Inflow Design Flood Control System Plan

Comanche Station - CCR Impoundment

Public Service Company of Colorado
Denver, Colorado

October 17, 2016

Revised September 10, 2019

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Table of Abbreviations and Acronyms

Abbreviation	Definition
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
PSCo	Public Service Company of Colorado
SCS	Soil Conservation Service

1.0 General Information

On April 17, 2015, the U.S. Environmental Protection Agency published regulations under Subtitle D of the Resource Conservation and Recovery Act meant to control the safe disposal of coal combustion residuals (CCR) generated by coal-fired electric utilities. The rule defines a set of requirements for the disposal and handling of CCR within CCR units (defined as either landfills or surface impoundments). The requirements include preparation of an Inflow Design Flood Control System Plan for all existing and new CCR impoundments.

This Inflow Design Flood Control System Plan has been prepared for the CCR impoundment unit at the Comanche Station. It has been prepared in accordance with the requirements of 40 Code of Federal Regulations (CFR) §257.82. The regulation requires an initial Inflow Design Flood Control System Plan be prepared and posted no later than October 17, 2016.

1.1 Facility Description

Comanche Station is a 1,450-megawatt coal-fired, steam turbine power plant owned and operated by Public Service Company of Colorado (PSCo), an Xcel Energy company. PSCo's corporate offices are located at 1800 Larimer Street, Denver, Colorado 80202.

Bottom ash from the Units 1 and 2 boiler bottoms is pumped as slurry to the on-site Bottom Ash Pond for dewatering. Per 40 CFR §257.53, the Bottom Ash Pond is a partially incised impoundment, with a constructed earthen berm on the west side that retains CCR. The Bottom Ash Pond has been assessed to be a low hazard potential CCR surface impoundment in accordance with §257.73. The bottom ash is sluiced to the impoundment, where solids are separated from the water in a dewatering box at one end of the pond. The box collects the larger bottom ash material, and water and fines are passed through to the impoundment. Dewatered bottom ash is removed from the impoundment dewatering box on a regular basis by a wheeled loader/excavator and hauled off site for encapsulated beneficial use, or alternatively disposed in the on-site CCR landfill.

Figure 1 provides a Site Plan that depicts the location of the Bottom Ash Pond and the CCR landfill.

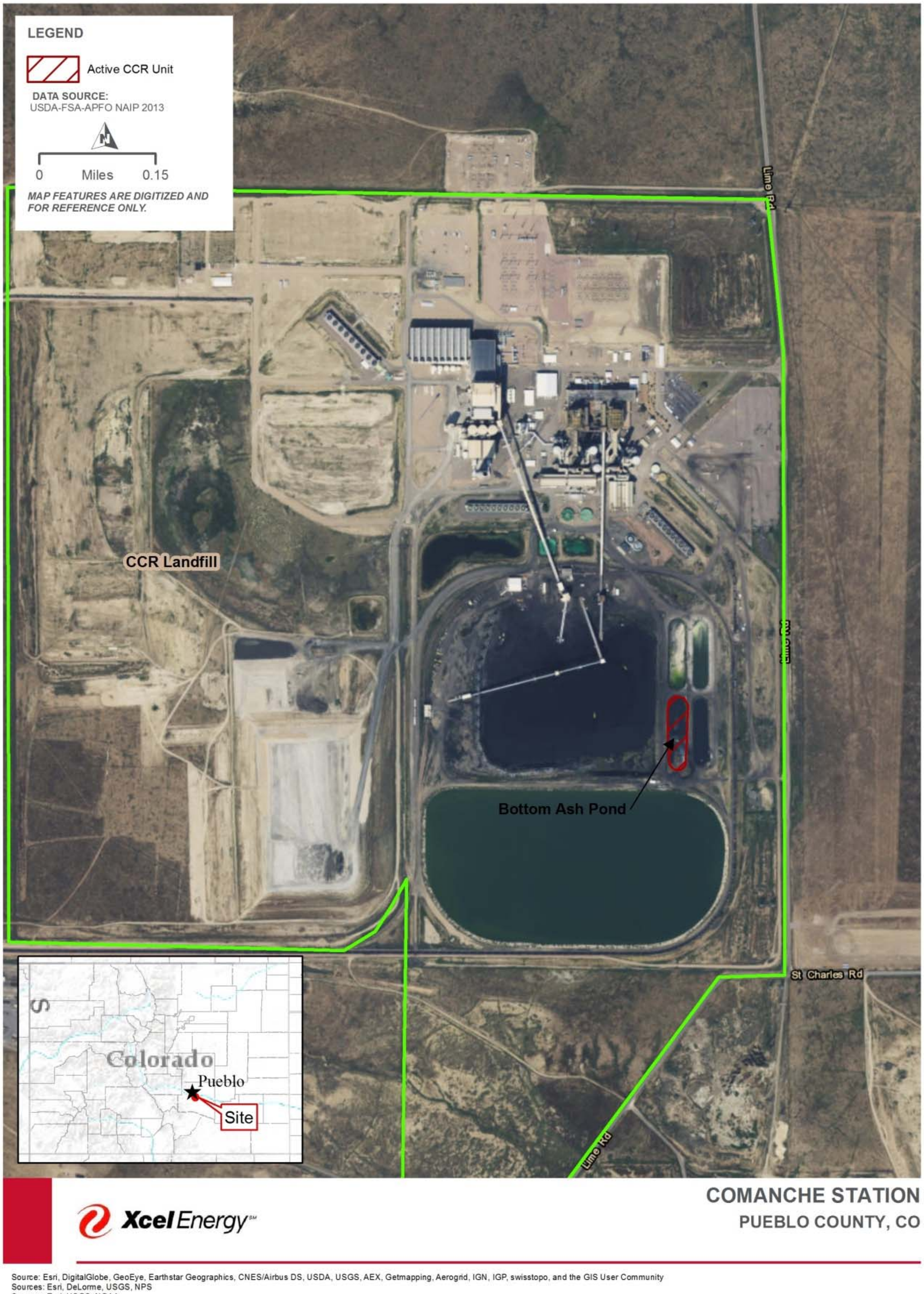


Figure 1. Site Location Plan

1.2 Regulatory Requirements

Title 40 CFR §257.82 requires that an owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR impoundment design, construct, operate, and maintain an inflow design flood control system per the following requirements:

1) The inflow design control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in item 3 below;
2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in item 3 below;
3) The inflow design flood is the 100-year flood for (low hazard potential) surface impoundments; and
4) Discharge from the CCR surface impoundment must not cause a discharge of pollutants to waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System under Section 402 of the Clean Water Act.

2.0 Hydrologic and Hydraulic Analysis for CCR Impoundments

A hydrologic and hydraulic analysis was completed for the active surface impoundment at the Comanche Station identified as the Bottom Ash Pond. The evaluation was completed in accordance with 40 CFR §257.82 and identified the drainage basin for the impoundment and evaluated the capacity of the outfalls to ensure safe passage of the 24-hour, 100-year storm event.

The evaluation included preparation of a surface water run-off model using AutoCAD Hydrographs to determine whether existing flood control systems meet the required criteria for controlling inflow from the 100-year flood.

The evaluation was completed based on the best available information provided by PSCo at the time of this report. There was no current survey of the impoundment. Estimates were made on the grade elevations of the impoundment and outfall structure based on historic drawings. Assumptions used to develop the hydraulic model are discussed in further detail below.

2.1 Description of CCR Surface Impoundment and Drainage Area

The impoundment is approximately 505 feet long by 140 feet wide and 20 feet deep. The impoundment has a surface area of approximately 1.6 acres. The impoundment has a top elevation of approximately 4,808 feet above mean sea level and a bottom elevation of 4,787 feet above mean sea level, and was designed with 3:1 horizontal to vertical side slopes. The design drawings indicate a normal pool of elevation of 4,803 feet above mean sea level for the impoundment.

The inflow drainage area to the impoundment is limited to the surface area of the pond (+/-1.6 acres) and the adjacent perimeter road (+/-0.27 acres). The site topography is shown in **Figure 2**.

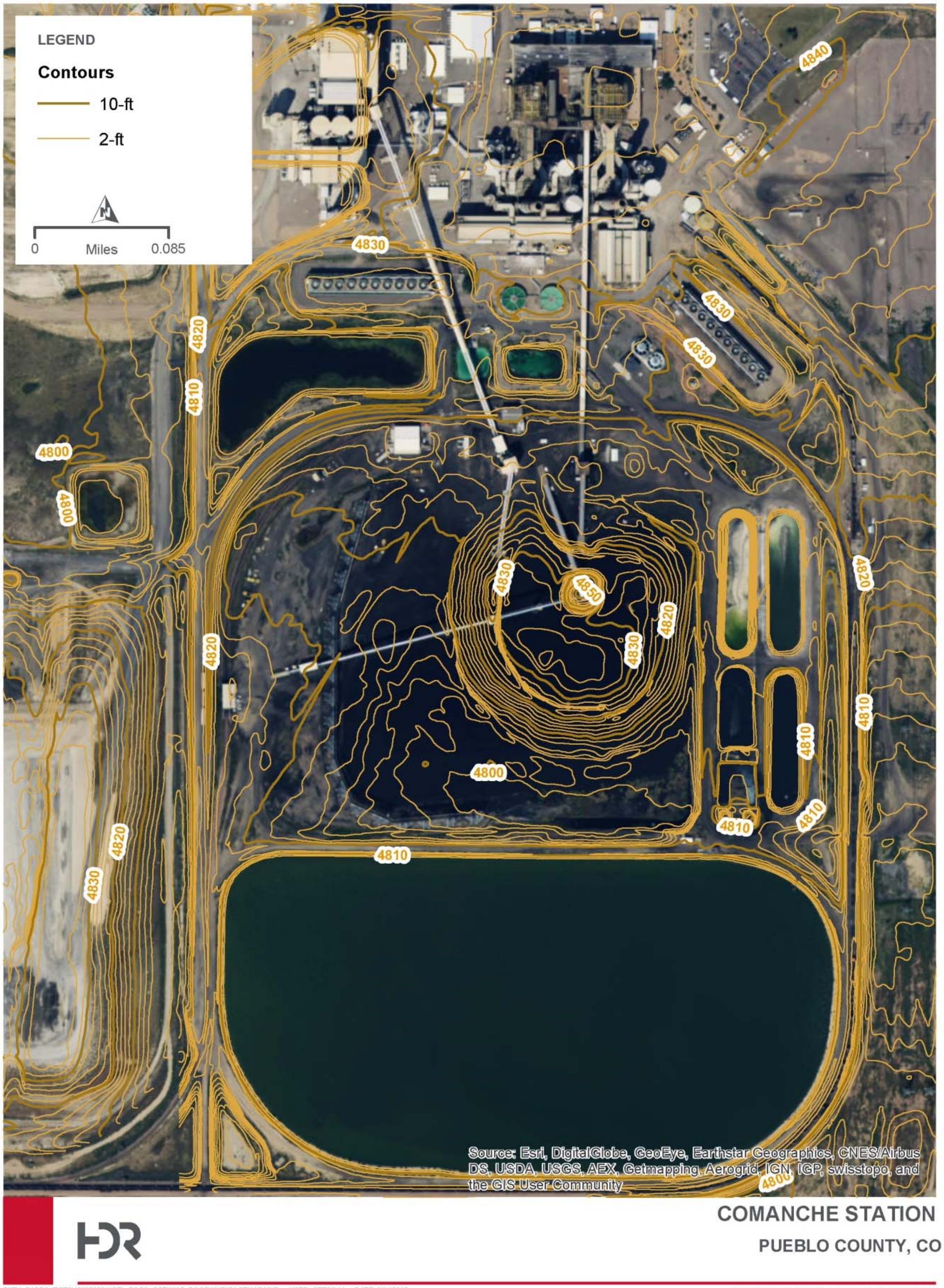


Figure 2. Site Topography

2.2 Description of Inflow Control System

There is no inflow control system for the Bottom Ash Pond. Surface water run-off enters the pond by rain falling directly in the pond or sheet flow from the adjacent perimeter road.

2.3 Description of the Outflow Control System

Outflow from the Bottom Ash Pond is via a culvert from the northeast corner of the pond under the road to the adjacent polishing pond, per the facility's existing wastewater discharge permit. Based on the limited drainage area, the peak discharge for 24-hour, 100-year event will be less than 10 cubic feet per second (see Attachment A).

2.4 Hydrologic and Hydraulic Model

A surface water run-off model was prepared using AutoCAD Hydrographs, which utilizes procedures outlined in the Soil Conservation Service (SCS) Technical Release 55 (TR-55) for computing curve numbers and times of concentration, and SCS TR-20 for generating run-off hydrographs. The model is included as Attachment B. A detailed discussion of the information input into the model is provided below.

The 24-hour, 100-year rainfall depth of 4.04 inches utilized was obtained from the National Oceanic and Atmospheric Administration Atlas 14 webserver (see Attachment C). A curve number of 98 was used for the entire drainage area because the land cover is either the pond surface area or the adjacent perimeter roads. Based on the limited drainage area, a 10-minute time of concentration was selected.

2.5 Evaluation of the Inflow Control System

There is no inflow control system for the Bottom Ash Pond, as surface water runoff enters the pond by rain falling directly in the pond or sheet flow from the adjacent perimeter road. For the minimal areas draining into the pond, the peak run-off estimated by the model for the 24-hour, 100-year design flood was approximately 9.0 cubic feet per second and the flood volume was approximately 26,600 cubic feet, resulting in a 5.4-inch rise in the pond elevation.

2.6 Evaluation of Outflow Control System

Controlling the outflow as a result of the 24-hour, 100-year event is simple, as the peak discharge is a relatively small 9.0 cubic feet per second. The most efficient method for controlling the run-off is to use the existing culvert in the northeast portion of the pond that discharges into the adjacent polishing pond. To handle the relatively small discharge quantity, the existing 12-inch culvert (Figure 3) is adequate to allow the peak flow from the 24-hour, 100-year storm to be conveyed out of the Bottom Ash impoundment without overtopping the impoundment. These existing controls are adequate for the operation of the Bottom Ash Pond and control of the outflow. Supporting calculations and information are included as attachments to this report.

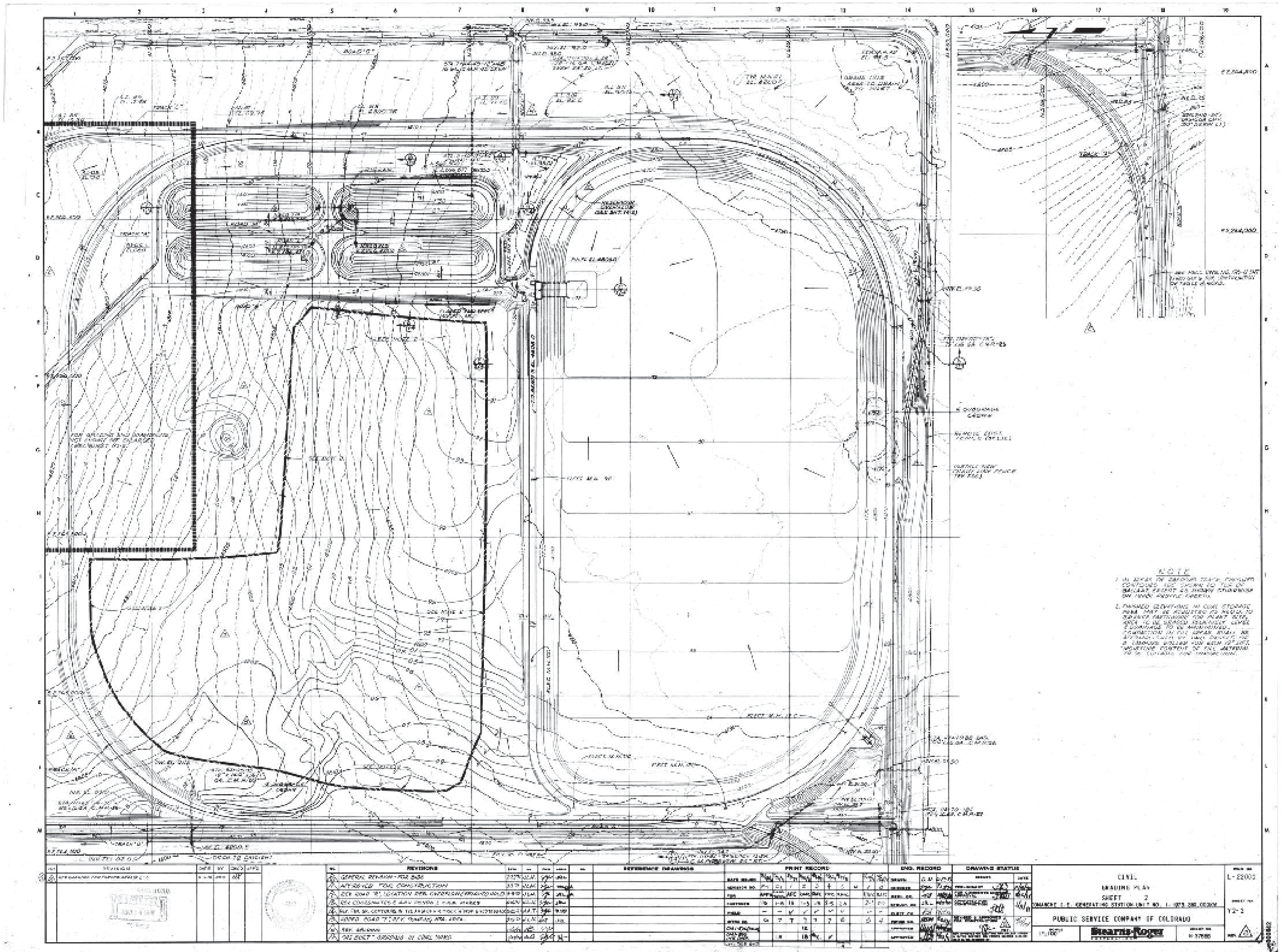


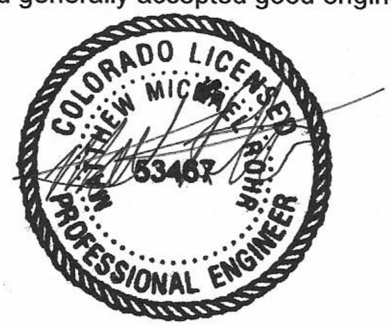
Figure 3. Location of Culvert

3.0 Certification §257.82(c)(5)

According to 40 CFR §257.81(c)(5), the owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the written inflow design flood control system plan meets the requirements of this section.

I, Matthew M. Rohr, being a registered Professional Engineer, in accordance with the Colorado State Board of Licensure for Architects, Professional Engineers, and Professional Land Surveyors, do hereby certify to the best of my knowledge, information, and belief, that the information contained in this Inflow Design Flood Control System Plan dated September 10, 2019, was conducted in accordance with the requirements of 40 CFR §257.82(c)(5), is true and correct, and was prepared in accordance with recognized and generally accepted good engineering practices.

SIGNATURE:



Colorado PE 0053467

DATE: September 10, 2019

ATTACHMENT A - CULVERT REPORT

Culvert Report

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

Xcel Comanche Bottom Ash Culvert - 12-inch

Invert Elev Dn (ft)	=	4799.00
Pipe Length (ft)	=	76.00
Slope (%)	=	0.99
Invert Elev Up (ft)	=	4799.75
Rise (in)	=	12.0
Shape	=	Circular
Span (in)	=	12.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

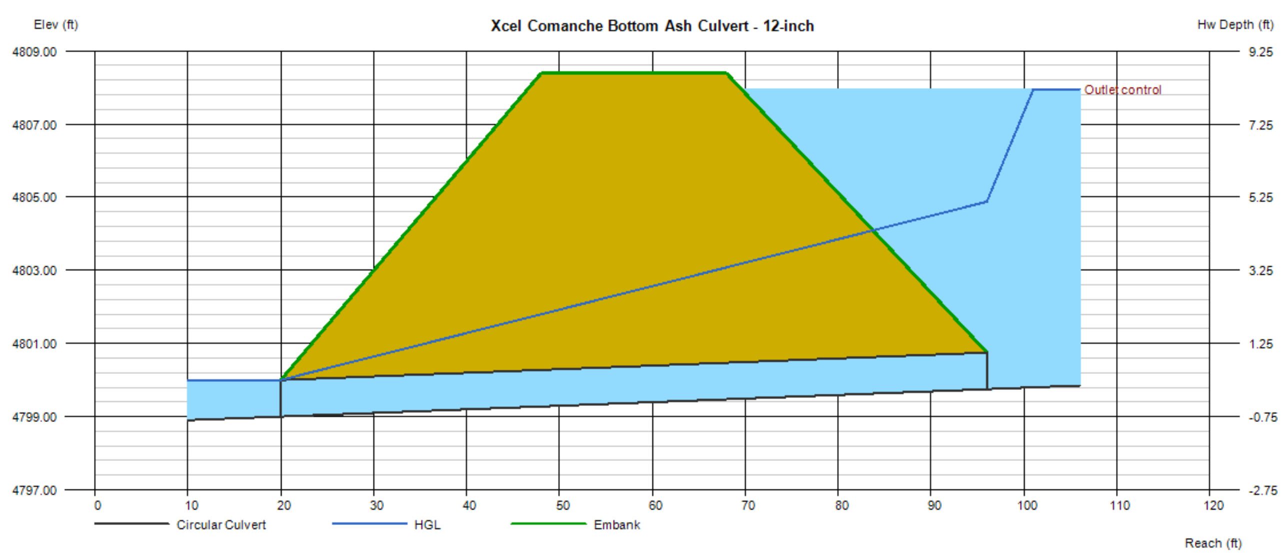
Top Elevation (ft)	=	4808.38
Top Width (ft)	=	20.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	9.00
Qmax (cfs)	=	10.00
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	9.02
Qpipe (cfs)	=	9.02
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	11.49
Veloc Up (ft/s)	=	11.48
HGL Dn (ft)	=	4800.00
HGL Up (ft)	=	4804.88
Hw Elev (ft)	=	4807.95
Hw/D (ft)	=	8.20
Flow Regime	=	Outlet Control

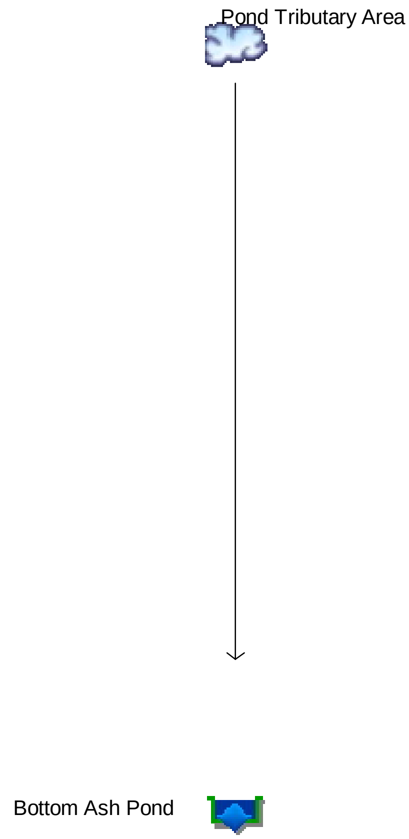


ATTACHMENT B - SURFACE WATER RUN-OFF MODEL

Hydraflow Table of Contents

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Project: Comanche.gpw	Friday, 09 / 2 / 2016

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	-------	-------	-------	-------	6.674	-------	9.015	Pond Tributary Area
2	Reservoir	1	-------	-------	-------	-------	-------	0.000	-------	0.000	Bottom Ash Pond

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	6.674	2	720	19,448	------	------	------	Pond Tributary Area
2	Reservoir	0.000	2	n/a	0	1	4803.33	468,247	Bottom Ash Pond

Comanche.gpw	Return Period: 25 Year	Friday, 09 / 2 / 2016

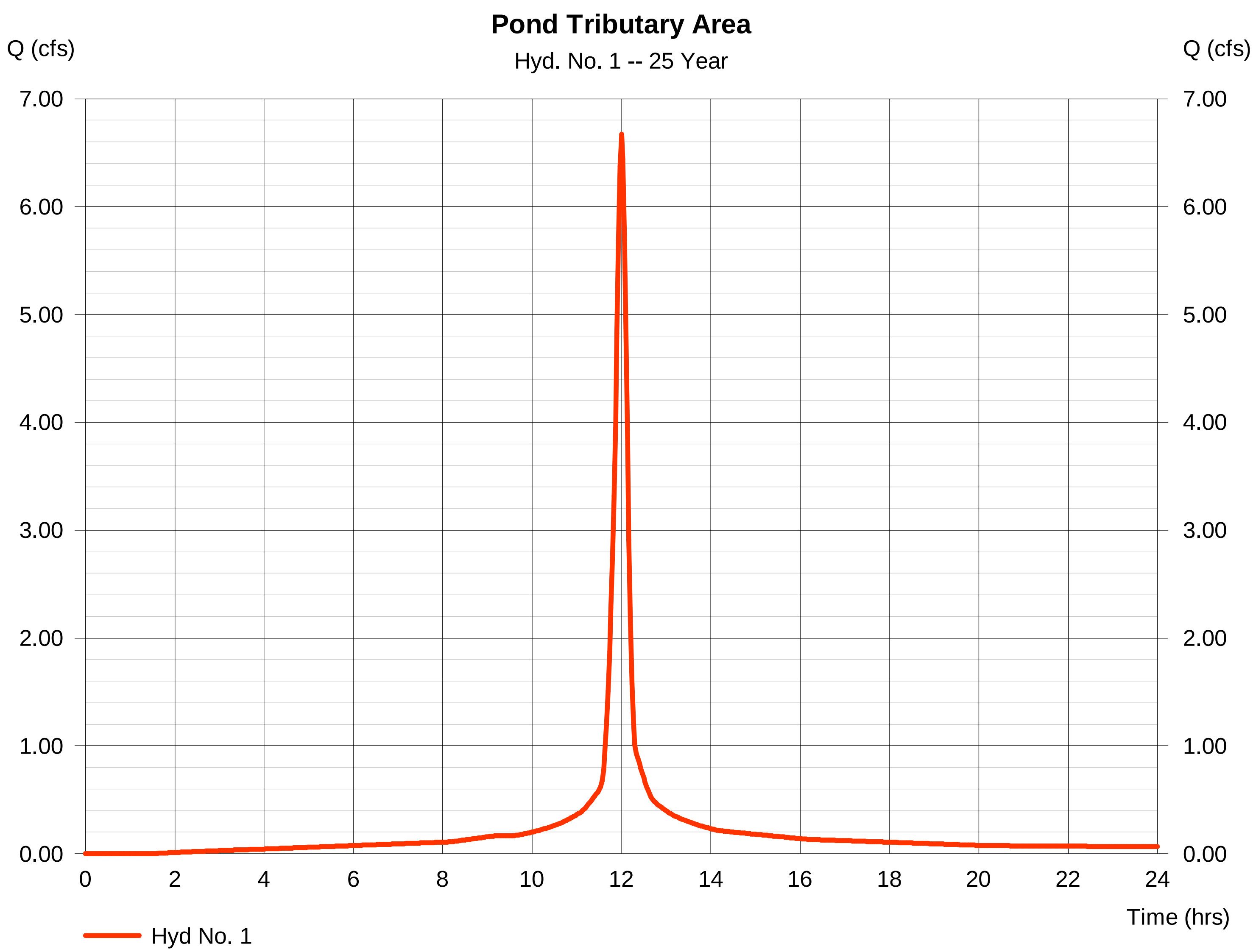
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 09 / 2 / 2016

Hyd. No. 1

Pond Tributary Area

Hydrograph type	= SCS Runoff	Peak discharge	= 6.674 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 19,448 cuft
Drainage area	= 1.870 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.01 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	9.015	2	720	26,636	------	------	------	Pond Tributary Area
2	Reservoir	0.000	2	n/a	0	1	4803.45	475,435	Bottom Ash Pond

Comanche.gpw	Return Period: 100 Year	Friday, 09 / 2 / 2016

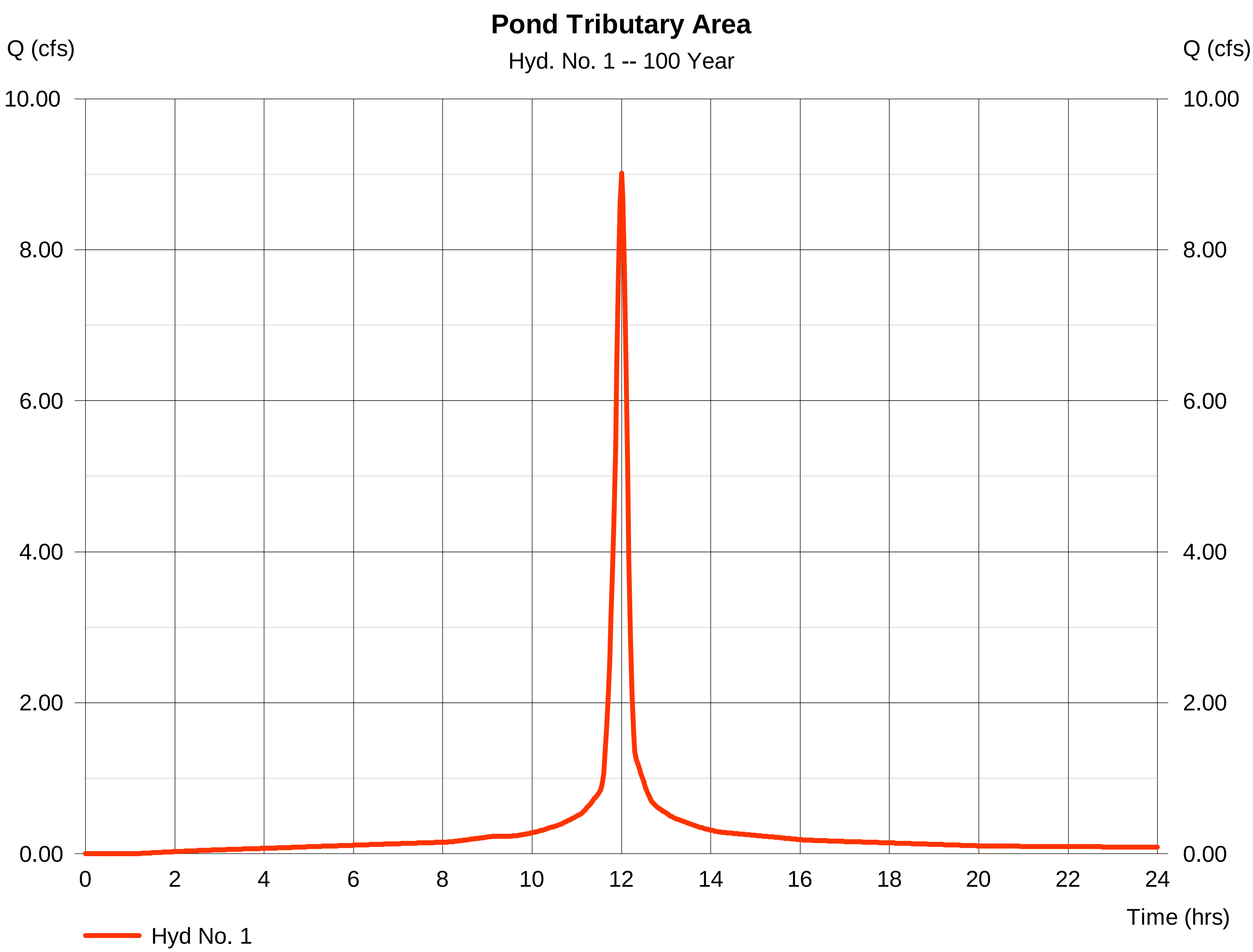
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 — Friday, 09 / 2 / 2016

Hyd. No. 1

Pond Tributary Area

Hydrograph type	= SCS Runoff	Peak discharge	= 9.015 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 26,636 cuft
Drainage area	= 1.870 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 4.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



ATTACHMENT C - PRECIPITATION ESTIMATES

NOAA Atlas 14, Volume 8, Version 2
Location name: Pueblo, Colorado, US*
Latitude: 38.2067°, Longitude: -104.5800°
Elevation: 4811 ft*
* source: Google Maps

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	**0.220** (0.176-0.279)	**0.266** (0.212-0.337)	**0.350** (0.279-0.445)	**0.429** (0.339-0.548)	**0.551** (0.424-0.741)	**0.655** (0.489-0.887)	**0.767** (0.551-1.06)	**0.891** (0.610-1.26)	**1.07** (0.700-1.55)	**1.21** (0.768-1.77)
10-min	**0.322** (0.257-0.408)	**0.389** (0.311-0.494)	**0.513** (0.408-0.652)	**0.628** (0.496-0.802)	**0.806** (0.621-1.08)	**0.958** (0.716-1.30)	**1.12** (0.807-1.56)	**1.30** (0.894-1.85)	**1.56** (1.02-2.27)	**1.78** (1.13-2.59)
15-min	**0.392** (0.314-0.498)	**0.475** (0.379-0.602)	**0.625** (0.497-0.795)	**0.766** (0.605-0.979)	**0.983** (0.758-1.32)	**1.17** (0.873-1.58)	**1.37** (0.984-1.90)	**1.59** (1.09-2.25)	**1.91** (1.25-2.77)	**2.17** (1.37-3.16)
30-min	**0.616** (0.493-0.781)	**0.737** (0.589-0.936)	**0.961** (0.764-1.22)	**1.17** (0.925-1.49)	**1.49** (1.15-2.01)	**1.77** (1.32-2.40)	**2.07** (1.49-2.87)	**2.40** (1.65-3.41)	**2.88** (1.89-4.18)	**3.27** (2.07-4.76)
60-min	**0.784** (0.627-0.994)	**0.934** (0.745-1.19)	**1.21** (0.961-1.54)	**1.47** (1.16-1.87)	**1.87** (1.44-2.51)	**2.21** (1.65-2.99)	**2.58** (1.85-3.57)	**2.99** (2.05-4.24)	**3.58** (2.35-5.19)	**4.06** (2.57-5.92)
2-hr	**0.952** (0.767-1.20)	**1.13** (0.909-1.42)	**1.46** (1.17-1.84)	**1.76** (1.41-2.23)	**2.24** (1.74-2.98)	**2.65** (2.00-3.55)	**3.09** (2.24-4.24)	**3.58** (2.47-5.03)	**4.28** (2.83-6.15)	**4.85** (3.10-7.01)
3-hr	**1.01** (0.814-1.26)	**1.19** (0.962-1.49)	**1.53** (1.23-1.92)	**1.85** (1.48-2.33)	**2.34** (1.83-3.10)	**2.76** (2.09-3.69)	**3.22** (2.34-4.39)	**3.72** (2.59-5.20)	**4.45** (2.96-6.36)	**5.04** (3.24-7.24)
6-hr	**1.11** (0.903-1.37)	**1.30** (1.06-1.61)	**1.65** (1.34-2.05)	**1.98** (1.60-2.48)	**2.50** (1.97-3.28)	**2.94** (2.24-3.88)	**3.42** (2.51-4.62)	**3.94** (2.77-5.46)	**4.70** (3.16-6.66)	**5.32** (3.46-7.58)
12-hr	**1.25** (1.02-1.53)	**1.45** (1.19-1.78)	**1.82** (1.49-2.24)	**2.17** (1.76-2.68)	**2.71** (2.15-3.52)	**3.17** (2.44-4.15)	**3.67** (2.73-4.92)	**4.23** (3.00-5.79)	**5.02** (3.41-7.05)	**5.67** (3.73-8.00)
24-hr	**1.40** (1.16-1.70)	**1.63** (1.35-1.98)	**2.04** (1.68-2.49)	**2.42** (1.99-2.97)	**3.01** (2.40-3.86)	**3.50** (2.72-4.54)	**4.04** (3.02-5.35)	**4.62** (3.31-6.27)	**5.46** (3.74-7.58)	**6.13** (4.07-8.57)
2-day	**1.56** (1.30-1.88)	**1.84** (1.53-2.21)	**2.33** (1.93-2.81)	**2.76** (2.28-3.35)	**3.42** (2.75-4.33)	**3.96** (3.10-5.07)	**4.54** (3.42-5.94)	**5.16** (3.72-6.92)	**6.04** (4.18-8.29)	**6.74** (4.52-9.34)
3-day	**1.68** (1.41-2.01)	**1.98** (1.66-2.38)	**2.51** (2.10-3.02)	**2.99** (2.48-3.60)	**3.69** (2.98-4.64)	**4.27** (3.35-5.43)	**4.88** (3.70-6.35)	**5.54** (4.02-7.39)	**6.47** (4.50-8.84)	**7.21** (4.87-9.94)
4-day	**1.79** (1.51-2.14)	**2.10** (1.77-2.51)	**2.66** (2.22-3.18)	**3.15** (2.62-3.79)	**3.88** (3.14-4.87)	**4.49** (3.54-5.68)	**5.13** (3.90-6.64)	**5.82** (4.24-7.72)	**6.78** (4.74-9.23)	**7.56** (5.13-10.4)
7-day	**2.07** (1.75-2.45)	**2.40** (2.03-2.85)	**2.99** (2.52-3.55)	**3.51** (2.94-4.19)	**4.29** (3.50-5.34)	**4.94** (3.92-6.20)	**5.62** (4.31-7.22)	**6.36** (4.67-8.37)	**7.39** (5.21-9.97)	**8.21** (5.62-11.2)
10-day	**2.29** (1.95-2.70)	**2.66** (2.26-3.14)	**3.30** (2.80-3.91)	**3.87** (3.26-4.59)	**4.70** (3.85-5.80)	**5.38** (4.29-6.71)	**6.09** (4.69-7.77)	**6.85** (5.05-8.96)	**7.91** (5.61-10.6)	**8.75** (6.03-11.9)
20-day	**2.90** (2.48-3.38)	**3.42** (2.93-4.00)	**4.28** (3.66-5.02)	**5.01** (4.25-5.89)	**6.01** (4.93-7.29)	**6.80** (5.45-8.34)	**7.59** (5.88-9.53)	**8.40** (6.24-10.8)	**9.48** (6.77-12.5)	**10.3** (7.17-13.8)
30-day	**3.42** (2.95-3.97)	**4.05** (3.49-4.71)	**5.06** (4.34-5.89)	**5.89** (5.02-6.88)	**7.00** (5.75-8.40)	**7.85** (6.31-9.54)	**8.68** (6.74-10.8)	**9.51** (7.09-12.1)	**10.6** (7.59-13.9)	**11.4** (7.97-15.2)
45-day	**4.14** (3.59-4.78)	**4.85** (4.19-5.60)	**5.96** (5.14-6.91)	**6.86** (5.88-7.98)	**8.05** (6.64-9.57)	**8.93** (7.21-10.8)	**9.78** (7.64-12.1)	**10.6** (7.95-13.4)	**11.7** (8.41-15.2)	**12.4** (8.75-16.5)
60-day	**4.80** (4.17-5.51)	**5.52** (4.80-6.35)	**6.67** (5.77-7.69)	**7.58** (6.53-8.78)	**8.79** (7.27-10.4)	**9.67** (7.84-11.6)	**10.5** (8.24-12.9)	**11.3** (8.52-14.3)	**12.3** (8.94-16.0)	**13.1** (9.25-17.3)

[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.

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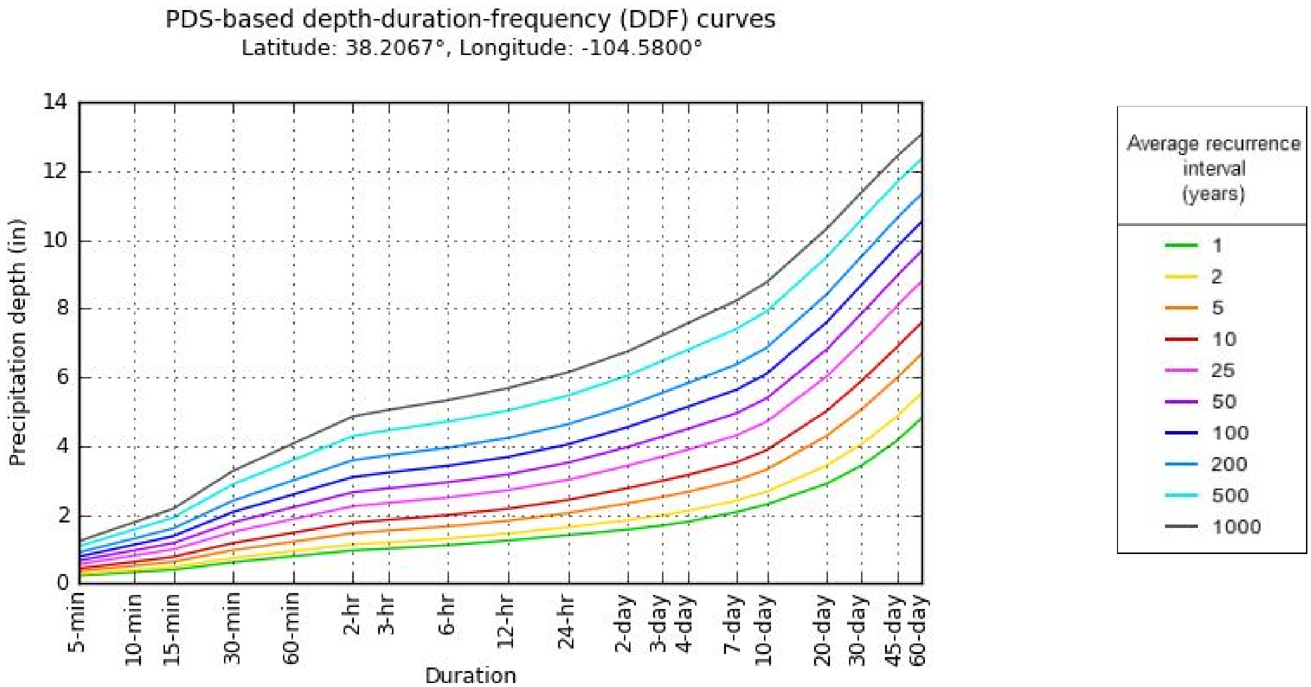
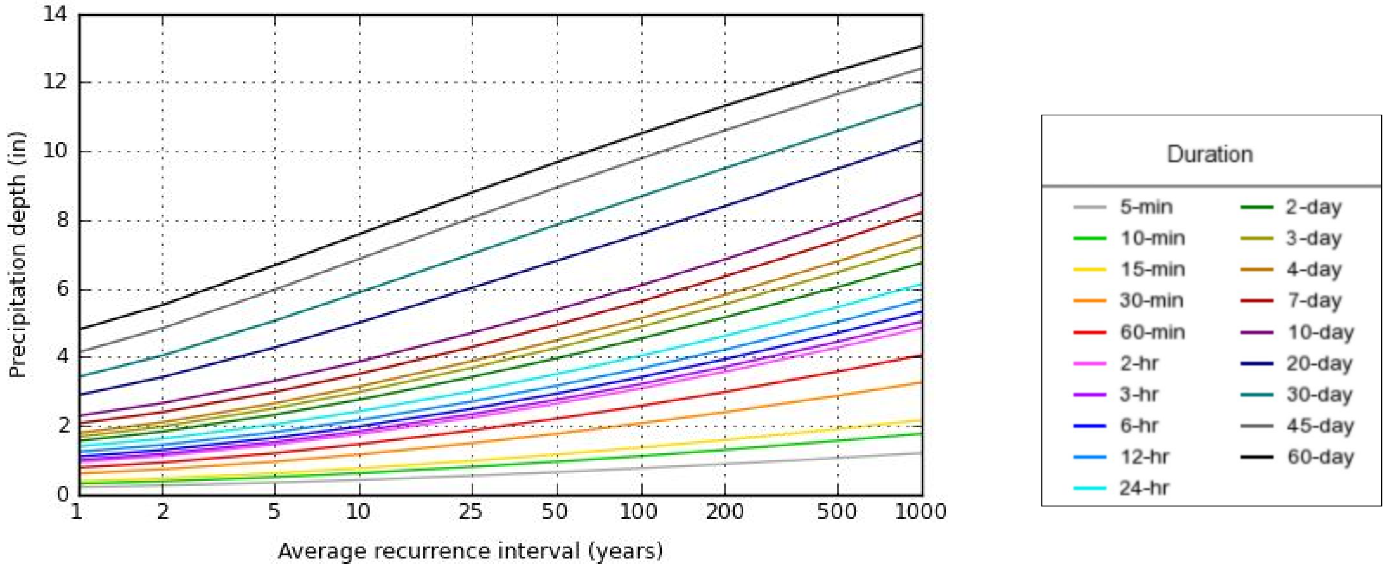
PF graphical





NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Tue Aug 30 14:50:19 2016

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Maps & aerials

Small scale terrain

Large scale terrain

Large scale map

Large scale aerial

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National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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