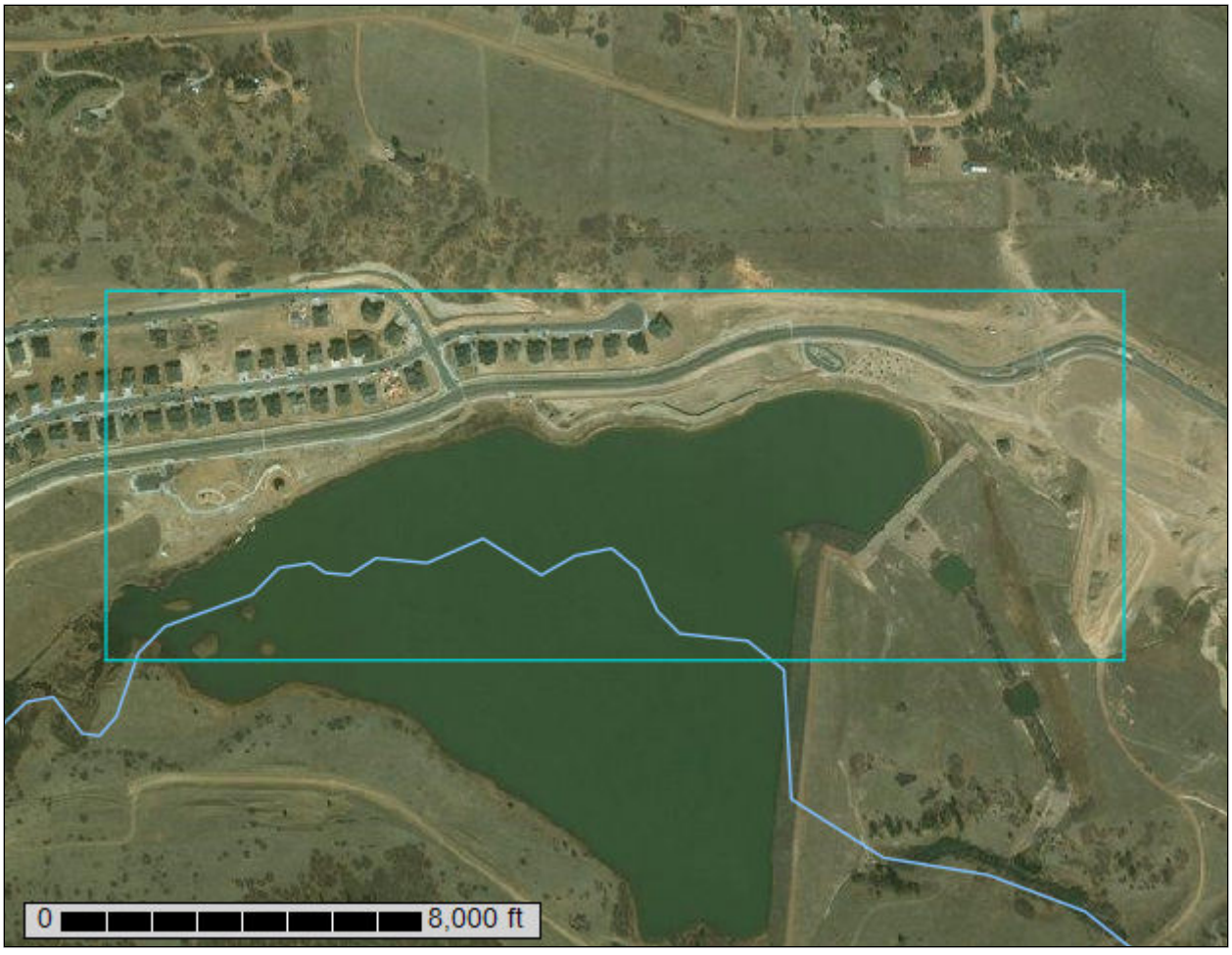
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for El Paso County Area, Colorado

FLMD Water Intake and Treatment Plant Project



August 19, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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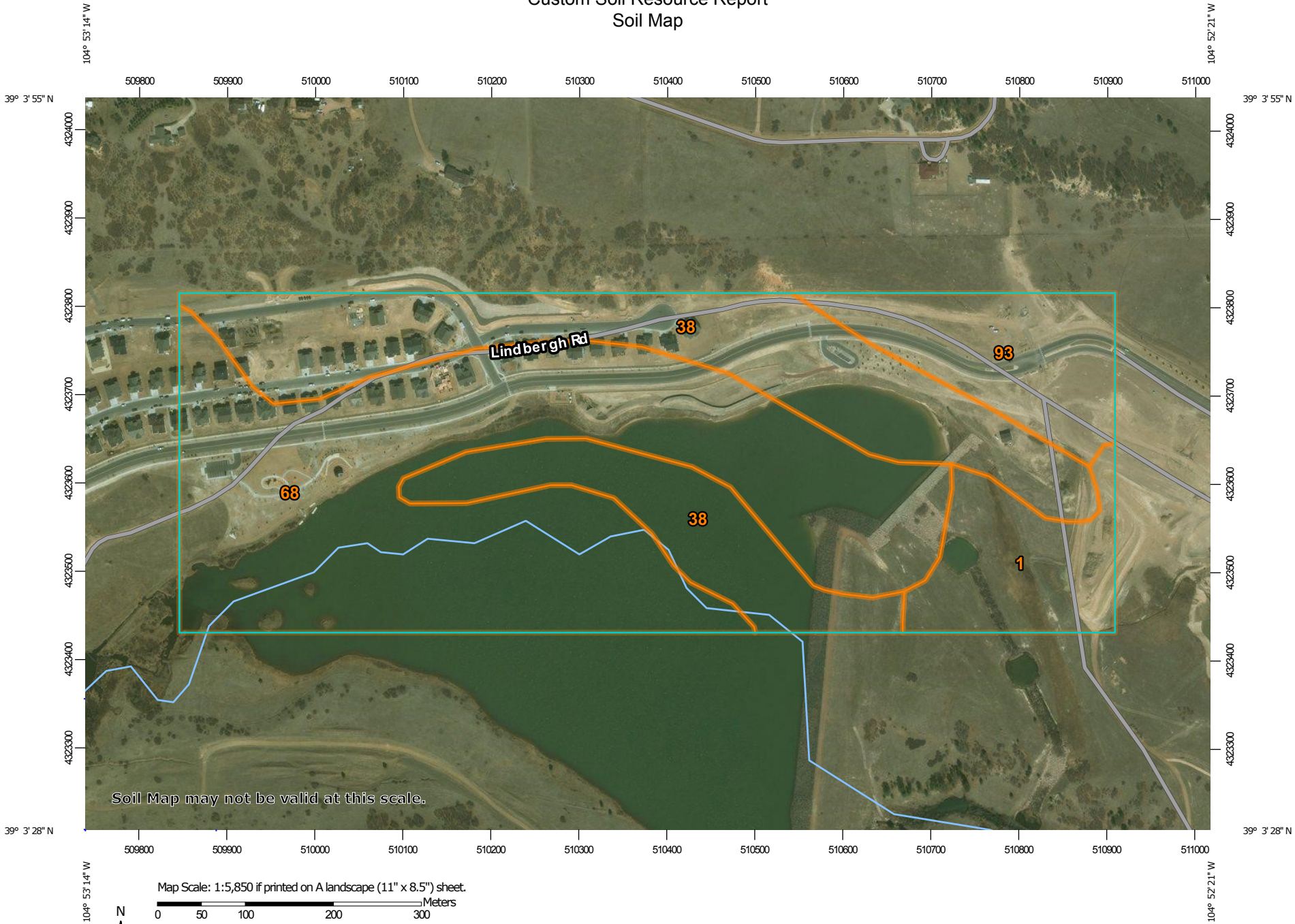
Contents

Preface..... 2
Soil Map..... 5
Soil Map.....6
Legend.....7
Map Unit Legend..... 8
Map Unit Descriptions..... 8
El Paso County Area, Colorado.....10
1—Alamosa loam, 1 to 3 percent slopes.....10
38—Jarre-Tecolote complex, 8 to 65 percent slopes..... 11
68—Peyton-Pring complex, 3 to 8 percent slopes..... 12
93—Tomah-Crowfoot complex, 8 to 15 percent slopes.....14
Soil Information for All Uses.....17
Soil Properties and Qualities..... 17
Soil Erosion Factors.....17
K Factor, Whole Soil (FLMD Water Intake and Treatment Plant).....17
Soil Physical Properties..... 20
Saturated Hydraulic Conductivity (Ksat) (FLMD Water Intake and Treatment Plant)..... 20
Soil Qualities and Features.....24
Hydrologic Soil Group (FLMD Water Intake and Treatment Plant)..... 24
Unified Soil Classification (Surface) (FLMD Water Intake and Treatment Plant)..... 28

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:5,850 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

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 14, Sep 23, 2016

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

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

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

Map Unit Legend

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Alamosa loam, 1 to 3 percent slopes	8.4	8.2%
38	Jarre-Tecolote complex, 8 to 65 percent slopes	32.5	32.0%
68	Peyton-Pring complex, 3 to 8 percent slopes	50.9	50.2%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	9.7	9.5%
Totals for Area of Interest		**101.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

1—Alamosa loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3670
Elevation: 7,200 to 7,700 feet
Farmland classification: Prime farmland if irrigated and reclaimed of excess salts and sodium

Map Unit Composition

Alamosa and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alamosa

Setting

Landform: Flood plains, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 6 inches: loam
Bt - 6 to 14 inches: clay loam
Btk - 14 to 33 inches: clay loam
Cg1 - 33 to 53 inches: sandy clay loam
Cg2 - 53 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 12 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Very slightly saline to strongly saline (2.0 to 16.0 mmhos/cm)
Available water storage in profile: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: Mountain Meadow (R048AY241CO)
Hydric soil rating: Yes

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

38—Jarre-Tecolote complex, 8 to 65 percent slopes

Map Unit Setting

National map unit symbol: 368c
Elevation: 6,700 to 7,500 feet
Frost-free period: 90 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

Jarre and similar soils: 40 percent
Tecolote and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Jarre

Setting

Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 5 inches: gravelly sandy loam
Bt - 5 to 22 inches: gravelly sandy clay loam
2C - 22 to 60 inches: very gravelly sandy loam

Properties and qualities

Slope: 8 to 30 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Description of Tecolote

Setting

Landform: Alluvial fans
Down-slope shape: Linear

Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 3 inches: very stony loam
E - 3 to 12 inches: very gravelly loamy sand
Bt - 12 to 45 inches: extremely gravelly sandy clay loam
C - 45 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 65 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

68—Peyton-Pring complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369f
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils
Percent of map unit:
Hydric soil rating: No

Pleasant
Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

93—Tomah-Crowfoot complex, 8 to 15 percent slopes

Map Unit Setting
National map unit symbol: 36bb
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition
Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting
Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile
A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities
Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Erosion Factors

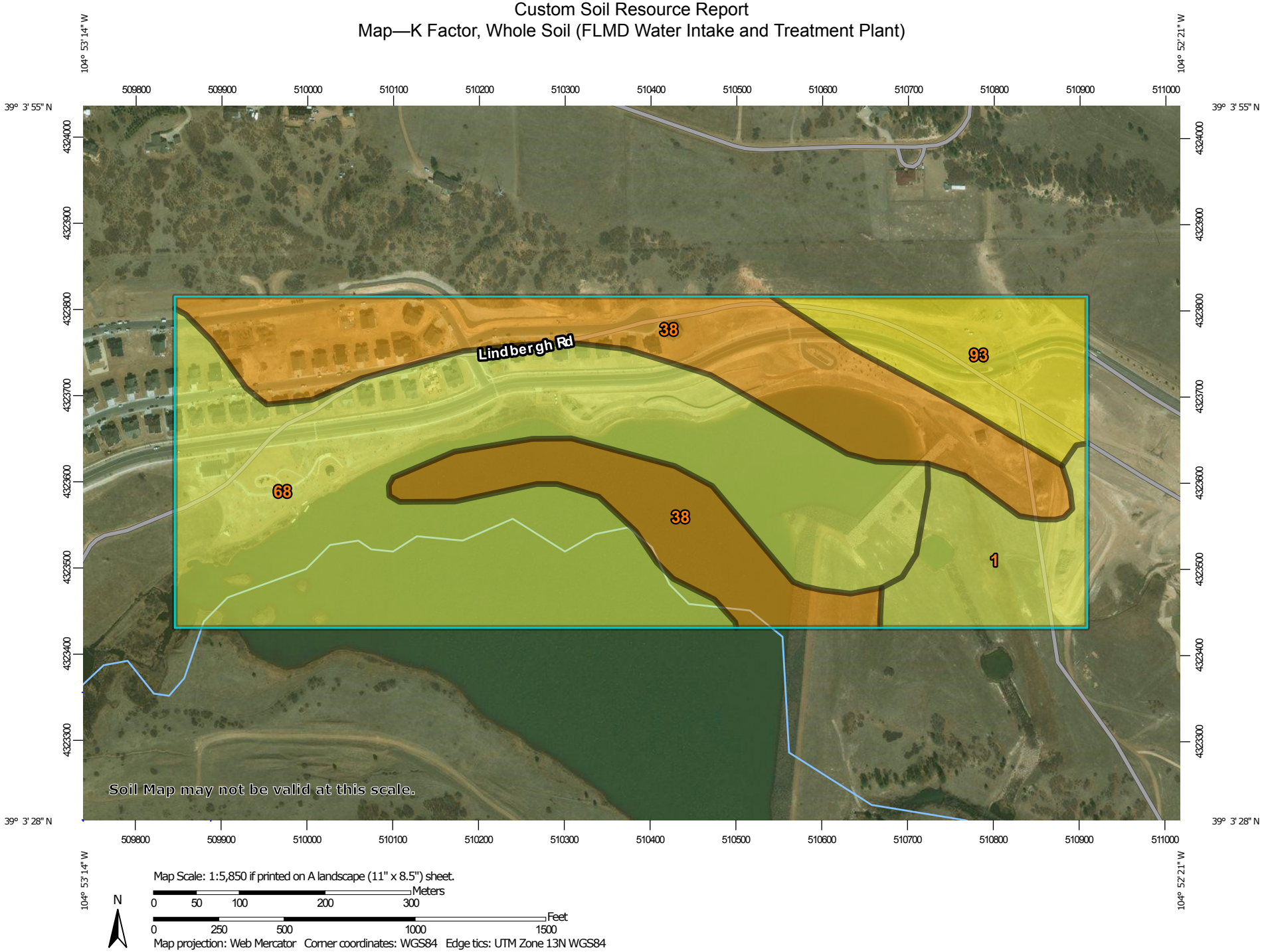
Soil Erosion Factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

K Factor, Whole Soil (FLMD Water Intake and Treatment Plant)

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Custom Soil Resource Report
Map—K Factor, Whole Soil (FLMD Water Intake and Treatment Plant)



Map Scale: 1:5,850 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Lines

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Points

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
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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Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

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

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

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Table—K Factor, Whole Soil (FLMD Water Intake and Treatment Plant)

K Factor, Whole Soil— Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
1	Alamosa loam, 1 to 3 percent slopes	.20	8.4	8.2%
38	Jarre-Tecolote complex, 8 to 65 percent slopes	.10	32.5	32.0%
68	Peyton-Pring complex, 3 to 8 percent slopes	.20	50.9	50.2%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	.17	9.7	9.5%
Totals for Area of Interest			**101.5**	**100.0%**

Rating Options—K Factor, Whole Soil (FLMD Water Intake and Treatment Plant)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Soil Physical Properties

Soil Physical Properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

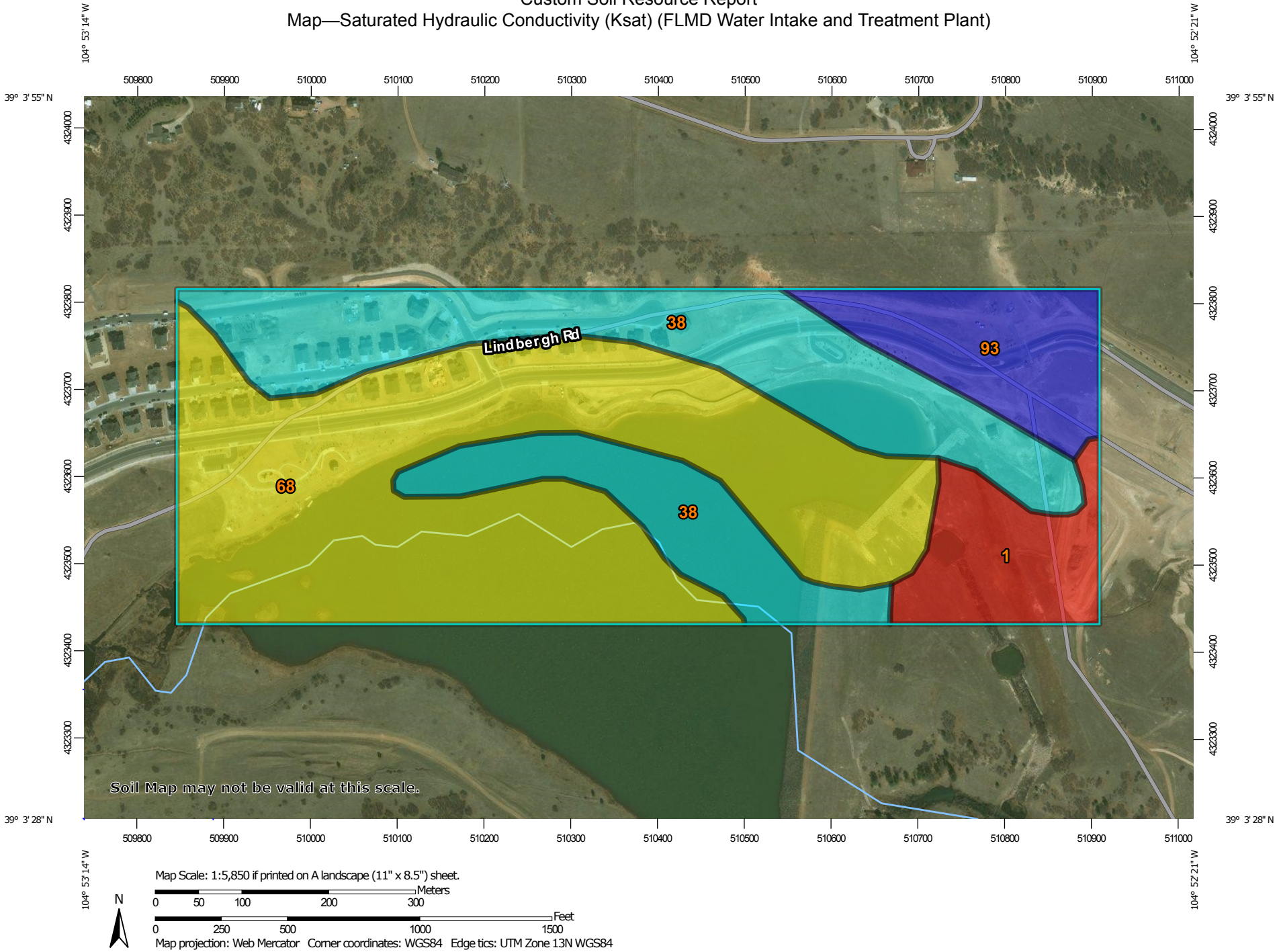
Saturated Hydraulic Conductivity (Ksat) (FLMD Water Intake and Treatment Plant)

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Custom Soil Resource Report
Map—Saturated Hydraulic Conductivity (Ksat) (FLMD Water Intake and Treatment Plant)



MAP LEGEND

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

Soils

Soil Rating Polygons
- <= 6.2763
- > 6.2763 and <= 10.4210
- > 10.4210 and <= 20.9276
- > 20.9276 and <= 65.9540
- Not rated or not available

Soil Rating Lines
- <= 6.2763
- > 6.2763 and <= 10.4210
- > 10.4210 and <= 20.9276
- > 20.9276 and <= 65.9540
- Not rated or not available

Soil Rating Points
- <= 6.2763
- > 6.2763 and <= 10.4210
- > 10.4210 and <= 20.9276
- > 20.9276 and <= 65.9540
- Not rated or not available

Water Features
- Streams and Canals

Transportation
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Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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Table—Saturated Hydraulic Conductivity (Ksat) (FLMD Water Intake and Treatment Plant)

Saturated Hydraulic Conductivity (Ksat)— Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	**Map unit name**	**Rating (micrometers per second)**	**Acres in AOI**	**Percent of AOI**
1	Alamosa loam, 1 to 3 percent slopes	6.2763	8.4	8.2%
38	Jarre-Tecolote complex, 8 to 65 percent slopes	20.9276	32.5	32.0%
68	Peyton-Pring complex, 3 to 8 percent slopes	10.4210	50.9	50.2%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	65.9540	9.7	9.5%
Totals for Area of Interest			**101.5**	**100.0%**

Rating Options—Saturated Hydraulic Conductivity (Ksat) (FLMD Water Intake and Treatment Plant)

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): All Layers (Weighted Average)

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (FLMD Water Intake and Treatment Plant)

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.

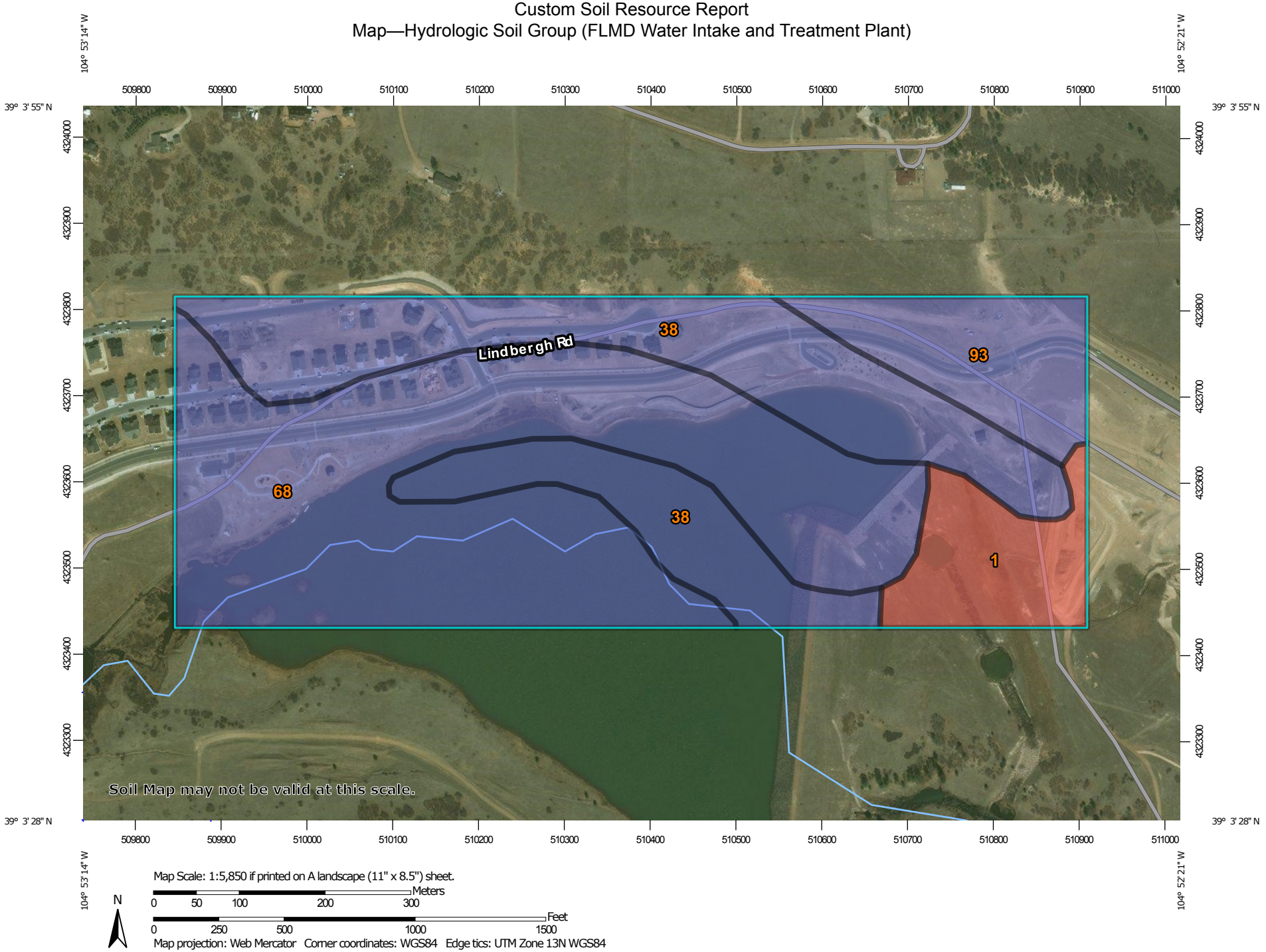
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Custom Soil Resource Report
Map—Hydrologic Soil Group (FLMD Water Intake and Treatment Plant)



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

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Coordinate System: Web Mercator (EPSG:3857)

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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 14, Sep 23, 2016

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

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

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

Table—Hydrologic Soil Group (FLMD Water Intake and Treatment Plant)

Hydrologic Soil Group— Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
1	Alamosa loam, 1 to 3 percent slopes	D	8.4	8.2%
38	Jarre-Tecolote complex, 8 to 65 percent slopes	B	32.5	32.0%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	50.9	50.2%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	9.7	9.5%
Totals for Area of Interest			**101.5**	**100.0%**

Rating Options—Hydrologic Soil Group (FLMD Water Intake and Treatment Plant)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

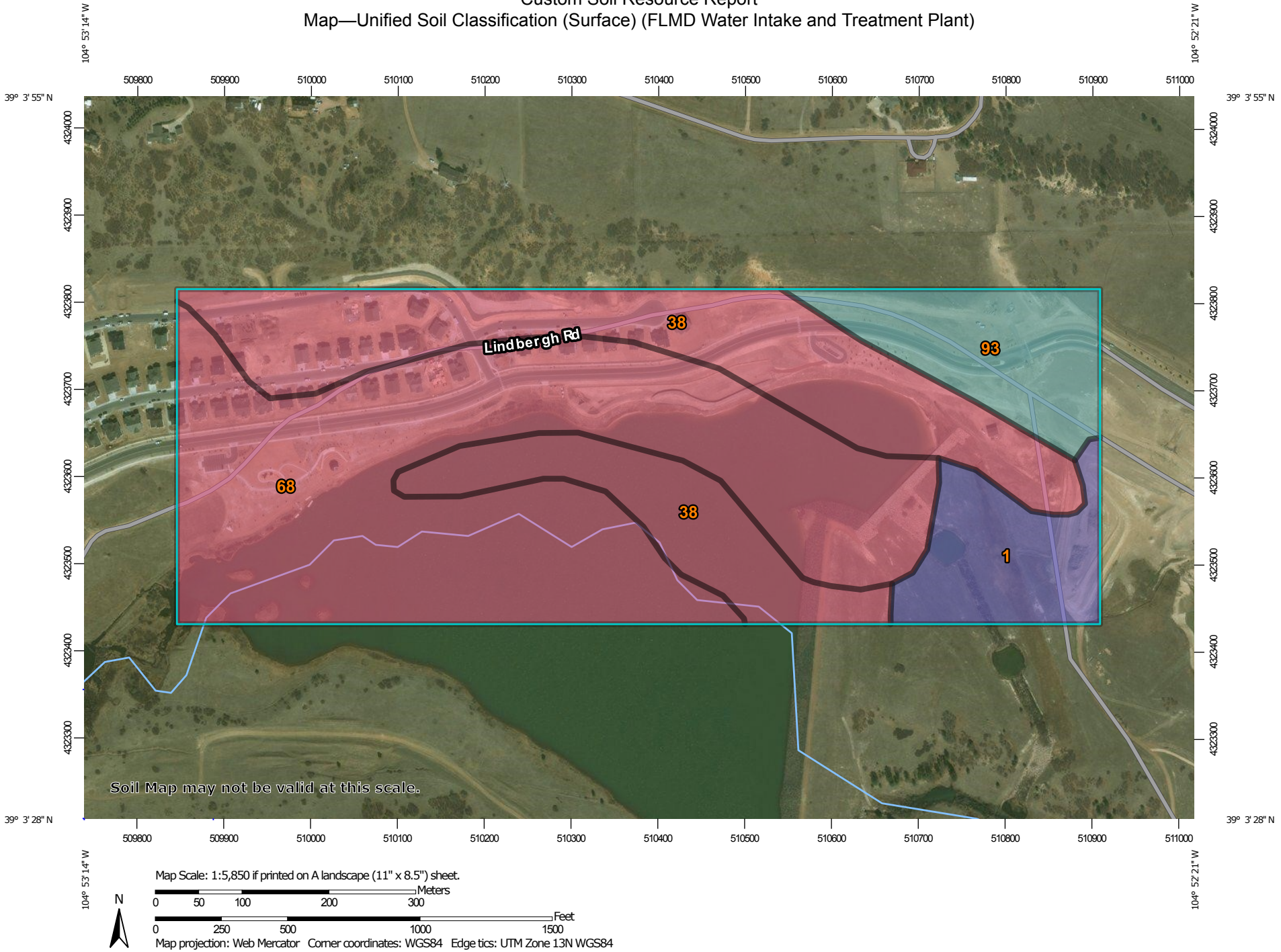
Unified Soil Classification (Surface) (FLMD Water Intake and Treatment Plant)

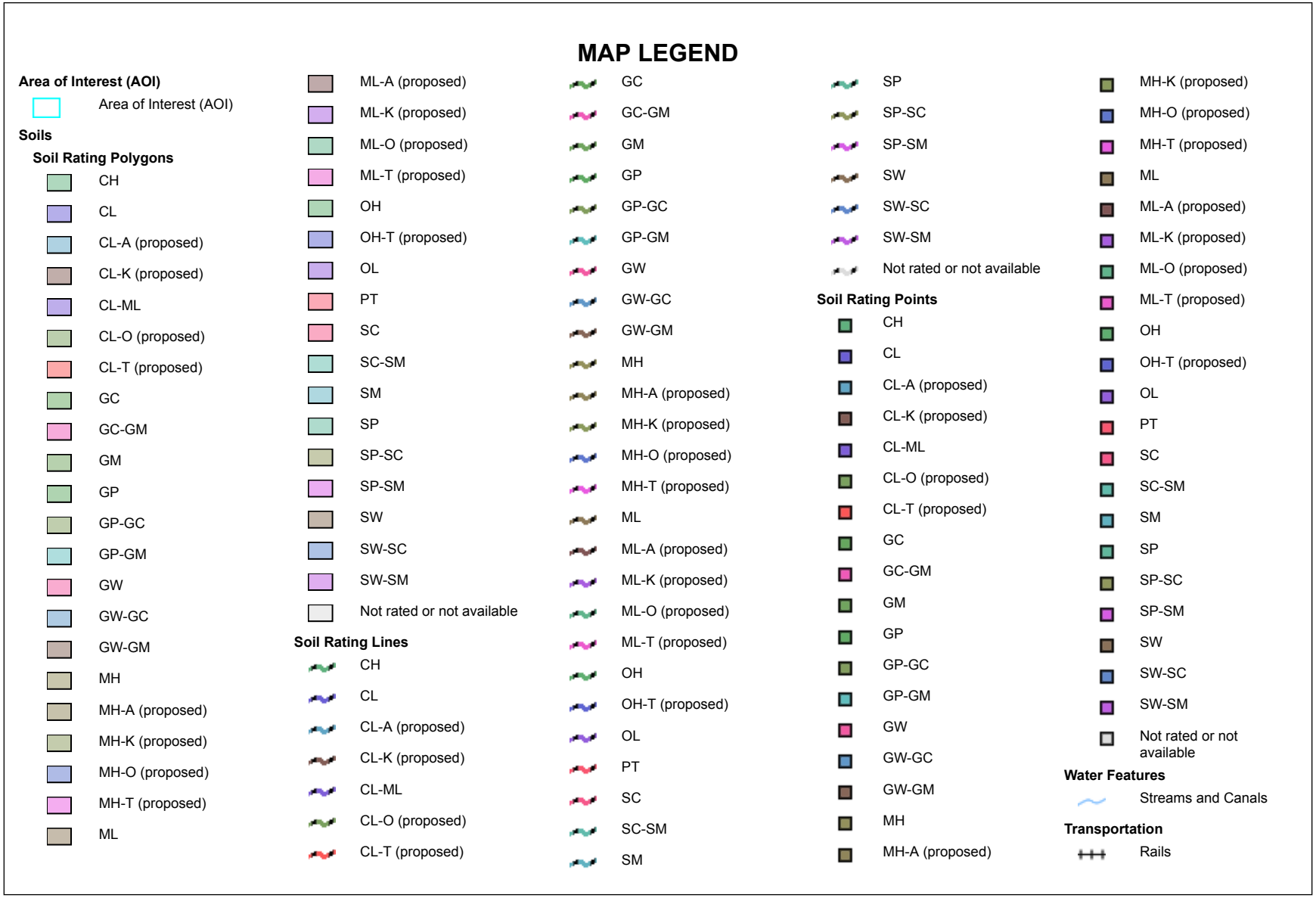
The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Map—Unified Soil Classification (Surface) (FLMD Water Intake and Treatment Plant)




MAP LEGEND
Area of Interest (AOI)
Area of Interest (AOI)
Soils
Soil Rating Polygons
CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available
Soil Rating Lines
CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available
Soil Rating Points
CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
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GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available
Water Features
Streams and Canals
Transportation
Rails

MAP INFORMATION


Interstate Highways


US Routes

Major Roads

Local Roads

Background


Aerial Photography

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 14, Sep 23, 2016

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93	Tomah-Crowfoot complex, 8 to 15 percent slopes	SM	9.7	9.5%
Totals for Area of Interest			**101.5**	**100.0%**

Rating Options—Unified Soil Classification (Surface) (FLMD Water Intake and Treatment Plant)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

NOAA Atlas 14, Volume 8, Version 2
Location name: Colorado Springs, Colorado, USA*
Latitude: 39.062°, Longitude: -104.875°
Elevation: 6898.04 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.231 (0.189-0.282)	0.295 (0.241-0.360)	0.403 (0.328-0.492)	0.494 (0.400-0.606)	0.624 (0.488-0.792)	0.727 (0.555-0.932)	0.833 (0.613-1.09)	0.943 (0.665-1.26)	1.09 (0.740-1.50)	1.21 (0.796-1.68)
10-min	0.339 (0.277-0.413)	0.432 (0.353-0.527)	0.590 (0.480-0.721)	0.724 (0.586-0.888)	0.914 (0.715-1.16)	1.07 (0.813-1.37)	1.22 (0.898-1.60)	1.38 (0.974-1.85)	1.60 (1.08-2.19)	1.77 (1.17-2.45)
15-min	0.413 (0.338-0.503)	0.527 (0.431-0.643)	0.719 (0.586-0.879)	0.883 (0.715-1.08)	1.12 (0.872-1.41)	1.30 (0.991-1.67)	1.49 (1.10-1.95)	1.68 (1.19-2.26)	1.95 (1.32-2.67)	2.16 (1.42-2.99)
30-min	0.560 (0.458-0.682)	0.716 (0.585-0.873)	0.977 (0.795-1.19)	1.20 (0.971-1.47)	1.51 (1.18-1.92)	1.76 (1.35-2.26)	2.02 (1.49-2.64)	2.29 (1.61-3.06)	2.65 (1.79-3.63)	2.93 (1.93-4.06)
60-min	0.720 (0.589-0.878)	0.888 (0.725-1.08)	1.18 (0.962-1.44)	1.45 (1.17-1.77)	1.84 (1.45-2.35)	2.16 (1.66-2.79)	2.50 (1.85-3.30)	2.87 (2.03-3.86)	3.39 (2.30-4.67)	3.80 (2.51-5.27)
2-hr	0.881 (0.725-1.06)	1.06 (0.871-1.28)	1.39 (1.14-1.68)	1.69 (1.38-2.06)	2.16 (1.72-2.76)	2.55 (1.98-3.29)	2.98 (2.23-3.92)	3.45 (2.47-4.64)	4.13 (2.83-5.67)	4.67 (3.10-6.44)
3-hr	0.994 (0.821-1.20)	1.16 (0.960-1.40)	1.49 (1.23-1.80)	1.81 (1.48-2.19)	2.32 (1.87-2.98)	2.77 (2.16-3.57)	3.27 (2.45-4.29)	3.82 (2.74-5.12)	4.62 (3.19-6.34)	5.29 (3.52-7.26)
6-hr	1.21 (1.00-1.44)	1.40 (1.16-1.67)	1.76 (1.46-2.11)	2.13 (1.75-2.56)	2.73 (2.22-3.49)	3.27 (2.57-4.19)	3.87 (2.93-5.06)	4.55 (3.30-6.08)	5.54 (3.85-7.57)	6.37 (4.28-8.70)
12-hr	1.46 (1.22-1.73)	1.71 (1.43-2.02)	2.18 (1.82-2.59)	2.64 (2.18-3.14)	3.36 (2.73-4.22)	3.98 (3.14-5.04)	4.67 (3.55-6.03)	5.43 (3.95-7.18)	6.54 (4.57-8.84)	7.45 (5.03-10.1)
24-hr	1.74 (1.47-2.04)	2.07 (1.74-2.42)	2.65 (2.22-3.12)	3.19 (2.65-3.76)	4.00 (3.26-4.96)	4.70 (3.71-5.87)	5.44 (4.15-6.95)	6.26 (4.57-8.18)	7.42 (5.21-9.93)	8.36 (5.69-11.3)
2-day	2.05 (1.73-2.38)	2.41 (2.03-2.80)	3.05 (2.57-3.56)	3.63 (3.04-4.25)	4.51 (3.68-5.52)	5.25 (4.17-6.49)	6.03 (4.63-7.63)	6.88 (5.06-8.92)	8.09 (5.71-10.7)	9.06 (6.20-12.1)
3-day	2.21 (1.88-2.56)	2.60 (2.20-3.00)	3.27 (2.77-3.80)	3.89 (3.27-4.53)	4.80 (3.94-5.85)	5.57 (4.44-6.85)	6.39 (4.92-8.03)	7.27 (5.36-9.37)	8.51 (6.03-11.2)	9.51 (6.54-12.7)
4-day	2.35 (2.00-2.71)	2.75 (2.34-3.17)	3.45 (2.92-3.99)	4.08 (3.44-4.74)	5.03 (4.13-6.10)	5.82 (4.65-7.13)	6.66 (5.14-8.34)	7.56 (5.60-9.72)	8.84 (6.29-11.7)	9.87 (6.81-13.1)
7-day	2.73 (2.34-3.12)	3.14 (2.69-3.60)	3.88 (3.31-4.46)	4.55 (3.86-5.25)	5.56 (4.59-6.69)	6.40 (5.15-7.79)	7.30 (5.66-9.09)	8.26 (6.15-10.6)	9.63 (6.89-12.6)	10.7 (7.45-14.2)
10-day	3.08 (2.64-3.50)	3.52 (3.02-4.02)	4.31 (3.69-4.93)	5.03 (4.27-5.77)	6.09 (5.04-7.29)	6.97 (5.63-8.44)	7.92 (6.17-9.81)	8.93 (6.67-11.4)	10.4 (7.43-13.5)	11.5 (8.01-15.2)
20-day	4.07 (3.52-4.60)	4.66 (4.03-5.27)	5.67 (4.88-6.43)	6.55 (5.60-7.45)	7.81 (6.48-9.22)	8.83 (7.15-10.6)	9.89 (7.74-12.1)	11.0 (8.25-13.8)	12.5 (9.04-16.2)	13.8 (9.64-18.0)
30-day	4.89 (4.24-5.49)	5.61 (4.86-6.30)	6.80 (5.88-7.67)	7.81 (6.71-8.85)	9.23 (7.67-10.8)	10.3 (8.39-12.3)	11.5 (8.99-13.9)	12.6 (9.49-15.8)	14.2 (10.3-18.2)	15.4 (10.8-20.1)
45-day	5.90 (5.14-6.59)	6.77 (5.89-7.57)	8.19 (7.10-9.18)	9.35 (8.06-10.5)	10.9 (9.08-12.6)	12.1 (9.86-14.3)	13.3 (10.5-16.0)	14.5 (10.9-18.0)	16.1 (11.6-20.5)	17.2 (12.2-22.3)
60-day	6.75 (5.89-7.51)	7.74 (6.75-8.62)	9.32 (8.10-10.4)	10.6 (9.16-11.9)	12.3 (10.2-14.1)	13.5 (11.0-15.8)	14.8 (11.6-17.7)	16.0 (12.0-19.6)	17.5 (12.7-22.1)	18.6 (13.2-24.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

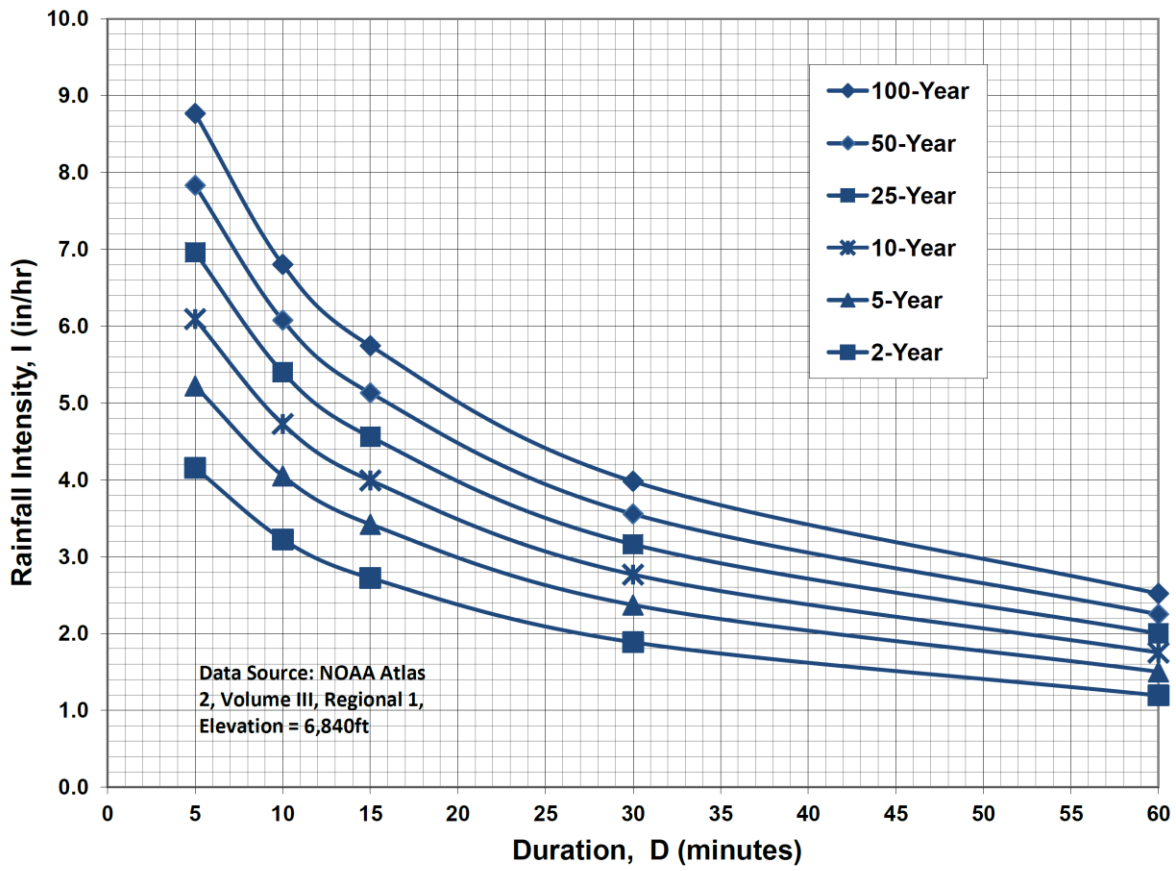
PF graphical

Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

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

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

3.2 Time of Concentration

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

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

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

Table 6-2. Rainfall Depths for Colorado Springs

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

Where Z= 6,840 ft/100

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

2.2 Design Storms

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

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

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

Attachment E

ISSUED FOR REGULATORY REVIEW

FOREST LAKES DRIVE

EXISTING RAW WATER PIPELINE

EXISTING GRADE, MINOR

EXISTING GRADE, MAJOR

BASIN BOUNDARY, TYP.

EFFECTIVE 100-YR FLOODPLAIN

RAW WATER PIPELINE DRAIN LINE

WATER TREATMENT PLANT

BRISTLECONE RESERVOIR

WATER TREATMENT PLANT CLEARWELL EMERGENCY OVERFLOW LINE

PROPOSED GRADE, MINOR

PROPOSED GRADE, MAJOR

EXISTING RESERVOIR SPILLWAY

EXISTING INLET

BACKWASH BASIN

BACKWASH BASIN EMERGENCY OVERFLOW LINE

FUTURE FILING 2A & 2B PROJECT AREA

PROPOSED MAJOR CONTOUR FOR FILING 2A AND 2B PROJECT

PROPOSED MAJOR CONTOUR (FOREST LAKES FILING 2B PROJECT)

PROPOSED MINOR CONTOUR FOR FILING 2A AND 2B PROJECT

EPHEMERAL TRIBUTARY TO PINON LAKE

EXISTING WELL TREATMENT BUILDING

RIPRAP LINED DRAINAGE CHANNEL

IMPACT BASIN

BIORETENTION / FSD FACILITY

BIORETENTION / FSD FACILITY OUTLET (AND OUTFALL)

BIORETENTION / FSD EMERGENCY OVERFLOW

EXISTING RESERVOIR OUTLET PIPE

18" RCP BIORETENTION FACILITY / FSD OUTLET PIPE

BASIN CONTINUES TO SOUTH, SEE 2016 FOREST LAKES FILING 2A &2B DRAINAGE REPORT

CONNECTION TO FOREST LAKES FILING 2B PROJECT STORM DRAIN SYSTEM

SEE 2016 FOREST LAKES FILING 2A &2B DRAINAGE REPORT FOR DESIGN POINT 6 LOCATION

LONG VALLEY DRIVE (TO BE CONSTRUCTED FOREST LAKES FILING 2A & 2B PROJECT)

100-YR FLOODPLAIN PER CLOMR CASE# 16-08-1035R

C 2.63

D.1 1.04

D 2.46

5

6

6.1

7

LEGEND

FLOW DIRECTION

BASIN ID — C

BASIN AREA (AC) — 2.63

BASIN BOUNDARY

DESIGN POINT — 5

BASIN RUNOFF SUMMARY

BASIN ID	Q100 (CFS)
C	9.11
D.1	5.30
D	10.63

DESIGN POINT SUMMARY

BASIN ID	Q100 (CFS)	INLET SIZE
5	9.11	EX 15' AT GRADE
6.1	1.10	OPEN CHANNEL
6	10.63	5' SUMP

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

NORTH

PLAN SCALE
40 20 0 20 40 80
SCALE IN FEET

DRAINAGE MAP

PCD PROJECT NO. PPR-17-043

WWE WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

NO.	BY	DATE	DESCRIPTION	COMMENTS
1	HAL	11/11/2017	REISSUED TO EL PASO COUNTY FOR REVIEW	-
2	HAL	12/06/2017	REISSUED TO EL PASO COUNTY FOR REVIEW	----
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---	---	---	---	---

		DATE
DESIGN	HAL	01/31/17
DETAIL	JKG	01/31/17
CHECK	WFL	01/31/17
APPROVAL		
SCALE		SHOWN
C8 BIORETENTION PLAN AND DETAILS.dwg		

FOREST LAKES METROPOLITAN DISTRICT WATER INTAKE AND TREATMENT PLANT

DRAINAGE BASINS MAP

JOB NO. 031-090.300
REVISION NO. 1
SHEET NO. 1

Plot Date/Time: 12/21/2017, 12:24:58 PM; Z:\PROJECT FILES\02-03\031-090\031-090.300\CAD-GIS\CAD\01_CAD\8_WWE DWGS\C8 BIORETENTION PLAN AND DETAILS.DWG DRAINAGE MAP