Appendix 6: Drainage Report

FINAL DRAINAGE STUDY

ENCANA OIL & GAS (USA) INC.
LIQUIDS HANDLING HUB

A parcel of land located in the East half of Section 21,
Township 1N, Range 68W of the 6th P.M., Weld County, Colorado

Prepared By:

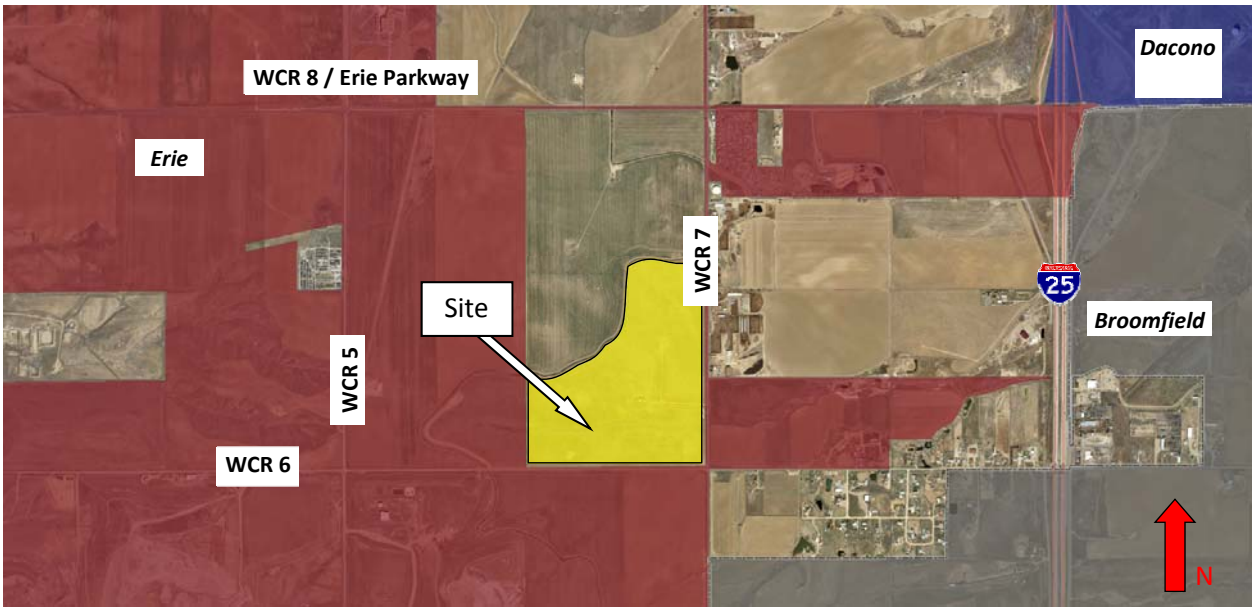
Baseline Engineering Corporation
700 12th Street # 220
Golden, Colorado 80401

Prepared For:

Encana Oil & Gas (USA) Inc.
370 17th Street, Suite 1700
Denver, Colorado 80202

March 19, 2014

Vicinity Map for the Encana Liquids Handling Hub



Section 21, Township 1N, Range 68W

"I hereby certify that this report for the drainage design of the *Encana Oil & Gas (USA) Inc.; Liquids Handling Hub*, was prepared by me (or under my direct supervision) in accordance with the provisions of the Weld County storm drainage criteria for the owners thereof."

_____

Noah Nemmers P.E.

State of Colorado No. 39820

Baseline Engineering Corp.

700 12th St. Suite 220

Golden CO 80401

Contents

Appendix

General Location and Description

Location

i. A parcel of land located in the east half of Section 21, Township 1 North, Range 68 West of the 6th Principal Meridian, County of Weld, State of Colorado
ii. The Liquids Handling Hub (hereinafter as "Site") bounded on the east by Weld County Road 7 (WCR 7), to the south by Weld County Road 6 (WCR 6) and rangeland to the north and east.
iii. There is an existing drainage way that runs through the Site and is being bypassed with this development and the Community Ditch is located to the north of the proposed Site.
iv. There are no surrounding developments.

Description of Property

i. The property encompasses approximately 137 acres; of this only 36.7 acres will be disturbed by the proposed site improvements.
ii. Existing ground cover for the on-site basin consists of native grasses and low brush. Soil type is primarily Type B (Wiley-Colby complex). Type C (Nunn Loam) is also present. A soil map for the entire drainage basin developed using the online NRCS Web Soil Survey mapping tool can be found in ***Appendix A***.
iii. There is a natural channel through the Site that flows to an existing 48" culvert under WCR 7.
iv. The proposed development is a centralized liquids management facility for the handling of produced liquids from Encana's operations in the surrounding area. Facilities to be installed include gravel roads, truck loading areas, and associated permanent structures.
v. Community Ditch is located directly north of the proposed Site.
vi. Ground water ranges from 9 to 20 feet deep. Any dewatering required during construction will need to be properly permitted through CDPHE.

Drainage Basin and Sub-Basin

Major Basin Description

i. No Weld County Master Drainage Plan exists for this basin.
ii. The Site is located near the upper-limits of the major basin which is bounded by Weld County Road 5 the west, Weld County Road 8 to the north and Weld County Road 6 to the south. Off-site flows from the basin are divided to the north and south by Weld County Road 8. The proposed Site will convey sheet flow from the north and west. The flows are currently conveyed via overland flow towards to the east towards WCR 7 where there is an existing 48" culvert

and will outfall into Little Dry Creek which is located approximately 3/4 of a mile downstream of the Site.

iii. No FEMA defined 100 year floodplains/floodways are present in this area as shown on FIRM Map 080266 0960 D, dated September 28, 1990 (***see Appendix A***).

iv. See Drainage Maps ***(see Appendix G and H)*** for existing and proposed contours. Off-site basins were defined based on a USGS Hydrography Map (***see Appendix G).*** On-Site basins and the conveyance structures for the off-site basins were defined based on ground topography surveyed using GPS and conventional survey methods.

Sub-Basin Description

i. Historically the site receives offsite flows from the west via overland flow. The site drains to the east at grades from 1.5-2%. All flows are transmitted overland east to an existing 48" culvert under WCR 7. Offsite flows from properties to the north will be routed to the existing culvert and accounted for within this drainage analysis. Historic sub-basins were modeled using HEC-HMS ***(see Appendix C)*** and the parameters for those basins are as follows:

Basin H1 is 0.038 square miles (24.44 acres) and has an imperviousness of less than 0.6% consisting of the County Road and open grass fields. The average basin slope is 1.1%. The basin contains primarily Type "B" and "C" soils ***(see Appendix A)***. For the HEC-HMS model an SCS Curve number of 79 was selected based on a hydrologic soil type "C" (to be conservative) with "Fair" conditions for Pasture or Rangeland. Flows from this basin are conveyed easterly to an existing 48" culvert under WCR 7. The existing culvert has a capacity of approximately 143 CFS. Calculations for the culverts can be found in ***"Appendix F****, Hydraulic Computations".*

Basin H-2 is 0.192 square miles (122 acres) and has an imperviousness of 0.6% consisting of a portion of Weld County Road 6, and open grasslands located directly west of the proposed Site. The average basin slope is 1.3%. For the HEC-HMS model an SCS Curve number of 79 was selected based on a hydrologic soil type of "C" ***(see Appendix A)*** with "Fair" conditions for Pasture or Rangeland. Flows from this basin are conveyed easterly and flow on-site by means over overland flow to the existing 48" culvert located under WCR 7.

Basin H-3 is 0.285 square miles (182.46 acres) and has an imperviousness of less than 0.6% consisting of open fields that is located directly north of the proposed Site. The average basin slope is 2.5%. For the HEC-HMS model an SCS Curve number of 79 was selected based on a hydrologic soil type of "C" ***(see Appendix A)*** with "Fair" conditions for Pasture or Rangeland. Flows from this basin are conveyed easterly flows into the existing 48" culvert located at WCR 7.

Detailed HEC-HMS Calculations and Output for the 5, 10, 25, 50, and 100-yr storm frequencies can be found in ***Appendix C and D***.

ii. Proposed sub-basins are described as follows:

Basin A1 is approximately 10.9 acres and is located on the western limits of the Site is included in the drainage study for future expansion capability. This basin is bounded on the east by a proposed drainage swale that is intended to intercept all offsite flows coming from the west. Runoff is conveyed via overland flow into a bypass swale.

Basin A2 is approximately 2.78 acres and is located southwest portion of the Site, which consists of open space and a portion of the Site access circulation road. Runoff is conveyed overland to the northeast limits of the basin to a proposed 15" RCP culvert where it ultimately outfalls into Basin A3 at Design Point 2.

Basin A3 is approximately 6.00 acres and is located on the northern limits of the Site. It consists of the processing area, firewater tank and pump, produced water holding tanks, and portions of the Site access circulation road. Basin A3 will convey flows that come from Basin B1 and A2. There is a proposed drainage swale within Basin A3 to convey these flows to a proposed 30" RCP culvert at Design Point 3. The proposed drainage swale has been sized to convey the 100-yr flows for Basin B1, A2 and A3, see ***Appendix F*** for detailed calculations.

Basin A4a is approximately 1.11 acres located at the south east portion of the Site. Basin A4a consists of a portion of open space and portion of the circulation road for the Site. Runoff within this basin will flow overland to a proposed drainage swale that has been sized to convey the 100-yr flow. The downstream portion of the swale within Basin A4 will receive flows from Basins B1, A2

and A3 and has been sized accordingly to do so, see ***Appendix F*** for detailed calculations. Flows tributary to this basin are conveyed within the drainage swale to a proposed 30" RCP culvert at Design Point 4a.

Basin A4b is approximately 4.65 acres located at the south east portion of the Site. Basin A4b consists of a portion of open space and portion of the circulation road for the Site. Runoff within this basin will flow overland to a proposed drainage swale that has been sized to convey the 100-yr flow. The downstream portion of the swale within Basin A4b will receive flows from Basins B1, A2, A3 and A4a and has been sized accordingly to do so, see ***Appendix F*** for detailed calculations. Flows tributary to this basin are conveyed within the drainage swale to a proposed 30" RCP culvert at Design Point 4b where it will ultimately outfall within the proposed detention pond.

Basin A5 is approximately 4.60 acres which is located on the eastern limits of the development and consists of the truck staging area and produced water and oil loadout. This area is primarily pavement which drains into a trench drain with a sump.

Basin A6 is approximately 3.79 acres which is located on the far eastern limits of the development and consists of a proposed detention pond. The detention pond was sized in accordance with COGCC Exploration and Production Facility Rule 908.b.5.E and the stormwater outfall has been designed to contain the water volume from the twenty-five (25) year, twenty-four (24) hour storm. Storms greater than the 25 year event will be released at a restricted rate matching Weld County Requirements. All of Basin H1 was also modeled using HEC-HMS to determine the 5-YR release rate for sizing the stormwater detention release (***see Appendix C***).

Basin B1 is approximately 4.32 acres and is included in the drainage study for future expansion capability. The area from Basin B1 is accounted for within the detention calculations. Flows tributary to this basin are conveyed within a drainage swale to a proposed 24" RCP culvert at Design Point 8.

Basin B2 is approximately 3.55 acres and consists of the make-up produced oil tanks. The containment has also been accounted for in terms of disturbed area but runoff produced within this area

will not have any impact on any downstream basins. The area from Basin B2 is also accounted for within the detention calculations though in reality it is confined by the containment berms.

Basin B3 is approximately 0.51 acres and consists of tanks and a small containment area. The containment has also been accounted for in terms of disturbed area but runoff produced within this area will not have any impact on any downstream basins. The area from Basin B2 is also accounted for within the detention calculations though in reality it is confined by the containment berms.

Basin C1 is approximately 0.53 acres and is located at the southwest of the Site along WCR 7. This basin consists of a portion of the roadside swale, and the northern half of WCR 6. Runoff will be conveyed within the roadside swale to where a future access may be needed. A 15" RCP culvert would be needed at this location where it will be conveyed into Basin C2.

Basin C2 is approximately 0.83 acres and is located directly west of Basin C1. This basin which is similar to Basin C1 consists of a portion of the roadside swale, and the northern half of WCR 6. Runoff within this basin and from Basin C1 is conveyed by a swale to a proposed 15" RCP culvert at Design Point 9.

Basin C3 is approximately 1.78 acres which is located at the southeast portion of the Site consists of roadside swale areas, berm areas and the northern portion of Weld County Road 6. Basin C3 will convey flows from Basin C1 and C2 through a proposed roadside swale. Flows will be conveyed to a proposed 18" RCP culvert at Design Point 10. Flows from Basin C1-C3 will bypass the proposed detention pond and ultimately outfall at the existing 48" CMP culvert under WCR 7.

In total there is a 23.35% imperviousness proposed with the improvements and much of the conveyance is done through long overland flows both in grass line swales and sheet flow across undisturbed rangeland. Detailed Rational Method calculations for the 5, 10, and 100 year storm frequencies for these basins can be found in ***Appendix E***.

Drainage Design Criteria

Development Criteria Reference and Constraints

i. No previous drainage studies are known to exist for the property.

ii. In the historic condition all flows travel overland from west to east. The proposed Site will interrupt flows from the north and south. These flows will be collected via swales and culverts and transmitted around the Site in order to bypass the upstream flow. Flows coming onto the Site will be intercepted by a proposed swale that will convey flows to the existing 48" CMP culvert located at WCR 7. Flows from the south portion of the site will be intercepted by a proposed roadside swale that will ultimately outfall into the existing 48" CMP culvert at WCR 7. The proposed buildings, mechanical areas, and gravel roads and parking areas were accounted for in the proposed site impervious calculations, as shown in the appendices.

Hydrological Criteria

i. Precipitation frequency for this site was determined using Colorado Precipitation Frequency Data from NOAA's Website. Using the site specific estimating tool for the sites coordinates yielded the following output from NOAA Atlas 2 data:

Map	Precipitation (Inches)	Intensity (In/Hr)
2-year, 6-hour	1.24	0.207
2-year, 24-hour	1.83	0.076
100-year, 6-hour	3.81	0.636
100-year, 24-hour	4.88	0.204

Design storm rainfall amounts for the 5, 10 and 100 year frequencies were generated from this data using the UDFCD Rainfall Workbook. IDF Curves generated from this data along with detailed tables and NOAA Atlas 2 Isopluvial Maps for each of the design storms can be found in ***Appendix B*** under the "Rainfall Data". This data and the 1-hour point rainfall that was generated were used in calculating the runoff in the Rational Method forms.

Return Period	Rainfall Depth in Inches at Time Duration								
	5-min	*10-min*	*15-min*	*30-min*	*1-hr*	*2-hr*	*3-hr*	*6-hr*	*24-hr*
2-yr	0.23	0.37	0.46	0.53	0.81	0.96	1.07	1.24	1.83
5-yr	0.37	0.59	0.74	0.86	1.31	1.43	1.66	1.66	2.39

10-yr	0.46	0.73	0.92	1.07	1.63	1.78	2.06	2.06	2.89
25-yr	0.58	0.92	1.16	1.34	2.04	2.26	2.69	2.69	3.62
50-yr	0.68	1.09	1.38	1.59	2.42	2.70	3.22	3.22	4.24
100-yr	0.79	1.26	1.58	1.83	2.79	3.14	3.81	3.81	4.88
500-yr	1.01	1.61	2.02	2.34	3.57	3.97	4.75	4.75	6.05

ii. The 5, 10, and 100 year storm recurrence intervals for this site were analyzed per Weld County specification.

iii. For basins less than 160 acres the Rational Method was used to determine peak runoff. For basins larger than 160 acres the Hydrologic Modeling Program HEC-HMS was used. HEC-HMS was primarily used on the off-site runoff and for comparison of the site runoff conditions between existing and proposed conditions. Basins A1-A5 were routed to the proposed detention pond located on the east side of the Site where it will ultimately outfall into existing 48" CMP culvert within Weld County Road 7. A summary of each of these computed flows for the 5, 10, and 100-YR storm frequencies can be found in ***Appendix E***. An output graph and hydrograph output can also be found in ***Appendix E.*** A runoff summary is noted on the Historic and Proposed drainage plans provided in ***Appendix G and H***.

The Rational Method was used exclusively for the developed site basins being that they are all less than 160 acres. Spreadsheet results for Rational Method calculations can be found in ***Appendix E*** and a runoff summary are noted on the Proposed Drainage Plan as well is below:

HISTORIC RUNOFF SUMMARY

(HEC-HMS)

			5-YR RUNOFF		10-YR RUNOFF		100-YR RUNOFF	
DESIGN POINT	***DESIGN BASIN***	***AREA (sq. miles)***	C_5	Q_5 ***(cfs)***	C_{10}	Q_{10} ***(cfs)***	C_{100}	Q_{100} ***(cfs)***
1	H1	0.04	0.15	4.2	0.25	7.7	0.50	26.9
2	H2	0.19	0.15	25.1	0.25	46.0	0.50	152.6
3	H3	0.29	0.15	36.9	0.25	67.8	0.50	228.3

DEVELOPED RUNOFF SUMMARY

(RATIONAL METHOD)

			5-YR RUNOFF		10-YR RUNOFF		100-YR RUNOFF	
DESIGN POINT	***DESIGN BASIN***	***AREA (acres)***	C_5	Q_5 ***(cfs)***	C_{10}	Q_{10} ***(cfs)***	C_{100}	Q_{100} ***(cfs)***
1	A1	10.90	0.08	2.7	0.15	6.2	0.35	24.9
2	A2	2.78	0.11	0.9	0.17	1.8	0.37	6.4
3	A3	6.00	0.16	2.8	0.23	4.8	0.41	14.7
4	A4a	1.11	0.13	0.5	0.20	0.9	0.39	3.1
5	A4b	4.65	0.10	1.4	0.16	3.1	0.36	11.5
6	A5	4.60	0.67	10.0	0.71	13.0	0.79	25.0
7	A6	3.79	0.08	1.0	0.15	2.3	0.35	9.4
8	B1	4.32	0.23	3.5	0.30	5.6	0.45	14.7
9	B2	3.55	0.41	5.5	0.46	7.7	0.58	16.7
10	B3	0.51	0.29	0.5	0.35	0.8	0.49	1.8
11	C1	0.53	0.47	0.7	0.51	1.0	0.64	2.1
12	C2	0.83	0.38	0.9	0.43	1.3	0.57	2.9
13	C3	1.78	0.34	1.7	0.39	2.5	0.54	5.8

iv. Detention calculations were performed using the UDFCD's UD-Detention v2.31 spreadsheet along with the existing and proposed HEC-HMS conditions.

v. All offsite flows will be routed through and around the proposed Site. The detention pond will convey the developed flows from within the proposed Site. Flows overtopping the pond will ultimately overtop the emergency overflow which has been designed to be 130 foot wide and capable of passing the 100-YR developed inflow (Basins A1-A5 & B1-B2) totaling 169 CFS at a depth of approximately 6 inches. The emergency overflow is designed to convey approximately 171 CFS.

Hydraulic Criteria

i. A swale is proposed to follow the proposed Site boundary (from the west of the Site to the northeast corner of the Site in order to collect runoff as it is transmitted via overland flow and discharge it to the existing 48" CMP culvert. These swales will be trapezoidal in section with 4:1 side slopes and a 12 foot wide bottom. They will follow the typical grade of the proposed Site at no less than 0.50%. An analysis of a typical swale section was performed using Hydraflow. The results indicate a 3 foot deep swale with the section outlined above will carry 838 CFS. There are also two proposed 36" culverts (Culvert 9) under

the proposed access road that leads from the Site to a remote strip of land that is directly north of the swale. All swales are compliant with Table 5-9 of the Weld County Engineering Criteria. These swales will ultimately drain either to the proposed detention pond or be spread out to sheet flow conditions before leaving the site. See ***Appendix F,*** "Hydraulic Computations," for details.

The low point for the swales will be at the east side of the site where the detention pond is located. Culverts were modeled using Hydraflow. Each culvert was sized to easily pass the 10-YR flow with a head to pipe diameter ratio of less than 1.5 in accordance with County Code on the upstream end of the pipe. Calculations for the swale as well as each of the culverts identified on the drainage plan and construction drawings can be found in ***Appendix C and D.***

ii. The detention pond was sized in accordance with COGCC Exploration and Production Facility Rules 908.b.5.E and the stormwater outfall has been designed to contain the water volume from the twenty-five (25) year, twenty-four (24) hour storm volume which was calculated to be 2.9 acre-ft. Storms greater than the 25 year event will be restricted and released at the 5-yr historic rate matching Weld County Requirements. The Hydrograph method based on the 10-YR and 100-YR developed site inflow hydrographs calculated using HEC-HMS for Basins A. The junction of these flows for the 10-YR and 100-YR frequency was used as the input for the UD Detention sizing based on the hydrograph method. The total area for these basins is 24.44 acres. The release rate is based on the 5-yr historic runoff for the 24.44 acres tributary to the detention pond above the 25-yr retention volume. The Rational Method was used to determine the appropriate release. The model calculated a peak discharge that is restricted to 4.2 CFS for the contributing area. The minor 10-YR storage based on the hydrograph spreadsheet is 0.41 acre-ft and the 100-YR storage volume was calculated to be 3.58 acre-ft. The historic and proposed HEC HMS results and hydrograph data can be found in ***Appendix F*** "Hydraulic Computations."

The detention outlet structure was designed using the UDFCD's UD-Detention v2.31 spreadsheet, the results can be found in ***Appendix F*** "Hydraulic Computations." The proposed structure is described in the spreadsheet as Routing Order #3, a rectangular box with a single stage open grate on the top. The grate elevation is 5192.75 which are also equal to the 25-yr water surface elevation, the 100-yr pond surface

(storage) elevation is 5193.91. The ultimate overflow weir elevation occurs at 5194.91 and provides an additional 1 foot of freeboard beyond the 100-yr storage volume. The 18" outlet culvert has been sized to pass the maximum release rate of 4.2 CFS for the developed site with a restrictor plate designed to achieve this flow. Flows from the outfall structure will release into a low tailwater basin just before releasing into the main channel and crossing WCR 7. See ***Appendix F*** "Hydraulic Computations," for all detention storage sizing, outlet calculations, and stage storage tables for the proposed detention pond.

iii. Water Quality is provided by way of the 25-yr retention volume.

iv. Culverts will convey flows around and through the site and maintenance road network. RCP with Manning's n-value of 0.013 is the pipe material that has been selected. Diameter and slope vary as needed to convey the 10-YR peak flows as shown in the appendices. HGLs and EGLs were calculated using Hydraflow software. Refer to the ***Appendix F,*** "Hydraulic Computations," for results of those calculations.

v. No inlet or manhole systems will be installed as part of this project.

vi. All culvert and detention outlet points will be protected by rip rap. The outlet for the detention pond has been designed with a low tailwater basin to provide additional erosion and sediment control as well as to dissipate the outflow from the pipe. All rip-rap is proposed to be Type "L" with dimensions as noted on the construction drawings and summarized below:

RIPRAP SIZING TABLE

Culvert	***Rock Type***	***D_{50}*** *(inches)*	***T*** *(feet)*	***L*** *(feet)*	***W*** *(feet)*
Culvert 1	Type L	9	1.5	8	8
Culvert 2	Type L	9	1.5	5	5
Culvert 3	Type L	9	1.5	10	10
Culvert 4	Type L	9	1.5	10	10
Culvert 5	Type L	9	1.5	5	5
Culvert 6	Type M	12	2.0	24	24
Culvert 7	Type L	9	1.5	6	6
Culvert 8	Type L	9	1.5	6	6

Calculations for the riprap sizing can also be found in ***Appendix F*** "Hydraulic Computations." The outlets for each culvert have been designed with a low tailwater basin to provide additional erosion and sediment control as well as to dissipate the outflow from the pipe.

vii. Native seed will be applied to any disturbed areas as a means of permanent erosion control.

viii. Only methods approved in the COGCC Rules, Weld County code, or the Weld County Drainage Criteria update to the UDFCD Criteria Manual were used for this analysis.

General Concept

i. Wherever possible, the historic drainage patterns for the site have been preserved. A combination of swales and culverts will be employed to divert water along and through the Site to a detention pond at the east side. It is anticipated that flows north and west of the proposed site will remain in the historic condition. An outlet structure will drain the pond returning the developed flows to the historic pattern. Using a low tailwater basin to dissipate velocity and spread the flow.

ii. Offsite flows will bypass the Site and remain at the historic condition and flow path.

iii. The appendices contain copies of all calculations, models, and resources referenced in previous sections that were used in the creation of this analysis.

iv. Hydraulic structures present in this design include culverts, swales, and the detention pond outlet structure mentioned in previous sections. No other structures are anticipated for this project.

Specific Details

i. A maintenance road will be constructed which will be used for maintenance and access to drainage facilities. The side slopes of the detention pond have been designed to be gradual so that it may be accessed from the west at a 4:1 slope.

In addition the following design considerations have been considered for maintenance purposes:

- A design slope of at least 0.5% in the vegetated bottom of the basin has been provided to help maintain the appearance of the turf grass in the bottom of the basin and reduce the possibility of saturated areas that may produce unwanted species of vegetation

and mosquito breeding conditions. Verify slopes during construction, prior to vegetation.

- Trash rack sizing recommendations have been implemented per UDFCD.
- Access has been provided to the outlet and micropool for maintenance purposes.

ii. The improvements noted are subject to a Use By Special Review (USR) approval as well as Grading Permit and Building Permit applications through Weld County. The disturbance will require a CDPHE Permit for construction discharge.

Conclusions

Compliance with Weld County Code

i. This drainage design conforms to all applicable Weld County codes and regulations.

Drainage Concept

i. This drainage design will be effective in controlling damage due to storm runoff for all storms up to and including the 100 year event. Off-site flows will bypass much of the proposed improvements and flow downstream along the historic flow path. On-site runoff from the 10-year and 100-year storm falling on the developed site will be detained within a pond and the detained water will be released at the rate of the runoff of the 5-year storm falling on the undeveloped pond catchment. Water quality is provided within the 25-yr retention volume. Much of the runoff within the site will be contained within spill containment berms and/or infiltrate before getting to the detention pond. What does not infiltrate will be detained and released at the 5-YR historic rate.

ii. The proposed development will not impact any existing Weld County Master Drainage Plan recommendations.

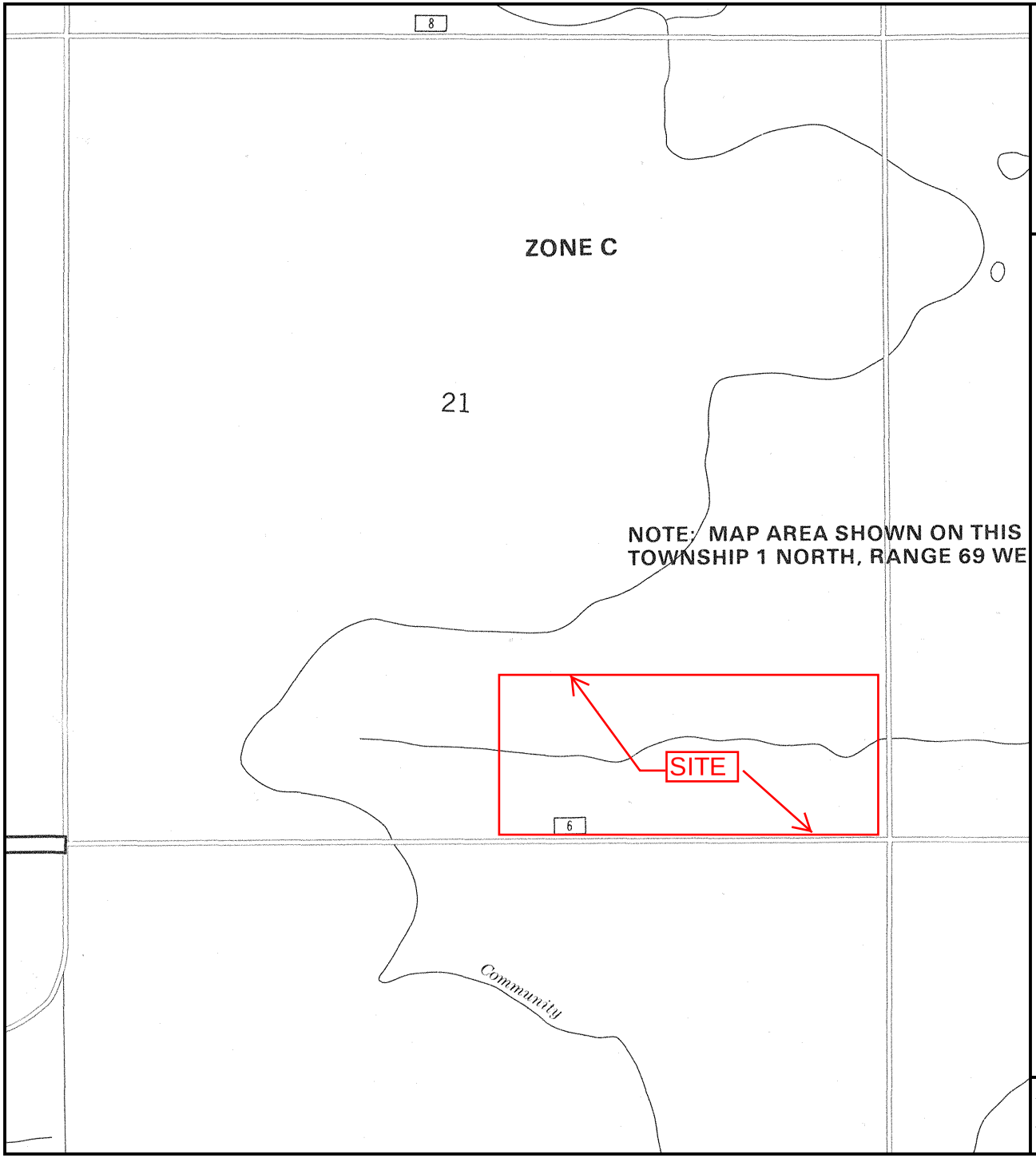
iii. No approval from offsite jurisdictions is required for this project.

References

1. *Urban Storm Drainage Criteria Manual, Volumes 1-3*; Urban Drainage and Flood Control District, Denver, CO. June 2001 (Revised April 2008).
2. *Weld County Storm Drainage Criteria Addendum to the Urban Strom Drainage Criteria Manuals Volumes 1, 2, and 3. Weld County Code Article XI and Appendix 8L.* Weld County Public Works Department, Greeley, CO. October 2006
3. *Home Rule Charter for the County of Weld, CO. November 6, 2009*
4. *COGCC Amended Rules, Series 100-1200, As of February 1, 2014*

APPENDIX

A. FIRM MAP & SOILS MAP



APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

WELD COUNTY, COLORADO
(UNINCORPORATED AREAS)

PANEL 960 OF 1075

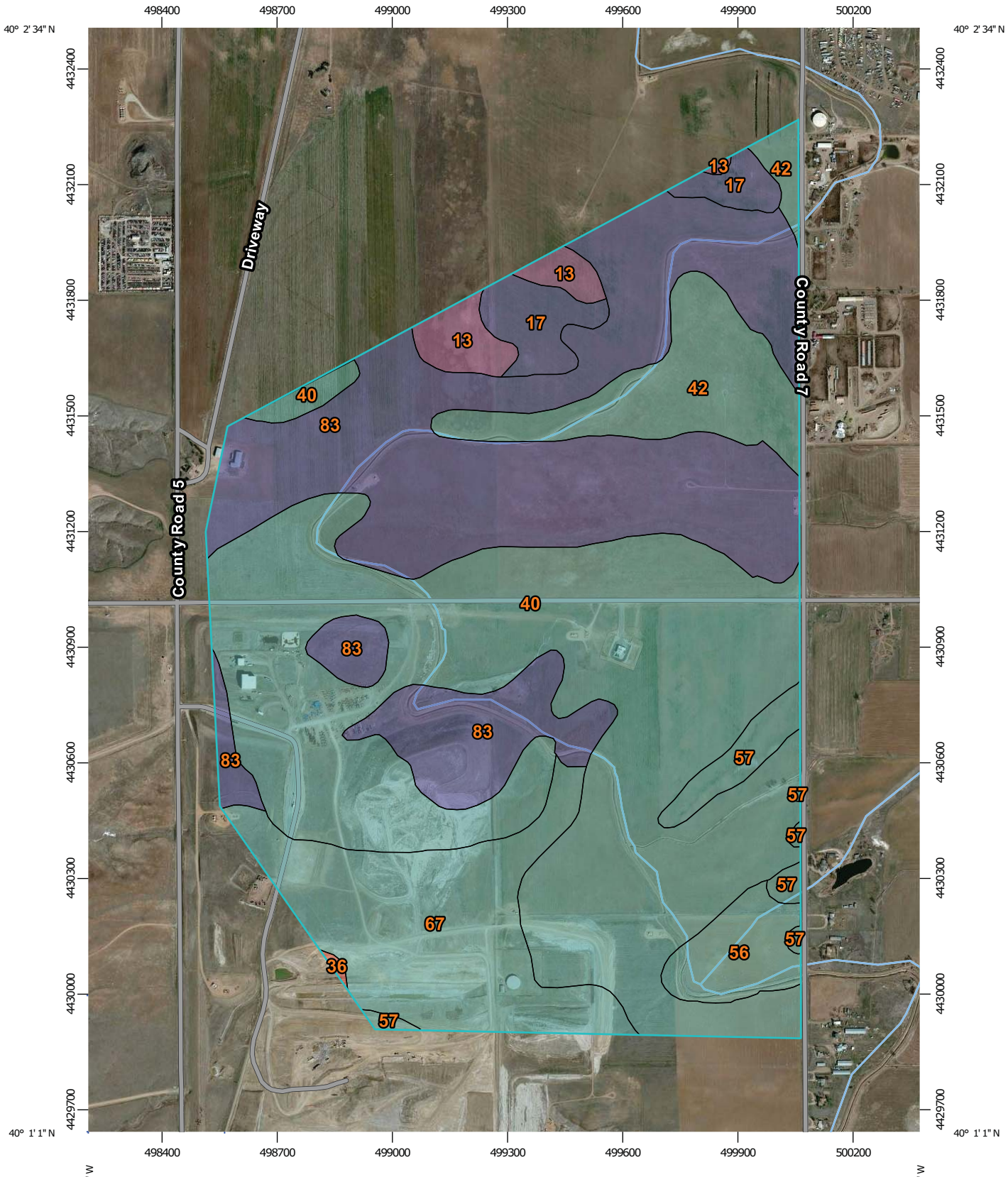
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
080266 0960 D

MAP REVISED:
SEPTEMBER 28, 1990

Federal Emergency Management Agency

Custom Soil Resource Report
Map—Hydrologic Soil Group (Liquids Handling Hub (Historic))



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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: Weld County, Colorado, Southern Part
Survey Area Data: Version 11, Aug 27, 2009

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

Date(s) aerial images were photographed: Apr 22, 2011—Apr 13, 2012

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 (Liquids Handling Hub (Historic))

Hydrologic Soil Group— Summary by Map Unit — Weld County, Colorado, Southern Part (CO618)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
13	Cascajo gravelly sandy loam, 5 to 20 percent slopes	A	13.9	2.0%
17	Colby loam, 5 to 9 percent slopes	B	19.6	2.8%
36	Midway-Shingle complex, 5 to 20 percent slopes	D	0.6	0.1%
40	Nunn loam, 1 to 3 percent slopes	C	293.3	41.2%
42	Nunn clay loam, 1 to 3 percent slopes	C	49.2	6.9%
56	Renohill clay loam, 0 to 3 percent slopes	C	18.4	2.6%
57	Renohill clay loam, 3 to 9 percent slopes	C	13.5	1.9%
67	Ulm clay loam, 3 to 5 percent slopes	C	80.4	11.3%
83	Wiley-Colby complex, 3 to 5 percent slopes	B	222.5	31.3%
Totals for Area of Interest			**711.5**	**100.0%**

Rating Options—Hydrologic Soil Group (Liquids Handling Hub (Historic))

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

B. RAINFALL DATA

NOAA Atlas 14, Volume 8, Version 2
Location name: Erie, Colorado, US*
Coordinates: 40.0328, -105.0085
Elevation: 5242 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	**0.222** (0.172-0.287)	**0.272** (0.210-0.352)	**0.368** (0.283-0.477)	**0.461** (0.353-0.601)	**0.610** (0.462-0.851)	**0.740** (0.543-1.04)	**0.885** (0.627-1.28)	**1.05** (0.712-1.55)	**1.28** (0.838-1.95)	**1.48** (0.933-2.25)
10-min	**0.325** (0.252-0.420)	**0.398** (0.308-0.515)	**0.538** (0.415-0.699)	**0.675** (0.517-0.880)	**0.892** (0.676-1.25)	**1.08** (0.796-1.52)	**1.29** (0.919-1.87)	**1.53** (1.04-2.27)	**1.88** (1.23-2.85)	**2.16** (1.37-3.30)
15-min	**0.397** (0.307-0.513)	**0.485** (0.375-0.628)	**0.657** (0.506-0.852)	**0.823** (0.631-1.07)	**1.09** (0.824-1.52)	**1.32** (0.970-1.86)	**1.58** (1.12-2.28)	**1.87** (1.27-2.77)	**2.29** (1.50-3.48)	**2.63** (1.67-4.02)
30-min	**0.546** (0.422-0.705)	**0.667** (0.516-0.863)	**0.900** (0.694-1.17)	**1.13** (0.864-1.47)	**1.49** (1.13-2.08)	**1.80** (1.32-2.54)	**2.15** (1.53-3.11)	**2.54** (1.73-3.77)	**3.11** (2.04-4.74)	**3.58** (2.27-5.47)
60-min	**0.665** (0.515-0.859)	**0.819** (0.633-1.06)	**1.11** (0.857-1.44)	**1.39** (1.07-1.82)	**1.84** (1.39-2.56)	**2.23** (1.63-3.13)	**2.66** (1.88-3.83)	**3.13** (2.13-4.64)	**3.82** (2.50-5.82)	**4.39** (2.78-6.71)
2-hr	**0.784** (0.614-1.00)	**0.970** (0.759-1.24)	**1.32** (1.03-1.70)	**1.66** (1.29-2.14)	**2.19** (1.67-3.01)	**2.65** (1.97-3.67)	**3.16** (2.26-4.49)	**3.72** (2.56-5.43)	**4.53** (3.00-6.80)	**5.20** (3.33-7.84)
3-hr	**0.847** (0.667-1.07)	**1.05** (0.827-1.33)	**1.43** (1.12-1.82)	**1.79** (1.40-2.29)	**2.36** (1.81-3.22)	**2.85** (2.13-3.92)	**3.39** (2.44-4.78)	**3.99** (2.76-5.77)	**4.85** (3.22-7.21)	**5.56** (3.58-8.30)
6-hr	**1.01** (0.803-1.26)	**1.24** (0.985-1.55)	**1.66** (1.32-2.09)	**2.06** (1.63-2.61)	**2.69** (2.08-3.61)	**3.22** (2.43-4.36)	**3.81** (2.77-5.28)	**4.45** (3.11-6.35)	**5.38** (3.61-7.88)	**6.14** (3.99-9.04)
12-hr	**1.26** (1.01-1.55)	**1.51** (1.22-1.87)	**1.98** (1.59-2.46)	**2.42** (1.93-3.01)	**3.09** (2.42-4.08)	**3.67** (2.79-4.88)	**4.29** (3.15-5.86)	**4.97** (3.51-6.98)	**5.95** (4.04-8.58)	**6.75** (4.44-9.80)
24-hr	**1.52** (1.24-1.85)	**1.83** (1.49-2.24)	**2.39** (1.94-2.93)	**2.89** (2.33-3.55)	**3.62** (2.85-4.68)	**4.24** (3.25-5.53)	**4.88** (3.62-6.54)	**5.58** (3.97-7.68)	**6.56** (4.49-9.29)	**7.34** (4.88-10.5)
2-day	**1.74** (1.43-2.09)	**2.14** (1.76-2.58)	**2.82** (2.32-3.41)	**3.40** (2.77-4.13)	**4.22** (3.33-5.32)	**4.86** (3.75-6.22)	**5.52** (4.12-7.25)	**6.21** (4.45-8.38)	**7.14** (4.92-9.91)	**7.86** (5.28-11.1)
3-day	**1.90** (1.57-2.26)	**2.31** (1.91-2.76)	**3.00** (2.48-3.60)	**3.59** (2.95-4.32)	**4.42** (3.52-5.52)	**5.07** (3.94-6.43)	**5.74** (4.32-7.47)	**6.44** (4.64-8.61)	**7.38** (5.12-10.2)	**8.11** (5.48-11.3)
4-day	**2.02** (1.69-2.41)	**2.43** (2.03-2.89)	**3.12** (2.59-3.72)	**3.70** (3.06-4.43)	**4.53** (3.62-5.63)	**5.19** (4.05-6.54)	**5.86** (4.43-7.58)	**6.57** (4.76-8.73)	**7.52** (5.25-10.3)	**8.27** (5.62-11.5)
7-day	**2.33** (1.96-2.74)	**2.74** (2.30-3.22)	**3.42** (2.87-4.04)	**4.01** (3.34-4.75)	**4.84** (3.91-5.95)	**5.50** (4.34-6.86)	**6.18** (4.71-7.90)	**6.89** (5.04-9.05)	**7.85** (5.53-10.6)	**8.60** (5.90-11.8)
10-day	**2.59** (2.19-3.02)	**3.01** (2.55-3.52)	**3.71** (3.13-4.35)	**4.31** (3.62-5.07)	**5.16** (4.19-6.28)	**5.82** (4.62-7.20)	**6.50** (4.99-8.24)	**7.21** (5.31-9.40)	**8.17** (5.79-11.0)	**8.91** (6.15-12.1)
20-day	**3.34** (2.86-3.84)	**3.82** (3.27-4.40)	**4.61** (3.94-5.33)	**5.28** (4.48-6.12)	**6.19** (5.08-7.41)	**6.90** (5.53-8.38)	**7.61** (5.90-9.48)	**8.34** (6.20-10.7)	**9.30** (6.66-12.2)	**10.0** (7.00-13.4)
30-day	**3.93** (3.39-4.49)	**4.49** (3.87-5.13)	**5.39** (4.64-6.18)	**6.14** (5.25-7.07)	**7.15** (5.90-8.46)	**7.92** (6.39-9.52)	**8.68** (6.77-10.7)	**9.45** (7.07-12.0)	**10.4** (7.52-13.6)	**11.2** (7.86-14.9)
45-day	**4.64** (4.04-5.26)	**5.32** (4.62-6.03)	**6.40** (5.54-7.28)	**7.28** (6.27-8.31)	**8.45** (7.01-9.89)	**9.32** (7.57-11.1)	**10.2** (7.98-12.4)	**11.0** (8.29-13.8)	**12.1** (8.75-15.6)	**12.9** (9.10-16.9)
60-day	**5.22** (4.57-5.88)	**6.02** (5.25-6.78)	**7.27** (6.33-8.22)	**8.28** (7.16-9.39)	**9.60** (8.00-11.2)	**10.6** (8.63-12.5)	**11.5** (9.08-13.9)	**12.4** (9.41-15.5)	**13.6** (9.89-17.4)	**14.4** (10.3-18.9)

[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
Location name: Erie, Colorado, US*
Coordinates: 40.0330, -105.0099
Elevation: 5243 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/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**2.66** (2.06-3.44)	**3.26** (2.52-4.22)	**4.42** (3.40-5.72)	**5.53** (4.24-7.21)	**7.32** (5.54-10.2)	**8.88** (6.52-12.5)	**10.6** (7.52-15.3)	**12.6** (8.54-18.6)	**15.4** (10.1-23.4)	**17.7** (11.2-27.0)
10-min	**1.95** (1.51-2.52)	**2.39** (1.85-3.09)	**3.23** (2.49-4.19)	**4.05** (3.10-5.28)	**5.35** (4.06-7.48)	**6.50** (4.78-9.14)	**7.77** (5.51-11.2)	**9.19** (6.25-13.6)	**11.3** (7.36-17.1)	**13.0** (8.20-19.8)
15-min	**1.59** (1.23-2.05)	**1.94** (1.50-2.51)	**2.63** (2.02-3.41)	**3.29** (2.52-4.29)	**4.35** (3.30-6.08)	**5.29** (3.88-7.44)	**6.32** (4.48-9.11)	**7.47** (5.08-11.1)	**9.15** (5.98-13.9)	**10.5** (6.67-16.1)
30-min	**1.09** (0.844-1.41)	**1.33** (1.03-1.73)	**1.80** (1.39-2.34)	**2.25** (1.73-2.94)	**2.98** (2.25-4.15)	**3.61** (2.65-5.07)	**4.31** (3.06-6.21)	**5.09** (3.46-7.54)	**6.22** (4.07-9.47)	**7.16** (4.53-10.9)
60-min	**0.665** (0.515-0.859)	**0.819** (0.633-1.06)	**1.11** (0.857-1.44)	**1.39** (1.07-1.82)	**1.84** (1.39-2.56)	**2.23** (1.63-3.13)	**2.66** (1.88-3.83)	**3.13** (2.13-4.64)	**3.82** (2.50-5.82)	**4.39** (2.78-6.71)
2-hr	**0.392** (0.307-0.500)	**0.485** (0.380-0.620)	**0.661** (0.515-0.848)	**0.830** (0.643-1.07)	**1.09** (0.836-1.51)	**1.32** (0.982-1.84)	**1.58** (1.13-2.24)	**1.86** (1.28-2.71)	**2.27** (1.50-3.40)	**2.60** (1.66-3.92)
3-hr	**0.282** (0.222-0.358)	**0.350** (0.275-0.444)	**0.477** (0.374-0.607)	**0.598** (0.466-0.764)	**0.787** (0.604-1.07)	**0.950** (0.709-1.31)	**1.13** (0.814-1.59)	**1.33** (0.918-1.92)	**1.61** (1.07-2.40)	**1.85** (1.19-2.76)
6-hr	**0.169** (0.134-0.211)	**0.207** (0.164-0.259)	**0.278** (0.220-0.349)	**0.345** (0.272-0.435)	**0.449** (0.348-0.602)	**0.538** (0.405-0.728)	**0.636** (0.463-0.882)	**0.743** (0.519-1.06)	**0.898** (0.603-1.32)	**1.02** (0.667-1.51)
12-hr	**0.104** (0.084-0.129)	**0.126** (0.101-0.155)	**0.165** (0.132-0.204)	**0.201** (0.160-0.250)	**0.257** (0.201-0.338)	**0.304** (0.231-0.405)	**0.356** (0.262-0.486)	**0.413** (0.291-0.579)	**0.494** (0.335-0.712)	**0.560** (0.368-0.813)
24-hr	**0.063** (0.052-0.077)	**0.076** (0.062-0.093)	**0.100** (0.081-0.122)	**0.120** (0.097-0.148)	**0.151** (0.119-0.195)	**0.176** (0.135-0.230)	**0.204** (0.151-0.273)	**0.232** (0.165-0.320)	**0.273** (0.187-0.387)	**0.306** (0.203-0.438)
2-day	**0.036** (0.030-0.044)	**0.045** (0.037-0.054)	**0.059** (0.048-0.071)	**0.071** (0.058-0.086)	**0.088** (0.069-0.111)	**0.101** (0.078-0.130)	**0.115** (0.086-0.151)	**0.129** (0.093-0.175)	**0.149** (0.103-0.206)	**0.164** (0.110-0.231)
3-day	**0.026** (0.022-0.031)	**0.032** (0.027-0.038)	**0.042** (0.034-0.050)	**0.050** (0.041-0.060)	**0.061** (0.049-0.077)	**0.070** (0.055-0.089)	**0.080** (0.060-0.104)	**0.089** (0.065-0.120)	**0.102** (0.071-0.141)	**0.113** (0.076-0.157)
4-day	**0.021** (0.018-0.025)	**0.025** (0.021-0.030)	**0.032** (0.027-0.039)	**0.039** (0.032-0.046)	**0.047** (0.038-0.059)	**0.054** (0.042-0.068)	**0.061** (0.046-0.079)	**0.068** (0.050-0.091)	**0.078** (0.055-0.107)	**0.086** (0.059-0.120)
7-day	**0.014** (0.012-0.016)	**0.016** (0.014-0.019)	**0.020** (0.017-0.024)	**0.024** (0.020-0.028)	**0.029** (0.023-0.035)	**0.033** (0.026-0.041)	**0.037** (0.028-0.047)	**0.041** (0.030-0.054)	**0.047** (0.033-0.063)	**0.051** (0.035-0.070)
10-day	**0.011** (0.009-0.013)	**0.013** (0.011-0.015)	**0.015** (0.013-0.018)	**0.018** (0.015-0.021)	**0.021** (0.017-0.026)	**0.024** (0.019-0.030)	**0.027** (0.021-0.034)	**0.030** (0.022-0.039)	**0.034** (0.024-0.046)	**0.037** (0.026-0.051)
20-day	**0.007** (0.006-0.008)	**0.008** (0.007-0.009)	**0.010** (0.008-0.011)	**0.011** (0.009-0.013)	**0.013** (0.011-0.015)	**0.014** (0.012-0.017)	**0.016** (0.012-0.020)	**0.017** (0.013-0.022)	**0.019** (0.014-0.026)	**0.021** (0.015-0.028)
30-day	**0.005** (0.005-0.006)	**0.006** (0.005-0.007)	**0.007** (0.006-0.009)	**0.009** (0.007-0.010)	**0.010** (0.008-0.012)	**0.011** (0.009-0.013)	**0.012** (0.009-0.015)	**0.013** (0.010-0.017)	**0.014** (0.010-0.019)	**0.016** (0.011-0.021)
45-day	**0.004** (0.004-0.005)	**0.005** (0.004-0.006)	**0.006** (0.005-0.007)	**0.007** (0.006-0.008)	**0.008** (0.006-0.009)	**0.009** (0.007-0.010)	**0.009** (0.007-0.011)	**0.010** (0.008-0.013)	**0.011** (0.008-0.014)	**0.012** (0.008-0.016)
60-day	**0.004** (0.003-0.004)	**0.004** (0.004-0.005)	**0.005** (0.004-0.006)	**0.006** (0.005-0.007)	**0.007** (0.006-0.008)	**0.007** (0.006-0.009)	**0.008** (0.006-0.010)	**0.009** (0.007-0.011)	**0.009** (0.007-0.012)	**0.010** (0.007-0.013)

[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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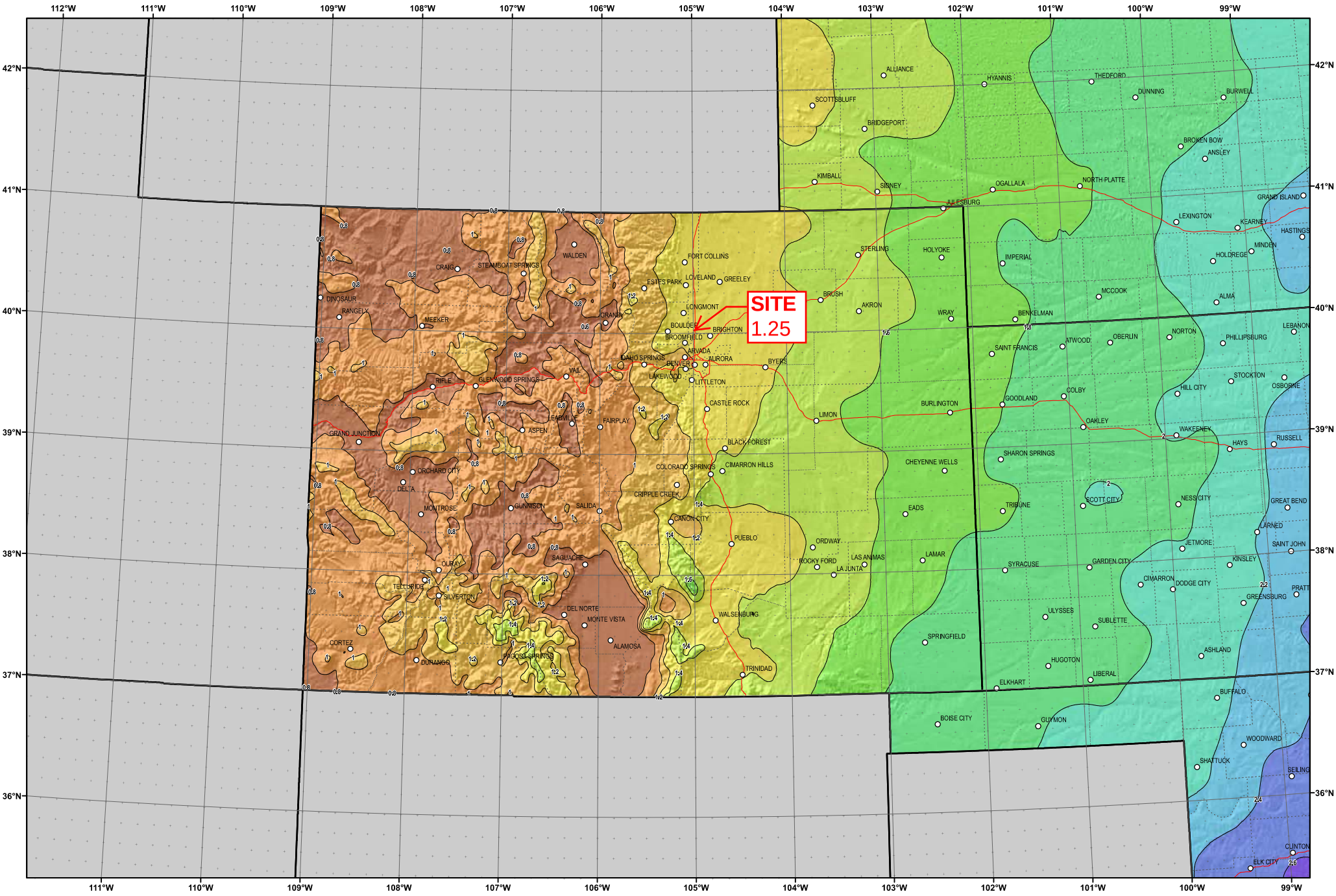
PF graphical



NOAA Atlas 14, Volume 8, Version 2
Midwestern States

Prepared by U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
OFFICE OF HYDROLOGIC DEVELOPMENT
HYDROMETEOROLOGICAL DESIGN STUDIES CENTER
April 2013

0 5 10 20 30 40 50 Miles

0 10 20 40 60 80 100 Kilometers

COLORADO

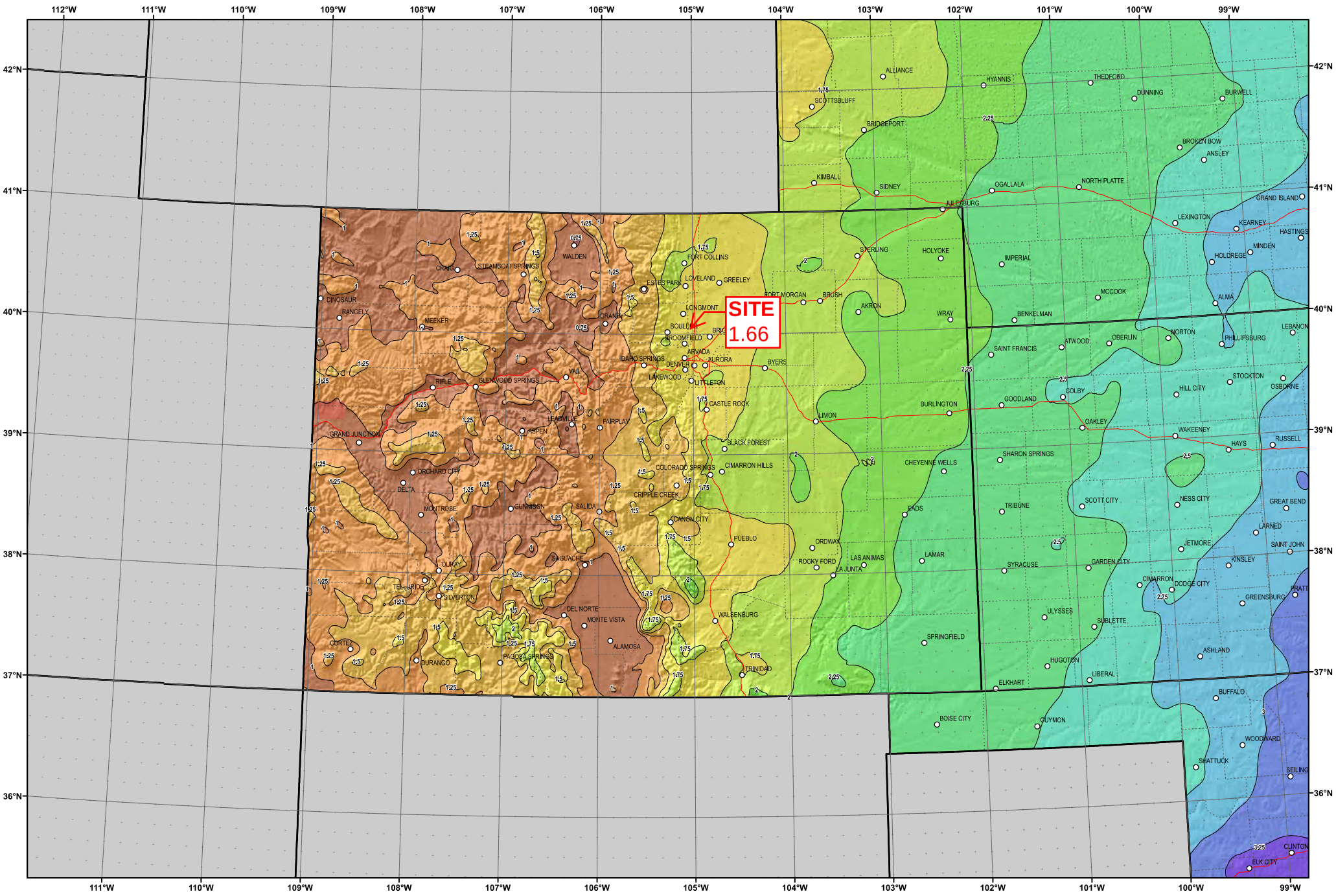
Isopluvials of 2-year 6-hour precipitation in inches

SCALE 1:2,250,000

Projection: Lambert Conformal Conic; Datum NAD83; Standard Parallels: 38°N and 40°N; Central Meridian 105.5°W.

0.59 - 0.60	1.21 - 1.40	2.01 - 2.20	2.81 - 3.00
0.61 - 0.80	1.41 - 1.60	2.21 - 2.40	3.01 - 3.20
0.81 - 1.00	1.61 - 1.80	2.41 - 2.60	3.21 - 3.40
1.01 - 1.20	1.81 - 2.00	2.61 - 2.80	3.41 - 3.58

Legend based on entire Volume 8 project area.



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April 2013

0 5 10 20 30 40 50 Miles

0 10 20 40 60 80 100 Kilometers

COLORADO

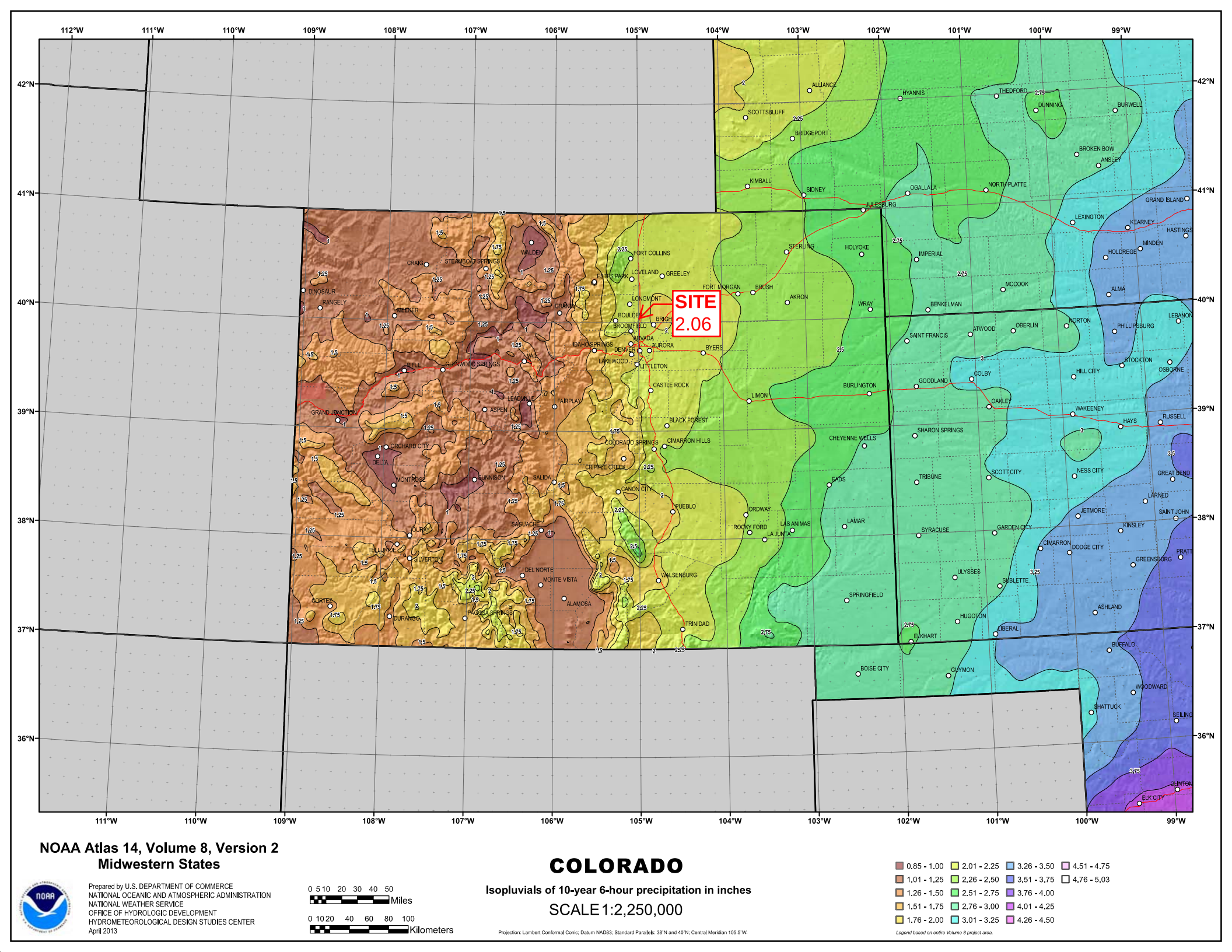
Isopluvials of 5-year 6-hour precipitation in inches

SCALE 1:2,250,000

Projection: Lambert Conformal Conic; Datum NAD83; Standard Parallels: 38°N and 40°N; Central Meridian 105.5°W.

0.72 - 0.75	1.51 - 1.75	2.51 - 2.75	3.51 - 3.75
0.76 - 1.00	1.76 - 2.00	2.76 - 3.00	3.76 - 4.00
1.01 - 1.25	2.01 - 2.25	3.01 - 3.25	4.01 - 4.25
1.26 - 1.50	2.26 - 2.50	3.26 - 3.50	4.26 - 4.36

Legend based on entire Volume 8 project area.



NOAA Atlas 14, Volume 8, Version 2
Midwestern States

Prepared by U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
OFFICE OF HYDROLOGIC DEVELOPMENT
HYDROMETEOROLOGICAL DESIGN STUDIES CENTER
April 2013

0 5 10 20 30 40 50 Miles

0 10 20 40 60 80 100 Kilometers

COLORADO

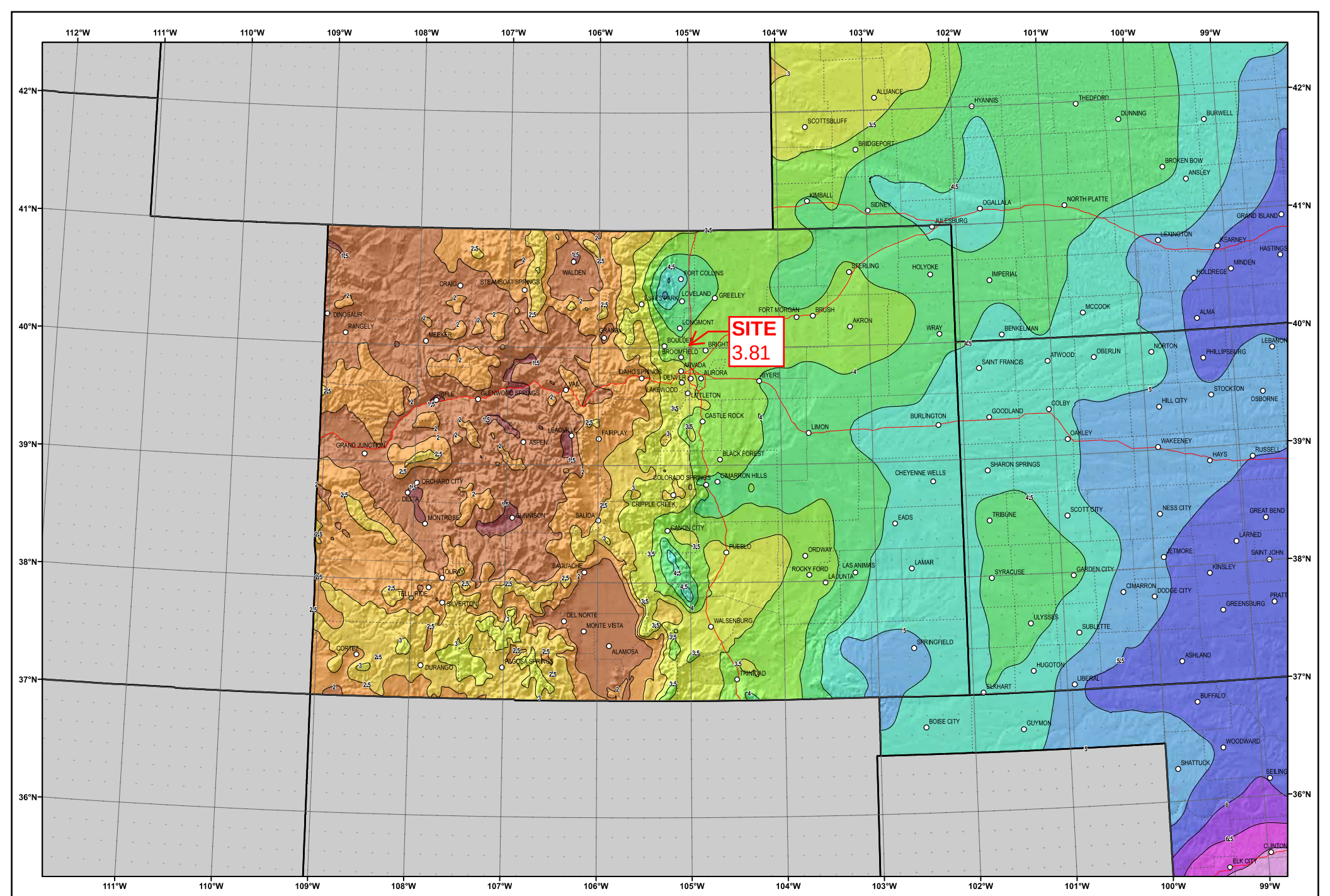
Isopluvials of 10-year 6-hour precipitation in inches

SCALE 1:2,250,000

Projection: Lambert Conformal Conic; Datum NAD83; Standard Parallels: 38°N and 40°N; Central Meridian 105.5°W.

0.85 - 1.00	2.01 - 2.25	3.26 - 3.50	4.51 - 4.75
1.01 - 1.25	2.26 - 2.50	3.51 - 3.75	4.76 - 5.03
1.26 - 1.50	2.51 - 2.75	3.76 - 4.00	
1.51 - 1.75	2.76 - 3.00	4.01 - 4.25	
1.76 - 2.00	3.01 - 3.25	4.26 - 4.50	

Legend based on entire Volume 8 project area.



NOAA Atlas 14, Volume 8, Version 2
Midwestern States

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April 2013

0 5 10 20 30 40 50 Miles

0 10 20 40 60 80 100 Kilometers

COLORADO

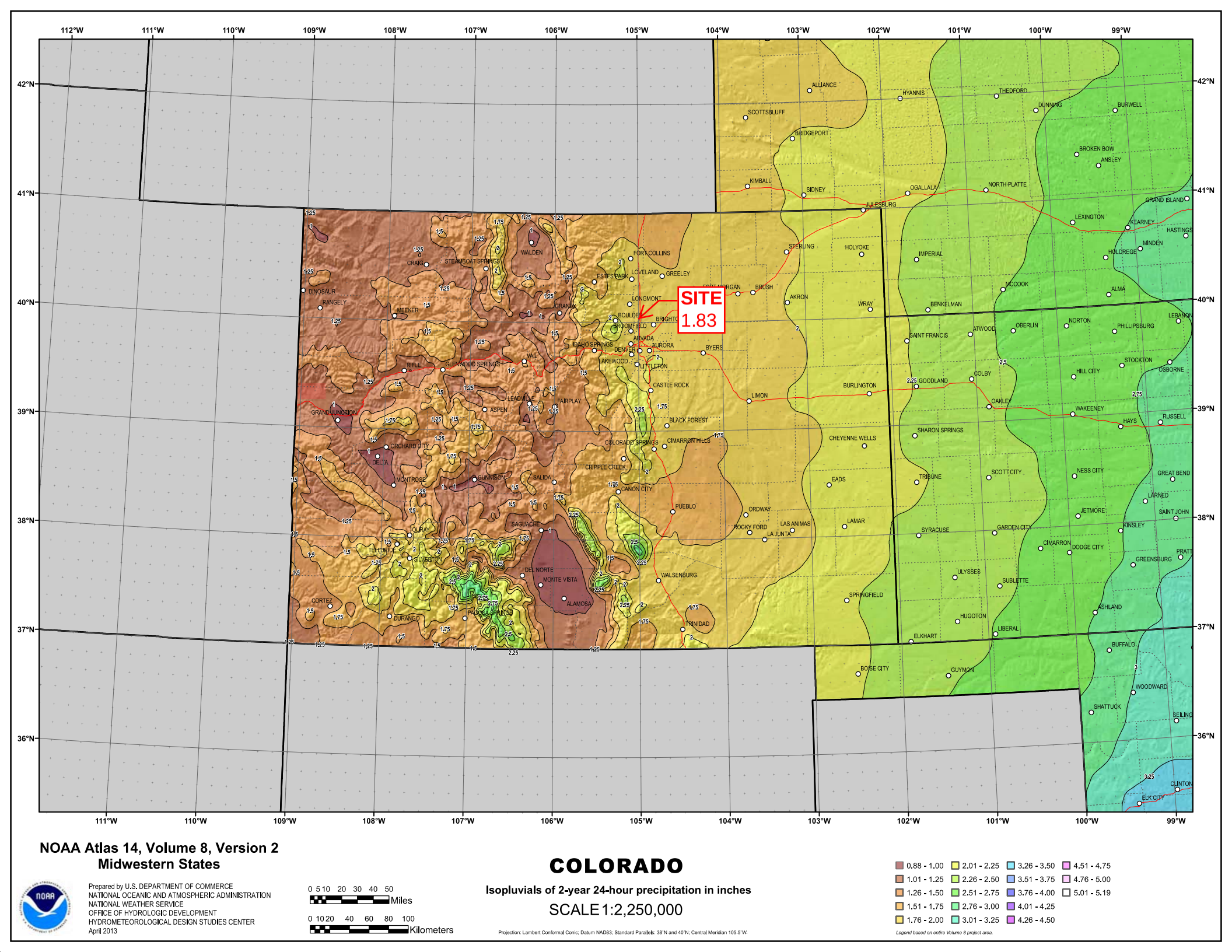
Isopluvials of 100-year 6-hour precipitation in inches

SCALE 1:2,250,000

Projection: Lambert Conformal Conic; Datum NAD83; Standard Parallels: 38°N and 40°N; Central Meridian 105.5°W.

1.29 - 1.50	3.01 - 3.50	5.01 - 5.50	7.01 - 7.50
1.51 - 2.00	3.51 - 4.00	5.51 - 6.00	7.51 - 7.94
2.01 - 2.50	4.01 - 4.50	6.01 - 6.50	
2.51 - 3.00	4.51 - 5.00	6.51 - 7.00	

Legend based on entire Volume 8 project area.



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April 2013

0 5 10 20 30 40 50 Miles

0 10 20 40 60 80 100 Kilometers

COLORADO

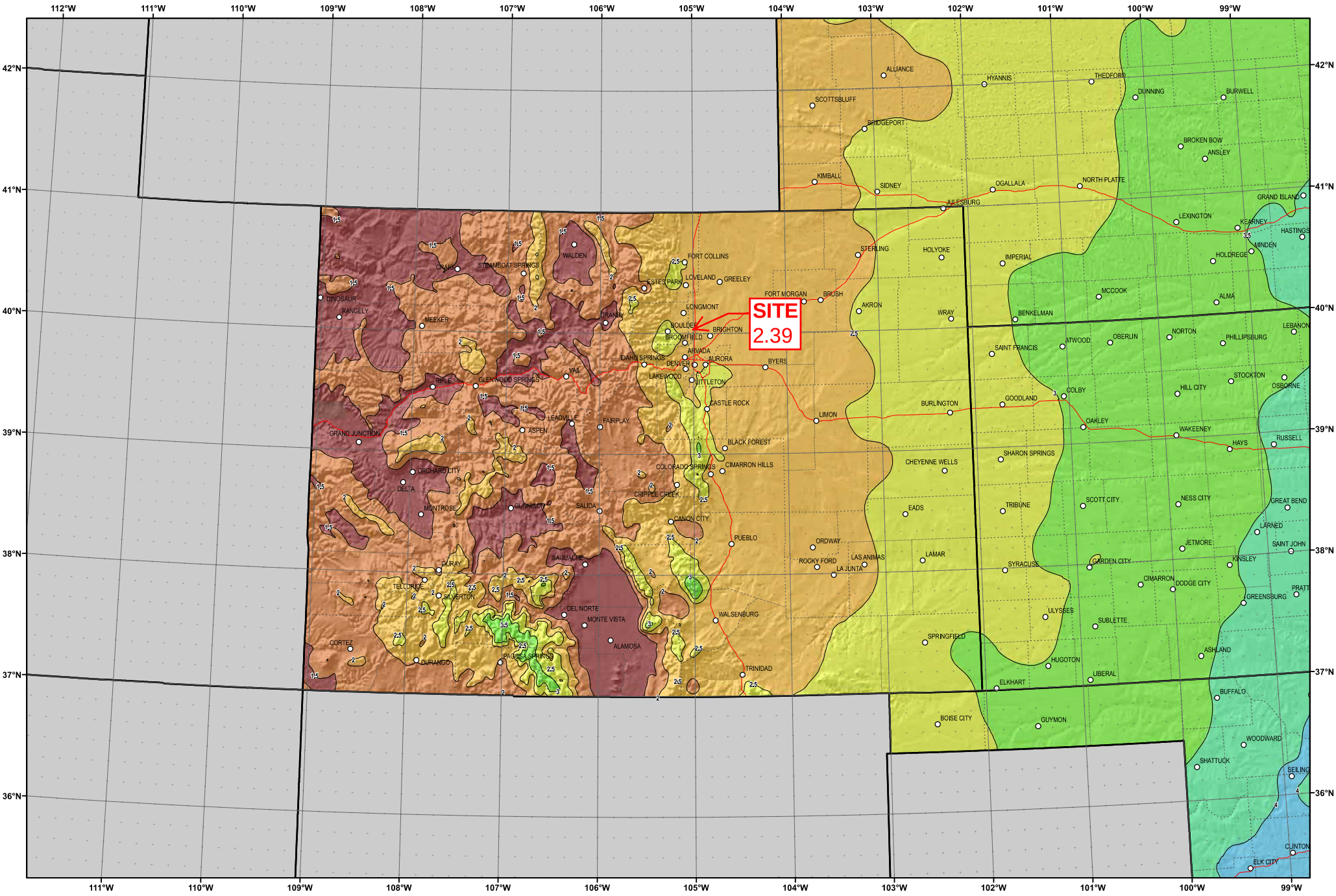
Isopluvials of 2-year 24-hour precipitation in inches

SCALE 1:2,250,000

Projection: Lambert Conformal Conic; Datum NAD83; Standard Parallels: 38°N and 40°N; Central Meridian 105.5°W.

0.88 - 1.00	2.01 - 2.25	3.26 - 3.50	4.51 - 4.75
1.01 - 1.25	2.26 - 2.50	3.51 - 3.75	4.76 - 5.00
1.26 - 1.50	2.51 - 2.75	3.76 - 4.00	5.01 - 5.19
1.51 - 1.75	2.76 - 3.00	4.01 - 4.25	
1.76 - 2.00	3.01 - 3.25	4.26 - 4.50	

Legend based on entire Volume 8 project area.



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April 2013

0 5 10 20 30 40 50 Miles

0 10 20 40 60 80 100 Kilometers

COLORADO

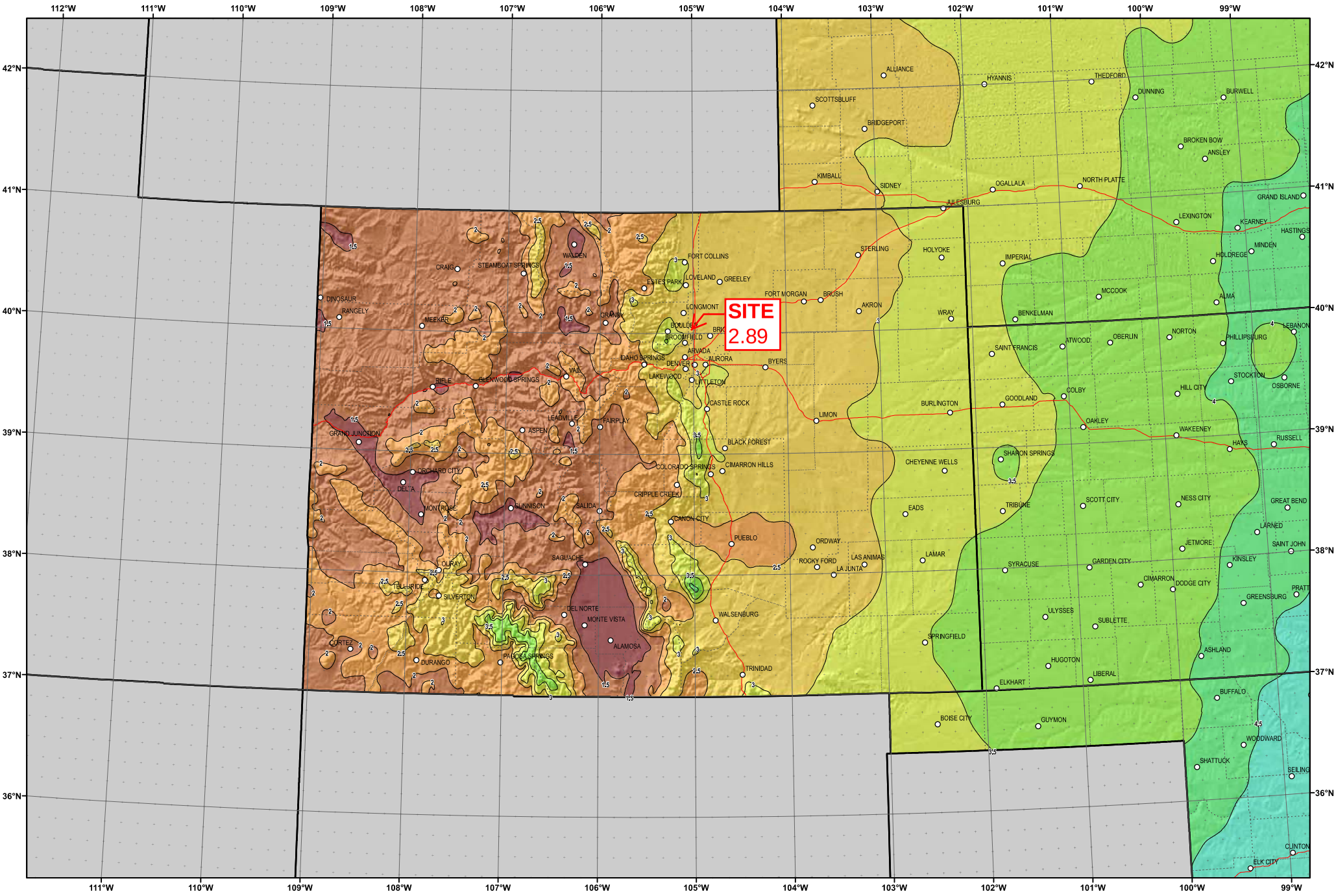
Isopluvials of 5-year 24-hour precipitation in inches

SCALE 1:2,250,000

Projection: Lambert Conformal Conic; Datum NAD83; Standard Parallels: 38°N and 40°N; Central Meridian 105.5°W.

1.11 - 1.50
1.51 - 2.00
2.01 - 2.50
2.51 - 3.00
3.01 - 3.50
3.51 - 4.00
4.01 - 4.50
4.51 - 5.00
5.01 - 5.50
5.51 - 6.00
6.01 - 6.49

Legend based on entire Volume 8 project area.



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April 2013

0 5 10 20 30 40 50 Miles

0 10 20 40 60 80 100 Kilometers

COLORADO

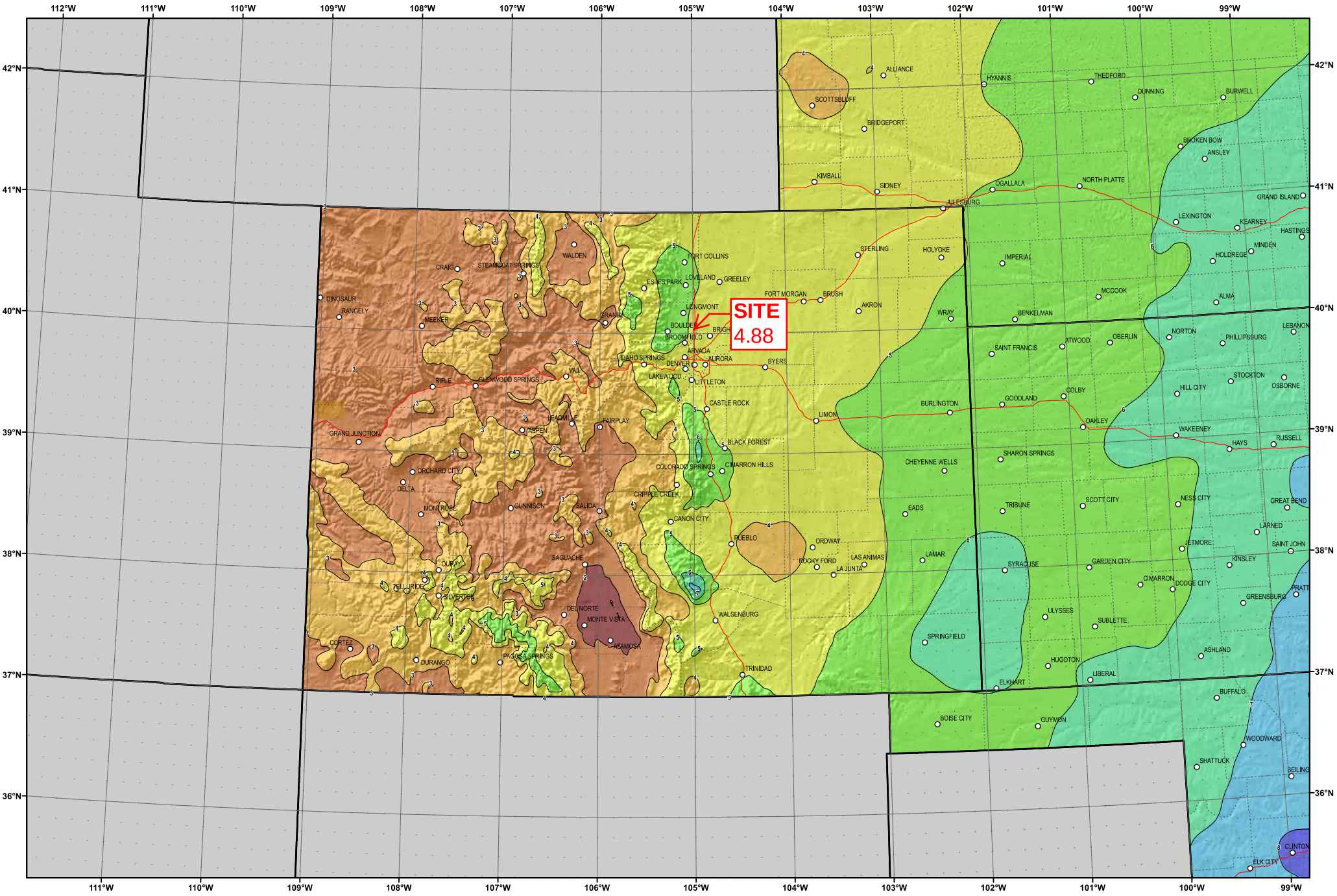
Isopluvials of 10-year 24-hour precipitation in inches

SCALE 1:2,250,000

Projection: Lambert Conformal Conic; Datum NAD83; Standard Parallels: 38°N and 40°N; Central Meridian 105.5°W.

1.28 - 1.50	3.01 - 3.50	5.01 - 5.50	7.01 - 7.50
1.51 - 2.00	3.51 - 4.00	5.51 - 6.00	7.51 - 7.62
2.01 - 2.50	4.01 - 4.50	6.01 - 6.50	
2.51 - 3.00	4.51 - 5.00	6.51 - 7.00	

Legend based on entire Volume 8 project area.



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April 2013

0 5 10 20 30 40 50 Miles

0 10 20 40 60 80 100 Kilometers

COLORADO

Isopluvials of 100-year 24-hour precipitation in inches

SCALE 1:2,250,000

Projection: Lambert Conformal Conic; Datum NAD83; Standard Parallels: 38°N and 40°N; Central Meridian 105.5°W.

1.88 - 2.00
2.01 - 3.00
3.01 - 4.00
4.01 - 5.00
5.01 - 6.00
6.01 - 7.00
7.01 - 8.00
8.01 - 9.00
9.01 - 10.00
10.01 - 11.00
11.01 - 11.93

Legend based on entire Volume 8 project area.

Depth-Duration-Frequency and Intensity-Duration-Frequency Tables for Colorado Hydrologic Zones 1 through 4

Blue cells are inputs.

Project: Liquids Handling Hub

Where is the Watershed Located? _____

- ○ Located within UDFCD Boundary
- ◉ Located outside of UDFCD Boundary

Hydrologic Zone (1, 2, 3, or 4) =	1	(see map)
Elevation at Center of Watershed =	5,220	ft
Watershed Area (Optional) =	N/A	sq. mi.

(Optional) Select a location within the UDFCD boundary:

1. Rainfall Depth-Duration-Frequency Table

If within the UDFCD Boundary, Enter the 1-hour and 6-hour rainfall depths from the USDCM Volume 1.
Otherwise, Enter the 6-hour and 24-hour rainfall depths from the NOAA Atlas 2 Volume III.

Return Period	Rainfall Depth in Inches at Time Duration								
	5-min	*10-min*	*15-min*	*30-min*	*1-hr*	*2-hr*	*3-hr*	*6-hr*	*24-hr*
2-yr	0.23	0.37	0.46	0.53	0.81	0.96	1.07	1.24	1.83
5-yr	0.37	0.59	0.74	0.86	1.31	1.43	1.52	1.66	2.39
10-yr	0.46	0.73	0.92	1.07	1.63	1.78	1.89	2.06	2.89
25-yr	0.58	0.92	1.16	1.34	2.04	2.26	2.43	2.69	3.62
50-yr	0.68	1.09	1.38	1.59	2.42	2.70	2.90	3.22	4.24
100-yr	0.79	1.26	1.58	1.83	2.79	3.14	3.40	3.81	4.88
500-yr	1.01	1.61	2.02	2.34	3.57	3.97	4.28	4.75	6.05

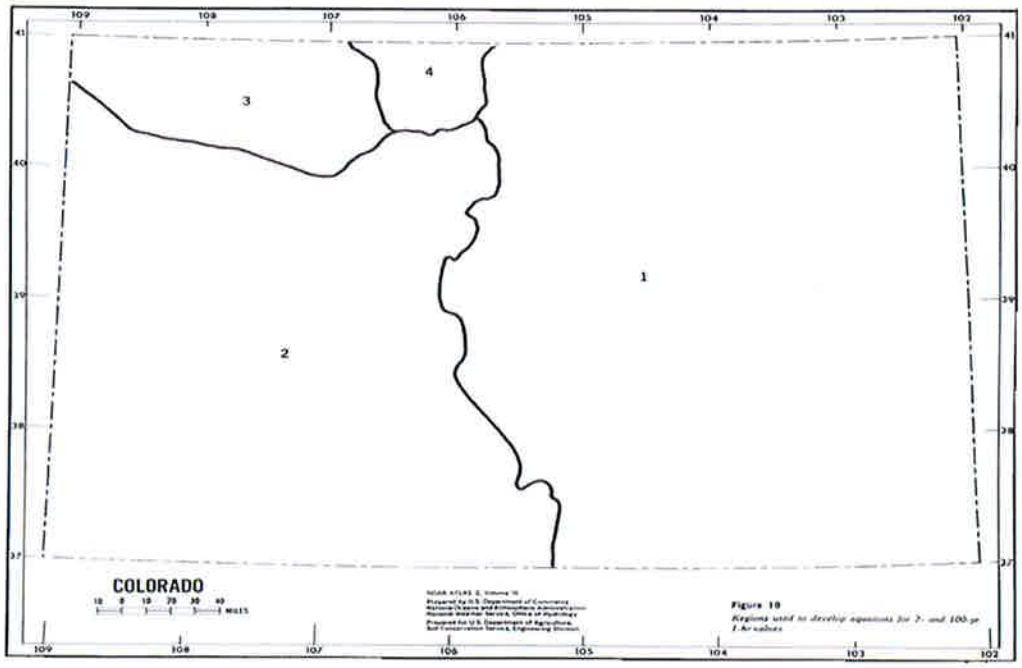
Note: Refer to Figures 4-1 through 4-12 of USDCM Volume 1 for 1-hr and 6-hr rainfall depths.
Refer to NOAA Atlas 2 Volume III isopluvial maps for 6-hr and 24-hr rainfall depths.
Rainfall depths for durations less than 1-hr are calculated using Equation 4-4 in USDCM Volume 1.

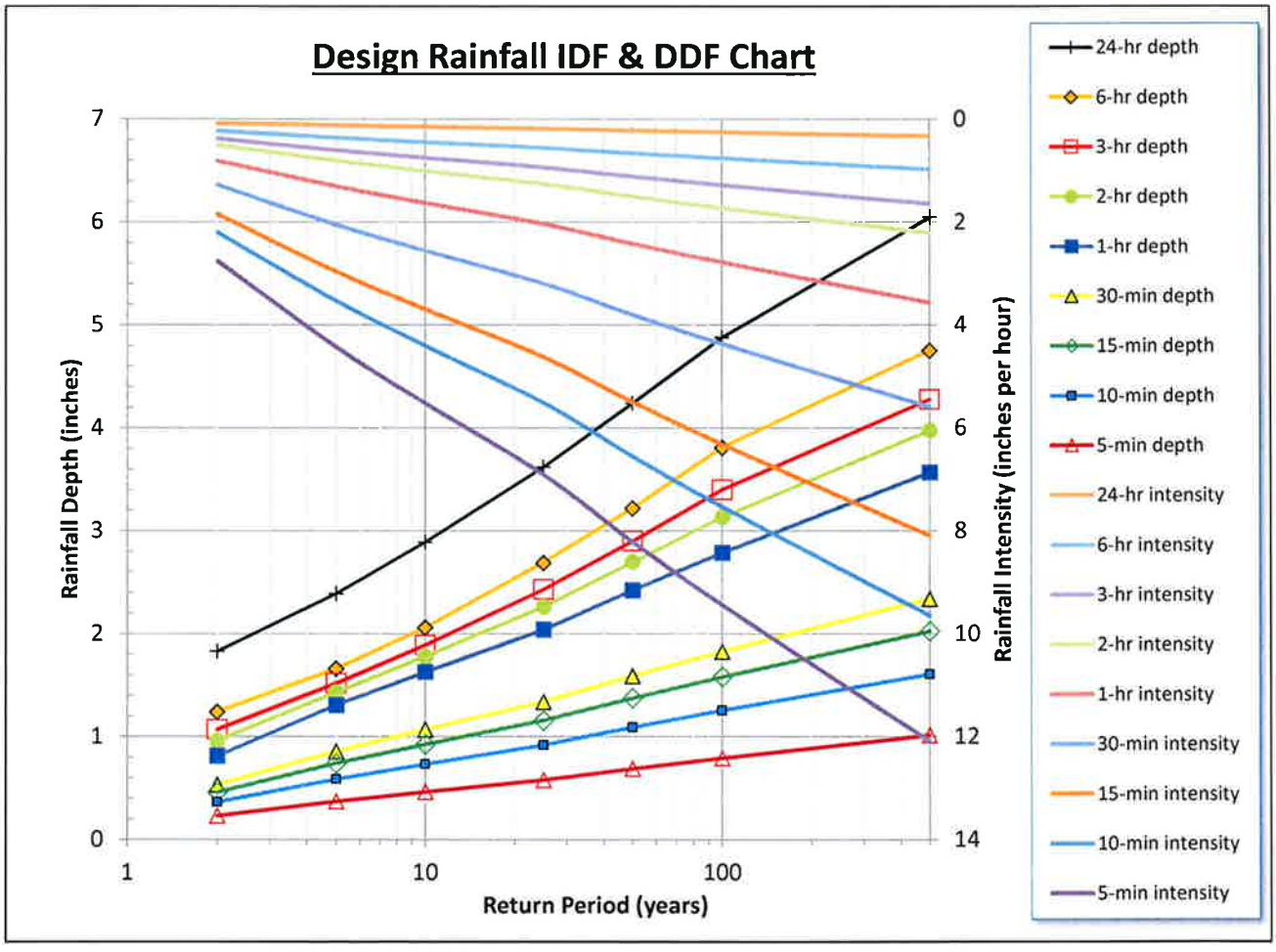
2. Rainfall Intensity-Duration-Frequency Table

Return Period	Rainfall Intensity in Inches Per Hour at Time Duration								
	5-min	*10-min*	*15-min*	*30-min*	*1-hr*	*2-hr*	*3-hr*	*6-hr*	*24-hr*
2-yr	2.76	2.20	1.85	1.28	0.81	0.51	0.38	0.22	0.08
5-yr	4.43	3.53	2.96	2.05	1.31	0.81	0.60	0.36	0.12
10-yr	5.53	4.41	3.70	2.56	1.63	1.01	0.75	0.44	0.15
25-yr	6.91	5.52	4.63	3.20	2.04	1.27	0.94	0.56	0.19
50-yr	8.22	6.56	5.50	3.80	2.42	1.51	1.12	0.66	0.23
100-yr	9.45	7.54	6.32	4.37	2.79	1.73	1.28	0.76	0.26
500-yr	12.10	9.65	8.10	5.60	3.57	2.22	1.64	0.97	0.33

Note: Intensity approximated using 1-hr rainfall depths and Equation 4-3 in USDCM Volume 1.

Depth-Duration-Frequency and Intensity-Duration-Frequency Tables for Colorado Hydrologic Zones 1 through 4





C. HEC-HMS CALCULATIONS AND OUTPUT (HISTORIC)

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and I_a = 0.2S.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

HEC-HMS
HISTORIC MODEL
INPUT PERAMETERS

Basin	*Area (MI2)*	*SCS Curve Number*	*Imperviousness %*	*Snyder Lag (HR)*	*Peaking Coefficient*
A	0.03819	79	30.7	0.42	0.48
H1	0.03819	79	0.6	0.48	0.48
H2	0.1923	79	0.6	0.61	0.71
H3	0.2851	79	0.6	0.51	0.61

Project: Overall Historic Simulation Run: 5YR STM

Start of Run: 01Jan2013, 00:00 Basin Model: Historic
End of Run: 02Jan2013, 00:00 Meteorologic Model: 5yr
Compute Time: 16Sep2013, 12:59:09 Control Specifications: Minor Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Basin-H1	0.03819	4.2	01Jan2013, 03:50	0.6
Basin-H2	0.19123	25.1	01Jan2013, 03:55	3.2
Basin-h3	0.28510	36.9	01Jan2013, 03:50	4.7

Project: Overall Historic Simulation Run: 10YR STM

Start of Run: 01Jan2013, 00:00 Basin Model: Historic
End of Run: 02Jan2013, 00:00 Meteorologic Model: 10yr
Compute Time: 16Sep2013, 12:59:09 Control Specifications: Minor Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Basin-H1	0.03819	7.7	01Jan2013, 03:50	0.55
Basin-H2	0.19123	46.0	01Jan2013, 03:55	0.55
Basin-h3	0.28510	67.8	01Jan2013, 03:50	0.55

Project: Overall Historic Simulation Run: 100YR STM

Start of Run: 01Jan2013, 00:00 Basin Model: Historic
End of Run: 02Jan2013, 00:00 Meteorologic Model: 100yr
Compute Time: 16Sep2013, 12:59:08 Control Specifications: Major Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Basin-H1	0.03819	26.9	01Jan2013, 03:50	3.7
Basin-H2	0.19123	152.6	01Jan2013, 03:50	18.6
Basin-h3	0.28510	228.3	01Jan2013, 03:50	27.7

D. HEC-HMS CALCULATIONS AND OUTPUT (PROPOSED)

Project: Proposed Simulation Run: 5YR STM

Start of Run: 01Jan2013, 00:00 Basin Model: Proposed
End of Run: 02Jan2013, 00:00 Meteorologic Model: 5yr
Compute Time: 16Sep2013, 12:36:44 Control Specifications: Minor Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Basin-A Proposed	0.03819	9.4	01Jan2013, 03:45	1.4
Basin-H2	0.19123	25.1	01Jan2013, 03:55	3.2
Basin-H3	0.28510	36.9	01Jan2013, 03:50	4.7

Project: Proposed
Simulation Run: 5YR STM Subbasin: Basin-A Proposed

Start of Run: 01Jan2013, 00:00 Basin Model: Proposed
End of Run: 02Jan2013, 00:00 Meteorologic Model: 5yr
Compute Time: 16Sep2013, 12:36:44 Control Specifications: Minor

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	00:00				0.0	0.0	0.0
01Jan2013	00:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	00:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	00:15	0.01	0.00	0.00	0.0	0.0	0.0
01Jan2013	00:20	0.01	0.00	0.00	0.1	0.0	0.1
01Jan2013	00:25	0.01	0.00	0.00	0.1	0.0	0.1
01Jan2013	00:30	0.01	0.00	0.00	0.2	0.0	0.2
01Jan2013	00:35	0.01	0.00	0.00	0.2	0.0	0.2
01Jan2013	00:40	0.01	0.00	0.00	0.2	0.0	0.2
01Jan2013	00:45	0.01	0.00	0.00	0.3	0.0	0.3
01Jan2013	00:50	0.01	0.00	0.00	0.3	0.0	0.3
01Jan2013	00:55	0.01	0.00	0.00	0.3	0.0	0.3
01Jan2013	01:00	0.01	0.00	0.00	0.4	0.0	0.4
01Jan2013	01:05	0.01	0.00	0.00	0.4	0.0	0.4
01Jan2013	01:10	0.01	0.00	0.00	0.4	0.0	0.4
01Jan2013	01:15	0.01	0.00	0.00	0.4	0.0	0.4
01Jan2013	01:20	0.01	0.01	0.00	0.5	0.0	0.5
01Jan2013	01:25	0.01	0.01	0.00	0.5	0.0	0.5
01Jan2013	01:30	0.01	0.01	0.00	0.5	0.0	0.5
01Jan2013	01:35	0.01	0.01	0.00	0.5	0.0	0.5
01Jan2013	01:40	0.01	0.01	0.00	0.5	0.0	0.5
01Jan2013	01:45	0.01	0.01	0.00	0.6	0.0	0.6
01Jan2013	01:50	0.01	0.01	0.00	0.6	0.0	0.6
01Jan2013	01:55	0.01	0.01	0.00	0.6	0.0	0.6
01Jan2013	02:00	0.01	0.01	0.00	0.6	0.0	0.6

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	02:05	0.01	0.01	0.00	0.7	0.0	0.7
01Jan2013	02:10	0.01	0.01	0.00	0.7	0.0	0.7
01Jan2013	02:15	0.02	0.01	0.00	0.7	0.0	0.7
01Jan2013	02:20	0.02	0.01	0.01	0.8	0.0	0.8
01Jan2013	02:25	0.02	0.01	0.01	0.9	0.0	0.9
01Jan2013	02:30	0.02	0.01	0.01	0.9	0.0	0.9
01Jan2013	02:35	0.09	0.06	0.03	1.1	0.0	1.1
01Jan2013	02:40	0.09	0.06	0.03	1.3	0.0	1.3
01Jan2013	02:45	0.09	0.06	0.03	1.7	0.0	1.7
01Jan2013	02:50	0.09	0.06	0.03	2.3	0.0	2.3
01Jan2013	02:55	0.09	0.06	0.03	3.0	0.0	3.0
01Jan2013	03:00	0.09	0.05	0.04	3.7	0.0	3.7
01Jan2013	03:05	0.09	0.05	0.04	4.4	0.0	4.4
01Jan2013	03:10	0.09	0.05	0.04	5.1	0.0	5.1
01Jan2013	03:15	0.09	0.04	0.04	5.9	0.0	5.9
01Jan2013	03:20	0.09	0.04	0.05	6.7	0.0	6.7
01Jan2013	03:25	0.09	0.04	0.05	7.4	0.0	7.4
01Jan2013	03:30	0.09	0.04	0.05	8.2	0.0	8.2
01Jan2013	03:35	0.02	0.01	0.01	8.9	0.0	8.9
01Jan2013	03:40	0.02	0.01	0.01	9.3	0.0	9.3
01Jan2013	03:45	0.02	0.01	0.01	9.4	0.0	9.4
01Jan2013	03:50	0.02	0.01	0.01	9.1	0.0	9.1
01Jan2013	03:55	0.01	0.01	0.01	8.5	0.0	8.5
01Jan2013	04:00	0.01	0.01	0.01	7.9	0.0	7.9
01Jan2013	04:05	0.01	0.00	0.01	7.2	0.0	7.2
01Jan2013	04:10	0.01	0.00	0.01	6.6	0.0	6.6
01Jan2013	04:15	0.01	0.00	0.01	6.0	0.0	6.0
01Jan2013	04:20	0.01	0.00	0.01	5.5	0.0	5.5
01Jan2013	04:25	0.01	0.00	0.01	5.0	0.0	5.0
01Jan2013	04:30	0.01	0.00	0.00	4.6	0.0	4.6
01Jan2013	04:35	0.01	0.00	0.01	4.2	0.0	4.2

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	04:40	0.01	0.00	0.00	3.9	0.0	3.9
01Jan2013	04:45	0.01	0.00	0.00	3.5	0.0	3.5
01Jan2013	04:50	0.01	0.00	0.00	3.3	0.0	3.3
01Jan2013	04:55	0.01	0.00	0.00	3.0	0.0	3.0
01Jan2013	05:00	0.01	0.00	0.00	2.8	0.0	2.8
01Jan2013	05:05	0.01	0.00	0.00	2.6	0.0	2.6
01Jan2013	05:10	0.01	0.00	0.00	2.4	0.0	2.4
01Jan2013	05:15	0.01	0.00	0.00	2.3	0.0	2.3
01Jan2013	05:20	0.01	0.00	0.00	2.2	0.0	2.2
01Jan2013	05:25	0.01	0.00	0.00	2.0	0.0	2.0
01Jan2013	05:30	0.01	0.00	0.00	1.9	0.0	1.9
01Jan2013	05:35	0.01	0.00	0.00	1.8	0.0	1.8
01Jan2013	05:40	0.01	0.00	0.00	1.7	0.0	1.7
01Jan2013	05:45	0.01	0.00	0.00	1.6	0.0	1.6
01Jan2013	05:50	0.01	0.00	0.00	1.5	0.0	1.5
01Jan2013	05:55	0.00	0.00	0.00	1.5	0.0	1.5
01Jan2013	06:00	0.00	0.00	0.00	1.4	0.0	1.4
01Jan2013	06:05	0.00	0.00	0.00	1.3	0.0	1.3
01Jan2013	06:10	0.00	0.00	0.00	1.3	0.0	1.3
01Jan2013	06:15	0.00	0.00	0.00	1.2	0.0	1.2
01Jan2013	06:20	0.00	0.00	0.00	1.0	0.0	1.0
01Jan2013	06:25	0.00	0.00	0.00	0.9	0.0	0.9
01Jan2013	06:30	0.00	0.00	0.00	0.8	0.0	0.8
01Jan2013	06:35	0.00	0.00	0.00	0.7	0.0	0.7
01Jan2013	06:40	0.00	0.00	0.00	0.6	0.0	0.6
01Jan2013	06:45	0.00	0.00	0.00	0.5	0.0	0.5
01Jan2013	06:50	0.00	0.00	0.00	0.4	0.0	0.4
01Jan2013	06:55	0.00	0.00	0.00	0.4	0.0	0.4
01Jan2013	07:00	0.00	0.00	0.00	0.3	0.0	0.3
01Jan2013	07:05	0.00	0.00	0.00	0.3	0.0	0.3
01Jan2013	07:10	0.00	0.00	0.00	0.2	0.0	0.2

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	07:15	0.00	0.00	0.00	0.2	0.0	0.2
01Jan2013	07:20	0.00	0.00	0.00	0.2	0.0	0.2
01Jan2013	07:25	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	07:30	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	07:35	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	07:40	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	07:45	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	07:50	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	07:55	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	08:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:45	0.00	0.00	0.00	0.0	0.0	0.0

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	09:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:20	0.00	0.00	0.00	0.0	0.0	0.0

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	12:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:55	0.00	0.00	0.00	0.0	0.0	0.0

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	15:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:30	0.00	0.00	0.00	0.0	0.0	0.0

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	17:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:05	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:15	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:25	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:35	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:45	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:55	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	20:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	20:05	0.00	0.00	0.00	0.0	0.0	0.0

Project: Proposed Simulation Run: 10YR STM

Start of Run: 01Jan2013, 00:00 Basin Model: Proposed
End of Run: 02Jan2013, 00:00 Meteorologic Model: 10yr
Compute Time: 16Sep2013, 12:36:44 Control Specifications: Minor Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Basin-A Proposed	0.03819	13.9	01Jan2013, 03:45	2.0
Basin-H2	0.19123	46.0	01Jan2013, 03:55	5.6
Basin-H3	0.28510	67.8	01Jan2013, 03:50	8.4

Project: Proposed Simulation Run: 25YR STM

Start of Run: 01Jan2013, 00:00 Basin Model: Proposed
End of Run: 02Jan2013, 00:00 Meteorologic Model: 25yr
Compute Time: 04Feb2014, 13:23:31 Control Specifications: Minor Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Basin-A Proposed	0.03819	22.6	01Jan2013, 03:40	2.9
Basin-H2	0.19123	85.5	01Jan2013, 03:50	9.3
Basin-H3	0.28510	126.0	01Jan2013, 03:45	13.9

Project: Proposed Simulation Run: 100YR STM

Start of Run: 01Jan2013, 00:00 Basin Model: Proposed
End of Run: 02Jan2013, 00:00 Meteorologic Model: 100yr
Compute Time: 16Sep2013, 12:36:43 Control Specifications: Major Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Basin-A Proposed	0.03819	34.9	01Jan2013, 03:40	4.9
Basin-H2	0.19123	152.6	01Jan2013, 03:50	18.6
Basin-H3	0.28510	228.3	01Jan2013, 03:50	27.7

Project: Proposed
Simulation Run: 100YR STM Subbasin: Basin-A Proposed

Start of Run: 01Jan2013, 00:00 Basin Model: Proposed
End of Run: 02Jan2013, 00:00 Meteorologic Model: 100yr
Compute Time: 16Sep2013, 12:36:43 Control Specifications: Major

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	00:00				0.0	0.0	0.0
01Jan2013	00:10	0.02	0.01	0.01	0.0	0.0	0.0
01Jan2013	00:20	0.02	0.01	0.01	0.2	0.0	0.2
01Jan2013	00:30	0.02	0.01	0.01	0.3	0.0	0.3
01Jan2013	00:40	0.02	0.01	0.01	0.4	0.0	0.4
01Jan2013	00:50	0.02	0.02	0.01	0.6	0.0	0.6
01Jan2013	01:00	0.02	0.02	0.01	0.7	0.0	0.7
01Jan2013	01:10	0.03	0.02	0.01	0.8	0.0	0.8
01Jan2013	01:20	0.03	0.02	0.01	0.9	0.0	0.9
01Jan2013	01:30	0.03	0.02	0.01	0.9	0.0	0.9
01Jan2013	01:40	0.03	0.02	0.01	1.0	0.0	1.0
01Jan2013	01:50	0.04	0.03	0.01	1.1	0.0	1.1
01Jan2013	02:00	0.04	0.03	0.01	1.3	0.0	1.3
01Jan2013	02:10	0.07	0.05	0.02	1.4	0.0	1.4
01Jan2013	02:20	0.08	0.05	0.02	1.7	0.0	1.7
01Jan2013	02:30	0.09	0.06	0.03	2.1	0.0	2.1
01Jan2013	02:40	0.44	0.26	0.18	3.6	0.0	3.6
01Jan2013	02:50	0.44	0.19	0.25	7.6	0.0	7.6
01Jan2013	03:00	0.44	0.15	0.29	13.6	0.0	13.6
01Jan2013	03:10	0.44	0.12	0.32	20.1	0.0	20.1
01Jan2013	03:20	0.44	0.10	0.34	26.2	0.0	26.2
01Jan2013	03:30	0.44	0.08	0.36	31.8	0.0	31.8
01Jan2013	03:40	0.10	0.02	0.09	34.9	0.0	34.9
01Jan2013	03:50	0.08	0.01	0.07	33.1	0.0	33.1
01Jan2013	04:00	0.07	0.01	0.06	28.5	0.0	28.5

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	04:10	0.04	0.01	0.04	23.9	0.0	23.9
01Jan2013	04:20	0.04	0.01	0.03	19.9	0.0	19.9
01Jan2013	04:30	0.04	0.01	0.03	16.5	0.0	16.5
01Jan2013	04:40	0.03	0.00	0.03	13.7	0.0	13.7
01Jan2013	04:50	0.03	0.00	0.02	11.4	0.0	11.4
01Jan2013	05:00	0.03	0.00	0.02	9.6	0.0	9.6
01Jan2013	05:10	0.02	0.00	0.02	8.2	0.0	8.2
01Jan2013	05:20	0.02	0.00	0.02	7.0	0.0	7.0
01Jan2013	05:30	0.02	0.00	0.02	6.0	0.0	6.0
01Jan2013	05:40	0.02	0.00	0.02	5.3	0.0	5.3
01Jan2013	05:50	0.02	0.00	0.02	4.7	0.0	4.7
01Jan2013	06:00	0.02	0.00	0.02	4.2	0.0	4.2
01Jan2013	06:10	0.00	0.00	0.00	3.6	0.0	3.6
01Jan2013	06:20	0.00	0.00	0.00	3.0	0.0	3.0
01Jan2013	06:30	0.00	0.00	0.00	2.3	0.0	2.3
01Jan2013	06:40	0.00	0.00	0.00	1.7	0.0	1.7
01Jan2013	06:50	0.00	0.00	0.00	1.3	0.0	1.3
01Jan2013	07:00	0.00	0.00	0.00	0.9	0.0	0.9
01Jan2013	07:10	0.00	0.00	0.00	0.6	0.0	0.6
01Jan2013	07:20	0.00	0.00	0.00	0.5	0.0	0.5
01Jan2013	07:30	0.00	0.00	0.00	0.4	0.0	0.4
01Jan2013	07:40	0.00	0.00	0.00	0.3	0.0	0.3
01Jan2013	07:50	0.00	0.00	0.00	0.2	0.0	0.2
01Jan2013	08:00	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	08:10	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	08:20	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	08:30	0.00	0.00	0.00	0.1	0.0	0.1
01Jan2013	08:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	08:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:10	0.00	0.00	0.00	0.0	0.0	0.0

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	09:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	09:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	10:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	11:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	12:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	13:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:20	0.00	0.00	0.00	0.0	0.0	0.0

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	14:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	14:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	15:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	16:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	17:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	18:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:30	0.00	0.00	0.00	0.0	0.0	0.0

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direct Flow (CFS)	Baseflow (CFS)	Total Flow (CFS)
01Jan2013	19:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	19:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	20:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	20:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	20:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	20:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	20:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	20:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	21:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	21:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	21:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	21:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	21:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	21:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	22:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	22:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	22:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	22:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	22:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	22:50	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	23:00	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	23:10	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	23:20	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	23:30	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	23:40	0.00	0.00	0.00	0.0	0.0	0.0
01Jan2013	23:50	0.00	0.00	0.00	0.0	0.0	0.0
02Jan2013	00:00	0.00	0.00	0.00	0.0	0.0	0.0

E. RATIONAL METHOD CALCULATIONS (PROPOSED)

Table RO-5— Runoff Coefficients, *C*

Percentage Imperviousness	Type C and D NRCS Hydrologic Soil Groups					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0%	0.04	0.15	0.25	0.37	0.44	0.50
5%	0.08	0.18	0.28	0.39	0.46	0.52
10%	0.11	0.21	0.30	0.41	0.47	0.53
15%	0.14	0.24	0.32	0.43	0.49	0.54
20%	0.17	0.26	0.34	0.44	0.50	0.55
25%	0.20	0.28	0.36	0.46	0.51	0.56
30%	0.22	0.30	0.38	0.47	0.52	0.57
35%	0.25	0.33	0.40	0.48	0.53	0.57
40%	0.28	0.35	0.42	0.50	0.54	0.58
45%	0.31	0.37	0.44	0.51	0.55	0.59
50%	0.34	0.40	0.46	0.53	0.57	0.60
55%	0.37	0.43	0.48	0.55	0.58	0.62
60%	0.41	0.46	0.51	0.57	0.60	0.63
65%	0.45	0.49	0.54	0.59	0.62	0.65
70%	0.49	0.53	0.57	0.62	0.65	0.68
75%	0.54	0.58	0.62	0.66	0.68	0.71
80%	0.60	0.63	0.66	0.70	0.72	0.74
85%	0.66	0.68	0.71	0.75	0.77	0.79
90%	0.73	0.75	0.77	0.80	0.82	0.83
95%	0.80	0.82	0.84	0.87	0.88	0.89
100%	0.89	0.90	0.92	0.94	0.95	0.96
	TYPE B NRCS HYDROLOGIC SOILS GROUP					
0%	0.02	0.08	0.15	0.25	0.30	0.35
5%	0.04	0.10	0.19	0.28	0.33	0.38
10%	0.06	0.14	0.22	0.31	0.36	0.40
15%	0.08	0.17	0.25	0.33	0.38	0.42
20%	0.12	0.20	0.27	0.35	0.40	0.44
25%	0.15	0.22	0.30	0.37	0.41	0.46
30%	0.18	0.25	0.32	0.39	0.43	0.47
35%	0.20	0.27	0.34	0.41	0.44	0.48
40%	0.23	0.30	0.36	0.42	0.46	0.50
45%	0.26	0.32	0.38	0.44	0.48	0.51
50%	0.29	0.35	0.40	0.46	0.49	0.52
55%	0.33	0.38	0.43	0.48	0.51	0.54
60%	0.37	0.41	0.46	0.51	0.54	0.56
65%	0.41	0.45	0.49	0.54	0.57	0.59
70%	0.45	0.49	0.53	0.58	0.60	0.62
75%	0.51	0.54	0.58	0.62	0.64	0.66
80%	0.57	0.59	0.63	0.66	0.68	0.70
85%	0.63	0.66	0.69	0.72	0.73	0.75
90%	0.71	0.73	0.75	0.78	0.80	0.81
95%	0.79	0.81	0.83	0.85	0.87	0.88
100%	0.89	0.90	0.92	0.94	0.95	0.96

Table RO-3—Recommended Percentage Imperviousness Values

Land Use or Surface Characteristics	Percentage Imperviousness
Business:	
Commercial areas	95
Neighborhood areas	85
Residential:	
Single-family	*
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	*
Apartments	80
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yard areas	15
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	0
Lawns, clayey soil	0

* See Figures RO-3 through RO-5 for percentage imperviousness.

$$C_A = K_A + \left(1.31i^3 - 1.44i^2 + 1.135i - 0.12\right) \text{ for } C_A \geq 0, \text{ otherwise } C_A = 0 \qquad \text{(RO-6)}$$

$$C_{CD} = K_{CD} + \left(0.858i^3 - 0.786i^2 + 0.774i + 0.04\right) \qquad \text{(RO-7)}$$

$$C_B = \left(C_A + C_{CD}\right)/2$$

PROJECT NAME: Liquids Handling Hub
PROJECT NUMBER: PL226
CALCULATED BY: SMB
CHECKED BY: NJN

DATE: 3/19/14

SF-1
RUNOFF COEFFICIENTS

HISTORIC RUNOFF COEFFICIENTS (Type C Soils)

LAND USE:	PAVED	ROOF	GRAVEL	LANDS
I	100%	90%	40%	0%
C_5	0.90	0.75	0.35	0.15
C_{10}	0.92	0.77	0.42	0.25
C_{100}	0.96	0.83	0.58	0.50

DEVELOPED RUNOFF COEFFICIENTS (Type B Soils)

LAND USE:	PAVED	ROOF	GRAVEL	LANDS
I	100%	90%	40%	0%
C_5	0.90	0.73	0.30	0.08
C_{10}	0.92	0.75	0.36	0.15
C_{100}	0.96	0.81	0.50	0.35

Note: Composite "C" values are derived from UDFCD Table RO-3 (Recommended Percentage Imperviousness Values) and Table RO-5 (Runoff Coefficients, C) for the corresponding Soil Type.

HISTORIC

DESIGN BASIN	DESIGN POINT	PAVED AREA (AC)	ROOF AREA (AC)	GRAVEL AREA (AC)	LANDS. AREA (AC)	TOTAL AREA (AC)	C_5	C_{10}	C_{100}	IMPERV. %
H1	1	0.00	0.00	0.00	28.20	28.20	0.15	0.25	0.50	0.00%
H2	2	0.00	0.00	0.00	122.39	122.39	0.15	0.25	0.50	0.00%
H3	3	0.00	0.00	0.00	182.46	182.46	0.15	0.25	0.50	0.00%
HISTORIC SUBTOTAL		***0.00***	***0.00***	***0.00***	***333.05***	***333.05***	***0.15***	***0.25***	***0.50***	***0.00%***
		0.0%	0.0%	0.0%	100.0%	100%				

Historic conditions are based on Type C Soils (See Soils Maps)

DEVELOPED - On Site

DESIGN BASIN	DESIGN POINT	PAVED AREA (AC)	ROOF AREA (AC)	GRAVEL AREA (AC)	LANDS. AREA (AC)	TOTAL AREA (AC)	C_5	C_{10}	C_{100}	IMPERV. %
A1	1	0.00	0.00	0.00	10.90	10.90	0.08	0.15	0.35	0.00%
A2	2	0.09	0.00	0.00	2.70	2.78	0.11	0.17	0.37	3.15%
A3	3	0.09	0.07	1.72	4.12	6.00	0.16	0.23	0.41	14.00%
A4a	4	0.00	0.00	0.28	0.84	1.11	0.13	0.20	0.39	9.90%
A4b	5	0.00	0.00	0.32	4.33	4.65	0.10	0.16	0.36	2.78%
A5	6	3.27	0.00	0.18	1.15	4.60	0.67	0.71	0.79	72.71%
A6	7	0.00	0.00	0.00	3.79	3.79	0.08	0.15	0.35	0.00%
B1	8	0.00	0.00	3.00	1.32	4.32	0.23	0.30	0.45	27.79%
B2	9	0.00	1.09	2.03	0.42	3.55	0.41	0.46	0.58	50.63%
B3	10	0.01	0.04	0.34	0.12	0.51	0.29	0.35	0.49	35.25%
DEVELOPED ON SITE SUBTOTAL		***3.46***	***1.20***	***7.87***	***29.69***	***42.22***	***0.21***	***0.27***	***0.44***	***18.21%***
		8.2%	2.9%	18.6%	70.3%	100.0%				

Developed conditions are based on Type B Soils (See Soils Maps)

DEVELOPED - Off Site

DESIGN BASIN	DESIGN POINT	PAVED AREA (AC)	ROOF AREA (AC)	GRAVEL AREA (AC)	LANDS. AREA (AC)	TOTAL AREA (AC)	C_5	C_{10}	C_{100}	IMPERV. %
C1	11	0.25	0.00	0.00	0.28	0.53	0.47	0.51	0.64	47.21%
C2	12	0.30	0.00	0.00	0.53	0.83	0.38	0.43	0.57	36.54%
C3	13	0.56	0.00	0.00	1.21	1.78	0.34	0.39	0.54	31.68%
DEVELOPED OFF SITE SUBTOTAL		***1.12***	***0.00***	***0.00***	***2.02***	***3.14***	***0.37***	***0.42***	***0.57***	***35.60%***
		35.6%	0.0%	0.0%	64.4%	100%				

Developed conditions are based on Type B Soils (See Soils Maps)

BASELINE
Engineering : Planning : Surveying

STANDARD FORM SF-2 - DEVELOPED
Time of Concentration

PROJECT NAME: Liquid Handling Hub
PROJECT NUMBER: PL226
CALCULATED BY: SMB
CHECKED BY: NJN

DATE: 3/19/14

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$

t_i = initial or overland flow time (minutes)

C_5 = runoff coefficient for 5-year frequency (from Table RO-5)

$$V = C_v S_w^{0.5}$$

V = velocity (ft/sec)

C_v = conveyance coefficient (from Table RO-2)

S_w = watercourse slope (ft/ft)

$$t_c = t_i + t_t \qquad t_c = \frac{L}{180} + 10$$

SUB-BASIN DATA			INITIAL TIME (T_i)			TRAVEL TIME (T_t)						tc CHECK (URBANIZED BASINS)			FINAL tc		
DESIGN BASIN (1)	AREA Ac (2)	C_5 (3)	LENGTH Ft (4)	SLOPE % (5)	T_i Min. (6)	LENGTH Ft. (7)	SLOPE % (8)	C_v (9)	Land Surface (10)	VEL fps (11)	T_t Min. (12)	COMP. tc (13)	TOTAL LENGTH (14)	tc=(L/180)+10 Min. (15)	Min.	C_{10}	C_{100}
HISTORIC																	
H1	28.20	0.15	500	3.4%	25.9	2,090	1.1%	15.0	Grassed Waterway	1.6	22.1	48.0			48.0	0.25	0.50
H2	122.39	0.15	500	1.3%	36.0	2,500	1.3%	15.0	Grassed Waterway	1.7	24.6	60.6			60.6	0.25	0.50
H3	182.46	0.15	500	2.5%	28.7	3,140	2.5%	15.0	Grassed Waterway	2.4	22.1	50.8			50.8	0.25	0.50
DEVELOPED																	
A1	10.90	0.08	355	2.2%	27.1	385	1.0%	15.0	Grassed Waterway	1.5	4.3	31.4	740	14.1	14.1	0.15	0.35
A2	2.78	0.11	943	33.0%	17.5	63	8.0%	15.0	Grassed Waterway	4.2	0.2	17.7	1006	15.6	15.6	0.17	0.37
A3	6.00	0.16	130	1.4%	17.5	1,070	1.4%	15.0	Grassed Waterway	1.8	10.0	27.6	1200	16.7	16.7	0.23	0.41
A4a	1.11	0.13	50	33.3%	3.9	900	1.8%	15.0	Grassed Waterway	2.0	7.5	11.3	950	15.3	11.3	0.20	0.39
A4b	4.65	0.10	150	0.8%	24.3	300	1.0%	10.0	Nearly Bare Ground	1.0	5.0	29.3	450	12.5	12.5	0.16	0.36
A5	4.60	0.67	150	1.0%	9.6	300	0.2%	10.0	Nearly Bare Ground	0.4	11.2	20.8	450	12.5	12.5	0.71	0.79
A6	3.79	0.08	20	1.0%	8.4	300	0.2%	10.0	Nearly Bare Ground	0.4	11.2	19.5	320	11.8	11.8	0.15	0.35
B1	4.32	0.23	40	1.0%	10.1	5	1.0%	15.0	Grassed Waterway	1.5	0.1	10.1	45	10.3	10.1	0.30	0.45
B2	3.55	0.41	40	1.0%	8.0	5	1.0%	15.0	Grassed Waterway	1.5	0.1	8.1	45	10.3	8.1	0.46	0.58
B3	0.51	0.29	40	6.0%	5.2	700	1.8%	15.0	Grassed Waterway	2.0	5.8	11.0	740	14.1	11.0	0.35	0.49
C1	0.53	0.47	250	6.0%	10.1	700	1.8%	15.0	Grassed Waterway	2.0	5.8	15.9	950	15.3	15.3	0.51	0.64
C2	0.83	0.38	300	6.0%	12.6	800	1.5%	15.0	Grassed Waterway	1.8	7.3	19.8	1100	16.1	16.1	0.43	0.57
C3	1.78	0.34	300	6.0%	13.3	920	1.2%	15.0	Grassed Waterway	1.6	9.3	22.6	1220	16.8	16.8	0.39	0.57

Table RO-2—Conveyance Coefficient, C_v

Type of Land Surface	Conveyance Coefficient, C_v
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

BASELINE
Engineering · Planning · Surveying

STANDARD FORM SF-3 - HISTORIC & DEVELOPED
STORM DRAINAGE DESIGN - RATIONAL METHOD 5-YEAR EVENT

PROJECT NAME: Liquids Handling Hub
PROJECT NUMBER: PL226
CALCULATED BY: SMB
CHECKED BY: NJN

DATE: 3/19/14

P_1 (1-Hour Rainfall) = 1.31

$$I = \frac{28.5\ P_1}{(10 + T_c)^{0.786}} \qquad Q = CIA$$

STORM LINE	DESIGN POINT	5-YR RUNOFF: DESIGN BASIN	AREA (AC)	RUNOFF COEFF C_5	t_c (min)	C*A(ac)	I (in/hr)	Q (cfs)	TOTAL RUNOFF: t_c(min)	Σ(C*A) (ac)	I (in/hr)	Q (cfs)	STREET: SLOPE (%)	STREET FLOW(cfs)	PIPE: DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	TRAVEL TIME: LENGTH (ft)	VELOCITY (fps)	tt (min)	REMARKS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		HISTORIC																			
	1	H1	28.20	0.15	48.0	4.23	1.53	6.5													
	2	H2	122.39	0.15	60.6	18.36	1.31	24.1													
	3	H3	182.46	0.15	50.8	27.37	1.48	40.5													
		DEVELOPED - ON SITE																			
	1	A1	10.90	0.08	14.1	0.87	3.06	2.7													
	2	A2	2.78	0.11	15.6	0.29	2.92	0.9													
	3	A3	6.00	0.16	16.7	0.98	2.83	2.8	24.7	2.28	2.30	5.2						860	1.8	8.1	Channel DP2 to DP3
	4	A4a	1.11	0.13	11.3	0.15	3.37	0.5	28.4	2.43	2.12	5.2						440	2.0	3.6	Channel DP3 to DP4
	5	A4b	4.65	0.10	12.5	0.44	3.23	1.4	34.1	2.87	1.91	5.5						340	1.0	5.7	Channel DP4 to DP5
	6	A5	4.60	0.67	12.5	3.09	3.23	10.0													
	7	A6	3.79	0.08	11.8	0.30	3.31	1.0													
	8	B1	4.32	0.23	10.1	1.01	3.53	3.5													
	9	B2	3.55	0.41	8.1	1.44	3.83	5.5													
	10	B3	0.51	0.29	11.0	0.15	3.41	0.5													
		DEVELOPED - OFF SITE																			
	11	C1	0.53	0.47	15.3	0.25	2.95	0.7				0.7									
	12	C2	0.83	0.38	16.1	0.32	2.87	0.9	37.1	0.32	1.81	0.6						102	1.6	5.7	Channel DP8 to DP9
	13	C3	1.78	0.34	16.8	0.60	2.82	1.7	22.4	0.85	2.42	2.1									

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DATE: 3/19/14

P_1 (1-Hour Rainfall) = 1.63

$$I = \frac{28.5\ P_1}{(10 + T_c)^{0.786}} \qquad Q = CIA$$

STORM LINE	DESIGN POINT	10-YR RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF C_{10}	t_c (min)	C*A(ac)	I (in/hr)	Q (cfs)	t_c(min)	Σ(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY (fps)	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		HISTORIC																			
	1	H1	28.20	0.25	48.0	7.05	1.91	13.5													
	2	H2	122.39	0.25	60.6	30.60	1.64	50.1													
	3	H3	182.46	0.25	50.8	45.62	1.84	84.0													
		DEVELOPED - ON SITE																			
	1	A1	10.90	0.15	14.1	1.64	3.81	6.2													
	2	A2	2.78	0.17	15.6	0.48	3.63	1.8													
	3	A3	6.00	0.23	16.7	1.37	3.52	4.8	24.7	3.14	2.86	9.0						860	1.8	8.1	Channel DP2 to DP3
	4	A4a	1.11	0.20	11.3	0.22	4.19	0.9	28.4	3.36	2.64	8.9						440	2.0	3.6	Channel DP3 to DP4
	5	A4b	4.65	0.16	12.5	0.77	4.02	3.1	34.1	4.13	2.37	9.8						340	1.0	5.7	Channel DP4 to DP5
	6	A5	4.60	0.71	12.5	3.25	4.02	13.0													
	7	A6	3.79	0.15	11.8	0.57	4.12	2.3													
	8	B1	4.32	0.30	10.1	1.28	4.39	5.6													
	9	B2	3.55	0.46	8.1	1.62	4.77	7.7													
	10	B3	0.51	0.35	11.0	0.18	4.25	0.8													
		DEVELOPED - OFF SITE																			
	11	C1	0.53	0.51	15.3	0.27	3.67	1.0				1.0									
	12	C2	0.83	0.43	16.1	0.36	3.58	1.3	37.1	0.36	2.25	0.8						102	1.6	5.7	Channel DP8 to DP9
	13	C3	1.78	0.39	16.8	0.70	3.51	2.5	22.4	0.97	3.01	2.9									

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PROJECT NAME: Liquids Handling Hub
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CALCULATED BY: SMB
CHECKED BY: NJN

DATE: 3/19/14

P_1 (1-Hour Rainfall) = **2.79**

$$I = \frac{28.5\,P_1}{(10 + T_c)^{0.786}} \qquad Q = CIA$$

STORM LINE	DESIGN POINT	100-YR RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF C_{100}	t_c (min)	C*A(ac)	I (in/hr)	Q (cfs)	t_c(min)	Σ(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY (fps)	t_t (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		HISTORIC																			
	1	H1	28.20	0.50	48.0	14.10	3.27	46.1													
	2	H2	122.39	0.50	60.6	61.20	2.80	171.4													
	3	H3	182.46	0.50	50.8	91.23	3.15	287.5													
		DEVELOPED - ON SITE																			
	1	A1	10.90	0.35	14.1	3.82	6.52	24.9													
	2	A2	2.78	0.37	15.6	1.03	6.22	6.4													
	3	A3	6.00	0.41	16.7	2.45	6.02	14.7	24.7	5.44	4.89	26.6						860	1.8	8.1	Channel DP2 to DP3
	4	A4a	1.11	0.39	11.3	0.43	7.17	3.1	28.4	5.87	4.52	26.5						440	2.0	3.6	Channel DP3 to DP4
	5	A4b	4.65	0.36	12.5	1.68	6.88	11.5	34.1	7.54	4.06	30.6						340	1.0	5.7	Channel DP4 to DP5
	6	A5	4.60	0.79	12.5	3.63	6.88	25.0													
	7	A6	3.79	0.35	11.8	1.33	7.06	9.4													
	8	B1	4.32	0.45	10.1	1.96	7.52	14.7													
	9	B2	3.55	0.58	8.1	2.05	8.16	16.7													
	10	B3	0.51	0.49	11.0	0.25	7.27	1.8													
		DEVELOPED - OFF SITE																			
	11	C1	0.53	0.64	15.3	0.34	6.28	2.1				2.1									
	12	C2	0.83	0.57	16.1	0.48	6.12	2.9	37.1	0.48	3.85	1.8						102	1.6	5.7	Channel DP8 to DP9
	13	C3	1.78	0.54	16.8	0.96	6.00	5.8	22.4	1.30	5.16	6.7									

F. HYDRAULIC COMPUTATIONS

DETENTION VOLUME BY THE HYDROGRAPH METHOD

Project: Liquids Handling Hub

Basin ID:

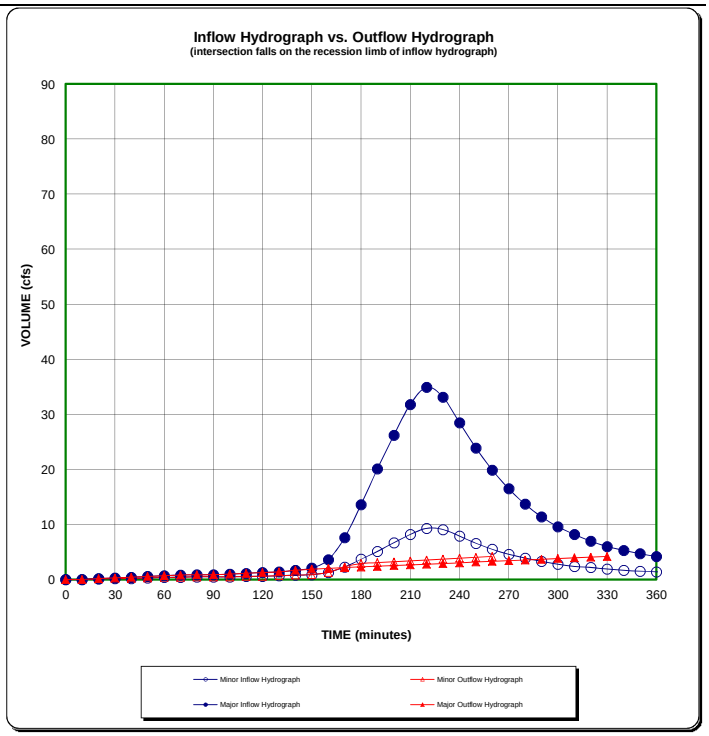
Design Information (Input):

		MINOR	MAJOR	
Max. Allowable Peak Outflow	Qp-out =	4.20	4.20	cfs
Time to Peak Outflow	Tp-out =	260	330	minutes

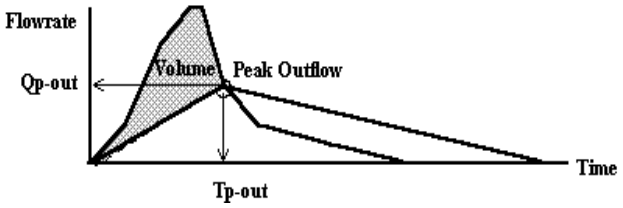
Minor Storage Volume (cubic ft.): **18,069** Major Storage Volume (cubic ft.): **155,797**

Minor Storage Volume (acre-ft.): **0.41** Major Storage Volume (acre-ft.): **3.58**

10	MINOR (e.g. 2-, 5-, OR 10-year) EVENT				MAJOR (e.g. 25-, 50-, or 100-year) EVENT			
Time	Inflow hydrograph	**Outflow** Rising Hy	Increm. Volume	**Storage** Volume	Inflow hydrograph	**Outflow** Rising Hy	Increm. Volume	**Storage** Volume
minutes	cfs	cfs	acre-ft	acre-ft	cfs	cfs	acre-ft	acre-ft
(input)	(input)	(output)	(output)	(output)	(input)	(output)	(output)	(output)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.10	0.10	0.00	0.00	0.20	0.20	0.00	0.00
30	0.20	0.20	0.00	0.00	0.30	0.30	0.00	0.00
40	0.20	0.20	0.00	0.00	0.40	0.40	0.00	0.00
50	0.30	0.30	0.00	0.00	0.60	0.60	0.00	0.00
60	0.40	0.40	0.00	0.00	0.70	0.70	0.00	0.00
70	0.40	0.40	0.00	0.00	0.80	0.80	0.00	0.00
80	0.50	0.50	0.00	0.00	0.90	0.90	0.00	0.00
90	0.50	0.50	0.00	0.00	0.90	0.90	0.00	0.00
100	0.50	0.50	0.00	0.00	1.00	1.00	0.00	0.00
110	0.60	0.60	0.00	0.00	1.10	1.10	0.00	0.00
120	0.60	0.60	0.00	0.00	1.30	1.30	0.00	0.00
130	0.70	0.70	0.00	0.00	1.40	1.40	0.00	0.00
140	0.80	0.80	0.00	0.00	1.70	1.70	0.00	0.00
150	0.90	0.90	0.00	0.00	2.10	1.91	0.00	0.00
160	1.30	1.30	0.00	0.00	3.60	2.04	0.02	0.02
170	2.30	2.30	0.00	0.00	7.60	2.16	0.07	0.10
180	3.70	2.91	0.01	0.01	13.60	2.29	0.16	0.25
190	5.10	3.07	0.03	0.04	20.10	2.42	0.24	0.50
200	6.70	3.23	0.05	0.09	26.20	2.55	0.33	0.82
210	8.20	3.39	0.07	0.15	31.80	2.67	0.40	1.23
220	9.30	3.55	0.08	0.23	34.90	2.80	0.44	1.67
230	9.10	3.72	0.07	0.31	33.10	2.93	0.42	2.08
240	7.90	3.88	0.06	0.36	28.50	3.05	0.35	2.43
250	6.60	4.04	0.04	0.40	23.90	3.18	0.29	2.72
260	5.50	4.20	0.02	0.41	19.90	3.31	0.23	2.95
270	4.60	#N/A			16.50	3.44	0.18	3.13
280	3.90	#N/A			13.70	3.56	0.14	3.27
290	3.30	#N/A			11.40	3.69	0.11	3.37
300	2.80	#N/A			9.60	3.82	0.08	3.45
310	2.40	#N/A			8.20	3.95	0.06	3.51
320	2.20	#N/A			7.00	4.07	0.04	3.55
330	1.90	#N/A			6.00	4.20	0.02	3.58
340	1.70	#N/A			5.30	#N/A		
350	1.50	#N/A			4.70	#N/A		
360	1.40	#N/A			4.20	#N/A		
370	1.30	#N/A			3.60	#N/A		
380	1.00	#N/A			3.00	#N/A		
390	0.80	#N/A			2.30	#N/A		
400	0.60	#N/A			1.70	#N/A		
410	0.40	#N/A			1.30	#N/A		
420	0.30	#N/A			0.90	#N/A		
430	0.20	#N/A			0.60	#N/A		
440	0.20	#N/A			0.50	#N/A		
450	0.10	#N/A			0.40	#N/A		
460	0.10	#N/A			0.30	#N/A		
470	0.10	#N/A			0.20	#N/A		
480	0.00	#N/A			0.10	#N/A		
490	0.00	#N/A			0.10	#N/A		
500	0.00	#N/A			0.10	#N/A		
510	0.00	#N/A			0.10	#N/A		
520	0.00	#N/A			0.00	#N/A		
530	0.00	#N/A			0.00	#N/A		
540	0.00	#N/A			0.00	#N/A		
550	0.00	#N/A			0.00	#N/A		
560	0.00	#N/A			0.00	#N/A		
570	0.00	#N/A			0.00	#N/A		
580	0.00	#N/A			0.00	#N/A		
590	0.00	#N/A			0.00	#N/A		
600	0.00	#N/A			0.00	#N/A		
610	0.00	#N/A			0.00	#N/A		
620	0.00	#N/A			0.00	#N/A		
630	0.00	#N/A			0.00	#N/A		
640	0.00	#N/A			0.00	#N/A		
650	0.00	#N/A			0.00	#N/A		
660	0.00	#N/A			0.00	#N/A		
670	0.00	#N/A			0.00	#N/A		
680	0.00	#N/A			0.00	#N/A		
690	0.00	#N/A			0.00	#N/A		
700	0.00	#N/A			0.00	#N/A		
710	0.00	#N/A			0.00	#N/A		
720	0.00	#N/A			0.00	#N/A		
730	0.00	#N/A			0.00	#N/A		
740	0.00	#N/A			0.00	#N/A		



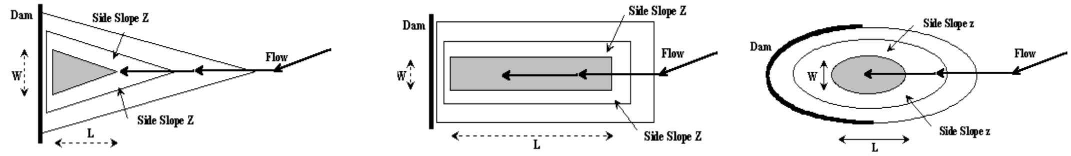
NOTE: THIS IS A FIRST APPROXIMATION ONLY



STAGE-STORAGE SIZING FOR DETENTION BASINS

Project: **Liquids Handling Hub**

Basin ID:



Design Information (Input):

Width of Basin Bottom, W =		ft
Length of Basin Bottom, L =		ft
Dam Side-slope (H:V), Z_d =		ft/ft

Check Basin Shape

Right Triangle		OR…
Isosceles Triangle		OR…
Rectangle		OR…
Circle / Ellipse		OR…
Irregular		(Use Overide values in cells G32:G52)

Stage-Storage Relationship:

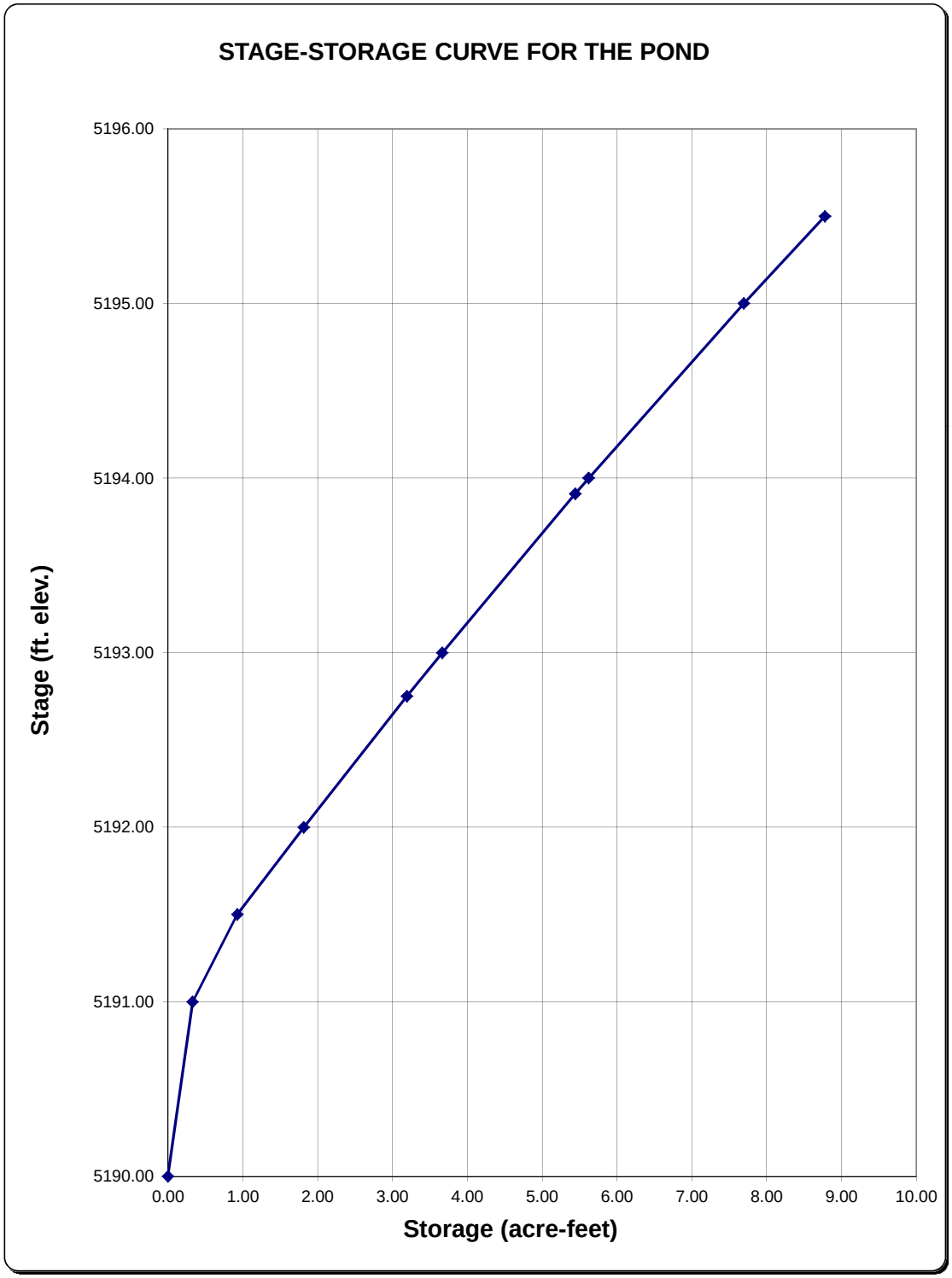
	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':	2.76		acre-ft.
Storage Requirement from Sheet 'Hydrograph':	0.41	3.58	acre-ft.
Storage Requirement from Sheet 'Full-Spectrum':			acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Water Surface Elevation ft (input)	Side Slope (H:V) ft/ft Below El.	Basin Width at Stage ft (output)	Basin Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
	5190.00	(input)				1000	0	0.023	0.00	
	5191.00		0.00	0.00		27737	14,369	0.637	0.33	
	5191.50		0.00	0.00		76336	40387	1.752	0.93	
	5192.00		0.00	0.00		78465	79,087	1.801	1.82	
	5192.75		0.00	0.00		81705	139151	1.876	3.19	25-Yr Volume (2.9 ac-ft) FROM HEC-HMS
	5193.00		0.00	0.00		82798	159,714	1.901	3.67	
	5193.91		0.00	0.00		87,287	237,102	2.004	5.44	100-YR WSEL
	5194.00		0.00	0.00		88,016	244,991	2.021	5.62	
	5195.00		0.00	0.00		92,583	335,290	2.125	7.697	FREEBOARD
	5195.50		0.00	0.00		96,000	382,436	2.204	8.780	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	

STAGE-STORAGE SIZING FOR DETENTION BASINS

Project: _____

Basin ID: _____

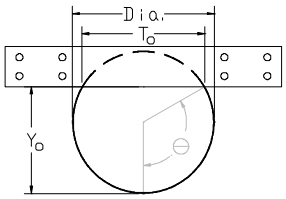


RESTRICTOR PLATE SIZING FOR CIRCULAR VERTICAL ORIFICES

Project: Liquids Handling Hub

Basin ID:

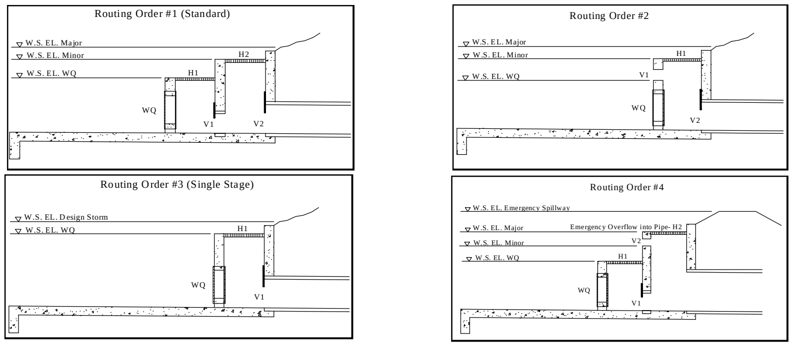
X



		#1 Vertical Orifice	#2 Vertical Orifice	
Sizing the Restrictor Plate for Circular Vertical Orifices or Pipes (Input)				
Water Surface Elevation at Design Depth	Elev: WS =	5,192.75		feet
Pipe/Vertical Orifice Entrance Invert Elevation	Elev: Invert =	5,190.90		feet
Required Peak Flow through Orifice at Design Depth	Q =	4.20		cfs
Pipe/Vertical Orifice Diameter (inches)	Dia =	18.0		inches
Orifice Coefficient	C_o =	0.62		
Full-flow Capacity (Calculated)				
Full-flow area	Af =	1.77		sq ft
Half Central Angle in Radians	Theta =	3.14		rad
Full-flow capacity	Qf =	9.2		cfs
	Percent of Design Flow =	220%		
Calculation of Orifice Flow Condition				
Half Central Angle (0<Theta<3.1416)	Theta =	1.39		rad
Flow area	A_o =	0.68		sq ft
Top width of Orifice (inches)	T_o =	17.70		inches
Height from Invert of Orifice to Bottom of Plate (feet)	Y_o =	0.61		feet
Elevation of Bottom of Plate	Elev Plate Bottom Edge =	5,191.51		feet
Resultant Peak Flow Through Orifice at Design Depth	Q_o =	4.2		cfs
Width of Equivalent Rectangular Vertical Orifice	**Equivalent Width =**	**1.11**		**feet**
Centroid Elevation of Equivalent Rectangular Vertical Orifice	**Equiv. Centroid El. =**	**5,191.21**		**feet**

STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: **Liquids Handling Hub**
Basin ID:



Current Routing Order is #3

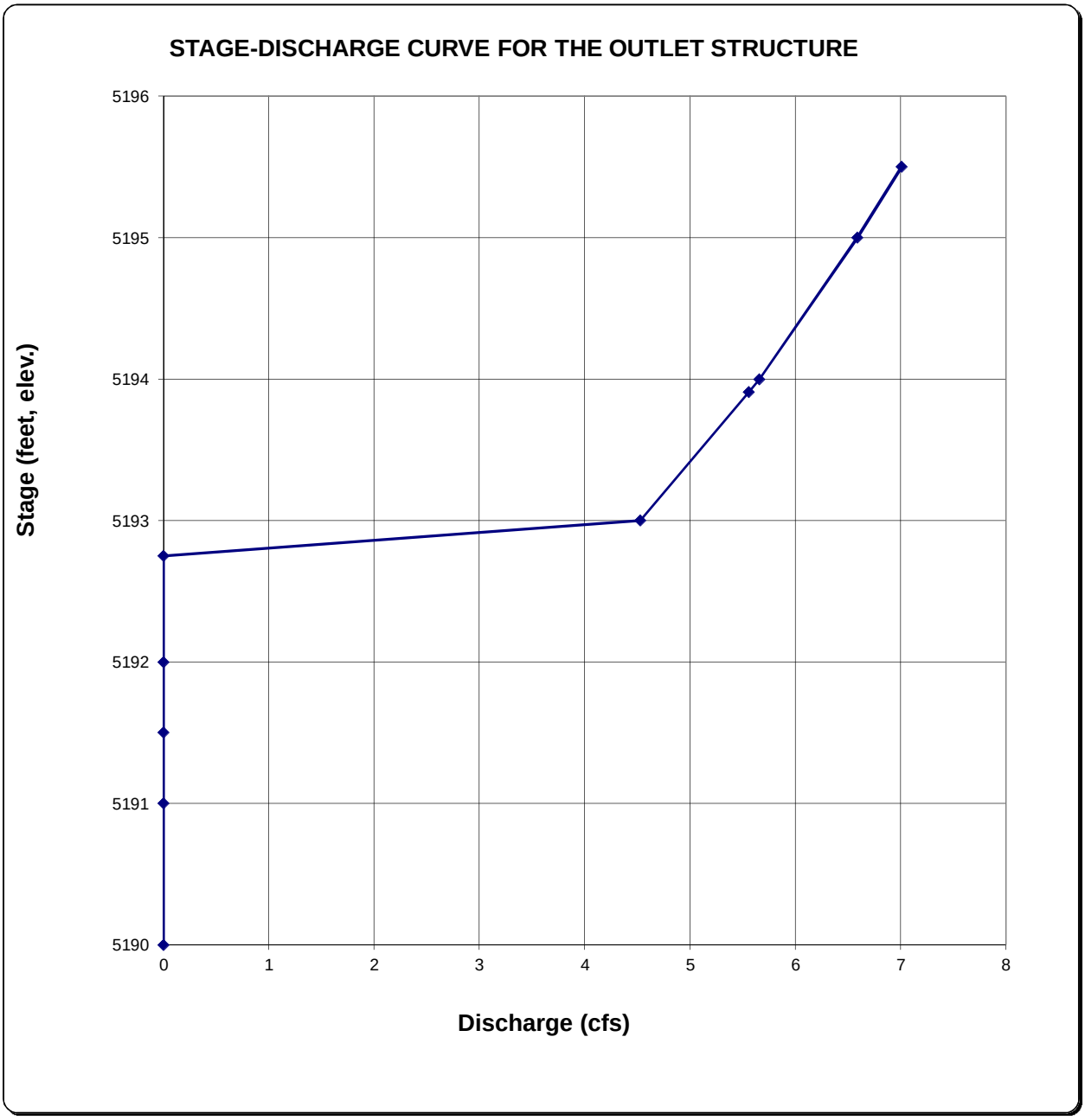
			#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Design Information (Input):							
Circular Opening:	Diameter in Inches	Dia. =					inches
OR							
Rectangular Opening:	Width in Feet	W =	4.00		1.11		ft.
	Length (Height for Vertical)	L or H =	4.00		0.61		ft.
	Percentage of Open Area After Trash Rack Reduction	% open =	90		100		%
	Orifice Coefficient	C_o =	0.50		0.62		
	Weir Coefficient	C_w =	3.40				
	Orifice Elevation (Bottom for Vertical)	E_o =	5192.75		5,190.90		ft.
Calculation of Collection Capacity:							
	Net Opening Area (after Trash Rack Reduction)	A_o =	14.40		0.68		sq. ft.
	OPTIONAL: User-Overide Net Opening Area	A_o =					sq. ft.
	Perimeter as Weir Length	L_w =	15.20		ft.		
	OPTIONAL: User-Overide Weir Length	L_w =			ft.		
	Top Elevation of Vertical Orifice Opening, Top =				5191.51		ft.
	Center Elevation of Vertical Orifice Opening, Cen =				5191.21		ft.

Routing 3: Single Stage - Water flows through WQCV plate and #1 horizontal opening into #1 vertical opening. This flow will be applied to culvert sheet (#2 vertical & horizontal openings is not used).

			Horizontal Orifices				Vertical Orifices			
Labels for WQCV, Minor, & Major Storage W.S. Elevations	Water Surface Elevation ft	WQCV Plate/Riser Flow cfs	#1 Horiz. Weir Flow cfs	#1 Horiz. Orifice Flow cfs	#2 Horiz. Weir Flow cfs	#2 Horiz. Orifice Flow cfs	#1 Vert. Collection Capacity cfs	#2 Vert. Collection Capacity cfs	**Total Collection Capacity cfs**	Target Volumes for WQCV, Minor, & Major Storage Volumes
(input)	(linked)	(User-linked)	(output)	(output)	(output)	(output)	(output)	(output)	**(output)**	(link for goal seek)
	5190.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	
	5191.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	**0.00**	
	5191.50	0.00	0.00	0.00	0.00	0.00	1.82	0.00	**0.00**	
	5192.00	0.00	0.00	0.00	0.00	0.00	3.02	0.00	**0.00**	
	5192.75	0.00	0.00	0.00	0.00	0.00	4.21	0.00	**0.00**	25-yr Storage
MAJOR	5193.00	0.00	6.46	28.89	0.00	0.00	4.53	0.00	**4.53**	
	5193.91	0.00	64.57	62.23	0.00	0.00	5.56	0.00	**5.56**	
	5194.00	0.00	72.22	64.60	0.00	0.00	5.66	0.00	**5.66**	
	5195.00	0.00	174.42	86.67	0.00	0.00	6.59	0.00	**6.59**	
	5195.50	0.00	235.68	95.82	0.00	0.00	7.01	0.00	**7.01**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	

STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: Liquids Handling Hub
Basin ID:

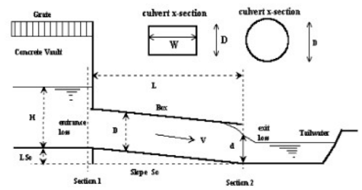


STAGE-DISCHARGE SIZING OF THE OUTLET CULVERT (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Liquids Handling Hub

Basin ID:

Status: Culvert Data is valid!



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches	D =	18	in.
Circular Culvert: Inlet Edge Type (choose from pull-down list)		Square End with Headwall	
OR:			
Box Culvert: Barrel Height (Rise) in Feet	Height (Rise) =		ft.
Box Culvert: Barrel Width (Span) in Feet	Width (Span) =		ft.
Box Culvert: Inlet Edge Type (choose from pull-down list)		1.5 : 1 Bevel w/ 90 Deg. Headwall	
Number of Barrels	No =	1	
Inlet Elevation at Culvert Invert	I_{elev} =	5190.80	ft. elev.
Outlet Elevation at Culvert Invert	O_{elev} =	5190.25	ft. elev.
Culvert Length in Feet	L =	130.0	ft.
Manning's Roughness	n =	0.0130	
Bend Loss Coefficient	K_b =	0.00	
Exit Loss Coefficient	K_x =	1.00	

Design Information (calculated):

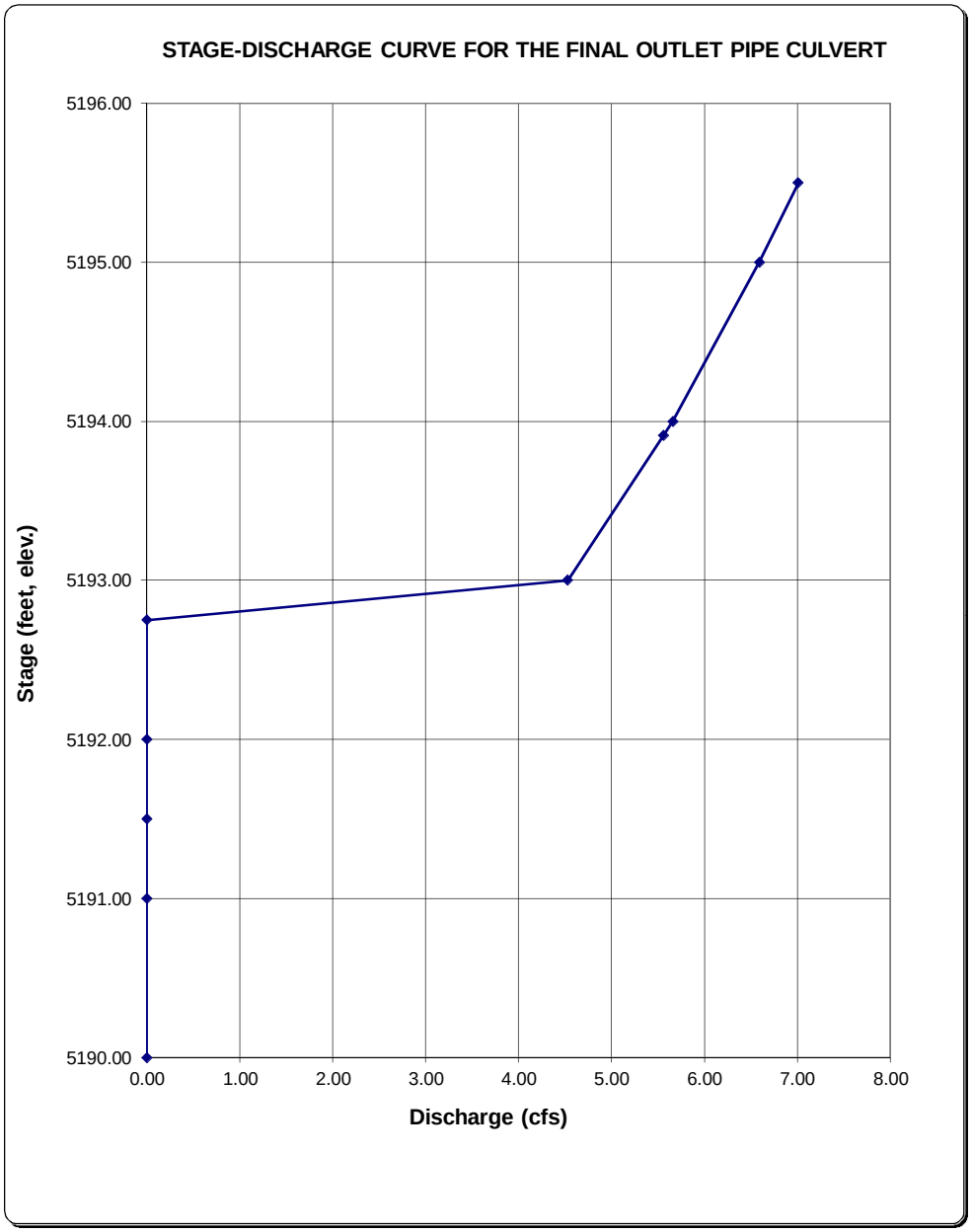
Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	2.36
Sum of All Loss Coefficients	K_s =	3.86
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.01

Calculations of Culvert Capacity (output):

Water Surface Elevation From Sheet "Basin" (ft., linked)	Tailwater Surface Elevation ft (input if known)	Culvert Inlet-Control Flowrate cfs (output)	Culvert Outlet-Control Flowrate cfs (output)	Flowrate Into Culvert From Sheet "Outlet" (cfs, linked)	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used (output)
5190.00	0.00	0.00	0.00	0.00	0.00	No Flow (WS < inlet)
5191.00	0.00	0.20	3.52	0.00	0.00	Min. Energy. Eqn.
5191.50	0.00	3.30	4.34	0.00	0.00	Regression Eqn.
5192.00	0.00	4.50	4.61	0.00	0.00	Regression Eqn.
5192.75	0.00	8.00	6.01	0.00	0.00	Regression Eqn.
5193.00	0.00	9.80	7.21	4.53	4.53	Regression Eqn.
5193.91	0.00	13.00	9.46	5.56	5.56	Regression Eqn.
5194.00	0.00	13.20	9.67	5.66	5.66	Regression Eqn.
5195.00	0.00	15.90	11.62	6.59	6.59	Regression Eqn.
5195.50	0.00	17.10	12.47	7.01	7.01	Orifice Eqn.
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	#N/A	#N/A	No Flow (WS < inlet)

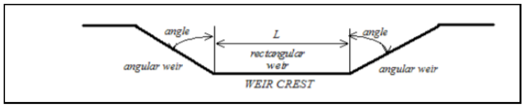
STAGE-DISCHARGE SIZING OF THE OUTLET CULVERT (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Liquids Handling Hub
Basin ID:



STAGE-DISCHARGE SIZING OF THE SPILLWAY

Project: **Liquids Handling Hub**
Basin ID:



Design Information (input):

Bottom Length of Weir	L =	130.00	feet
Angle of Side Slope Weir	Angle =	75.96	degrees
Elev. for Weir Crest	EL. Crest =	5,194.91	feet
Coef. for Rectangular Weir	C_w =	3.00	
Coef. for Trapezoidal Weir	C_t =	2.52	

Calculation of Spillway Capacity (output):

Water Surface Elevation ft. (linked)	Rect. Weir Flowrate cfs (output)	Triangle Weir Flowrate cfs (output)	Total Spillway Release cfs (output)	Total Pond Release cfs (output)
5190.00	0.00	0.00	0.00	0.00
5191.00	0.00	0.00	0.00	0.00
5191.50	0.00	0.00	0.00	0.00
5192.00	0.00	0.00	0.00	0.00
5192.75	0.00	0.00	0.00	0.00
5193.00	0.00	0.00	0.00	4.53
5193.91	0.00	0.00	0.00	5.56
5194.00	0.00	0.00	0.00	5.66
5195.00	10.53	0.02	10.55	17.14
5195.50	176.74	2.69	179.44	186.45
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
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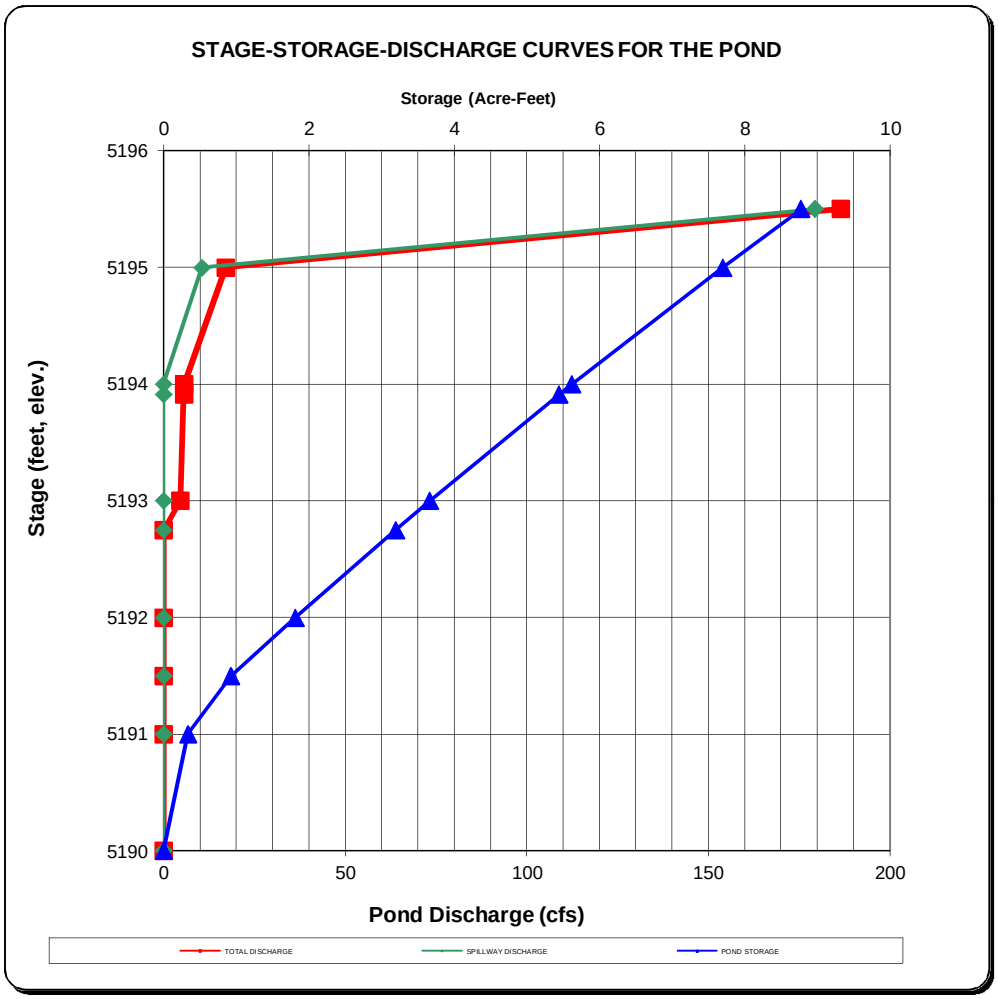
STAGE-DISCHARGE SIZING OF THE SPILLWAY

Project: Liquids Handling Hub
Basin ID:



Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Friday, Sep 20 2013

Ex. 48 inch CMP Culvert

Invert Elev Dn (ft)	= 5187.37
Pipe Length (ft)	= 59.50
Slope (%)	= 2.84
Invert Elev Up (ft)	= 5189.06
Rise (in)	= 90.0
Shape	= Circular
Span (in)	= 90.0
No. Barrels	= 1
n-Value	= 0.022
Culvert Type	= Circular Corrugate Metal Pipe
Culvert Entrance	= Mitered to slope (C)
Coeff. K,M,c,Y,k	= 0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

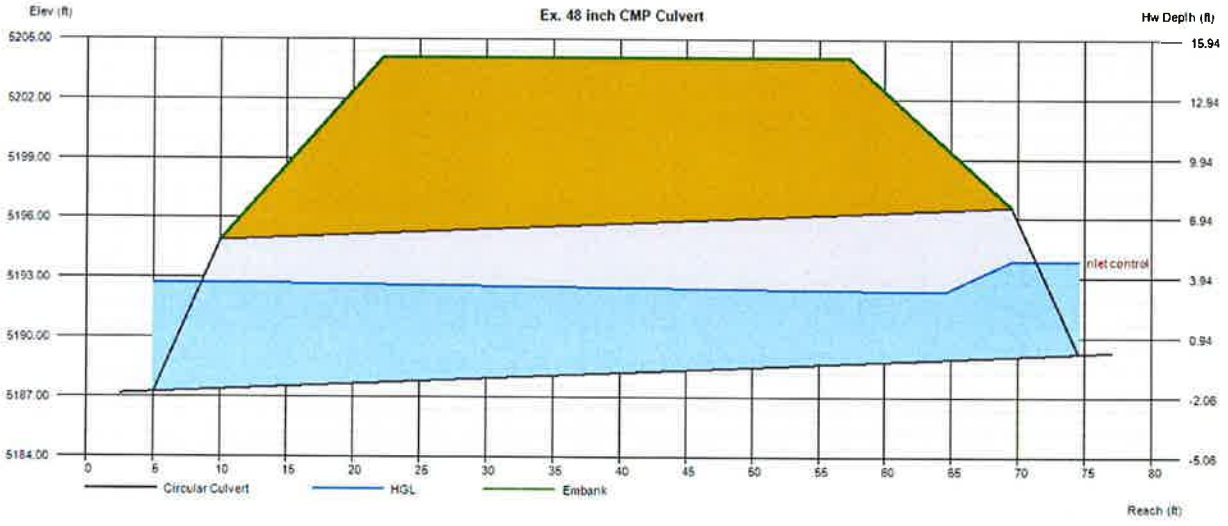
Top Elevation (ft)	= 5204.06
Top Width (ft)	= 35.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 140.00
Qmax (cfs)	= 474.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 160.00
Qpipe (cfs)	= 160.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.74
Veloc Up (ft/s)	= 8.86
HGL Dn (ft)	= 5192.73
HGL Up (ft)	= 5192.27
Hw Elev (ft)	= 5193.87
Hw/D (ft)	= 0.64
Flow Regime	= Inlet Control



Q			Veloc		Depth	
Total	Pipe	Over	Dn	Up	Dn	Up
(cfs)	(cfs)	(cfs)	(ft/s)	(ft/s)	(in)	(in)
140.00	140.00	0.00	4.24	8.43	62.97	36.16
160.00	160.00	0.00	4.74	8.86	64.27	38.53
180.00	180.00	0.00	5.23	9.20	65.48	40.96
200.00	200.00	0.00	5.70	9.52	66.64	43.28
220.00	220.00	0.00	6.17	9.82	67.75	45.50
240.00	240.00	0.00	6.62	10.12	68.81	47.62
260.00	260.00	0.00	7.07	10.40	69.83	49.66
280.00	280.00	0.00	7.51	10.68	70.81	51.62
300.00	300.00	0.00	7.94	10.96	71.75	53.51
320.00	320.00	0.00	8.37	11.23	72.68	55.35
340.00	340.00	0.00	8.80	11.50	73.56	57.12
360.00	360.00	0.00	9.22	11.77	74.41	58.82
380.00	380.00	0.00	9.63	12.04	75.24	60.48
400.00	400.00	0.00	10.05	12.30	76.05	62.09
420.00	420.00	0.00	10.46	12.57	76.83	63.66
440.00	440.00	0.00	10.86	12.84	77.58	65.16
460.00	460.00	0.00	11.27	13.12	78.31	66.62

HGL			
Dn	Up	Hw	Hw/D
(ft)	(ft)	(ft)	
5192.62	5192.07	5193.52	0.59
5192.73	5192.27	5193.87	0.64
5192.83	5192.47	5194.21	0.69
5192.92	5192.67	5194.53	0.73
5193.02	5192.85	5194.85	0.77
5193.10	5193.03	5195.16	0.81
5193.19	5193.20	5195.47	0.85
5193.27	5193.36	5195.77	0.89
5193.35	5193.52	5196.06	0.93
5193.43	5193.67	5196.36	0.97
5193.50	5193.82	5196.65	1.01
5193.57	5193.96	5196.94	1.05
5193.64	5194.10	5197.22	1.09
5193.71	5194.23	5198.63	1.28
5193.77	5194.37	5199.02	1.33
5193.84	5194.49	5199.43	1.38
5193.90	5194.61	5199.85	1.44

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Friday, Sep 20 2013

<Name>

Circular

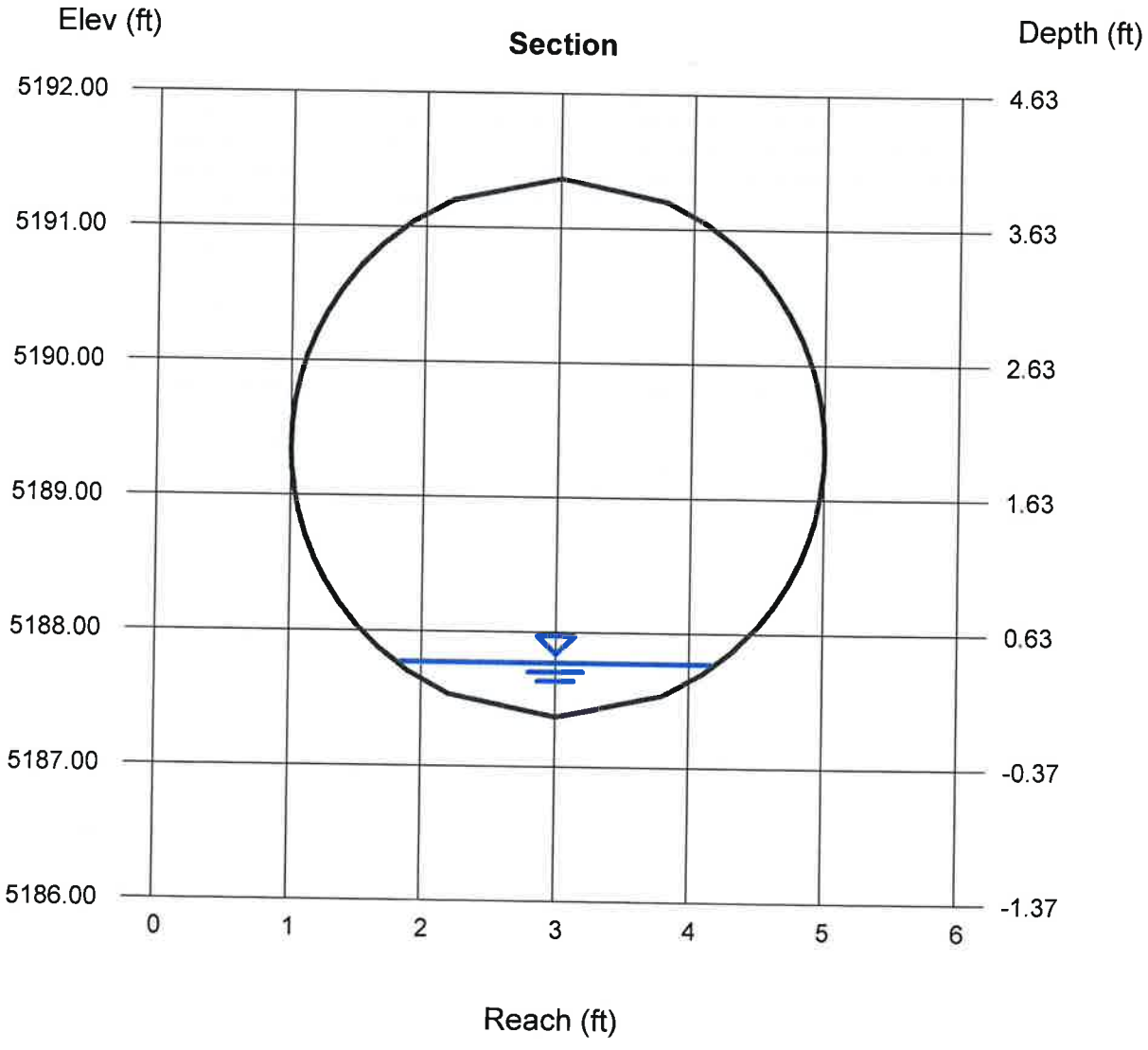
Diameter (ft)	= 4.00
Invert Elev (ft)	= 5187.37
Slope (%)	= 2.84
N-Value	= 0.022

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

Depth (ft)	= 0.40
Q (cfs)	= 3.013
Area (sqft)	= 0.66
Velocity (ft/s)	= 4.58
Wetted Perim (ft)	= 2.58
Crit Depth, Yc (ft)	= 0.50
Top Width (ft)	= 2.40
EGL (ft)	= 0.73



Depth	Q	Area	Veloc	Wp
(ft)	(cfs)	(sqft)	(ft/s)	(ft)
0.40	3.013	0.658	4.58	2.58
0.80	12.66	1.803	7.02	3.72
1.20	28.07	3.176	8.84	4.64
1.60	48.26	4.698	10.27	5.48
2.00	72.03	6.317	11.40	6.30
2.40	96.45	7.894	12.22	7.10
2.80	120.0	9.414	12.75	7.94
3.20	139.9	10.78	12.97	8.86
3.60	152.5	11.92	12.80	10.00
4.00	143.0	12.57	11.38	12.57

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Wednesday, Sep 25 2013

Swale Capacity Analysis: Basin H2

Trapezoidal

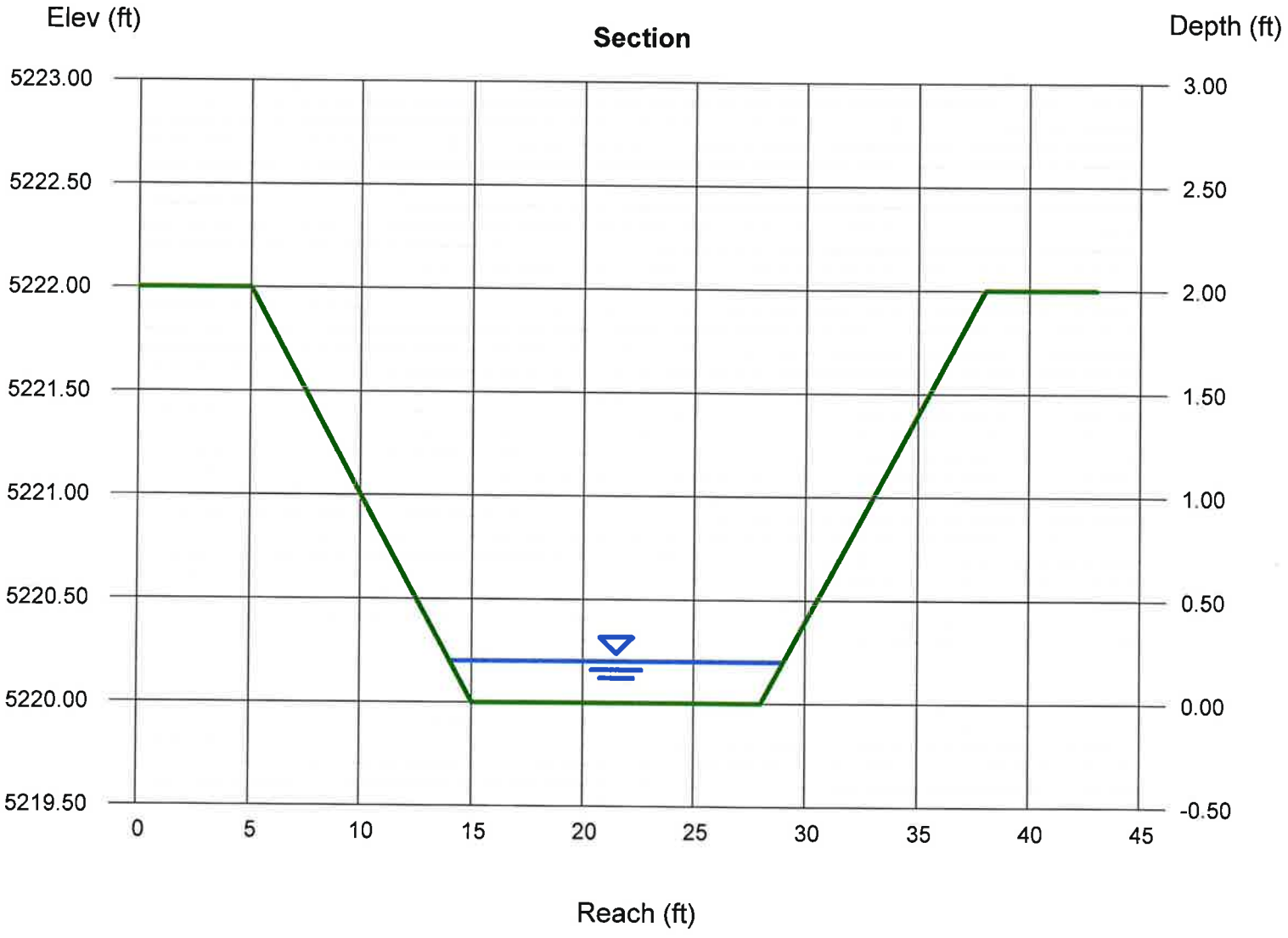
Bottom Width (ft)	= 13.00
Side Slopes (z:1)	= 5.00, 5.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 5220.00
Slope (%)	= 1.50
N-Value	= 0.020

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

Depth (ft)	= 0.20
Q (cfs)	= 8.303
Area (sqft)	= 2.80
Velocity (ft/s)	= 2.97
Wetted Perim (ft)	= 15.04
Crit Depth, Yc (ft)	= 0.23
Top Width (ft)	= 15.00
EGL (ft)	= 0.34



Depth	Q	Area	Veloc	Wp
(ft)	(cfs)	(sqft)	(ft/s)	(ft)
0.20	8.303	2.800	2.97	15.04
0.40	27.17	6.000	4.53	17.08
0.60	55.18	9.600	5.75	19.12
0.80	92.16	13.60	6.78	21.16
1.00	138.3	18.00	7.68	23.20
1.20	193.9	22.80	8.50	25.24
1.40	259.3	28.00	9.26	27.28
1.60	334.9	33.60	9.97	29.32
1.80	421.1	39.60	10.63	31.36
2.00	518.3	46.00	11.27	33.40

Yc	TopWidth	Energy
(ft)	(ft)	(ft)
0.23	15.00	0.34
0.49	17.00	0.72
0.75	19.00	1.11
1.02	21.00	1.51
1.29	23.00	1.92
1.56	25.00	2.32
1.83	27.00	2.73
2.00	29.00	3.14
2.00	31.00	3.56
2.00	33.00	3.97

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Friday, Oct 4 2013

Swale Capacity Analysis: Basin H2 & H3

Trapezoidal

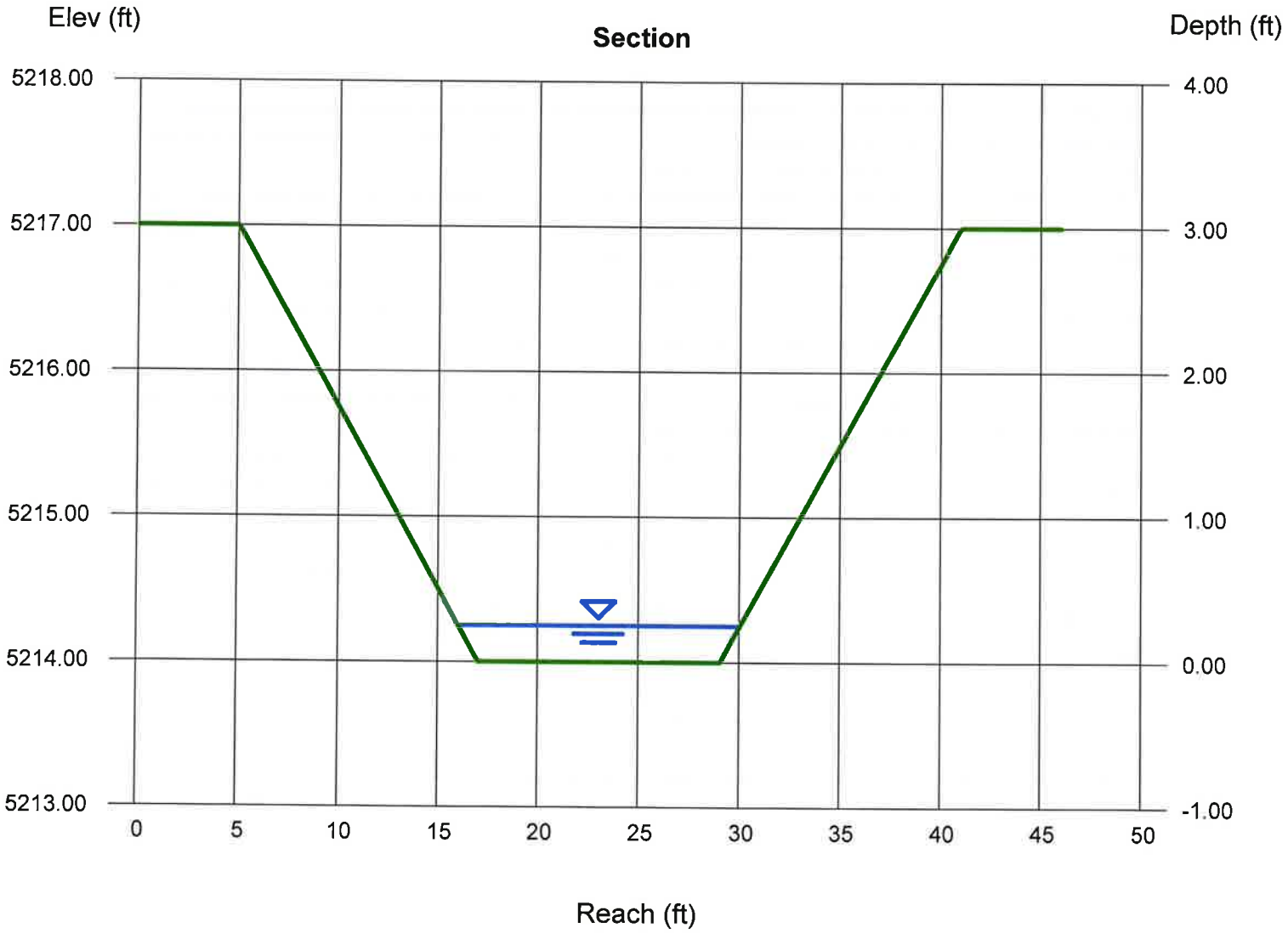
Bottom Width (ft)	= 12.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 5214.00
Slope (%)	= 1.00
N-Value	= 0.020

Calculations

Compute by:	Q vs Depth
No. Increments	= 12

Highlighted

Depth (ft)	= 0.25
Q (cfs)	= 9.090
Area (sqft)	= 3.25
Velocity (ft/s)	= 2.80
Wetted Perim (ft)	= 14.06
Crit Depth, Yc (ft)	= 0.26
Top Width (ft)	= 14.00
EGL (ft)	= 0.37



Depth	Q	Area	Veloc	Wp
(ft)	(cfs)	(sqft)	(ft/s)	(ft)
0.25	9.090	3.250	2.80	14.06
0.50	29.81	7.000	4.26	16.12
0.75	60.68	11.25	5.39	18.18
1.00	101.6	16.00	6.35	20.25
1.25	152.9	21.25	7.19	22.31
1.50	214.8	27.00	7.96	24.37
1.75	287.9	33.25	8.66	26.43
2.00	372.7	40.00	9.32	28.49
2.25	469.5	47.25	9.94	30.55
2.50	579.1	55.00	10.53	32.62
2.75	701.7	63.25	11.09	34.68
3.00	838.0	72.00	11.64	36.74

Yc	TopWidth	Energy
(ft)	(ft)	(ft)
0.26	14.00	0.37
0.55	16.00	0.78
0.84	18.00	1.20
1.15	20.00	1.63
1.45	22.00	2.05
1.76	24.00	2.48
2.07	26.00	2.92
2.38	28.00	3.35
2.70	30.00	3.79
3.00	32.00	4.22
3.00	34.00	4.66
3.00	36.00	5.11

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Monday, Oct 14 2013

SECTION A-A (Basin H2 & H3)

Trapezoidal

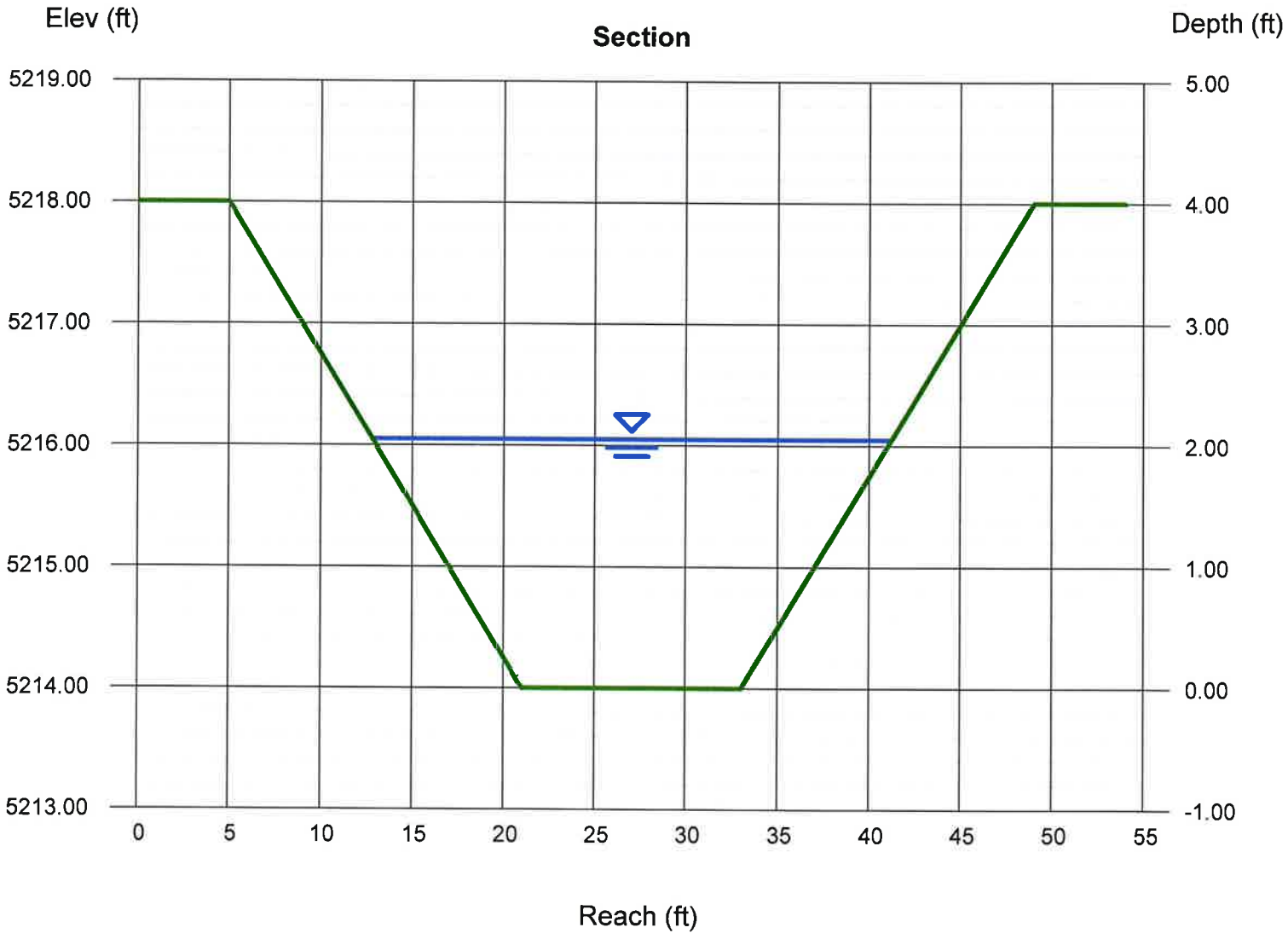
Bottom Width (ft)	= 12.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 5214.00
Slope (%)	= 1.00
N-Value	= 0.020

Calculations

Compute by:	Known Q
Known Q (cfs)	= 390.00

Highlighted

Depth (ft)	= 2.05
Q (cfs)	= 390.00
Area (sqft)	= 41.41
Velocity (ft/s)	= 9.42
Wetted Perim (ft)	= 28.90
Crit Depth, Yc (ft)	= 2.44
Top Width (ft)	= 28.40
EGL (ft)	= 3.43



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Wednesday, Mar 19 2014

SECTION B-B (Basin B1 & A3)

Trapezoidal

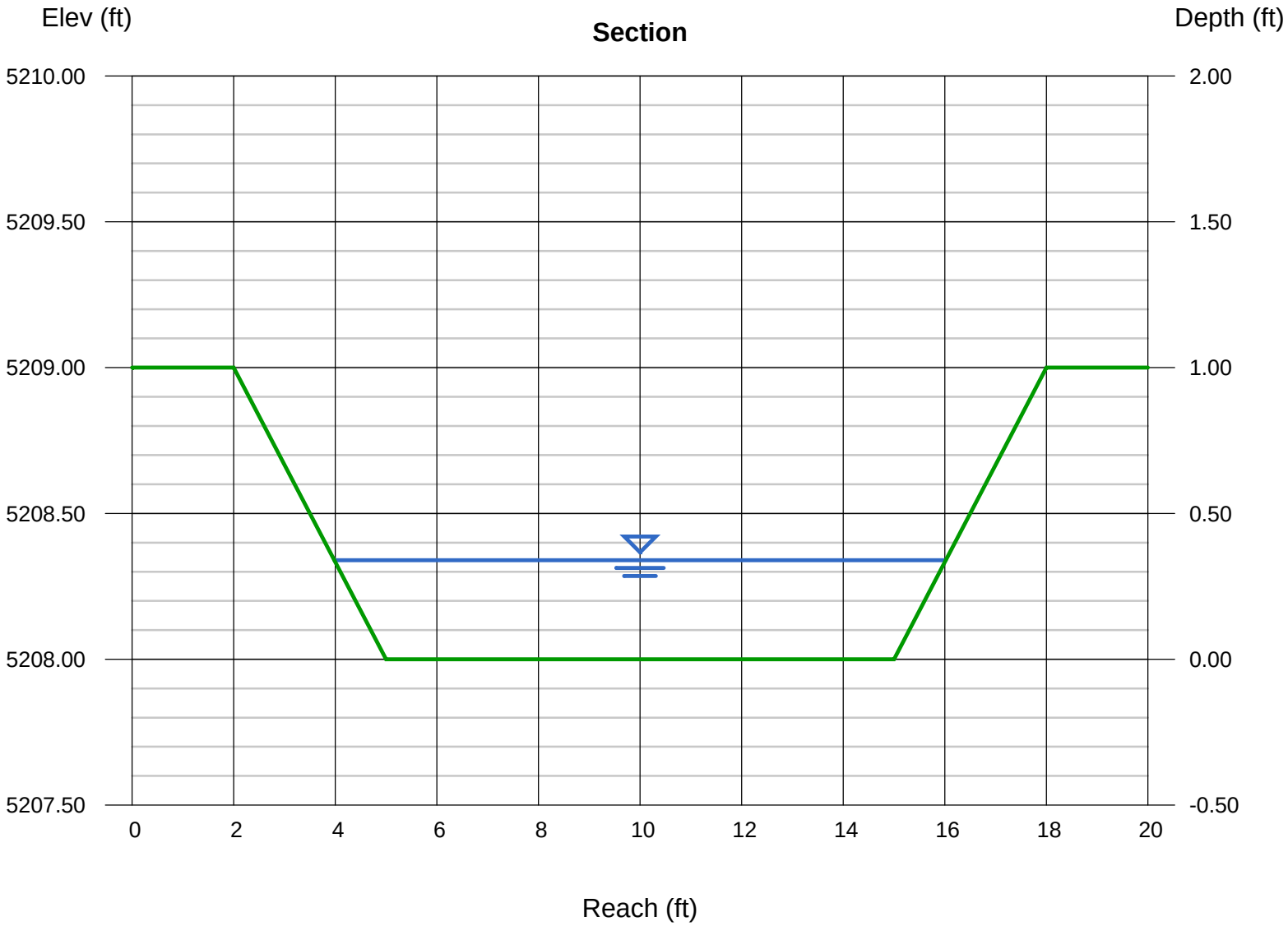
Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 1.00
Invert Elev (ft)	= 5208.00
Slope (%)	= 1.40
N-Value	= 0.020

Calculations

Compute by:	Known Q
Known Q (cfs)	= 14.70

Highlighted

Depth (ft)	= 0.34
Q (cfs)	= 14.70
Area (sqft)	= 3.75
Velocity (ft/s)	= 3.92
Wetted Perim (ft)	= 12.15
Crit Depth, Yc (ft)	= 0.40
Top Width (ft)	= 12.04
EGL (ft)	= 0.58



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Wednesday, Mar 19 2014

SECTION D-D (Basin B1,A3,A4a)

Trapezoidal

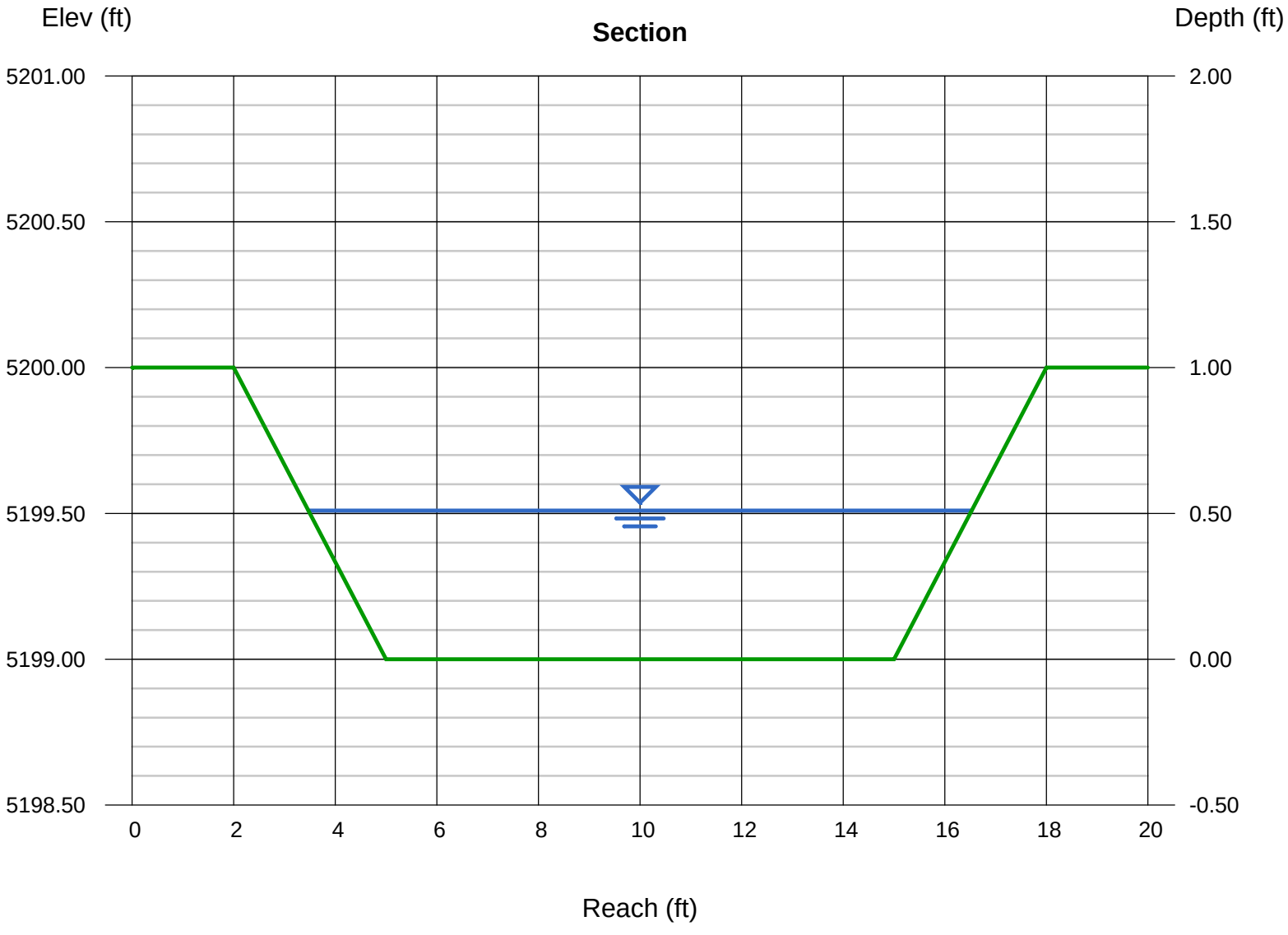
Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 1.00
Invert Elev (ft)	= 5199.00
Slope (%)	= 1.54
N-Value	= 0.020

Calculations

Compute by:	Known Q
Known Q (cfs)	= 30.60

Highlighted

Depth (ft)	= 0.51
Q (cfs)	= 30.60
Area (sqft)	= 5.88
Velocity (ft/s)	= 5.20
Wetted Perim (ft)	= 13.23
Crit Depth, Yc (ft)	= 0.63
Top Width (ft)	= 13.06
EGL (ft)	= 0.93



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Wednesday, Mar 19 2014

SECTION E-E (Basin A-4b)

Trapezoidal

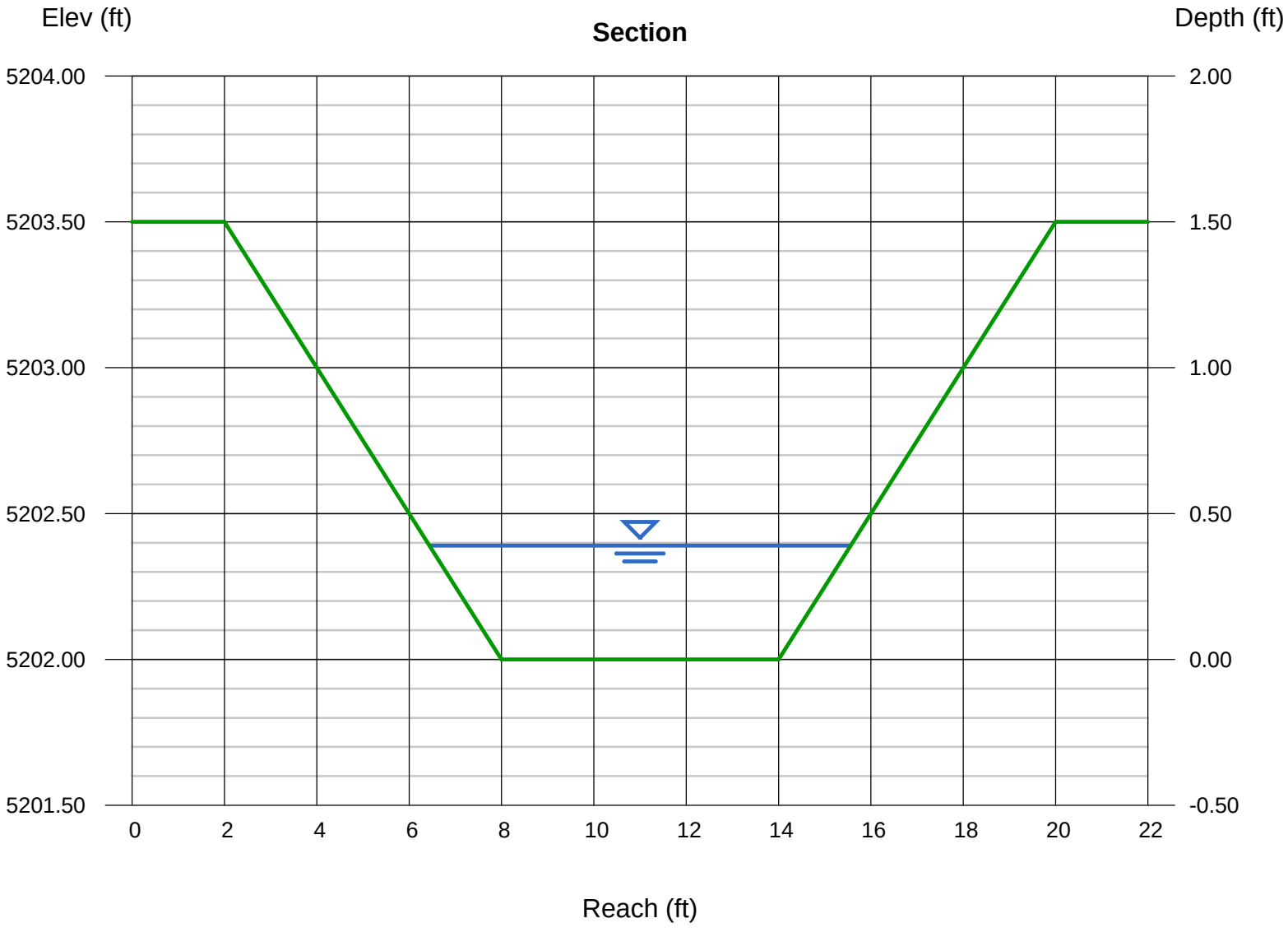
Bottom Width (ft)	= 6.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 5202.00
Slope (%)	= 1.30
N-Value	= 0.020

Calculations

Compute by:	Known Q
Known Q (cfs)	= 11.50

Highlighted

Depth (ft)	= 0.39
Q (cfs)	= 11.50
Area (sqft)	= 2.95
Velocity (ft/s)	= 3.90
Wetted Perim (ft)	= 9.22
Crit Depth, Yc (ft)	= 0.44
Top Width (ft)	= 9.12
EGL (ft)	= 0.63



Culvert Report

DP8 - CULVERT 1

Invert Elev Dn (ft)	=	5208.52
Pipe Length (ft)	=	37.80
Slope (%)	=	0.40
Invert Elev Up (ft)	=	5208.67
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
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

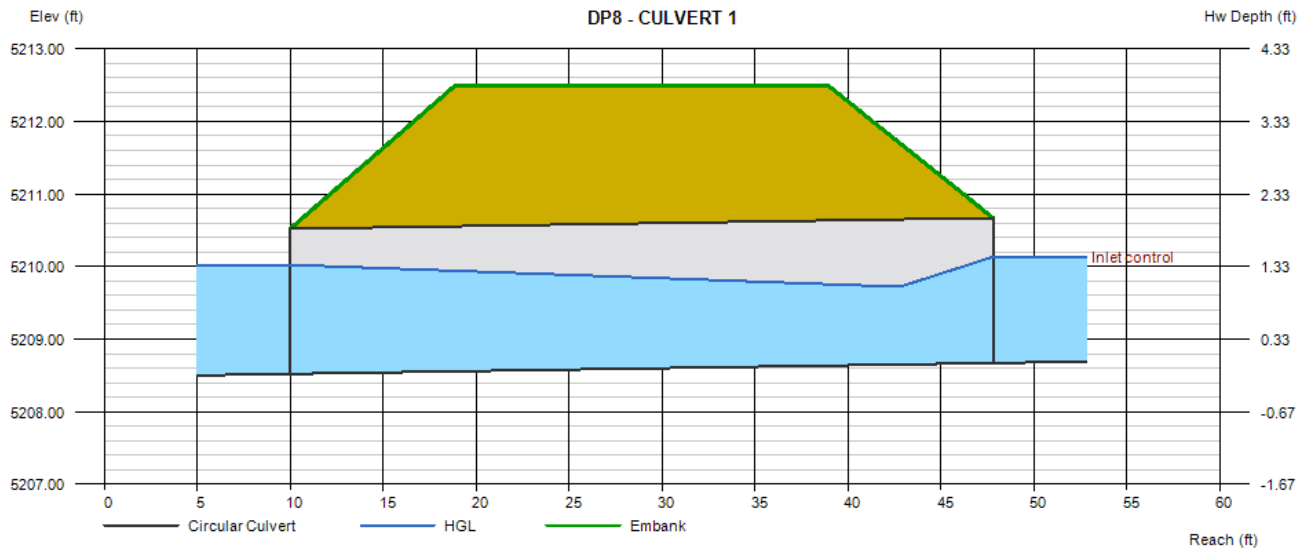
Top Elevation (ft)	=	5212.50
Top Width (ft)	=	20.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	8.00
Qmax (cfs)	=	14.70
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	8.00
Qpipe (cfs)	=	8.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.16
Veloc Up (ft/s)	=	5.06
HGL Dn (ft)	=	5210.02
HGL Up (ft)	=	5209.68
Hw Elev (ft)	=	5210.13
Hw/D (ft)	=	0.73
Flow Regime	=	Inlet Control



Culvert Report

DP2 - CULVERT 2

Invert Elev Dn (ft)	=	5210.75
Pipe Length (ft)	=	44.80
Slope (%)	=	0.51
Invert Elev Up (ft)	=	5210.98
Rise (in)	=	15.0
Shape	=	Circular
Span (in)	=	15.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0018, 2, 0.0292, 0.74, 0.2

Embankment

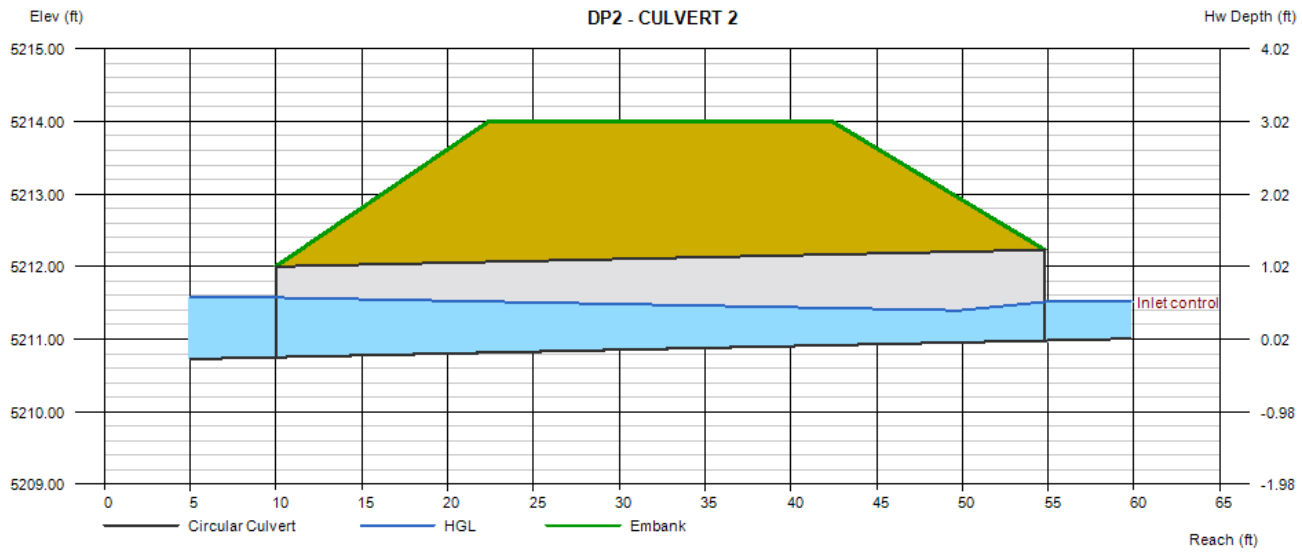
Top Elevation (ft)	=	5214.00
Top Width (ft)	=	20.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	1.00
Qmax (cfs)	=	6.40
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1.00
Qpipe (cfs)	=	1.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	1.17
Veloc Up (ft/s)	=	3.03
HGL Dn (ft)	=	5211.57
HGL Up (ft)	=	5211.37
Hw Elev (ft)	=	5211.51
Hw/D (ft)	=	0.43
Flow Regime	=	Inlet Control



Culvert Report

DP3 - CULVERT 3

Invert Elev Dn (ft)	=	5201.27
Pipe Length (ft)	=	57.60
Slope (%)	=	0.40
Invert Elev Up (ft)	=	5201.50
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0018, 2, 0.0292, 0.74, 0.2

Embankment

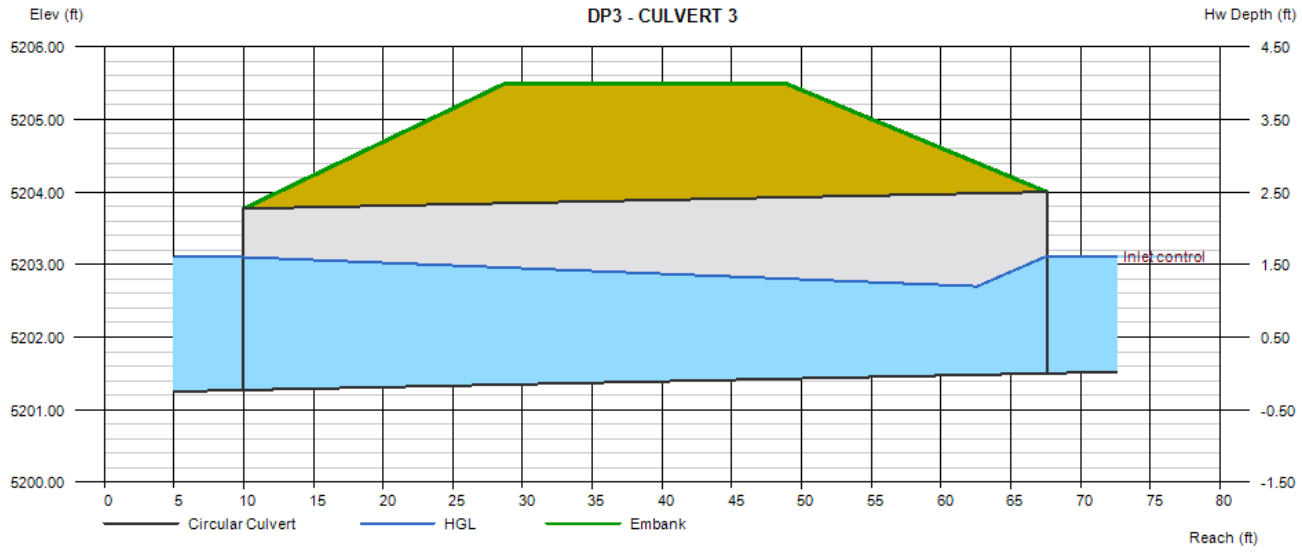
Top Elevation (ft)	=	5205.50
Top Width (ft)	=	20.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	12.00
Qmax (cfs)	=	26.60
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	12.00
Qpipe (cfs)	=	12.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.12
Veloc Up (ft/s)	=	5.38
HGL Dn (ft)	=	5203.10
HGL Up (ft)	=	5202.66
Hw Elev (ft)	=	5203.12
Hw/D (ft)	=	0.65
Flow Regime	=	Inlet Control



Culvert Report

DP4 - CULVERT 4

Invert Elev Dn (ft)	=	5196.67
Pipe Length (ft)	=	45.40
Slope (%)	=	0.51
Invert Elev Up (ft)	=	5196.90
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0018, 2, 0.0292, 0.74, 0.2

Embankment

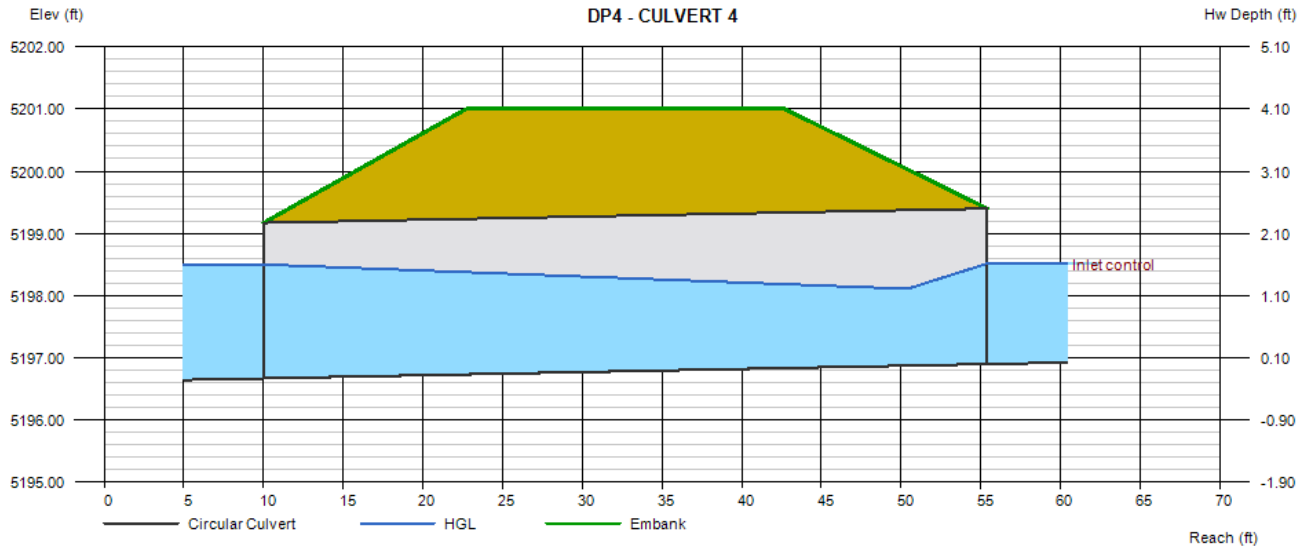
Top Elevation (ft)	=	5201.00
Top Width (ft)	=	20.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	12.00
Qmax (cfs)	=	26.50
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	12.00
Qpipe (cfs)	=	12.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.12
Veloc Up (ft/s)	=	5.38
HGL Dn (ft)	=	5198.50
HGL Up (ft)	=	5198.06
Hw Elev (ft)	=	5198.52
Hw/D (ft)	=	0.65
Flow Regime	=	Inlet Control



Culvert Report

DP5 - CULVERT 5

Invert Elev Dn (ft)	=	5194.00
Pipe Length (ft)	=	78.50
Slope (%)	=	1.03
Invert Elev Up (ft)	=	5194.81
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0018, 2, 0.0292, 0.74, 0.2

Embankment

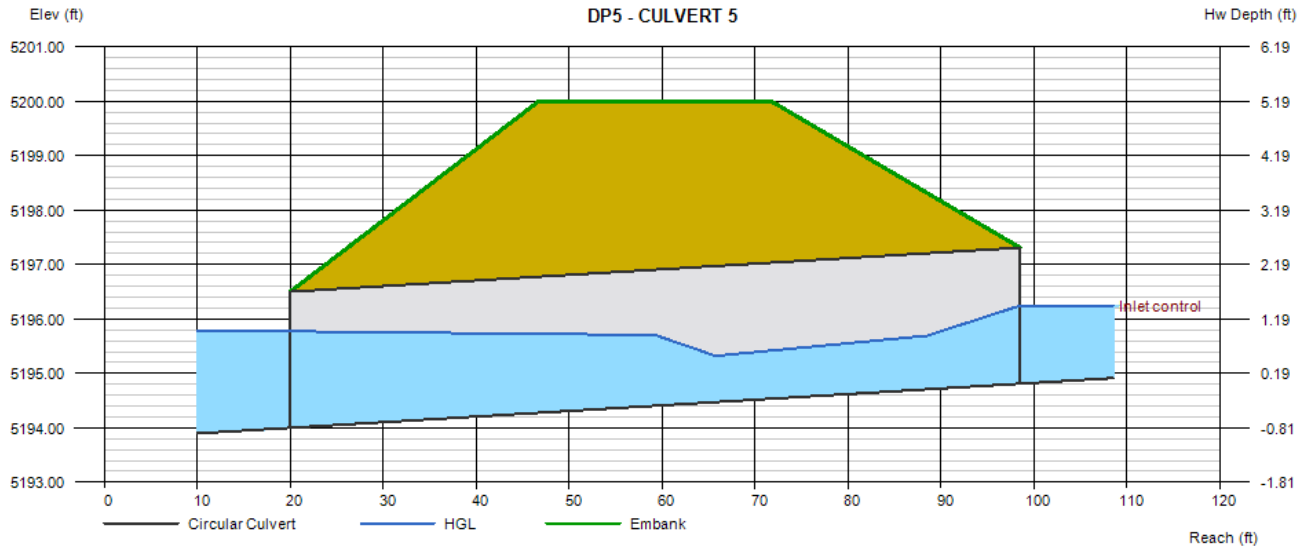
Top Elevation (ft)	=	5200.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	9.80
Qmax (cfs)	=	30.60
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	9.80
Qpipe (cfs)	=	9.80
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	2.63
Veloc Up (ft/s)	=	5.05
HGL Dn (ft)	=	5195.77
HGL Up (ft)	=	5195.85
Hw Elev (ft)	=	5196.24
Hw/D (ft)	=	0.57
Flow Regime	=	Inlet Control



Culvert Report

DP12 - CULVERT 7

Invert Elev Dn (ft)	=	5214.60
Pipe Length (ft)	=	46.30
Slope (%)	=	0.54
Invert Elev Up (ft)	=	5214.85
Rise (in)	=	15.0
Shape	=	Circular
Span (in)	=	15.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0018, 2, 0.0292, 0.74, 0.2

Embankment

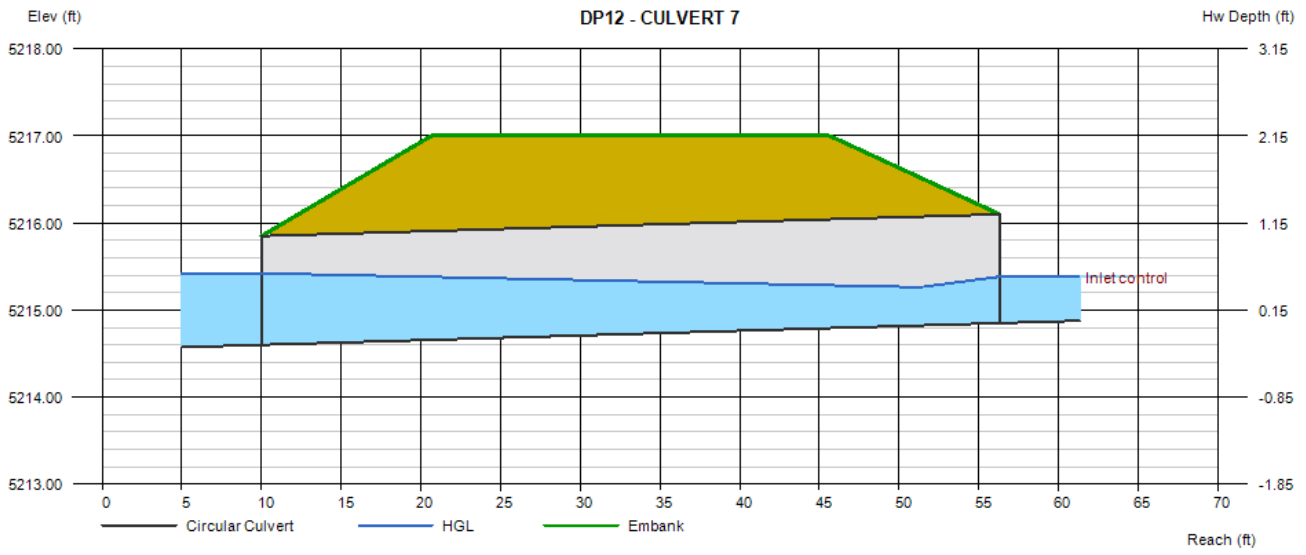
Top Elevation (ft)	=	5217.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	1.00
Qmax (cfs)	=	2.10
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1.00
Qpipe (cfs)	=	1.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	1.17
Veloc Up (ft/s)	=	3.03
HGL Dn (ft)	=	5215.42
HGL Up (ft)	=	5215.24
Hw Elev (ft)	=	5215.38
Hw/D (ft)	=	0.43
Flow Regime	=	Inlet Control



Culvert Report

DP13 - CULVERT 8

Invert Elev Dn (ft)	=	5201.41
Pipe Length (ft)	=	60.70
Slope (%)	=	0.51
Invert Elev Up (ft)	=	5201.72
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0018, 2, 0.0292, 0.74, 0.2

Embankment

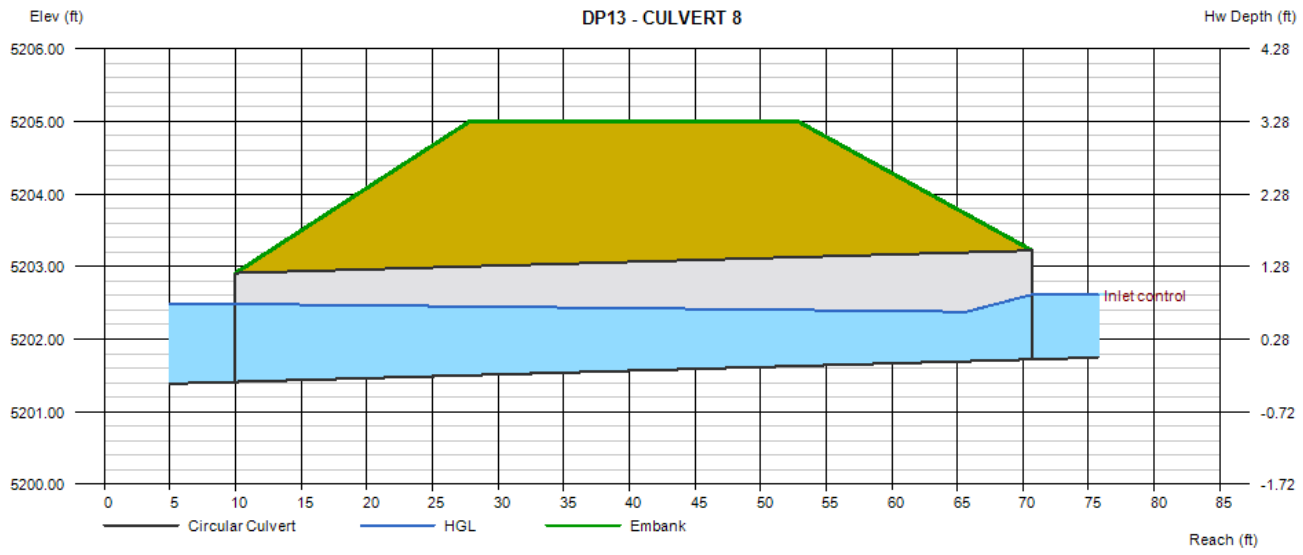
Top Elevation (ft)	=	5205.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	2.90
Qmax (cfs)	=	6.70
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	2.90
Qpipe (cfs)	=	2.90
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	2.14
Veloc Up (ft/s)	=	3.98
HGL Dn (ft)	=	5202.48
HGL Up (ft)	=	5202.37
Hw Elev (ft)	=	5202.61
Hw/D (ft)	=	0.60
Flow Regime	=	Inlet Control



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Friday, Sep 20 2013

Emergency Overflow

Rectangular

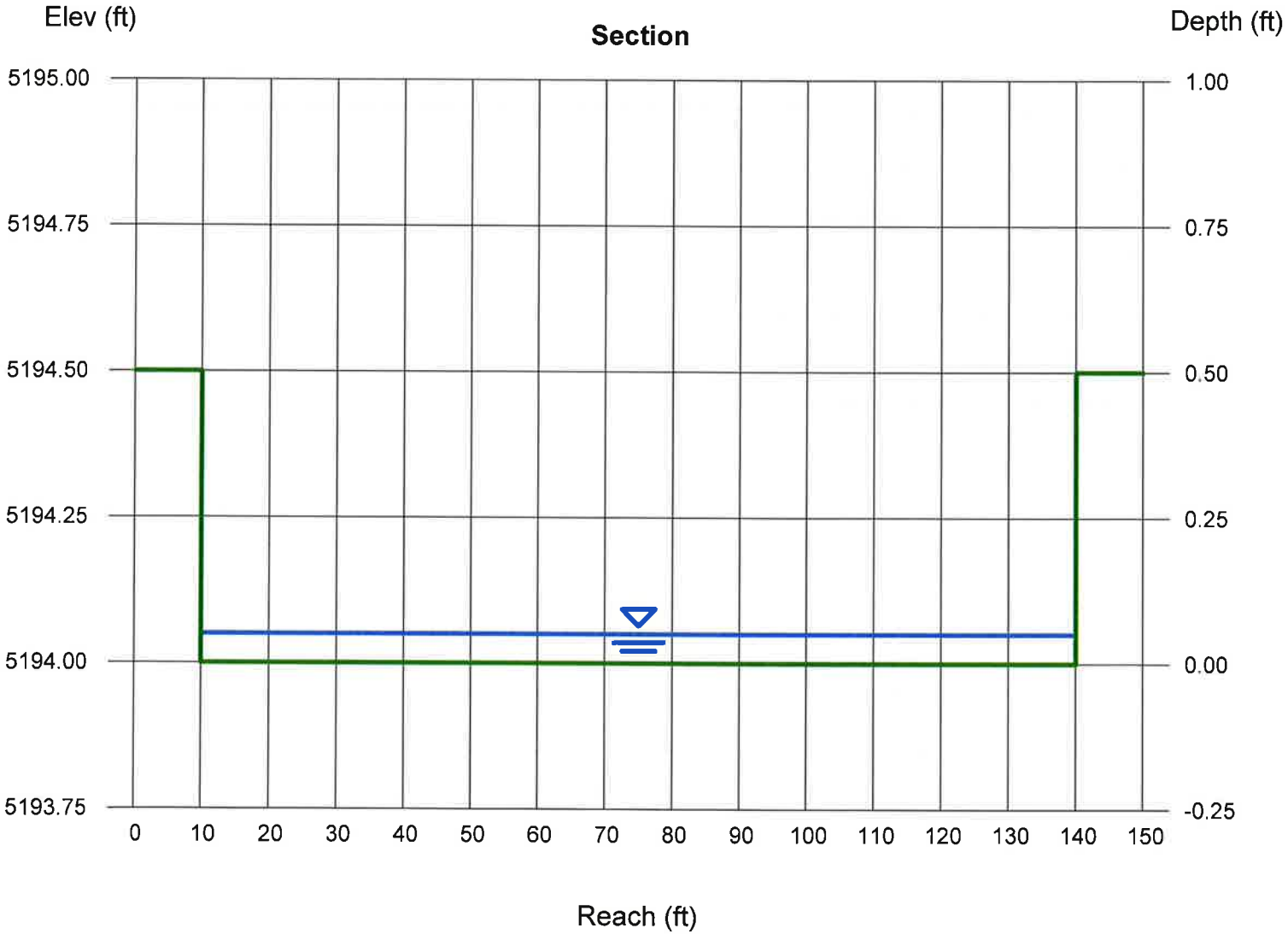
Bottom Width (ft)	= 130.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 5194.00
Slope (%)	= 0.50
N-Value	= 0.025

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

Depth (ft)	= 0.05
Q (cfs)	= 3.702
Area (sqft)	= 6.50
Velocity (ft/s)	= 0.57
Wetted Perim (ft)	= 130.10
Crit Depth, Yc (ft)	= 0.03
Top Width (ft)	= 130.00
EGL (ft)	= 0.06



Depth	Q	Area	Veloc	Wp
(ft)	(cfs)	(sqft)	(ft/s)	(ft)
0.05	3.702	6.500	0.57	130.10
0.10	11.75	13.00	0.90	130.20
0.15	23.09	19.50	1.18	130.30
0.20	37.28	26.00	1.43	130.40
0.25	54.05	32.50	1.66	130.50
0.30	73.20	39.00	1.88	130.60
0.35	94.60	45.50	2.08	130.70
0.40	118.1	52.00	2.27	130.80
0.45	143.7	58.50	2.46	130.90
0.50	171.2	65.00	2.63	131.00

Yc	TopWidth	Energy
(ft)	(ft)	(ft)
0.03	130.00	0.06
0.07	130.00	0.11
0.10	130.00	0.17
0.14	130.00	0.23
0.18	130.00	0.29
0.22	130.00	0.35
0.26	130.00	0.42
0.30	130.00	0.48
0.34	130.00	0.54
0.38	130.00	0.61

PROJECT NAME: Liquids Handling Hub
PROJECT NUMBER: PL226
CALCULATED BY: SMB
CHECKED BY: NJN

DATE: 3/19/14

RIPRAP SIZING CALCULATIONS

Culvert	*d (ft) [VELOCITY]*	*W (ft)*	*V (ft/s) [VELOCITY]*	*d (ft) [DEPTH]*	*Pd [Design Perameter]*	*Rock Size [Figure HS-20]*	*D_{50} (inches) [Figure HS-9]*	*T (feet) [THICKNESS]*	*L (feet) [LENGTH]*	*W (feet) [WIDTH]*	*AREA REQUIRED (SY)*	*AREA PROVIDED (SY)*
Culvert 1	2	8	5.07	0.98	7.6	Type L	9	1.5	8	8	7.1	11
Culvert 2	1.25	5	3.03	0.51	5.1	Type L	9	1.5	5	5	2.8	4
Culvert 3	2.5	10	5.38	1.14	8.1	Type L	9	1.5	10	10	11.1	17
Culvert 4	2.5	10	5.35	1.14	5.7	Type L	9	1.5	10	10	11.1	17
Culvert 5	1.25	5	5.05	0.11	5.4	Type L	9	1.5	5	5	2.8	4
Culvert 6	6	24	9.06	2.41	12.6	Type M	12	2.0	24	24	64.0	128
Culvert 7	1.5	6	3.03	0.58	5.3	Type L	9	1.5	6	6	4.0	6
Culvert 8	1.5	6	3.98	0.98	6.9	Type L	9	1.5	6	6	4.0	6

Note: 1. Equations per UDFCD Criteria Manual Section 3.4.3.2

$$P_d = (V^2 + gd)^{1/2} \qquad W = 4d$$

$$L = 4d \qquad T = 2 \times D_{50}$$

Riprap Type	*D_{50} (Median Rock Size- inches)*
L	9
M	12
H	18
B18	18 (min. dimension of grouted boulders)

Table HS-9: Median (D50) Size of District's Riprap/Boulder

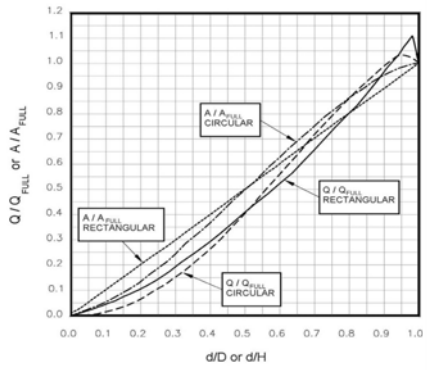


Figure HS-20a—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Discharge and Flow Area Relationships for Circular and Rectangular Pipes (Ratios for Flow Based on Manning's n Varying With Depth)
(Stevens and Urbonas 1996)

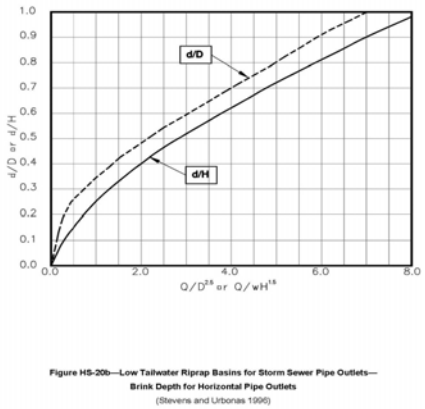


Figure HS-20b—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Brink Depth for Horizontal Pipe Outlets
(Stevens and Urbonas 1996)

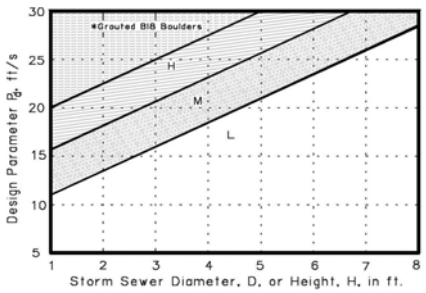
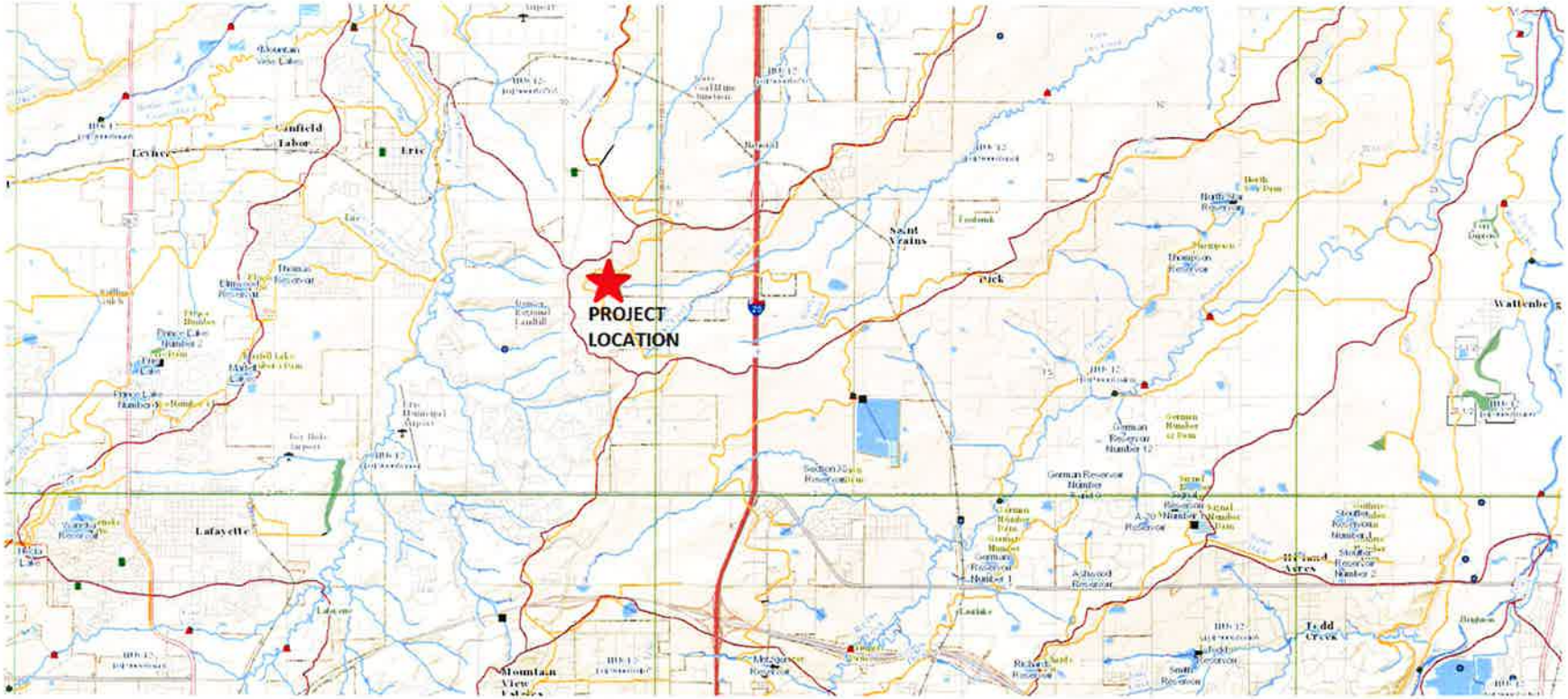


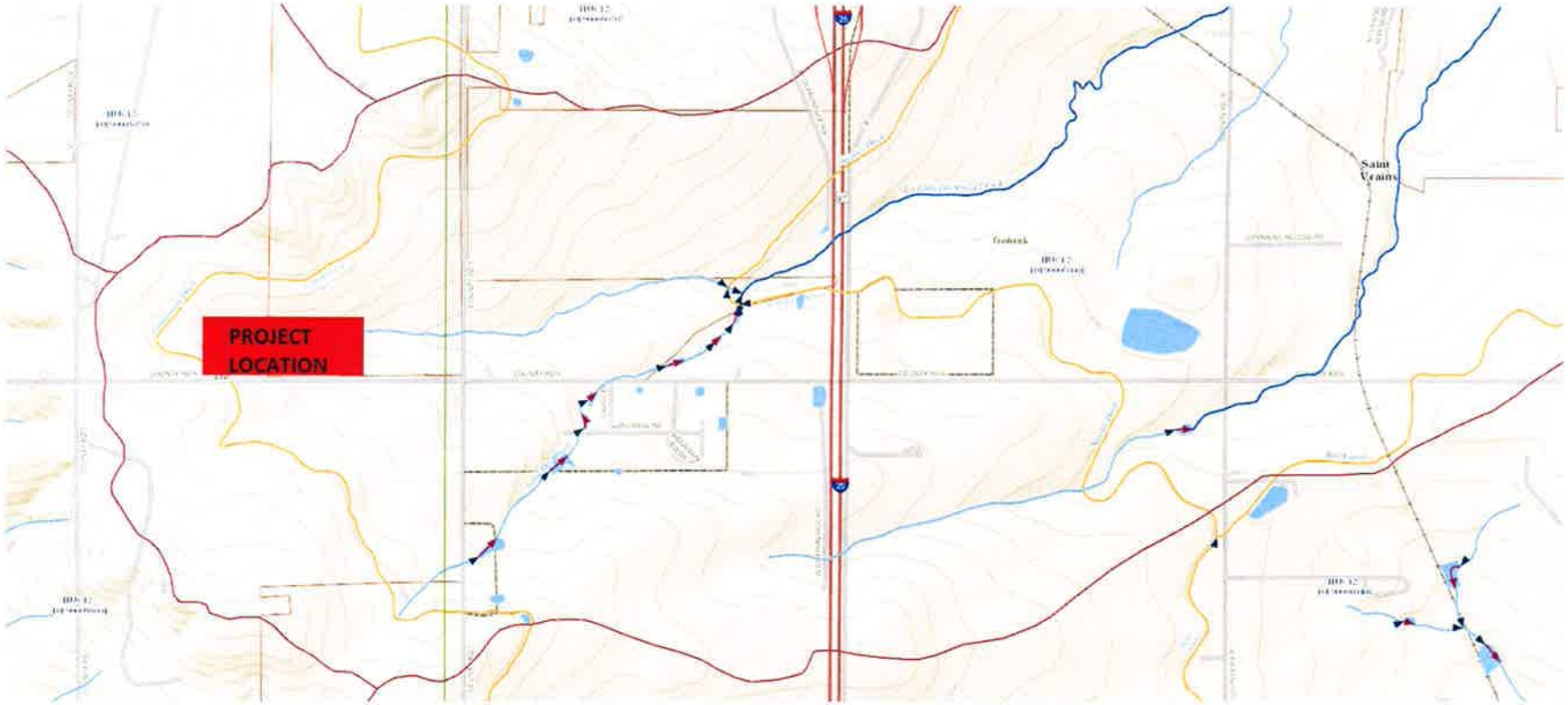
Figure HS-20c—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Riprap Selection Chart for Low Tailwater Basin at Pipe Outlet
(Stevens and Urbonas 1996)

G. HISTORIC DRAINAGE PLAN

Major Drainage Basin Map 1- USGS National Map Viewer, August 2013



Major Drainage Basin Map 2- USGS National Map Viewer, August 2013

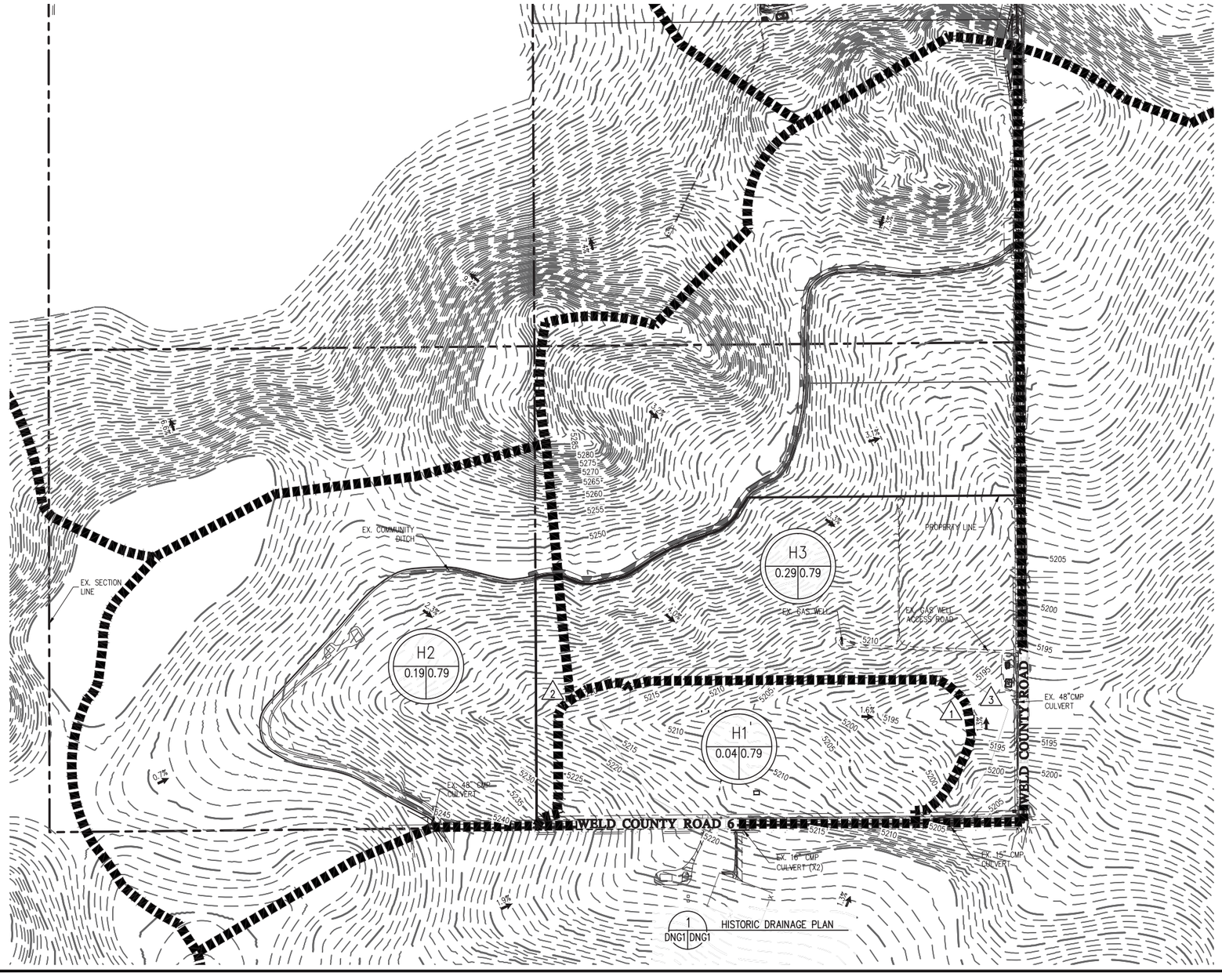


DRAINAGE PLANS
FOR

ENCANA OIL & GAS (USA) INC.

LIQUIDS HANDLING HUB

A PARCEL OF LAND LOCATED IN THE EAST HALF OF SECTION 21,
TOWNSHIP 1 NORTH, RANGE 68 WEST OF THE 6TH P.M.
WELD COUNTY, COLORADO
SHEET 1 OF 2



LEGEND

- EXISTING DRAINAGE BASIN
- 5220 EXISTING CONTOUR
- PROPERTY LINE
- EXISTING EASEMENT
- EXISTING RIGHT OF WAY
- PAVED FLOW DIRECTION & SLOPE
- SWALE FLOW DIRECTION & SLOPE
- DESIGN POINT
- A — HISTORIC SUBBASIN
- 1.01 — HISTORIC SUBBASIN AREA (SQ. MILES)
- 0.79 — SCS CURVE NUMBER

HISTORIC RUNOFF SUMMARY
(HEC-HMS)

DESIGN POINT	DESIGN BASIN	AREA (sq. miles)	5-YR RUNOFF C_5	5-YR RUNOFF Q_5 (cfs)	10-YR RUNOFF C_{10}	10-YR RUNOFF Q_{10} (cfs)	100-YR RUNOFF C_{100}	100-YR RUNOFF Q_{100} (cfs)
1	H1	0.04	0.15	4.2	0.25	7.7	0.50	26.9
2	H2	0.19	0.15	25.1	0.25	46.0	0.50	152.6
3	H3	0.29	0.15	36.9	0.25	67.8	0.50	228.3

NOTES

1. FLOWS WERE OBTAINED USING HEC-HMS, REFER TO DRAINAGE REPORT FOR DETAIL CALCULATIONS.

N

GRAPHIC SCALE
300 0 300 600
(IN FEET)
1 INCH = 300 FT

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DESIGNED BY LTV
DRAWN BY LTV
CHECKED BY NJM

PREPARED BY LTV
DATE 03-14-2014

REVISION DESCRIPTION
PER ENCANA REVIEW

ENCANA OIL & GAS (USA) INC.
LIQUIDS HANDLING HUB
PART OF SE 1/4 SECTION 21, T1N, R68W
HISTORIC DRAINAGE PLAN
WELD COUNTY COLORADO

PREPARED UNDER THE DIRECT SUPERVISION OF

FOR AND ON BEHALF OF BASELINE CORPORATION

INITIAL SUBMITTAL	8/9/2013
DRAWING SIZE	24" X 36"
SURVEY FIRM BASELINE	SURVEY DATE 7/23/2013
JOB NO.	PL 226
DRAWING NAME	226 BEC DNG Plan.dwg
SHEET # OF	2

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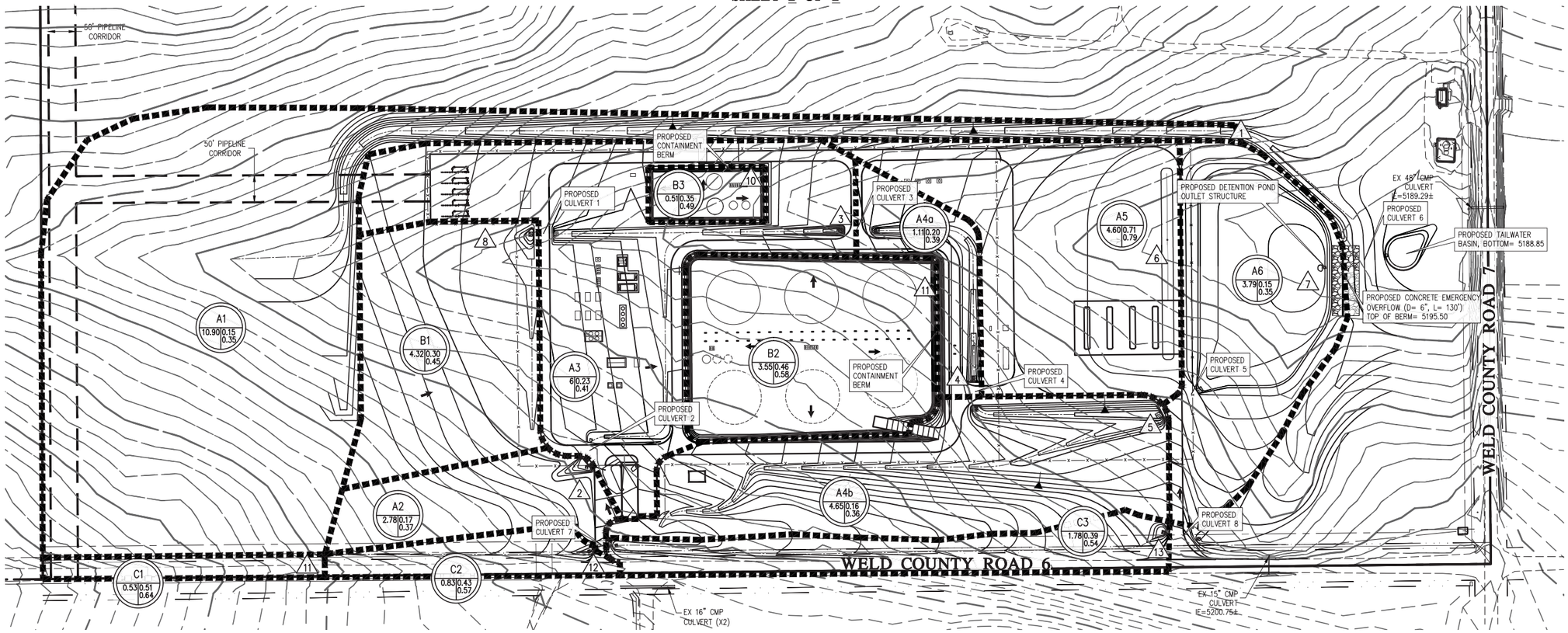
H. PROPOSED DRAINAGE PLAN

DRAINAGE PLANS
FOR
ENCANA OIL & GAS (USA) INC.
LIQUIDS HANDLING HUB
A PARCEL OF LAND LOCATED IN THE EAST HALF OF SECTION 21,
TOWNSHIP 1 NORTH, RANGE 68 WEST OF THE 6TH P.M.
WELD COUNTY, COLORADO
SHEET 2 OF 2



1 PROPOSED DRAINAGE PLAN
DNG2 DNG2

DEVELOPED RUNOFF SUMMARY
(RATIONAL METHOD)

DESIGN POINT	DESIGN BASIN	AREA (acres)	5-YR RUNOFF C_5	5-YR RUNOFF Q_5 (cfs)	10-YR RUNOFF C_{10}	10-YR RUNOFF Q_{10} (cfs)	100-YR RUNOFF C_{100}	100-YR RUNOFF Q_{100} (cfs)
1	A1	10.90	0.08	2.7	0.15	6.2	0.35	24.9
2	A2	2.78	0.11	0.9	0.17	1.8	0.37	6.4
3	A3	6.00	0.16	2.8	0.23	4.8	0.41	14.7
4	A4a	1.11	0.13	0.5	0.20	0.9	0.39	3.1
5	A4b	4.65	0.10	1.4	0.16	3.1	0.36	11.5
6	A5	4.60	0.67	10.0	0.71	13.0	0.79	25.0
7	A6	3.79	0.08	1.0	0.15	2.3	0.35	9.4
8	B1	4.32	0.23	3.5	0.30	5.6	0.45	14.7
9	B2	3.55	0.41	5.5	0.46	7.7	0.58	16.7
10	B3	0.51	0.29	0.5	0.35	0.8	0.49	1.8
11	C1	0.53	0.47	0.7	0.51	1.0	0.64	2.1
12	C2	0.83	0.38	0.9	0.43	1.3	0.57	2.9
13	C3	1.78	0.34	1.7	0.39	2.5	0.54	5.8

DETENTION STAGE-STORAGE

WATER SURFACE ELEVATION (FT)	SURFACE AREA AT STAGE (FT^2)	VOLUME BELOW STAGE (FT^3)	SURFACE AREA AT STAGE (ACRES)	VOLUME BELOW STAGE (ACRE-FT)	TARGET VOLUMES
5190.00	1,000	0	0.02	0.00	
5191.00	27,737	14,369	0.64	0.33	
5191.50	76,336	40,387	1.75	0.93	
5192.00	78,465	79,087	1.80	1.82	
5192.75	81,705	139,151	1.88	3.19	25-Yr Volume (2.9 ac-ft) FROM HEC-HMS
5193.00	82,798	159,714	1.90	3.67	
5193.91	87,287	237,102	2.00	5.44	100-YR WSEL
5194.00	88,016	244,991	2.02	5.62	
5195.00	92,583	335,290	2.13	7.70	FREEBOARD
5195.50	96,000	382,436	2.20	8.78	

LEGEND

- PROPOSED DRAINAGE BASIN
- EXISTING CONTOUR
- PROPOSED CONTOUR
- PROPERTY LINE
- EXISTING EASEMENT
- EXISTING RIGHT OF WAY
- PROPOSED SWALE CL
- HP — HIGH POINT ELEVATION
- LP — LOW POINT ELEVATION
- 4.3% — FLOW DIRECTION & SLOPE
- 2:1 — NOMINAL SLOPE
- 1 — DESIGN POINT
- A / 1.01 / 0.77 / 0.83 — PROPOSED SUBBASIN AREA; PROPOSED SUBBASIN; 10-YR RUNOFF COEFF.; 100-YR RUNOFF COEFF.

N

GRAPHIC SCALE
100 0 100 200
(IN FEET)
1 INCH = 100 FT

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DESIGNED BY LTV
DRAWN BY LTV
CHECKED BY NJN

REVISION DESCRIPTION	PREPARED BY	DATE
PER ENCANA REVIEW	LTV	03-18-2014

ENCANA OIL & GAS (USA) INC.
LIQUIDS HANDLING HUB
PART OF SE 1/4 SECTION 21, T1N, R68W
PROPOSED DRAINAGE PLAN
WELD COUNTY COLORADO

PREPARED UNDER THE DIRECT SUPERVISION OF

FOR AND ON BEHALF OF BASELINE CORPORATION

INITIAL SUBMITTAL	6/9/2013
DRAWING SIZE	24" X 36"
SURVEY FIRM	BASELINE
SURVEY DATE	7/23/2013
JOB NO.	PL 226
DRAWING NAME	226 BEC DNG Plan.dwg
SHEET	2 OF

DNG2

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