APPENDIX K

PACKER TEST RESULTS

Industrial Compliance Inc.

1746 Cole Blvd., Bldg. 21 #300 Golden, CO 80401

PACKER PERMEABILITY - DATA SHEET

Boring No. PZ-46 (50' north of PZ-46) Job No. 2-4079
Boring Radius (r) 0.23 (ft) Engineer Unger
Depth of Boring (d) 20 (ft) Date 9-23-92
Depth to Static Water (A) 19 (ft) Flow Meter No. Hays 38800483
Depth to Center of Packer (B) 8.65 (ft) Height of Gauge above
Gauge Pressure (P) (psi) Ground Surface (C) 2.75 (ft)

Flow Data

	Time	Gallons	Cubic Feet	Flow Rate
				Gal/min.
10:29	0	3234.0		
	1	3239.4		5.4
5-8 psi	2	3243.8		4.4
	3	3247.2		3.4
	4	3251.8		4.6
	5	3254.5		2.7
	10	3272.2	Ave.	3.54
10:44	15	3290.8	Ave.	3.72
10psi	0 10:46	3300.8		
	1	3305.9		5.1
	2	3311.6		5.7
	3	3317.9		6.3
	4	3324.2		6.3
	5	3330.3		6.1
	10	3360.8	Ave.	6.1
	15	3396.6	Ave	7.1
11:06	20	3431.0	Ave	6.8

Ave (5-8 psi) = 3.9 gal/min Ave (10psi) = 6.18 g/m

Notes

20 psi

11:09	0	3460.0	
	1	3475.9	15.9
	2	3491.2	15.3
	3	3509.0	17.8
	4	3522.8	13.8
	5	3539.0	16.2
	10	3619.5	Ave. 4.5
	15	3699.0	Ave 15.9
11:29	20	3778.5	Ave 15.9

Ave. (20psi) = 15.8 g/m
(* discount 4.5 5-10 min)

soil boring lithology similar to PZ-46
v. moist to wet @ 19'

Average Q = ft³/min

CALCULATIONS

$K = \frac{Q}{2\pi LH} \ln \frac{L}{r}$: $L \geq 10r$

$K = \frac{Q}{2\pi LH} \sinh^{-1} \frac{L}{2r}$: $10r > L \geq r$

$L = d - B$

$H = B + C + (L/2) + (P)(2.31) - S$

where $S = B + L/2 - A$

Note: If no free water is encountered, $S = 0$

Industrial Compliance

A Subsidiary of
SP Environmental Systems, Inc.

SHEET ___ OF ___ JOB NO. 2.4079
PROJECT CSI
BY mcw / mAm DATE / /
CHECKED BY ___ DATE / /

Packer Test PK-46

Approximately 50' north of PZ-46

Average Flow @ 10 psi = 6.18 gal/min = 0.826 Ft^3/min = Q
Average Flow @ 20 psi = 15.8 gal/min = 2.11 Ft^3/min = Q

$$K = \frac{Q}{2\pi L H} \ln \frac{L}{r}$$

$L \geq 10r$
$11.35 \geq 2.3$

$L = d - B = 20 - 8.65 = 11.35$

$H = B + C + (\frac{L}{2}) + P(2.31) - S = 8.65 + 2.75 + (\frac{11.35}{2}) + 10(2.31) = 40.175$

10 psi $r = 0.23'$ $P = 10$ psi
$B = 8.65$
$C = 2.75$

$$K = \frac{0.826\ Ft^3/min.}{2865.05\ Ft^2} \ln 49.35 = 0.00029\ Ft/min\ (3.90) = 0.0011\ Ft/min$$

$K = 0.0011\ Ft/min\ (0.508) = 0.00056\ cm/sec = \underline{5.6 \times 10^{-4}\ cm/sec}$.

20 psi $L = 11.35$ $C = 2.75$
$r = 0.23$ $P = 20$ psi.
$B = 8.65$ $H = 8.65 + 2.75 + (\frac{11.35}{2}) + 20(2.31) = 63.27$

$$K = \frac{2.11\ Ft^3/min}{4512.05\ Ft^2} \ln 3.9 = 0.00047\ (3.9) = 0.0018\ Ft/min$$

$K = 0.0018\ Ft/min\ (0.508) = \underline{9.1 \times 10^{-4}\ cm/sec}$

Industrial Compliance

A Subsidiary of
SP Environmental Systems, Inc.

SHEET ___ OF ___ JOB NO. 2.4079
PROJECT CSI
BY MCW/MAM DATE / /
CHECKED BY _____ DATE / /

Packer Test PK-46 (continued)

Assume tested interval is 1' saturated unit (TD @ 20', static water at 19')

$$K = \frac{Q}{2\pi L H} \sinh^{-1}\frac{L}{2r}$$

$10r > L \geq r$
$2.3 > 1 \geq 0.23$

$L = 1$ $H = \cancel{45.35}$ 42.06
$r = 0.23$
$P = 10$
$C = 2.75$
$B = 19'$
$Q = 0.826\ Ft^3/min$

10 psi $K = \frac{0.826\ Ft^3/min}{264.27\ Ft^2} \sinh^{-1} 2.17$

$K = 0.00313\ Ft/min\ (1.52)$

$K = 0.00476\ Ft/min\ (0.508) = 0.00242\ cm/sec = 2.42 \times 10^{-3}\ cm/sec$

20 psi $K = \frac{2.11\ Ft^3/min}{426.94\ Ft^2} \sinh^{-1} 2.17$

$H = 67.95$
$r = 0.23$
$P = 20$
$C = 2.75$
$B = 19'$
$Q = 2.11\ Ft^3/min$

$K = 0.00494\ Ft/min\ (1.52)$

$K = 0.0075\ Ft/min\ (0.508)$

$K = 0.0038\ Ft/min = 3.8 \times 10^{-3}\ cm/sec$

Industrial Compliance Inc.

1746 Cole Blvd., Bldg. 21 #300 Golden, CO 80401

PACKER PERMEABILITY - DATA SHEET

Boring No. PZ-47 (≈ 50' south of PZ-47) Job No. 2-4079
Boring Radius (r) 0.23 (ft) Engineer Unger
Depth of Boring (d) 55 (ft) Date 9-23-92
Depth to Static Water (A) — dry (ft) Flow Meter No. Hays 38800483
Depth to Center of Packer (B) 43.65 (ft) Height of Gauge above
Gauge Pressure (P) (psi) Ground Surface (C) 0.5 (ft)

Flow Data

	Time	Gallons	Cubic Feet	Flow Rate gal/min.
15psi	0 2:45	3792.5		
	1	3792.75		0.25
	2	3792.76		0.01
	3	3792.76		-
	4	3792.77		0.01
	5	3792.77		-
	10	3792.77		-
	15	3792.77		-
3:05	20	3792.77		-
			0.27	~~0.54~~ ~~0.135~~
20psi				
3:07	0	3793.26		-
	1	3793.26		-
	2	3793.26		-
	3	3793.26		-
	4	3793.26		-
	5	3793.26		-
	10	3793.26		-
	15	3793.26		-
3:37	30	3793.26		-

Notes

25psi

3:44	0	3793.56	-
	1	3793.54	-
	2	3793.56	-
	3	3793.56	-
	4	3793.57	0.01
	5	3793.58	0.01
	10	3793.59	0.01
	15	3793.59	-
4:14	30	3793.59	-

Q = 0.03 / 30 = 0.001 / 7.43 = 0.0001337

40psi

4:16	0	3793.91	
	1	3793.93	0.02
	2		
	3		
	4		
	5		
	10		
	15		

hose leaking @ surface connection, stopped test

Average Q = ft³/min

CALCULATIONS

$K = \frac{Q}{2\pi LH} \ln \frac{L}{r}$: $L \geq 10r$

$K = \frac{Q}{2\pi LH} \sinh^{-1} \frac{L}{2r}$: $10r > L \geq r$

L = d-B

H = B + C + (L/2) + (P)(2.31)-S

where S = B + L/2 - A

Note: If no free water is encountered, S = 0

Industrial Compliance

A Subsidiary of
SP Environmental Systems, Inc.

SHEET ___ OF ___ JOB NO. 2-4079
PROJECT CSI
BY MAM/MCU DATE / /
CHECKED BY _____ DATE / /

Packer Test PK-47

Approximately 50' south of PZ-47

Average Flow @ 25 psi = $\frac{0.03 \text{ gal}}{30 \text{ min}} = 0.001 \text{ gal/min} = 0.000134 \text{ ft}^3/\text{min}$

$L = d - B = 55 - 43.65 = 11.35$

$H = B + C + \frac{L}{2} + 25(2.31) = 107.58$

$d = 55$

$B = 43.65$

$r = 0.23'$

$C = 0.5$

$K = \frac{Q}{2\pi L H} \ln \frac{L}{r}$ $\quad \therefore L \geq 10r$ $\quad 11.35 > 2.3$

$K = \frac{0.000134 \text{ ft}^3/\text{min}}{2(3.14)(11.35)(107.58)} \ln \frac{11.35}{0.23}$

$K = \frac{0.000134 \text{ ft}^3/\text{min}}{7671.62} (3.90)$

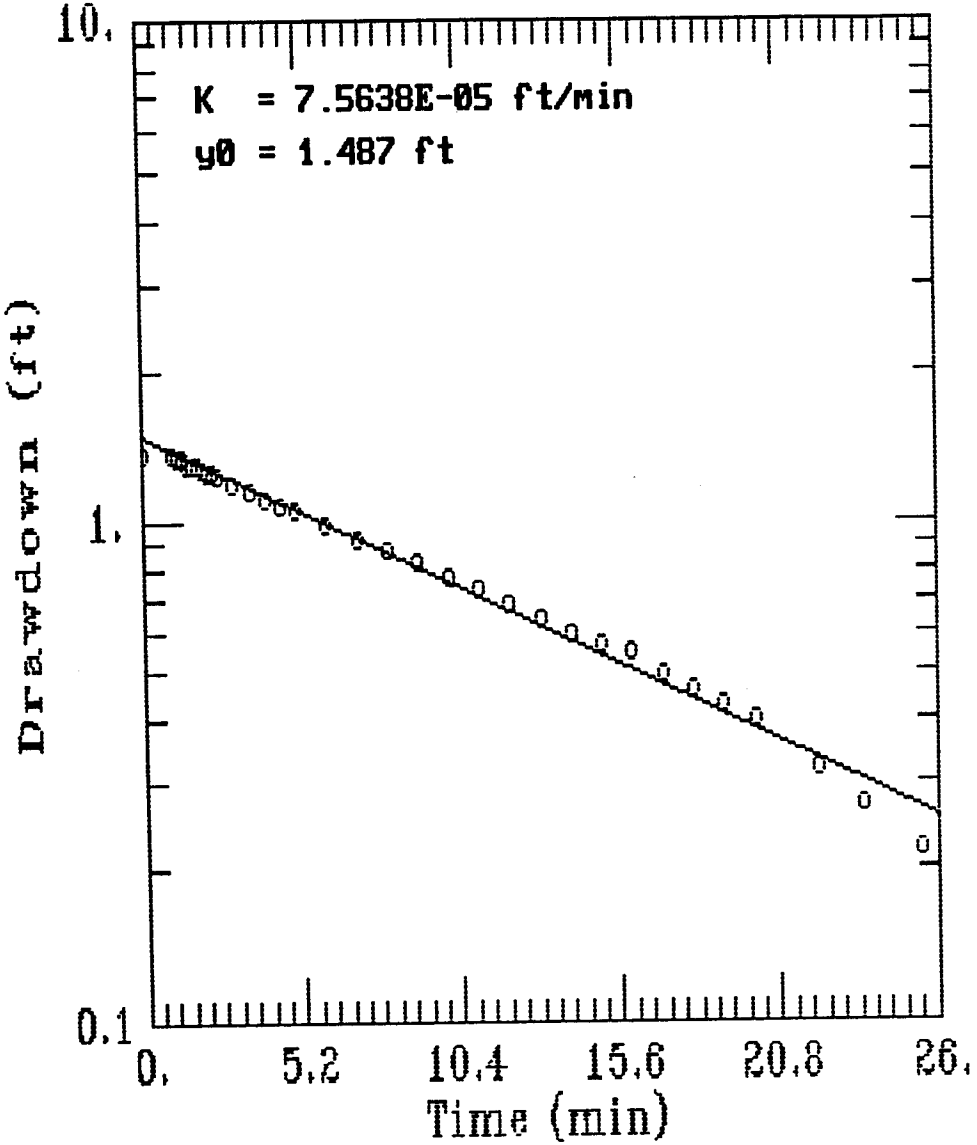
$K = 1.743 \times 10^{-8} (3.9) = 6.8 \times 10^{-8} \text{ ft/min} \; (0.508)$

$K = 3.45 \times 10^{-8} \text{ cm/sec}$

APPENDIX L

SLUG TEST RESULTS

MW-109 SLUG OUT

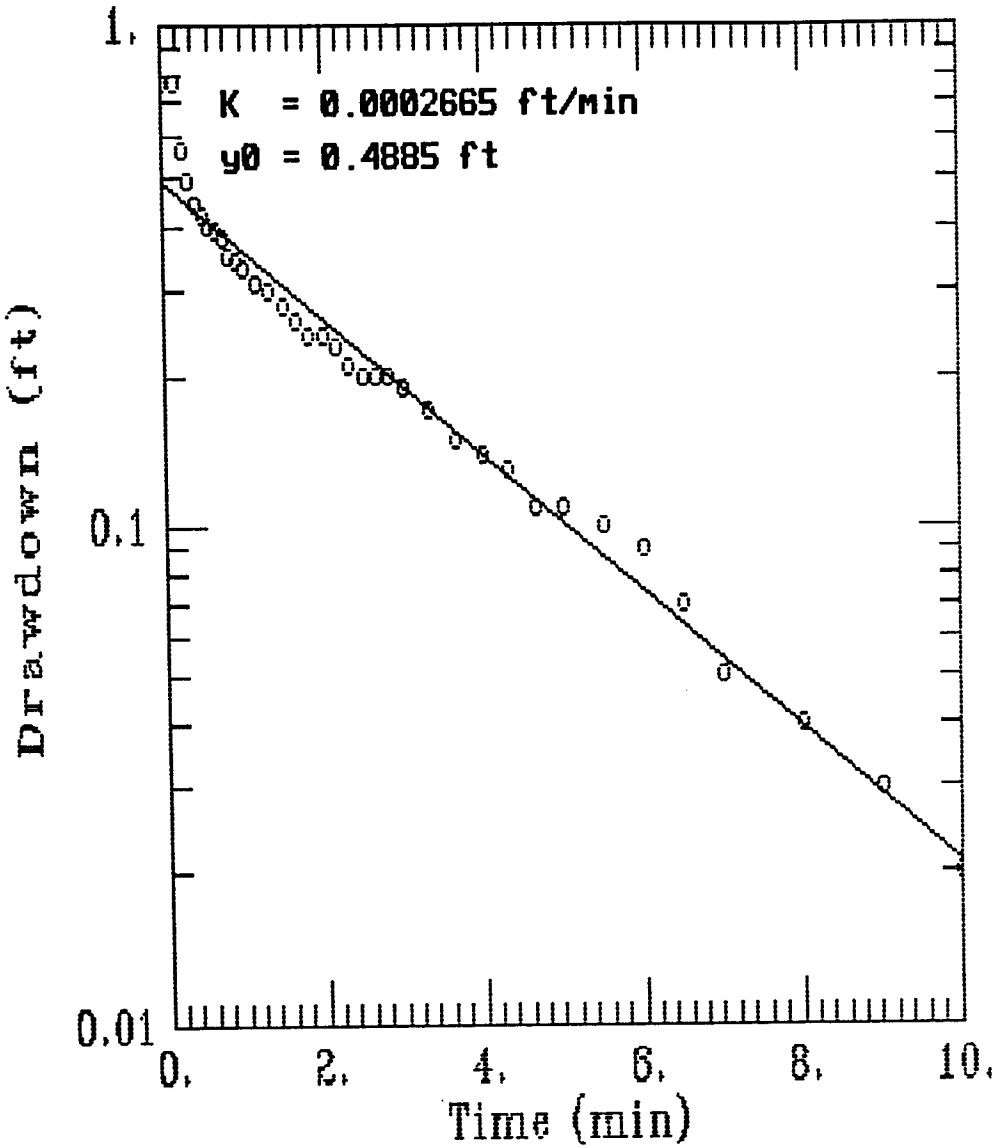


AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

MW-111 SLUG OUT

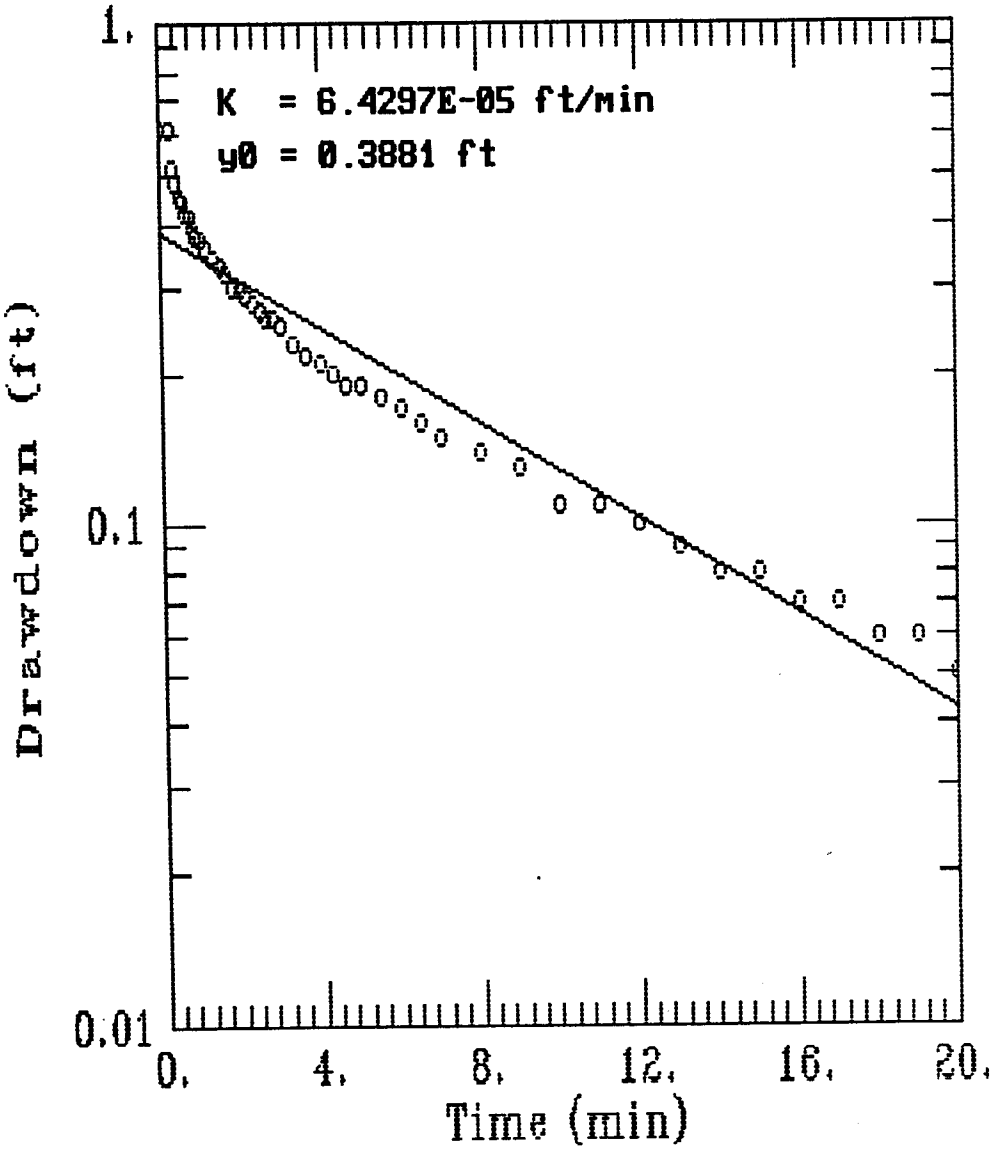


AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

MW-112 SLUG OUT



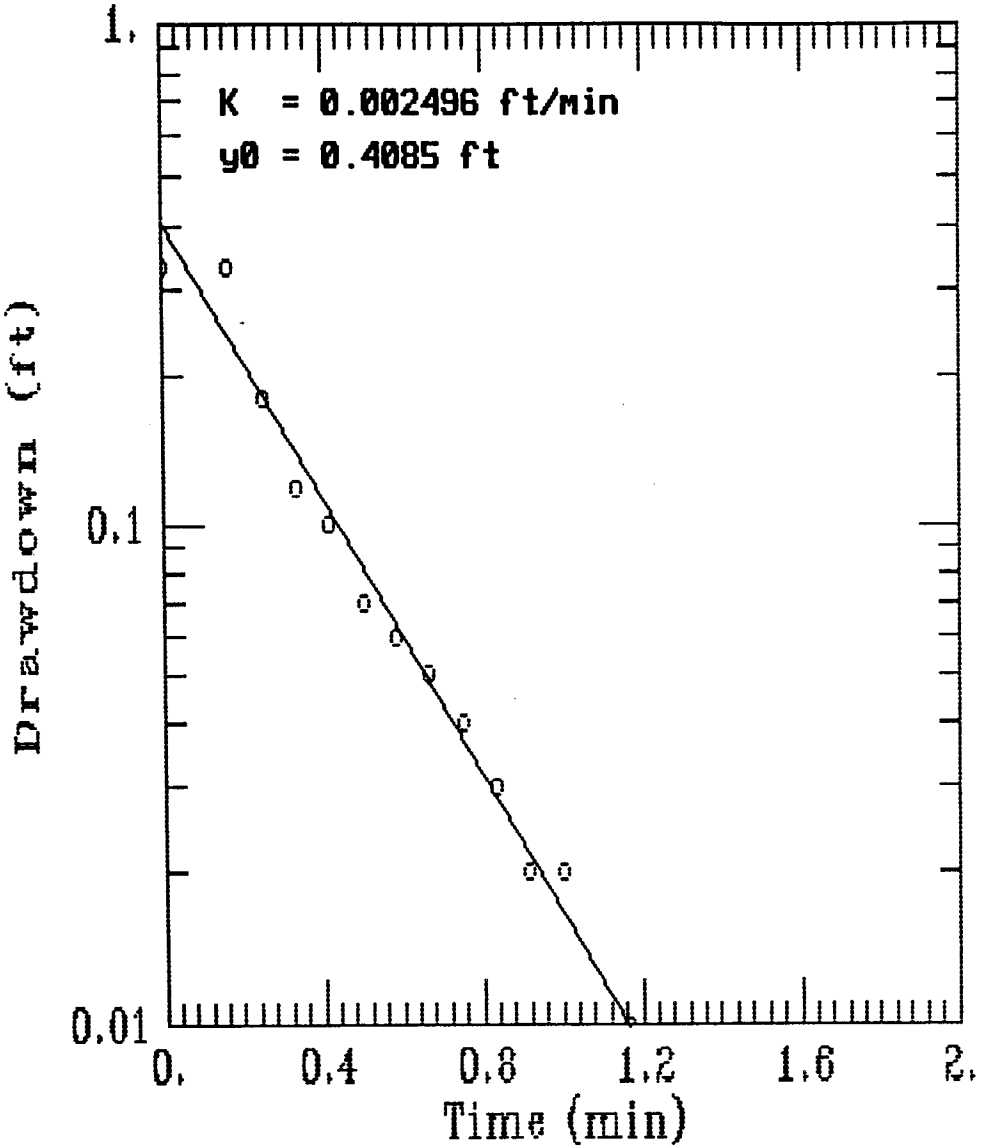
AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

MW-114 SLUG OUT

MW-204 SLUG OUT



AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

Appendix B
Legal Description

LEGAL DESCRIPTION
PART OF THE SOUTH ONE-HALF OF SECTION 25
TOWNSHIP 2 SOUTH, RANGE 64 WEST
SIXTH PRINCIPAL MERIDIAN
COUNTY OF ADAMS, STATE OF COLORADO

THAT PART OF THE SOUTH ONE-HALF OF SECTION 25, TOWNSHIP 2 SOUTH, RANGE 64 WEST OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF ADAMS, STATE OF COLORADO, DESCRIBED AS: COMMENCING AT THE SOUTHEAST CORNER OF SAID SECTION 25; THENCE N88°37'05"W ALONG THE SOUTH LINE OF THE SOUTHEAST ONE-QUARTER OF SAID SECTION 25, A DISTANCE OF 30.01 FEET TO THE WEST RIGHT-OF-WAY LINE OF SCHUMAKER MILE ROAD, BEING THE POINT OF BEGINNING; THENCE CONTINUING N88°37'05"W ALONG SAID SOUTH LINE, A DISTANCE OF 2627.55 FEET TO THE SOUTHEAST CORNER OF THE SOUTHWEST ONE-QUARTER OF SAID SECTION 25; THENCE N88°29'52"W ALONG THE SOUTH LINE OF SAID SOUTHWEST ONE-QUARTER, A DISTANCE OF 644.01 FEET; THENCE N10°50'39"E, A DISTANCE OF 1023.42 FEET; THENCE N54°08'55"W, A DISTANCE OF 593.30 FEET; THENCE N09°37'19"W, A DISTANCE OF 1327.80 FEET TO THE NORTH LINE OF SAID SOUTHWEST ONE-QUARTER; THENCE S88°28'44"E ALONG SAID NORTH LINE, A DISTANCE OF 1170.21 FEET TO THE NORTHWEST CORNER OF SAID SOUTHEAST ONE-QUARTER OF SECTION 25; THENCE CONTINUING S88°28'44"E ALONG THE NORTH LINE OF THE NORTHWEST ONE-QUARTER OF SAID SOUTHEAST ONE-QUARTER, A DISTANCE OF 1155.48 FEET, BEING 170.06 FEET WEST OF, AS MEASURED ALONG SAID NORTH LINE, FROM THE NORTHEAST CORNER OF SAID NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER; THENCE S00°16'07"W PARALLEL WITH THE EAST LINE OF SAID NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER, A DISTANCE OF 1322.44 FEET TO THE SOUTH LINE OF SAID NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER; THENCE S88°32'55"E ALONG SAID SOUTH LINE, A DISTANCE OF 170.05 FEET TO THE NORTHWEST CORNER OF THE SOUTHEAST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER OF SAID SECTION 25; THENCE CONTINUING S88°32'55"E ALONG THE NORTH LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER, A DISTANCE OF 1297.15 FEET TO THE WEST RIGHT-OF-WAY LINE OF SAID SCHUMAKER MILE ROAD, THENCE S00°11'50"W ALONG SAID WEST RIGHT-OF-WAY LINE, A DISTANCE OF 1320.69 FEET TO THE POINT OF BEGINNING.

CONTAINS 164.50 ACRES, MORE OR LESS.

Appendix C
Location Restrictions

LOCATION RESTRICTION SECTION EXCERPTED FROM THE ORIGINAL PERMIT DOCUMENT

"Prior to the initial field program, an initial site assessment was conducted of the WSI permit area. The initial site assessment was conducted to ensure that the area would comply with all location criteria set forth in proposed draft State of Colorado solid waste regulations. Existing topography, surface water conditions and local climatology as they relate to landfilling operations were also investigated and are presented in this Section.

Location Criteria

Proximity to Airports

Due to the non-putrescible nature of ash to be disposed of at the WSI facility, there is no additional potential for bird-strike problems. The WSI disposal facility will remain outside the zone of influence of the Denver International Airport which is presently under construction. The facility is not located within 10,000 feet of any airport serving either turbo-jet or piston type aircraft. The facility is located within five miles of the ultimate design of the Front Range Airport, which has been notified of the proposed facility.

Since this facility was permitted, ERL has worked with Adams County and the Federal Aviation Administration on a bird mitigation plan. Additional information regarding the proximity to airports is included in the updated EDOP text, dated September 2024.

Fault Areas

The site is not located within 200 feet of a fault that has had a displacement in Holocene time. The nearest reported fault to the site is the Rocky Mountain Arsenal Fault located approximately 15 miles to the west.

Unstable Areas

Based on site reconnaissance and document reviews, there is no evidence of unstable areas, geologic hazards or unstable human made features on the site.

Wetlands

According to the U.S. Soil Conservation Service (SCS) Soil Survey of Adams County and the U.S. Army Corps of Engineers, there are no designated wetlands in the permit area. Other surface water systems near the site are more fully discussed in other portions of this permit application. Ash will not be placed into surface waters or intermittent stream courses.

Flood Plain Information

The proposed ash disposal facility is not located within any designated 100-year flood plain according to the Federal Emergency Management Agency (FEMA) flood insurance rate maps (Community Panel Number 080001 0210A). Therefore, the facility will not restrict the flow or reduce the temporary storage capacity of the 100-year flood. A 100-yr, 24-hr flood plain on an

unnamed tributary to Lost Sand Creek, located in the western portion of Section 25 and estimated by QCI Consultants (Northglenn, Colorado) is referenced throughout this document. This flood plain was defined in the drainage study completed in November, 1989, conducted during the permitting process for the adjacent CSI disposal facility, and assumed the maximum probable urban development upstream. The proposed WSI coal ash disposal area is not located in this flood plain.

Ground Water

All disposal activities will take place above the natural ground-water table. Adequate ground-water protection will be provided at the facility by using a barrier soil layer and geocomposite bottom liner which will create a nearly impermeable barrier separating the ash from ground water. The liner system is discussed in detail throughout this permit application.

Appendix D
Bird Mitigation Plan

FIVE PART DISPOSAL FACILITY
ADAMS COUNTY, COLORADO

BIRD MITIGATION PLAN

Prepared for:

Five Part Development Company

Prepared by:

American Environmental Consulting, LLC
6885 S. Marshall St. Suite 3
Littleton, Colorado 80128

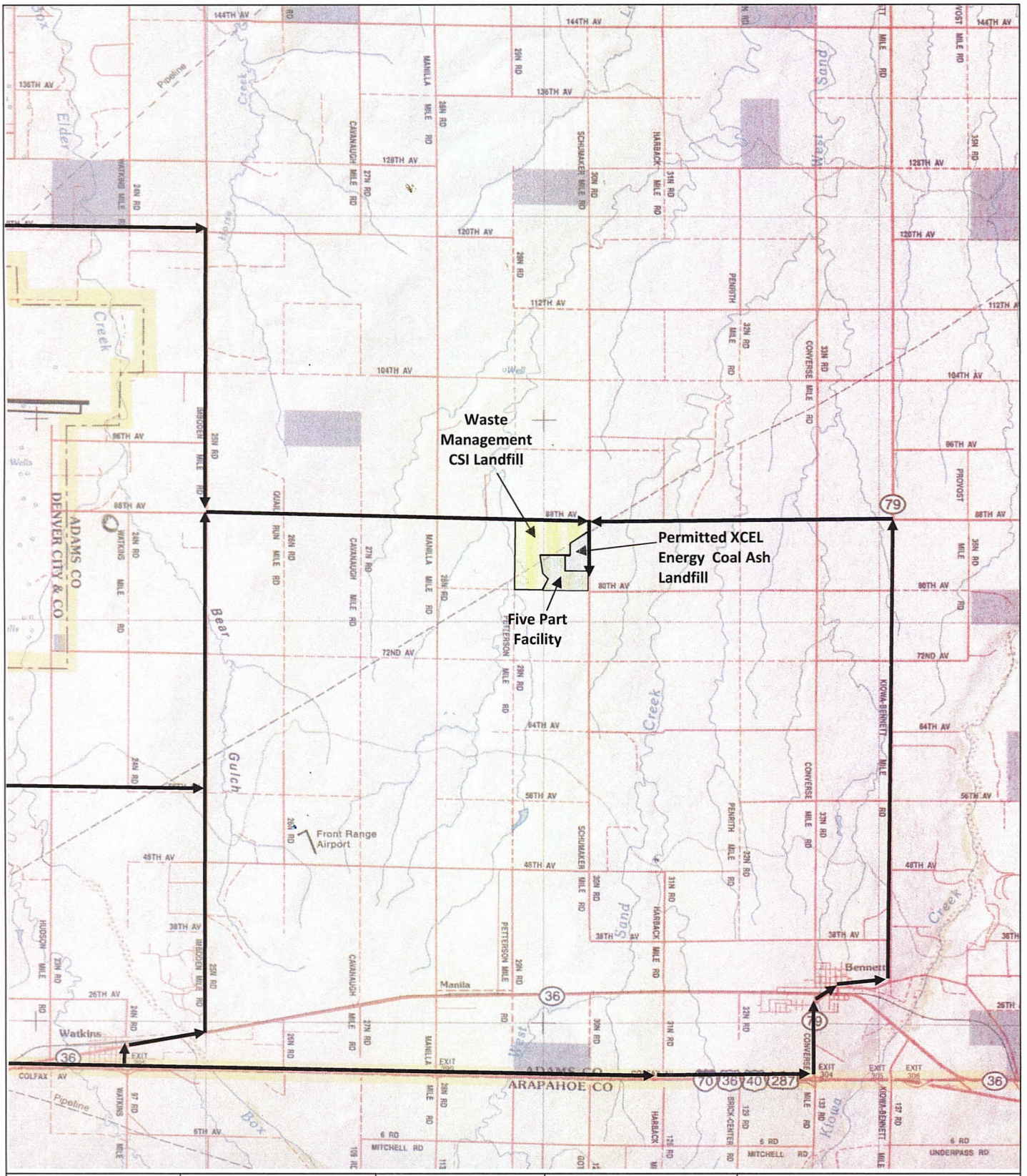
July 24, 2009

INTRODUCTION

The Five Part Disposal Facility is owned and operated by Five Part Development Company and is located one-half mile south of the intersection of 88th Avenue and Schumaker Mile Road in Adams County, Colorado. The facility provides composting of food wastes and other approved feedstocks and final disposal for municipal solid waste (MSW) that includes non-hazardous solid waste from a variety of sources, including residential, commercial, and industrial wastes. Some of the waste accepted at the facility is putrescible and would provide a food source for vectors such as flies, mosquitoes, rodents, and birds if operations were not controlled in an appropriate manner.

The control of birds at the landfill deserves special consideration because of the well publicized and dangerous occurrences of bird strikes by aircraft. The Federal Aviation Administration (FAA), United States Environmental Protection Agency (USEPA) and Colorado Department of Public Health and Environment (CDPHE) recognize the potential danger of bird strikes to aircraft associated with landfills and have promulgated rules specific to the relationship of MSW landfills to airports. Federal regulations (40 CFR § 258.10), require owners and operators of municipal solid waste landfills to demonstrate that landfills within 10,000 feet of any airport runway used by turbo-jet aircraft or within 5,000 feet of any airport runway which receives only piston-type aircraft be designed and operated in a manner which does not pose a bird hazard to aircraft, and requires notification if a landfill is outside of these ranges but within five miles of certain airports. The CDPHE regulations mirror those in 40 CFR§ 258.10. The Five Part facility is located approximately four miles north of the Front Range Airport and eight miles east of the Denver International Airport (Figure 1) and is in compliance with all of the U.S.E.P.A. and CDPHE requirements. The facility is not within 10,000 feet of any runway at either of the airports, and provided notification to Ms. Linda Bruce, Colorado State Planner with the FAA of the planned development to accept putrescible waste in October 2007. FAA regulations (49 U.S.C Section 44718(d)) require any landfill accepting putrescible waste and located within six miles of an airport meeting specific criteria, notify the applicable State aviation authority, who must request and obtain an exemption from the Administrator of the FAA. Five Part and its attorneys contacted the FAA headquarters in October 2007 to confirm that the statutory siting restriction under 49 U.S.C Section 44718(d) does not apply to Front Range Airport or the Five Part facility and that an exemption is not necessary.

Recent publicity and studies have shown the Denver International Airport (DIA) to be among the leading airports in the United States for bird strikes. The proximity of DIA runway 7/25 to the Rocky Mountain Arsenal National Wildlife Refuge and DIA runway 16/34 to Barr Lake State Park (the site of a 2,000 acre waterfowl sanctuary, the headquarters location for the Rocky Mountain Bird Observatory and an Audubon Society "Important Bird Area"), which is well recognized for its very favorable bird habitat, are likely the substantial contributors to this situation. The Front Range Airport is located south of, and closer to, the facility than DIA.



Proj: Five Part	Drawn by: CJA	AEC	AMERICAN ENVIRONMENTAL CONSULTING, LLC	FIGURE 1 LOCATION MAP FIVE PART DISPOSAL FACILITY
Date: March 17, 2009	Reviewed by: MAM			
File: vicinity map				

Five Part Development met with and worked closely with representatives of the FAA, United States Department of Agriculture (USDA, as wildlife consultant to the FAA), DIA, and the Front Range Airport to explain the planned operations and develop effective bird mitigation procedures. Each entity was provided an opportunity to review the facility development and voice any concerns they may have as part of the permitting process for Five Part to accept putrescible wastes for disposal. The facility did not receive any negative responses and received a number of positive responses. Bird control is discussed as part of the discussion on vector control in Section 7.5.2 of the facility's Engineering Design and Operations Plan (EDOP), and this bird mitigation plan provides more specific guidance for the control of birds at the facility.

BIRD CONTROL PRACTICES

The most effective methods of controlling birds at the facility is to take steps to make the facility unattractive to birds by a combination of reducing access to food sources and frightening birds from the facility.

The relatively low volume of vehicle traffic and waste arriving at the facility allows Five Part to maintain a relatively small working face, on the order of five times smaller than that of the Tower Road Landfill, which in turn allows Five Part to establish greater control of birds at the landfill with the goal of creating undesirable conditions for birds. Continuous activity at the working face, including offloading waste vehicles and operation of the compaction equipment will discourage birds from alighting on the exposed refuse. The cover material applied on a daily basis creates a barrier above the refuse which vectors such as birds and rodents cannot penetrate. This barrier eliminates the ability of birds and rodents to access refuse (a potential source of food) thereby eliminating the desirability of the area. In addition, the cover material helps control rodent populations by eliminating the source of food. Minimizing rodent populations decreases the desirability of the landfill to birds of prey. The use of cover materials as prescribed by applicable regulations and the standard of practice that will be employed at the Five Part facility will virtually eliminate the foraging or loitering birds at the landfill when the landfill is closed.

The planned design and operation of the Five Part facility also minimizes other bird attractants. The landfill will be constructed and operated in such a manner that water does not pond on the surface. Debris and other items on-site which may provide shelter for nesting birds or rodents are eliminated as soon as practicable.

If additional measures are necessary to further discourage bird activity on the landfill, Five Part will implement additional measures that have been shown to be effective at other landfills, including:

- frequent and erratic use of bird repellent devices to discourage birds from landing at the facility;
- minimizing other bird attractants such as shelter and rodent populations to decrease the desirability of the Five Part facility;
- Professional extermination services will be obtained as necessary to reduce vectors that attract birds, such as rodents.

During daily landfill operations when refuse is actively being placed, trained site personnel will use hand held bird repelling devices as needed to repel approaching and/or loitering birds. When fired, the bird repellent device provides alarming, irritating and disturbing stimuli that discourages birds from landing at the facility. Bird repellents typically consist of a pyrotechnic shell fired from a hand held gun and may deliver any one or more of the following stimuli:

- whistle noise
- flash of light
- concussion
- smoke trail
- sound of propellant

When used appropriately by trained personnel, the hand held bird repellent devices are very effective at discouraging birds from landing at landfills and in training birds to recognize that the site is an undesirable destination on a long-term basis. The use of pyrotechnic shells is most effective if the stimuli is varied from time to time to prevent the birds from becoming accustomed to any particular stimuli.

Other types of bird repellent devices are available and can be used in varied combinations with pyrotechnic methods and include such items as decoys of bird predators, automated cannons which periodically release a loud blast and squawk boxes which make continuous high pitched irritating noises.

Attentive use of the above methods should create a situation where birds will find the reward not worth the effort and make the facility unattractive in the long term; however, landfill personnel will need to reinforce the undesirability of the facility periodically by continuing the use of the above methods even after bird populations decrease markedly.

Appendix E
Surface Water Management Design

STORMWATER DRAINAGE DESIGN REPORT AND PLAN

EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

Prepared for:
Five Part Development, LLC
East Regional Landfill

Prepared by:
American Environmental Consulting, LLC
8191 Southpark Lane, Suite 107
Littleton, Colorado 80120

February 2025

1.0 INTRODUCTION

Five Part Development, LLC (Five Part) is applying for a vertical expansion of the East Regional Landfill (ERL) final cover. As part of this vertical expansion, Five Part contracted American Environmental Consulting, LLC (AEC) to conduct a revision of the surface water control design as a result of the modification to the final cover configuration. The vertical expansion includes increasing outside side slopes from a 4:1 ratio to a 3.5:1 ratio and raising the 5% grade deck on top by approximately 107 feet. This is the drainage plan and report for the revised configuration.

The ERL received an amendment to their CD on June 29, 2009 based on the application in the form of an Engineering Design and Operations Plan (EDOP) developed by Doty & Associates, LLC (June 1, 2006). That document included the design for permanent surface water control structures to manage surface water run-on and run-off to and from the site. The structures included a surface water channel design to control run-on to the site from the south and run-off from the south and east portions of the developed landfill (after final cover installation) and route it around the east side of the facility. The channel was designed to discharge stormwater to property owned by Waste Management over 2,000 feet north of the ERL.

In 2009, as a condition of approval of the amendment to the CD, Five Part contracted AEC to conduct a review of the surface water control design by Doty & Associates and complete the required Drainage Report and Plan. As a result of this review, AEC revised the drainage controls at the site to control not only run-on to the site from the south, but all run-off from the developed landfill. The revision is referred herein as the 2009 revision.

In accordance with 2.1.6 of 6 CCR 1007-2, the solid waste regulations, the revision to the drainage plan presented in this report are intended collect the 24-hour, 25-year volume and control the 24 hour 100-year storm volume.

This report includes a narrative of the concept for the revised surface water control system, engineering calculations and supporting data, and two plan sheets depicting the revised surface water channel in plan view and includes appropriate details.

2.0 DESIGN NARRATIVE AND SUMMARY OF RESULTS

The commonly used model HydroCAD (version 10.2-5b) was used to evaluate the needed capacity and performance of the channel design.

The 2009 revision surface water control system consisted of four grass-lined channels around the perimeter of the final cover on the landfill, representing anticipated post-closure conditions at the site. The 2009 revision designed these channels to control the 24-hour, 25-year storm volume and did not ensure collection of this volume. This revision retains all the perimeter ditches but adds detention weirs within the perimeter ditches to collect the 24-hour, 25-year storm volume. Additionally, some sections of the perimeter ditches are deepened by increasing the channel side slopes so the 24-hour, 25-year storm volume can be collected.

Erosion control features are added to the final cover stormwater design to account for the steepened side slopes in the vertical expansion. This includes a network of 1.5% slope tack-on berms and two down chutes to route runoff and control erosion from the final cover.

The perimeter channels will be built in phases as necessary based on the progression of landfilling throughout the operating life of the landfill. This scenario assumes that all operating facilities, including the gatehouse and scales will be removed from the site after it is closed. Surface water control structures for operational purposes will be constructed as needed during the operating life of the landfill to collect and control the 24-hour, 25-year event as required in 6 CCR 1007-2, Part 1, Sections 2.1.6 and 3.2.6. The operational surface water control structures for the active landfill are dependent on the landfill configuration and operating needs such as access roads, soil stockpile areas, etc. and their location and design will constantly change based on the particular landfill configuration at any one time. Therefore, the operational surface water control structures are not included herein. Aside from operational surface water controls required by regulation to control surface water to and from the refuse fill area, the natural drainage through the site will be maintained as much as possible until the permanent system is constructed.

The only run-on to the site from an off-site area is along the southern property boundary. This run on is precluded from entering the site by a tree-lined berm and road so it does not need to be included in the calculations for ERL.

A 40-foot buffer has been established along the southern property boundary as required by Adams County in which no landfill or permanent structures may be located, and all disturbance associated with this channel are outside of the 40-foot buffer. In addition, the channel was designed outside of the 40-foot Right-of-Way along Schumaker Road.

The stormwater control system on the final cover consists of tack-on berms that route run off to two down chutes and then to four separate channels with detention areas that ultimately discharge off site at two discharge points as shown on Sheet 1. The channels are labeled as:

Channel 1: Perimeter channel starting on the south and routing water north to Discharge Point 1
Channel 2: Perimeter channel starting on the north and routing water east to Discharge Point 1

Channel 3: Perimeter channel starting on the west and routing water south to Discharge Point 2
Channel 4: Perimeter channel starting on the south and routing water west and north to Discharge Point 2

The tack-on berm system consists of two down chutes, one on the northeast side and one on the south side. On the northeast down chute, three tiers of tack on berms collect run-off and route it to the chute. On the south down chute there are two tiers of tack-on berms that route run-off to the chute. The majority of run-off from the final cover will be routed through the tack on berm system.

The south down chute discharges into the south perimeter ditch (Channel 2). The south perimeter ditch has the capacity to collect 2.4-acre feet of run-off water. Overflow from this storage area gets routed north around the eastern perimeter of the facility to Discharge Point 1.

The northeast down chute discharges into the eastern perimeter ditch (Channel 1). The eastern perimeter ditch has the capacity to collect 6.1 acre-feet of run-off. The channel that routes from the 6.1 acre feet storage to discharge point 1 currently has weirs to slow flow.

The southwestern outfall (Discharge Point 2) will receive water from the southwest portion of the final cover that does not route run-off through the tack on berm system. This drainage plan revises the channel leading to this outfall to be deeper with steeper side slopes to collect, 0.56 acre-feet of run-off, the 24 hour 25-year volume from these areas.

This drainage plan also revises the north perimeter ditch (Channel 2) to have a detention area to hold 0.32 acre-feet also consisting of a detention weir and a deeper channel by steepening side slopes.

The slope of the channel bottom varies, but was designed to control the rate of drainage so that velocities are maintained below 5 feet per second (fps) so the use of grass-lined channels is permissible according to Metro Drainage guidelines (Urban Drainage and Flood Control District, Drainage Criteria Manual, Section 3.2.7). Attachment 1 provides details of the design of the permanent surface water control system.

As shown on Figure 1 and Figure 2, the limit of the final cover was designed to tie into the crest of the channels either at the natural ground surface or at the top of the embankment (as applicable).

The following pages provide the general modeling input and a summary of the design for the site surface water control system. Included at the end of the summary section is Sheet 1 that depicts the drainage configuration used in the design evaluation. Attachment 2 includes the model output for the site drainage system design.

GENERAL INPUT DATA

- Use Runoff Curve Number 69 for Pasture/grassland/range, Fair, HSG B (1S)
- 25-year, 24-hour rainfall = 3.56 inches
- 100-year, 24-hour rainfall = 4.73 inches
- Used Type II type storm distribution
- Generally 3-foot wide ditch with 3H:1V Slopes, excluding detention areas
- Manning's value Constant n= 0.030 Stream, clean & straight for channels
- Manning's value Constant n= 0.069 6 inch riprap for down chutes
- Manning's value Constant n= 0.035 for reach 4.2.1 to account for existing weirs

See the following Attachment 1 and Figures 1 and 2 for Design Details.

WASTE MANAGEMENT / CSI PROPERTY

XCEL ENERGY PROPERTY

DEEPENED CHANNEL BOTTOM
WITH STEEPER 1:1 SLOPES INSIDE
5302' CONTOUR
STORAGE CAPACITY = 0.37 ACRE-FEET

DETENTION WEIR #1
OUTLET ELEVATION = 5302'

DISCHARGE POINT #1

GP-2

GP-3

1.5% TACK ON BERM

PERIMETER
DRAINAGE
CHANNEL

6 INCH R/PRAP LINED DOWNCHUTE

DETENTION WEIR #2
OUTLET ELEVATION = 5306'

DEEPENED CHANNEL BOTTOM
WITH STEEPER 1:1 SLOPES
INSIDE 5306 CONTOUR
STORAGE CAPACITY = 6.1 ACRE-FEET

5% SLOPE

6% SLOPE

DETENTION WEIR #4
OUTLET ELEVATION = 5320'

DISCHARGE POINT #2

DEEPENED CHANNEL BOTTOM
WITH STEEPER 1:1 SLOPES
INSIDE 5320' CONTOUR
STORAGE CAPACITY = 0.56 ACRE-FEET

WASTE MANAGEMENT / CSI PROPERTY

GP-4

GP-5

GP-6

MW-5

MW-6

LANDSCAPE BERM

DETENTION WEIR #3
OUTLET ELEVATION = 5316'

DEEPENED CHANNEL BOTTOM
WITH STEEPER 2:1 SLOPES
INSIDE 5316 CONTOUR
STORAGE CAPACITY = 7.21 ACRE-FEET

40' - LANDSCAPE WITH TREES
NORTH OF PROPERTY LINE
(1 TREE EVERY 20')

QUONSET HUT
MAINTENANCE FLUID STORAGE
AND MAINTENANCE ACTIVITIES

LANDSCAPE WITH GRASS,
TREES AND BUSHES

LEGEND

- 5315 — EXISTING CONTOURS (2 FT. INTERVAL)
- 5330 — PROPOSED FINAL COVER CONTOURS (2 FT. INTERVAL)
- 5300 — PERMITTED STORAGE DITCH CONTOURS (2 FT. INTERVAL)
- 5300 — PROPOSED STORAGE DITCH CONTOURS (0.5 FT. INTERVAL)
- PROPOSED 1.5% TACK ON BERM
- LIMITS OF FINAL COVER
- PROPERTY LIMIT (BY R.W. BAYER & ASSOCIATES, 2007)
- PERIMETER DRAINAGE CHANNEL
- ADJOINING PROPERTY BOUNDARY
- GAS PIPELINE RIGHT OF WAY
- GAS PIPELINE ACCESS ROAD
- G — GAS PIPELINE
- SECTION MARKER (NOT VARIFIED)
- (Gnd. El. 5306.03) EXISTING GROUND WATER MONITORING LOCATION
- GP-2 EXISTING GAS MONITORING WELL LOCATION
- MW EXISTING GROUND WATER MONITORING LOCATION
- GP EXISTING GAS MONITORING WELL LOCATION
- ACTIVE AGRICULTURAL AREA
- EXISTING BUILDING
- EXISTING SUMP RISER PIPE
- LANDSCAPED SCREENING BERM
- SCREENING TREE LOCATION
- SITE AREA GRID SYSTEM

Note:
See legal discription for precise location of property boundary.

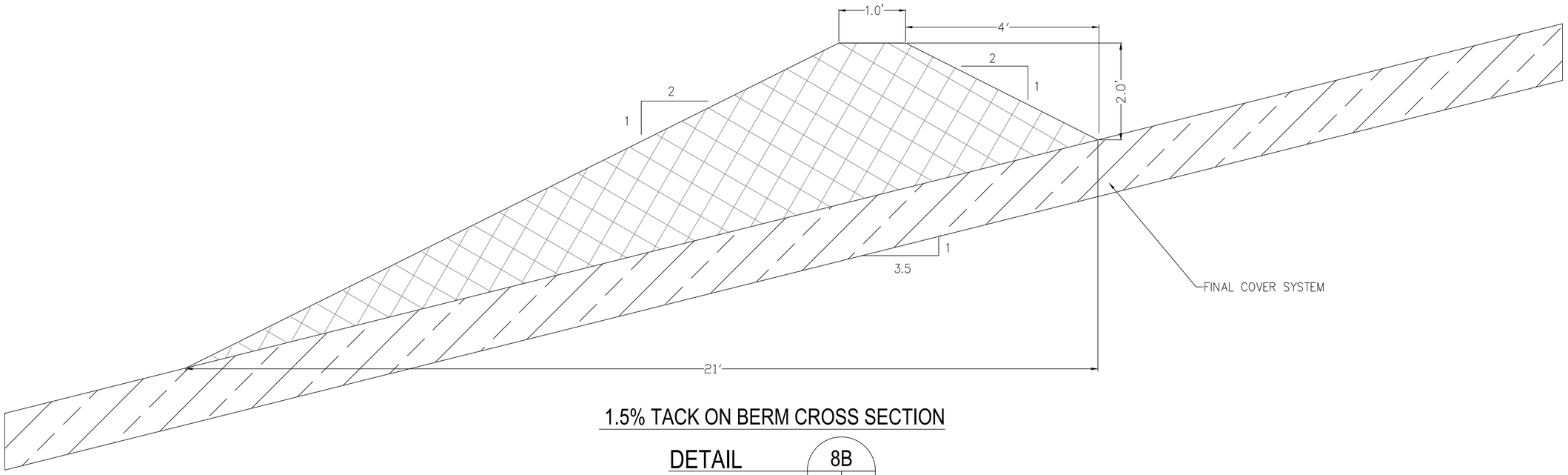
0 75 150 300
APPROXIMATE SCALE (FEET)

CONTOUR INTERVAL: 2'
DATE OF TOPOGRAPHY FLIGHT: 1-6-12

FIGURE 1
SURFACE WATER MANAGEMENT PLAN
EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

CLIENT: FIVE PART DEVELOPMENT, LLC	
PROJECT: VERTICAL EXPANSTION EDOP	
PROJECT NO:	DATE COMPLETED: 8/2013
DESIGNED BY: RDS	APPROVED BY: WAC
DRAWN BY: TML/RDS	DWG NAME:
REVISION:	REVISED BY: RDS DATE: 9/2024
2 ISSUED FOR REVIEW	

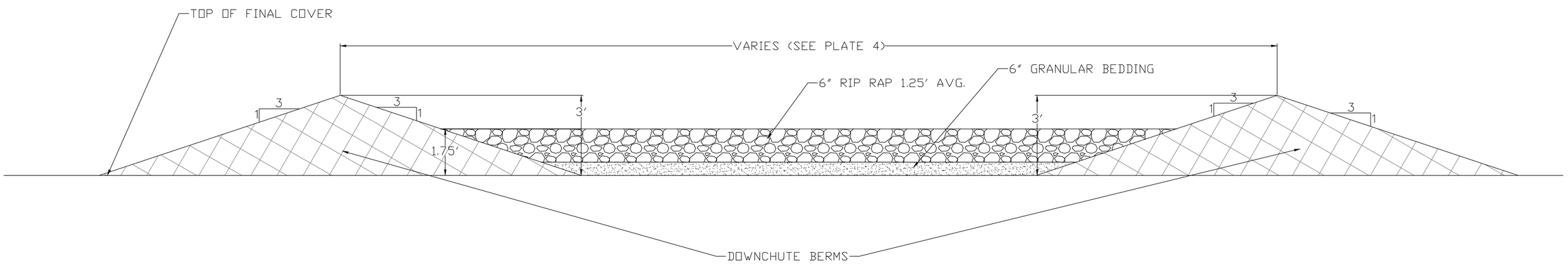
AEC AMERICAN ENVIRONMENTAL CONSULTING, LLC.



1.5% TACK ON BERM CROSS SECTION

DETAIL 8B / 1

SCALE: N.T.S.



DOWNCHUT CROSS SECTION

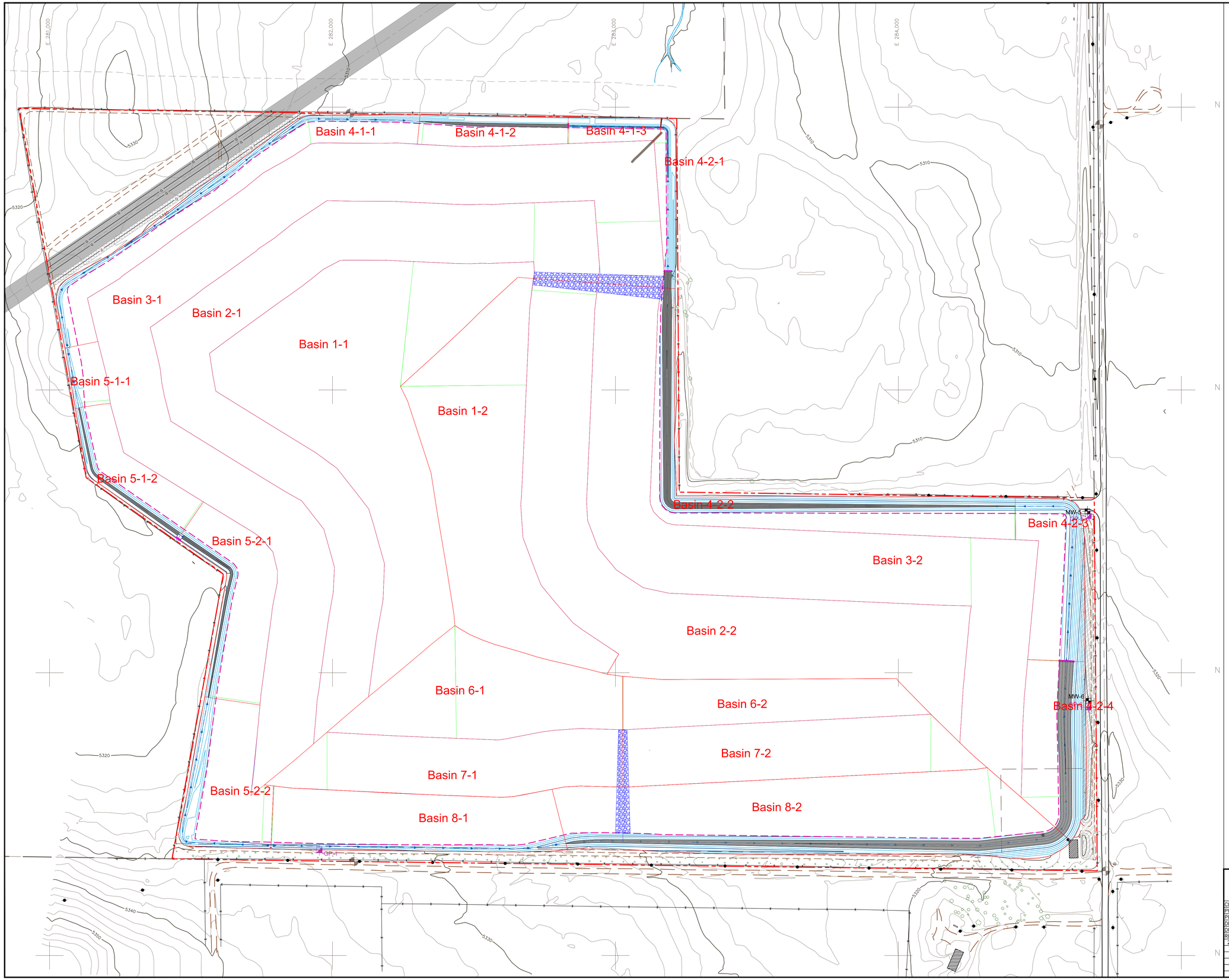
DETAIL 8B / 2

SCALE: N.T.S.

FIGURE 2
STORMWATER CONTROL DETAILS
EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

CLIENT: FIVE PART DEVELOPMENT, LLC	
PROJECT: 2024 ERL EXPANSION	
PROJECT NO:	DATE COMPLETED: 8/2024
DESIGNED BY: AEC	APPROVED BY: WAC
DRAWN BY: RDS	DWG NAME:
REVISION:	REVISED BY: / DATE:
0 ISSUED FOR REVIEW	

AEC AMERICAN ENVIRONMENTAL CONSULTING, LLC.



LEGEND

- 5300 — PERMITTED STORAGE DITCH CONTOURS (2 FT. INTERVAL)
- 5300 — PROPOSED STORAGE DITCH CONTOURS (0.5 FT. INTERVAL)
- PROPOSED 1.5% TACK ON BERM
- LIMITS OF FINAL COVER
- PROPERTY LIMIT (BY R.W. BAYER & ASSOCIATES, 2007)
- PERIMETER DRAINAGE CHANNEL
- STORMWATER BASINS USED IN HYDROCAD MODEL
- BASIN HYDRUALIC LENGTHS USED IN HYDROCAD MODEL
- PROPOSED RIPRAP LINED DOWNCHUTE

N

0 75 150 300
APPROXIMATE SCALE (FEET)

CONTOUR INTERVAL: 2'
DATE OF TOPOGRAPHY FLIGHT: 1-6-12

FIGURE 3
STORMWATER BASINS
EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

CLIENT: FIVE PART DEVELOPMENT, LLC	
PROJECT: VERTICAL EXPANSTION EDOP	
PROJECT NO:	DATE COMPLETED: 8/2013
DESIGNED BY: RDS	APPROVED BY:
DRAWN BY: TML/RDS	DWG NAME:
REVISION:	REVISED BY: RDS DATE: 9/2024
2 ISSUED FOR REVIEW	

AEC AMERICAN ENVIRONMENTAL CONSULTING, LLC.

3.0 INSPECTIONS AND MAINTENANCE

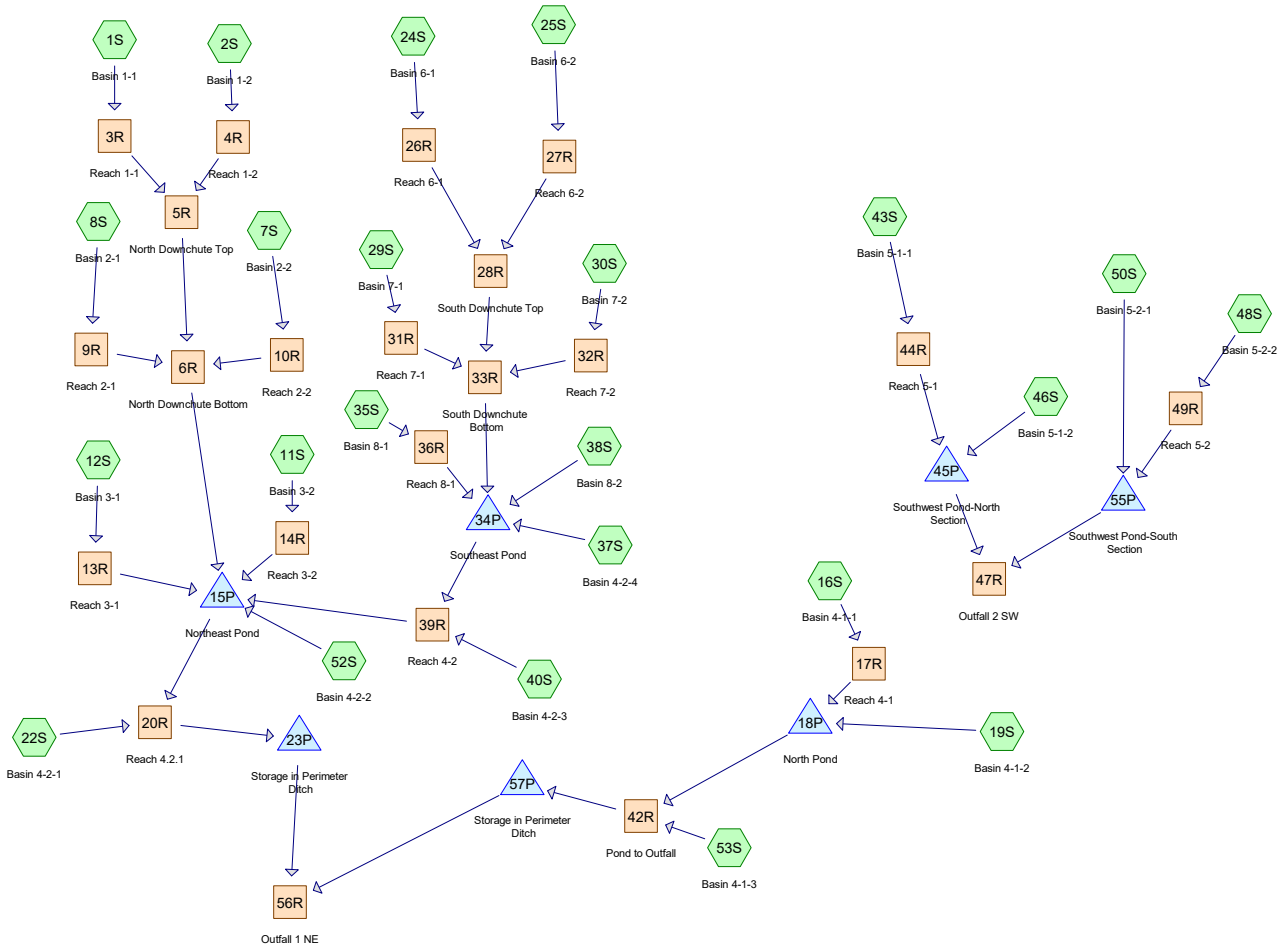
The site had a construction stormwater permit for the initial disposal cell construction at the site (# COR-03C609). Prior to beginning disposal operations, the site was required to have in effect a permit for Heavy Industrial Activity issued through the Colorado Discharge Permit System (CDPS) to allow off-site discharge of storm water throughout the operating life of the facility and following closure of the facility. This permit was obtained (Permit COR900439) and requires that the site stormwater drainage system be inspected twice per year, generally once in the spring and once in the fall. The drainage system will also be inspected following heavy precipitation events. In reality, because of the nature of the site operations, the entire site will be inspected even more frequently during the operating life of the facility. The CDPS permit also requires the facility have a Storm Water Management Plan (SWMP), which does not require approval but must be maintained on site and revised as necessary to reflect any revisions to the storm water drainage system. The SWMP includes an evaluation of the potential pollutant sources from the site, Best Management Practices (BMP's) implemented to control discharge of pollutants from the site, and reporting requirements, and was submitted to the Colorado Department of Public Health and Environment Water Quality Control Division (WQCD) and Adams County for their records. A copy is also maintained in the site Operating Record. The site operator is required by their CDPS permit to collect at least one sample of off-site stormwater discharge on an annual basis from each discharge point. The results of the site inspections and sampling are reported to the Colorado Department of Public Health and Environment by November 28th of each year, and are also reported to Adams County. In addition, the facility will be required to conduct post-closure care and monitoring activities for at least 30 years following site closure, and a portion of this obligation will include site inspections on at least an annual basis, or more frequently if required by the CDPS permit.

Once any portion of the site storm water drainage system is constructed, it will be seeded with grasses as recommended by the East Adams Soil Conservation District, the Natural Resource Conservation Service, or other landscape expert knowledgeable with the vegetation of the area. Formal inspections of the site drainage system will be conducted at least twice per year (once in the spring and once in the fall) and following any heavy precipitation events. The inspections will include noting the degree of success of the grass lined areas in limiting erosion and sediment transport, examinations for evidence of sediment transport, inspections of areas of excessive erosion, and establishment of any Best Management Practices (BMP's) to mitigate any deficiencies noted.

Basins	Area (sqft)	Area (Acres)	Hydraulic Lengths	0.2857 slope	0.05 slope	CN	Sheet Flow Length (100xslope^0.5/n)	manning's n
1.1	647502.341	14.86	443.557	138.557	305	69	172.005229	0.13
1.2	436938.343	10.03	445.044	140.044	305	69	172.005229	0.13
2.1	629522.216	14.45	208.776	208.776	0	69	411.160862	0.13
2.2	676616.737	15.53	228.7	228.7	0	69	411.160862	0.13
3.1	860688.358	19.76	226.554	231	0	69		0.13
3.2	680476.058	15.62	241.203	241.203	0	69		0.13
4.1.1	153453.20	3.52	88.4	88.4	0	69		0.13
4.1.2	55626.018	1.28	81.12	81.12	0	69		0.13
4.1.3	28157.436	0.65	62.4	62.4	0	69		0.13
4.2.1	34506.53	0.79	47.7	47.7	0	69		0.13
4.2.2	212419.552	4.88	118.107	118.107	0	69		0.13
4.2.3	111771.991	2.57	137.098	137.098	0	69		0.13
4.2.4	125998.325	2.89	158.265	158.265	0	69		0.13
5.1.1	27337.116	0.63	113	113	0	69		
5.1.2	82128.662	1.89	142.6	142.6	0	69		
5.2.1	134691.199	3.09	183.4	183.4	0	69		
5.2.2	131775.448	3.03	213.745	213.745	0	69		
6.1	255051.367	5.86	398.968	165.756	233.212	69	61.212	0.13
6.2	158314.715	3.63	188.327	188.327	0	69		0.13
7.1	235935.409	5.42	203.315	203.315	0	69		0.13
7.2	241245.44	5.54	203.042	203.042	0	69		0.13
8.1	258734.446	5.94	210.648	210.648	0	69		0.13
8.2	398238.955	9.14	272.294	272.294	0	69		0.13

Reaches	slopes	Reach Length	inlet invert	outlet invert	calculated slope	Manning's n	Notes
1.1	0.015	2790.21	5479.25	5437.5	0.0150	0.03	
1.2	0.015	1471.4	5460.5	5438.5	0.0150	0.03	
2.1	0.015	3772	5431.75	5371.25	0.0160	0.03	
2.2	0.015	2776	5415.25	5373.5	0.0150	0.03	
3.1	0.015	4718.4	5377.75	5306	0.0152	0.03	
3.2	0.015	3049	5355	5309.25	0.0150	0.03	
4.1		1661.818	5326	5302	0.0144	0.03	
4.2		737.014	5308.25	5306	0.0031	0.03	
4.2.1		525	5306	5298	0.0152	0.035	Increased n to account for existing wiers
5.1		212.735	5328	5320	0.0376	0.03	
5.2		817.555	5330	5320	0.0122	0.03	
6.1	0.015	1031.617	5443.5	5428	0.0150	0.03	
6.2	0.015	1072.699	5444	5428	0.0149	0.03	
7.1	0.015	1253.977	5389	5370	0.0152	0.03	
7.2	0.015	1272.141	5389	5370	0.0149	0.03	
8.1		1036.9	5330	5316	0.0135	0.03	
North Downcomer Top	0.2857	227.5	5438.5	5373.5	0.2857	0.069	
North Downcomer Bottom	0.2857	233	5373.5	5306	0.2897	0.069	
South Downcomer Top	0.2857	203	5428	5370	0.2857	0.069	
South Downcomer Bottom	0.2857	191.909	5370	5316	0.2814	0.069	

Ponds	Length	Required Storage (Acre-Feet)	
North	525.801	0.32	
Northeast	2047.763	6.1	
Southwest-North Section	613.437	0.15	
Southwest-South Section	671.811	0.43	
Southeast	2362.113	2.4	



Routing Diagram for ERL Stormwater Design Calculations

Prepared by American Environmental Consultng, Printed 9/5/2024

HydroCAD® 10.20-5b s/n 04925 © 2023 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	25-Year	Type II 24-hr		Default	24.00	1	3.56	2
2	100-Year	Type II 24-hr		Default	24.00	1	4.73	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
111.660	69	(7S, 11S, 12S, 16S, 19S, 22S, 24S, 25S, 29S, 30S, 35S, 37S, 38S, 40S, 43S, 46S, 48S, 50S, 52S, 53S)
39.340	69	Pasture/grassland/range, Fair, HSG B (1S, 2S, 8S)
151.000	**69**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
39.340	HSG B	1S, 2S, 8S
0.000	HSG C	
0.000	HSG D	
111.660	Other	7S, 11S, 12S, 16S, 19S, 22S, 24S, 25S, 29S, 30S, 35S, 37S, 38S, 40S, 43S, 46S, 48S, 50S, 52S, 53S
151.000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	111.660	111.660		7S, 11S, 12S, 16S, 19S, 22S, 24S, 25S, 29S, 30S, 35S, 37S, 38S, 40S, 43S, 46S, 48S, 50S, 52S, 53S
0.000	39.340	0.000	0.000	0.000	39.340	Pasture/grassland/range, Fair	1S, 2S, 8S
0.000	**39.340**	**0.000**	**0.000**	**111.660**	**151.000**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.01 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Basin 1-1 Runoff Area=14.860 ac 0.00% Impervious Runoff Depth>0.88"
Flow Length=444' Tc=14.2 min CN=69 Runoff=18.35 cfs 1.093 af

Subcatchment 2S: Basin 1-2 Runoff Area=10.030 ac 0.00% Impervious Runoff Depth>0.88"
Flow Length=445' Tc=14.2 min CN=69 Runoff=12.39 cfs 0.737 af

Subcatchment 7S: Basin 2-2 Runoff Area=15.530 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=229' Slope=0.2857 '/' Tc=7.6 min CN=69 Runoff=25.09 cfs 1.146 af

Subcatchment 8S: Basin 2-1 Runoff Area=14.450 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=209' Slope=0.2857 '/' Tc=7.1 min CN=69 Runoff=23.84 cfs 1.066 af

Subcatchment 11S: Basin 3-2 Runoff Area=15.620 ac 0.00% Impervious Runoff Depth>0.88"
Flow Length=241' Slope=0.2857 '/' Tc=8.0 min CN=69 Runoff=24.81 cfs 1.152 af

Subcatchment 12S: Basin 3-1 Runoff Area=19.760 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=227' Slope=0.2857 '/' Tc=7.6 min CN=69 Runoff=31.93 cfs 1.458 af

Subcatchment 16S: Basin 4-1-1 Runoff Area=3.520 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=88' Slope=0.2857 '/' Tc=3.6 min CN=69 Runoff=6.73 cfs 0.260 af

Subcatchment 19S: Basin 4-1-2 Runoff Area=1.280 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=81' Slope=0.2857 '/' Tc=3.3 min CN=69 Runoff=2.48 cfs 0.095 af

Subcatchment 22S: Basin 4-2-1 Runoff Area=0.790 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=48' Slope=0.2857 '/' Tc=2.2 min CN=69 Runoff=1.60 cfs 0.058 af

Subcatchment 24S: Basin 6-1 Runoff Area=5.860 ac 0.00% Impervious Runoff Depth>0.88"
Flow Length=399' Tc=13.5 min CN=69 Runoff=7.43 cfs 0.431 af

Subcatchment 25S: Basin 6-2 Runoff Area=3.630 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=188' Slope=0.2857 '/' Tc=6.5 min CN=69 Runoff=6.14 cfs 0.268 af

Subcatchment 29S: Basin 7-1 Runoff Area=5.420 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=203' Slope=0.2857 '/' Tc=6.9 min CN=69 Runoff=9.01 cfs 0.400 af

Subcatchment 30S: Basin 7-2 Runoff Area=5.540 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=203' Slope=0.2857 '/' Tc=6.9 min CN=69 Runoff=9.21 cfs 0.409 af

Subcatchment 35S: Basin 8-1 Runoff Area=5.940 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=211' Slope=0.2857 '/' Tc=7.2 min CN=69 Runoff=9.75 cfs 0.438 af

Subcatchment 37S: Basin 4-2-4 Runoff Area=2.890 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=158' Slope=0.2857 '/' Tc=5.7 min CN=69 Runoff=5.06 cfs 0.213 af

Subcatchment 38S: Basin 8-2 Runoff Area=9.140 ac 0.00% Impervious Runoff Depth>0.88"
Flow Length=272' Slope=0.2857 '/' Tc=8.8 min CN=69 Runoff=14.03 cfs 0.674 af

Subcatchment 40S: Basin 4-2-3 Runoff Area=2.570 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=137' Slope=0.2857 '/' Tc=5.1 min CN=69 Runoff=4.61 cfs 0.190 af

Subcatchment 43S: Basin 5-1-1 Runoff Area=0.630 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=113' Slope=0.2857 '/' Tc=4.3 min CN=69 Runoff=1.17 cfs 0.047 af

Subcatchment 46S: Basin 5-1-2 Runoff Area=1.890 ac 0.00% Impervious Runoff Depth>0.88"
Flow Length=143' Slope=0.0286 '/' Tc=13.2 min CN=69 Runoff=2.43 cfs 0.139 af

Subcatchment 48S: Basin 5-2-2 Runoff Area=3.030 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=214' Slope=0.2857 '/' Tc=7.2 min CN=69 Runoff=4.98 cfs 0.224 af

Subcatchment 50S: Basin 5-2-1 Runoff Area=3.090 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=183' Slope=0.2857 '/' Tc=6.4 min CN=69 Runoff=5.25 cfs 0.228 af

Subcatchment 52S: Basin 4-2-2 Runoff Area=4.880 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=118' Slope=0.2857 '/' Tc=4.5 min CN=69 Runoff=8.98 cfs 0.361 af

Subcatchment 53S: Basin 4-1-3 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth>0.89"
Flow Length=62' Slope=0.2857 '/' Tc=2.7 min CN=69 Runoff=1.29 cfs 0.048 af

Reach 3R: Reach 1-1 Avg. Flow Depth=1.06' Max Vel=3.83 fps Inflow=18.35 cfs 1.093 af
n=0.030 L=2,790.0' S=0.0150 '/' Capacity=65.35 cfs Outflow=12.13 cfs 1.068 af

Reach 4R: Reach 1-2 Avg. Flow Depth=0.99' Max Vel=3.66 fps Inflow=12.39 cfs 0.737 af
n=0.030 L=1,471.0' S=0.0150 '/' Capacity=65.33 cfs Outflow=10.13 cfs 0.728 af

Reach 5R: North Downchute Top Avg. Flow Depth=0.19' Max Vel=3.74 fps Inflow=20.22 cfs 1.796 af
n=0.069 L=227.5' S=0.2857 '/' Capacity=2,266.93 cfs Outflow=20.18 cfs 1.791 af

Reach 6R: North Downchute Bottom Avg. Flow Depth=0.18' Max Vel=3.74 fps Inflow=44.57 cfs 3.946 af
n=0.069 L=233.0' S=0.2897 '/' Capacity=4,848.31 cfs Outflow=44.46 cfs 3.935 af

Reach 9R: Reach 2-1 Avg. Flow Depth=1.03' Max Vel=3.83 fps Inflow=23.84 cfs 1.066 af
n=0.030 L=3,772.0' S=0.0154 '/' Capacity=66.39 cfs Outflow=11.61 cfs 1.034 af

Reach 10R: Reach 2-2 Avg. Flow Depth=1.15' Max Vel=4.05 fps Inflow=25.09 cfs 1.146 af
n=0.030 L=2,776.0' S=0.0150 '/' Capacity=65.52 cfs Outflow=15.09 cfs 1.121 af

Reach 13R: Reach 3-1 Avg. Flow Depth=1.11' Max Vel=4.00 fps Inflow=31.93 cfs 1.458 af
n=0.030 L=4,718.0' S=0.0152 '/' Capacity=65.88 cfs Outflow=14.06 cfs 1.405 af

Reach 14R: Reach 3-2 Avg. Flow Depth=1.12' Max Vel=3.99 fps Inflow=24.81 cfs 1.152 af
n=0.030 L=3,049.0' S=0.0150 '/' Capacity=65.44 cfs Outflow=14.21 cfs 1.125 af

Reach 17R: Reach 4-1 Avg. Flow Depth=0.67' Max Vel=2.83 fps Inflow=6.73 cfs 0.260 af
n=0.030 L=1,662.0' S=0.0144 '/' Capacity=206.38 cfs Outflow=4.04 cfs 0.255 af

Reach 20R: Reach 4.2.1 Avg. Flow Depth=0.47' Max Vel=1.71 fps Inflow=1.60 cfs 0.058 af
n=0.035 L=525.0' S=0.0114 '/' Capacity=157.37 cfs Outflow=1.21 cfs 0.058 af

Reach 26R: Reach 6-1 Avg. Flow Depth=0.83' Max Vel=3.27 fps Inflow=7.43 cfs 0.431 af
n=0.030 L=1,031.5' S=0.0150 '/' Capacity=65.49 cfs Outflow=6.40 cfs 0.427 af

Reach 27R: Reach 6-2 Avg. Flow Depth=0.74' Max Vel=3.03 fps Inflow=6.14 cfs 0.268 af
n=0.030 L=1,073.0' S=0.0149 '/' Capacity=65.24 cfs Outflow=4.76 cfs 0.265 af

Reach 28R: South Downchute Top Avg. Flow Depth=0.19' Max Vel=3.73 fps Inflow=10.43 cfs 0.692 af
n=0.069 L=203.0' S=0.2857 '/' Capacity=1,299.49 cfs Outflow=10.39 cfs 0.690 af

Reach 31R: Reach 7-1 Avg. Flow Depth=0.85' Max Vel=3.34 fps Inflow=9.01 cfs 0.400 af
n=0.030 L=1,254.0' S=0.0152 '/' Capacity=65.76 cfs Outflow=6.89 cfs 0.395 af

Reach 32R: Reach 7-2 Avg. Flow Depth=0.86' Max Vel=3.34 fps Inflow=9.21 cfs 0.409 af
n=0.030 L=1,272.0' S=0.0149 '/' Capacity=65.29 cfs Outflow=7.01 cfs 0.404 af

Reach 33R: South Downchute Bottom Avg. Flow Depth=0.19' Max Vel=3.76 fps Inflow=23.64 cfs 1.489 af
n=0.069 L=192.0' S=0.2813 '/' Capacity=2,527.32 cfs Outflow=23.53 cfs 1.486 af

Reach 36R: Reach 8-1 Avg. Flow Depth=0.88' Max Vel=3.26 fps Inflow=9.75 cfs 0.438 af
n=0.030 L=1,037.0' S=0.0135 '/' Capacity=199.55 cfs Outflow=7.88 cfs 0.434 af

Reach 39R: Reach 4-2 Avg. Flow Depth=0.67' Max Vel=2.72 fps Inflow=4.61 cfs 0.190 af
n=0.030 L=737.0' S=0.0136 '/' Capacity=200.05 cfs Outflow=3.80 cfs 0.188 af

Reach 42R: Pond to Outfall Avg. Flow Depth=0.70' Max Vel=0.42 fps Inflow=1.29 cfs 0.048 af
n=0.030 L=326.0' S=0.0003 '/' Capacity=30.08 cfs Outflow=0.66 cfs 0.047 af

Reach 44R: Reach 5-1 Avg. Flow Depth=0.34' Max Vel=2.95 fps Inflow=1.17 cfs 0.047 af
n=0.030 L=213.0' S=0.0376 '/' Capacity=332.84 cfs Outflow=1.14 cfs 0.046 af

Reach 47R: Outfall 2 SW Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af
n=0.030 L=10.0' S=0.0500 '/' Capacity=177.35 cfs Outflow=0.00 cfs 0.000 af

Reach 49R: Reach 5-2 Avg. Flow Depth=0.70' Max Vel=2.66 fps Inflow=4.98 cfs 0.224 af
n=0.030 L=817.5' S=0.0122 '/' Capacity=189.95 cfs Outflow=4.05 cfs 0.221 af

Reach 56R: Outfall 1 NE Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af
n=0.030 L=50.0' S=0.0200 '/' Capacity=222.42 cfs Outflow=0.00 cfs 0.000 af

Pond 15P: Northeast Pond Peak Elev=5,305.91' Storage=6.153 af Inflow=71.48 cfs 7.014 af
Discarded=1.54 cfs 0.860 af Primary=0.00 cfs 0.000 af Outflow=1.54 cfs 0.860 af

Pond 18P: North Pond Peak Elev=5,301.72' Storage=0.277 af Inflow=4.40 cfs 0.350 af
Discarded=0.12 cfs 0.073 af Primary=0.00 cfs 0.000 af Outflow=0.12 cfs 0.073 af

Pond 23P: Storage in Perimeter Ditch Peak Elev=5,301.60' Storage=0.058 af Inflow=1.21 cfs 0.058 af
Outflow=0.00 cfs 0.000 af

Pond 34P: Southeast Pond Peak Elev=5,310.91' Storage=2.491 af Inflow=35.73 cfs 2.807 af
Discarded=0.54 cfs 0.315 af Primary=0.00 cfs 0.000 af Outflow=0.54 cfs 0.315 af

Pond 45P: Southwest Pond-North Section Peak Elev=5,319.87' Storage=0.138 af Inflow=3.28 cfs 0.185 af
Discarded=0.08 cfs 0.048 af Primary=0.00 cfs 0.000 af Outflow=0.08 cfs 0.048 af

Pond 55P: Southwest Pond-South Section Peak Elev=5,319.61' Storage=0.367 af Inflow=6.71 cfs 0.449 af
Discarded=0.13 cfs 0.082 af Primary=0.00 cfs 0.000 af Outflow=0.13 cfs 0.082 af

Pond 57P: Storage in Perimeter Ditch Peak Elev=5,301.67' Storage=0.047 af Inflow=0.66 cfs 0.047 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 151.000 ac Runoff Volume = 11.133 af Average Runoff Depth = 0.88"
100.00% Pervious = 151.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Basin 1-1

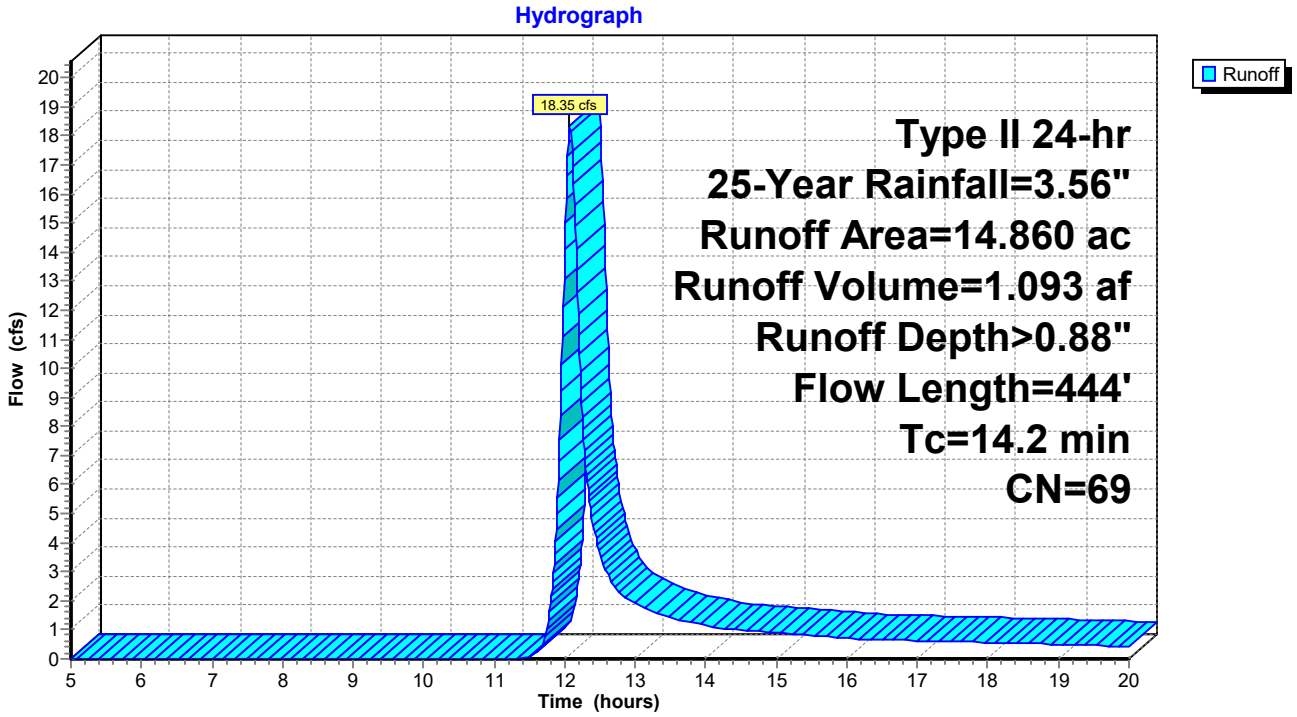
Runoff = 18.35 cfs @ 12.07 hrs, Volume= 1.093 af, Depth> 0.88"
Routed to Reach 3R : Reach 1-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

Area (ac)	CN	Description
14.860	69	Pasture/grassland/range, Fair, HSG B
14.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	172	0.0500	0.24		**Sheet Flow,** Range n= 0.130 P2= 1.88"
1.4	133	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	139	0.2857	3.74		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.2	444	Total			

Subcatchment 1S: Basin 1-1



Summary for Subcatchment 2S: Basin 1-2

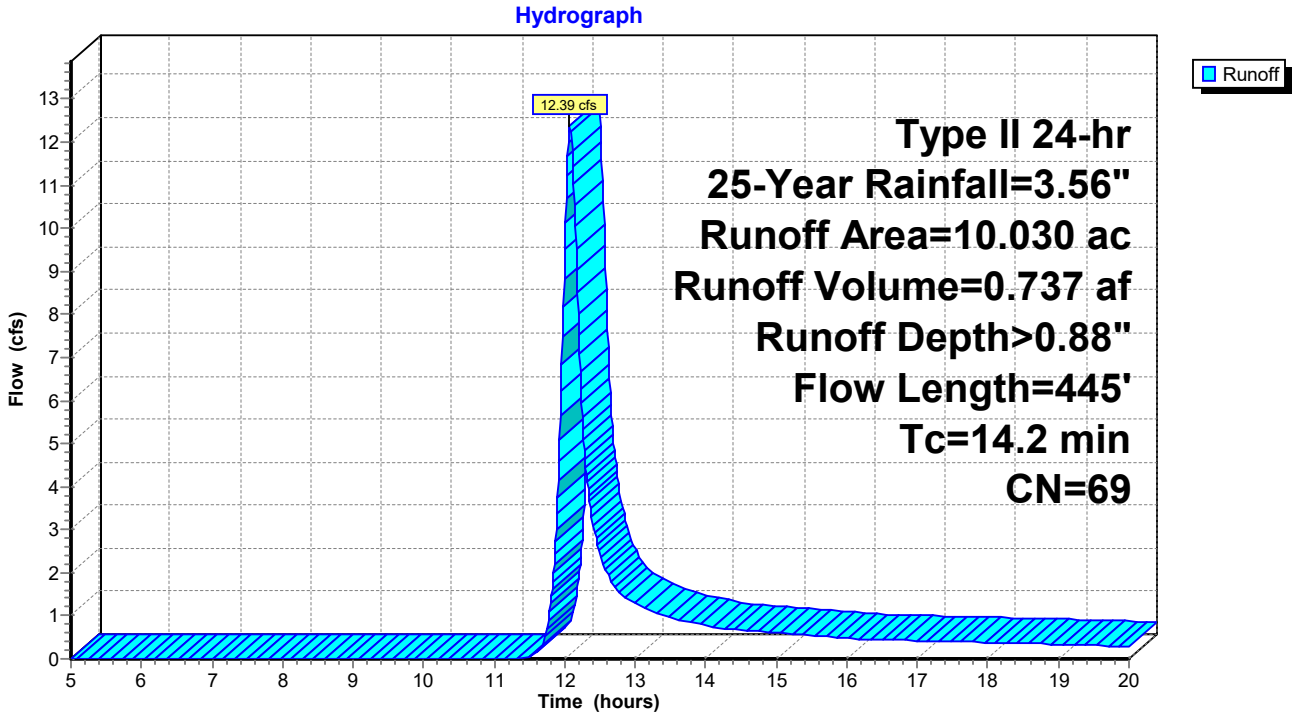
Runoff = 12.39 cfs @ 12.07 hrs, Volume= 0.737 af, Depth> 0.88"
Routed to Reach 4R : Reach 1-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

Area (ac)	CN	Description
10.030	69	Pasture/grassland/range, Fair, HSG B
10.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	172	0.0500	0.24		**Sheet Flow,** Range n= 0.130 P2= 1.88"
1.4	133	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	140	0.2857	3.74		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.2	445	Total			

Subcatchment 2S: Basin 1-2



Summary for Subcatchment 7S: Basin 2-2

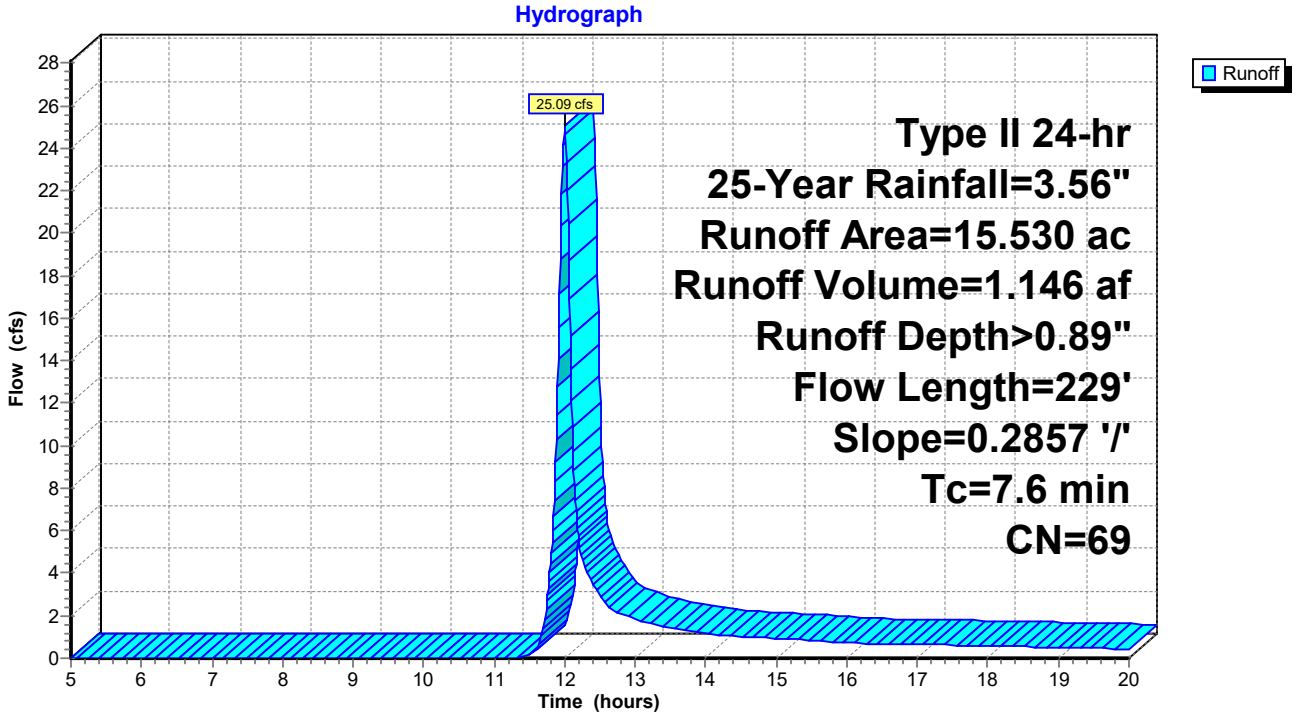
Runoff = 25.09 cfs @ 12.00 hrs, Volume= 1.146 af, Depth> 0.89"
Routed to Reach 10R : Reach 2-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	15.530	69	
	15.530		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	229	0.2857	0.50		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 7S: Basin 2-2



Summary for Subcatchment 8S: Basin 2-1

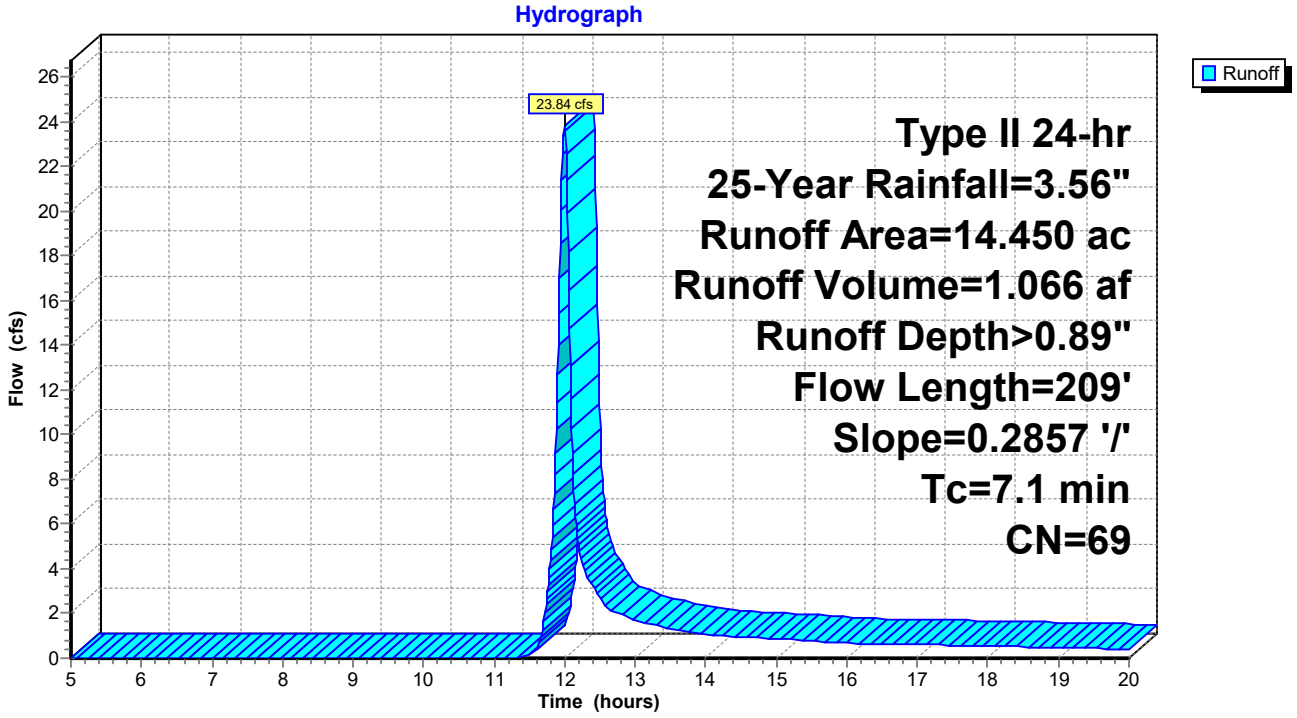
Runoff = 23.84 cfs @ 12.00 hrs, Volume= 1.066 af, Depth> 0.89"
Routed to Reach 9R : Reach 2-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

Area (ac)	CN	Description
14.450	69	Pasture/grassland/range, Fair, HSG B
14.450		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	209	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 8S: Basin 2-1



Summary for Subcatchment 11S: Basin 3-2

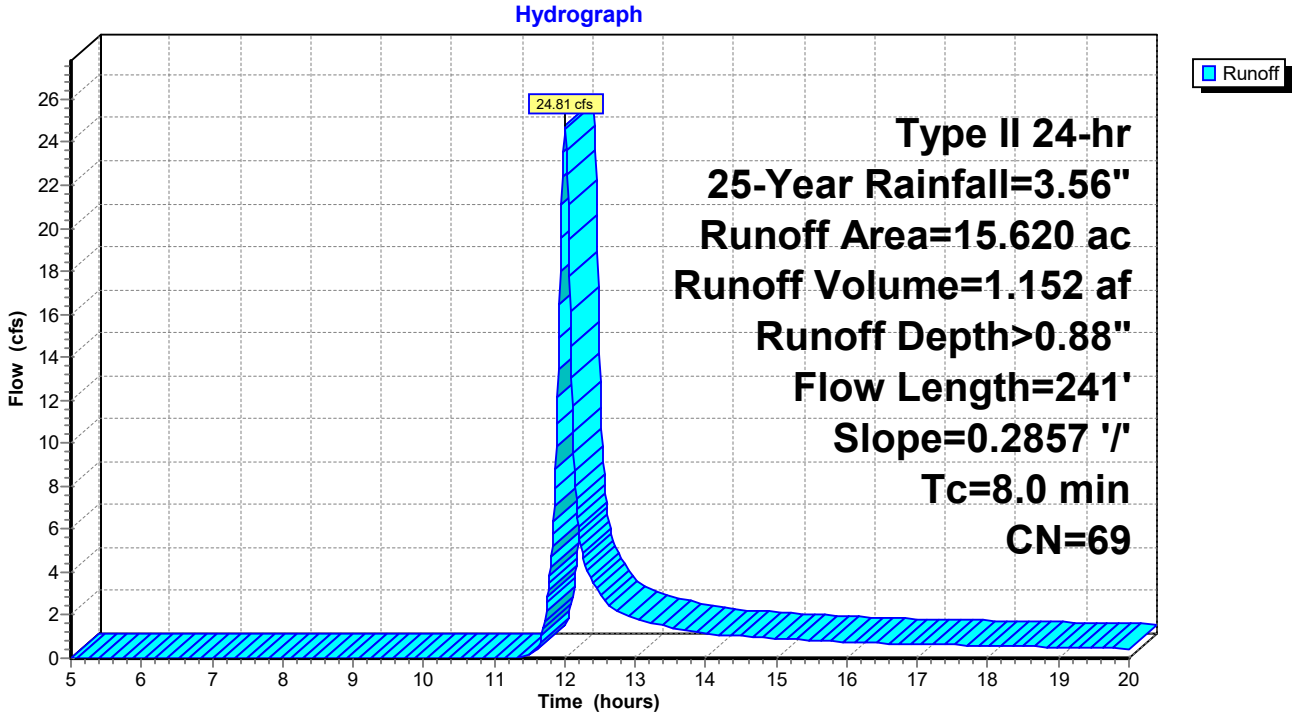
Runoff = 24.81 cfs @ 12.01 hrs, Volume= 1.152 af, Depth> 0.88"
Routed to Reach 14R : Reach 3-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	15.620	69	
	15.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	241	0.2857	0.50		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 11S: Basin 3-2



Summary for Subcatchment 12S: Basin 3-1

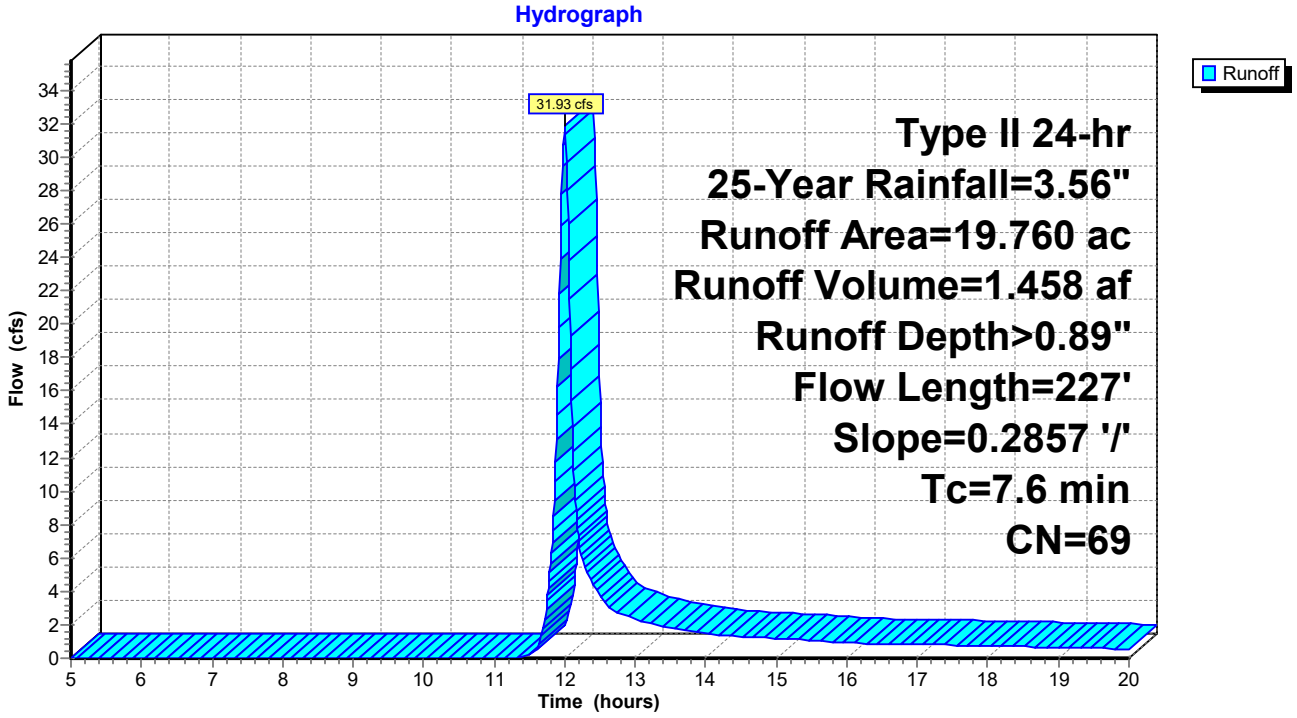
Runoff = 31.93 cfs @ 12.00 hrs, Volume= 1.458 af, Depth> 0.89"
Routed to Reach 13R : Reach 3-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	19.760	69	
	19.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	227	0.2857	0.50		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 12S: Basin 3-1



Summary for Subcatchment 16S: Basin 4-1-1

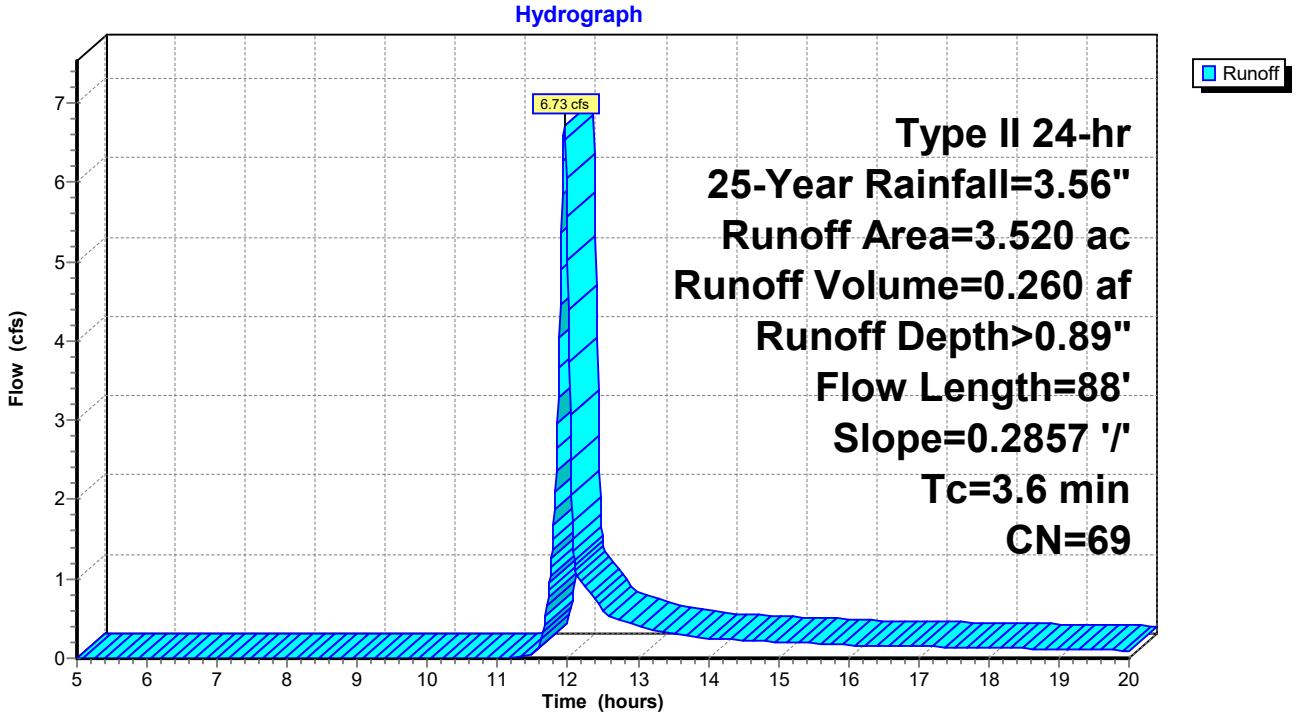
Runoff = 6.73 cfs @ 11.95 hrs, Volume= 0.260 af, Depth> 0.89"
Routed to Reach 17R : Reach 4-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	3.520	69	
	3.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	88	0.2857	0.41		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 16S: Basin 4-1-1



Summary for Subcatchment 19S: Basin 4-1-2

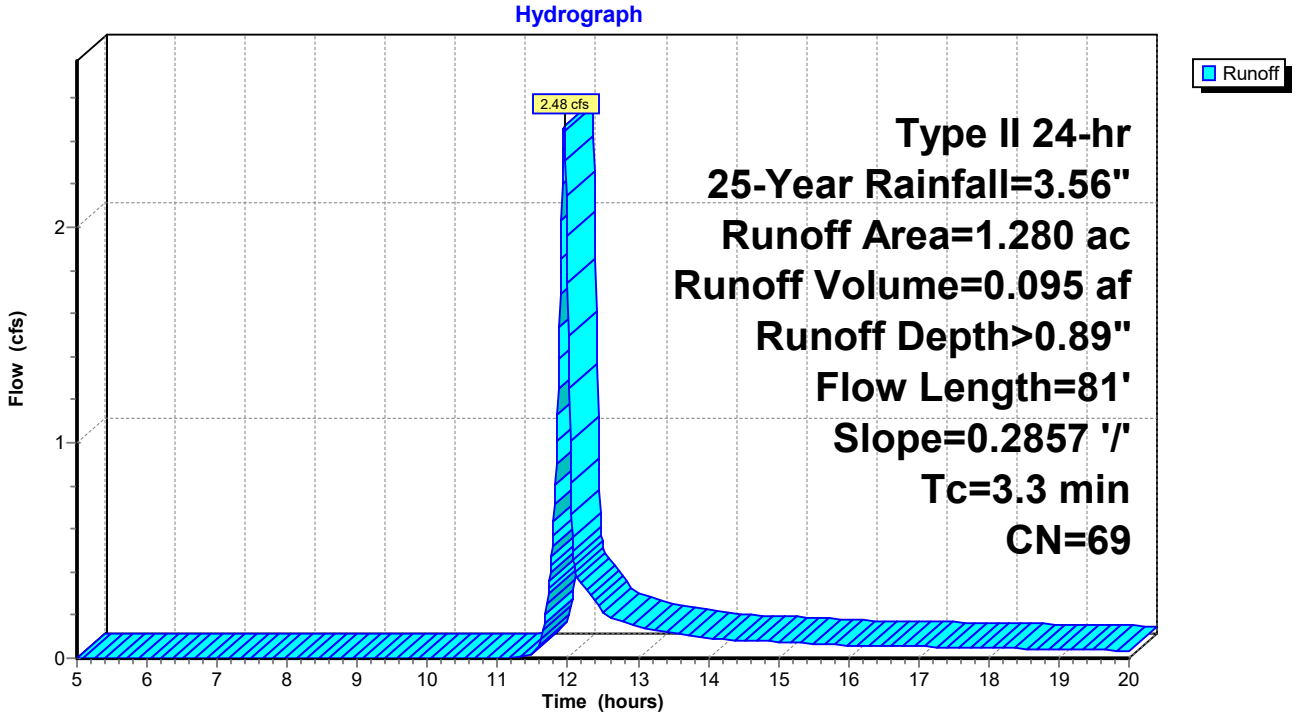
Runoff = 2.48 cfs @ 11.95 hrs, Volume= 0.095 af, Depth> 0.89"
Routed to Pond 18P : North Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	1.280	69	
	1.280		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	81	0.2857	0.41		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 19S: Basin 4-1-2



Summary for Subcatchment 22S: Basin 4-2-1

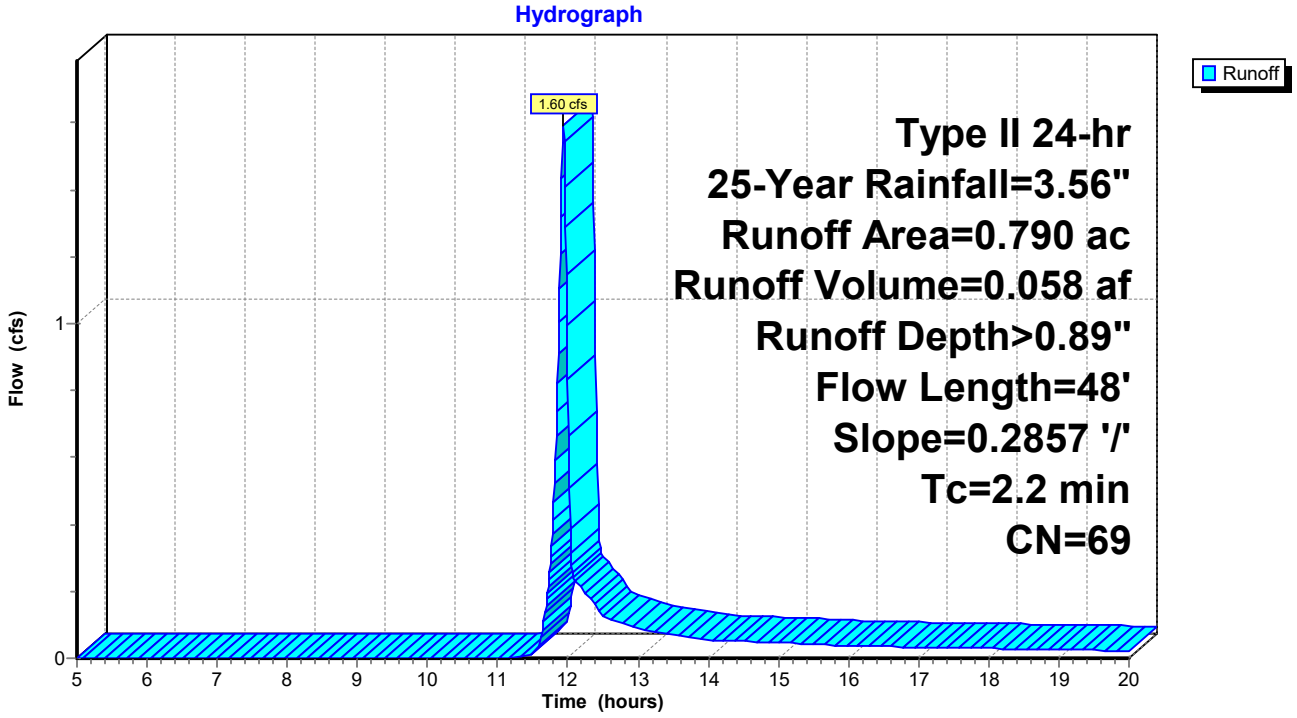
Runoff = 1.60 cfs @ 11.93 hrs, Volume= 0.058 af, Depth> 0.89"
Routed to Reach 20R : Reach 4.2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	0.790	69	
	0.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	48	0.2857	0.37		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 22S: Basin 4-2-1



Summary for Subcatchment 24S: Basin 6-1

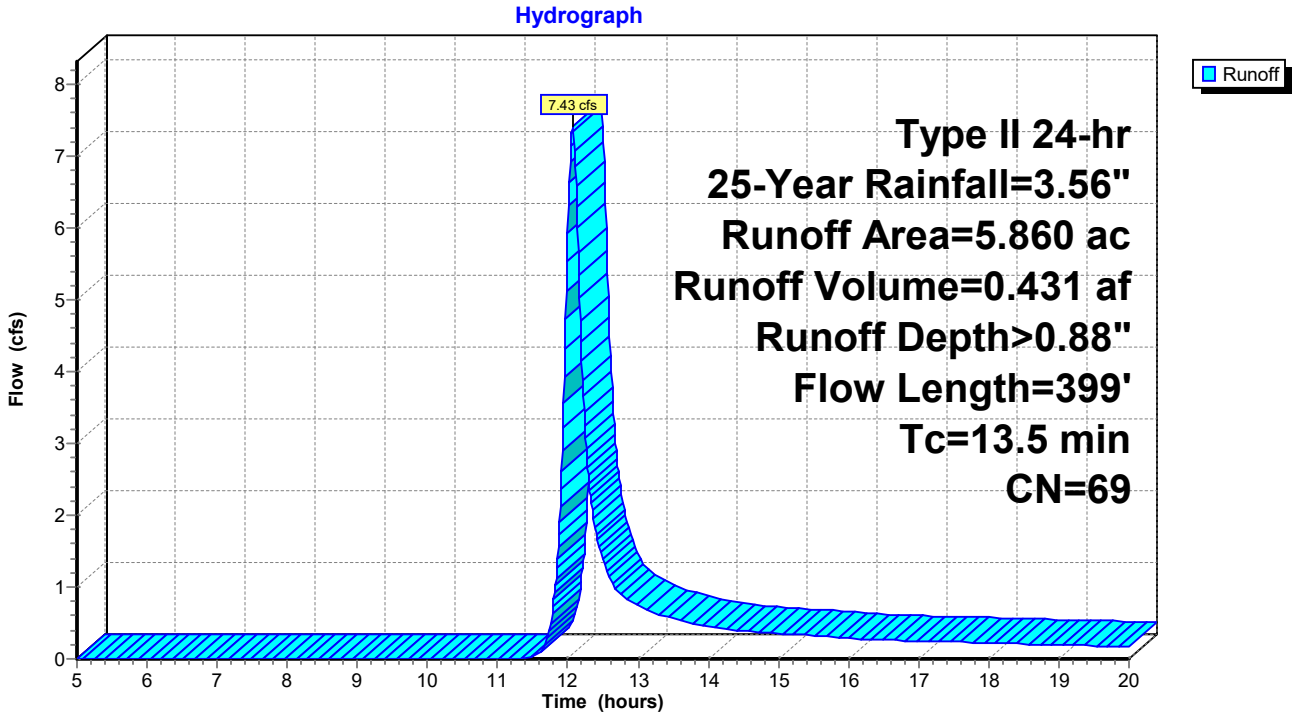
Runoff = 7.43 cfs @ 12.07 hrs, Volume= 0.431 af, Depth> 0.88"
Routed to Reach 26R : Reach 6-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	5.860	69	
	5.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	172	0.0500	0.24		**Sheet Flow,** Range n= 0.130 P2= 1.88"
0.6	61	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	166	0.2857	3.74		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.5	399	Total			

Subcatchment 24S: Basin 6-1



Summary for Subcatchment 25S: Basin 6-2

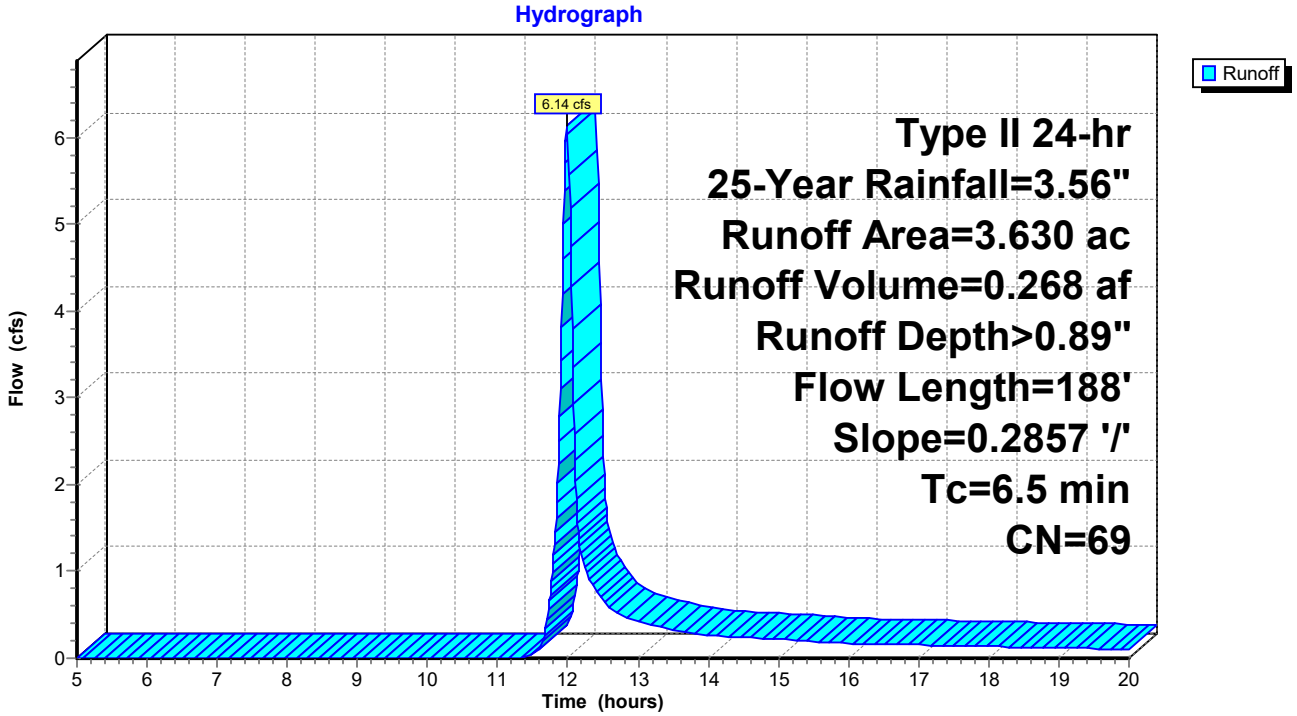
Runoff = 6.14 cfs @ 11.99 hrs, Volume= 0.268 af, Depth> 0.89"
Routed to Reach 27R : Reach 6-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	3.630	69	
	3.630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	188	0.2857	0.48		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 25S: Basin 6-2



Summary for Subcatchment 29S: Basin 7-1

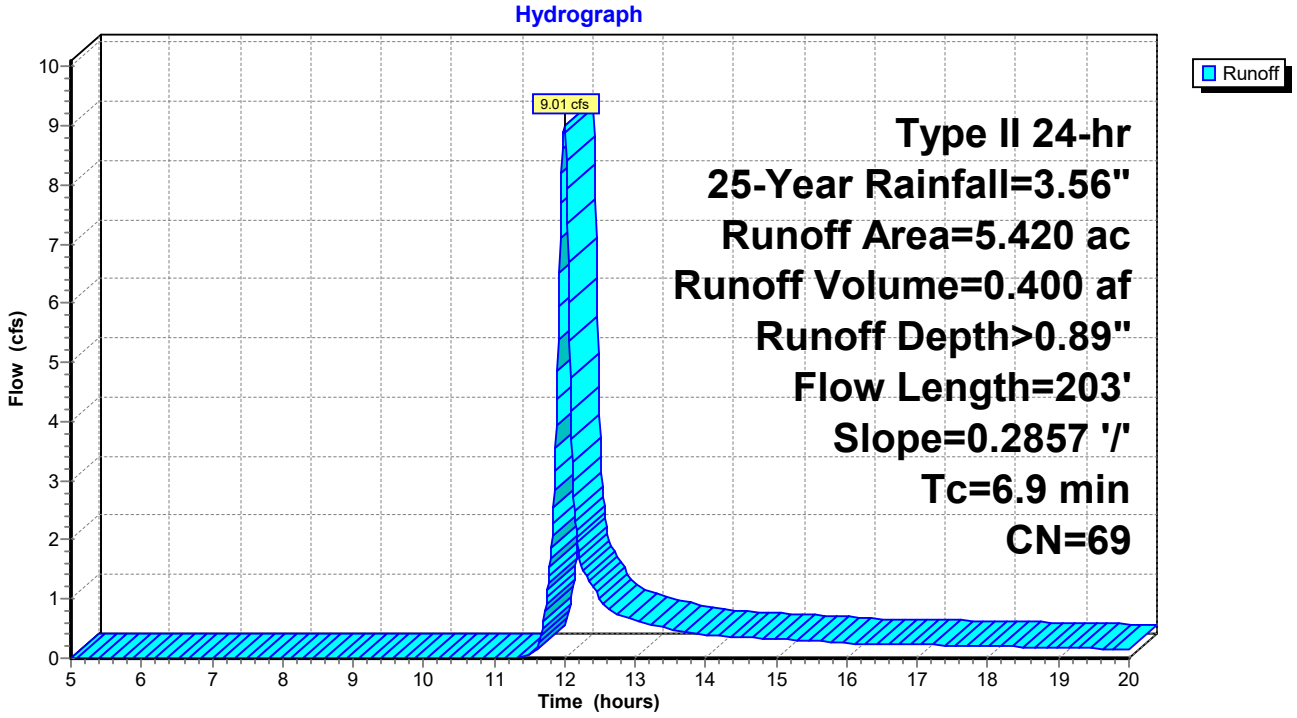
Runoff = 9.01 cfs @ 11.99 hrs, Volume= 0.400 af, Depth> 0.89"
Routed to Reach 31R : Reach 7-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	5.420	69	
	5.420		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	203	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 29S: Basin 7-1



Summary for Subcatchment 30S: Basin 7-2

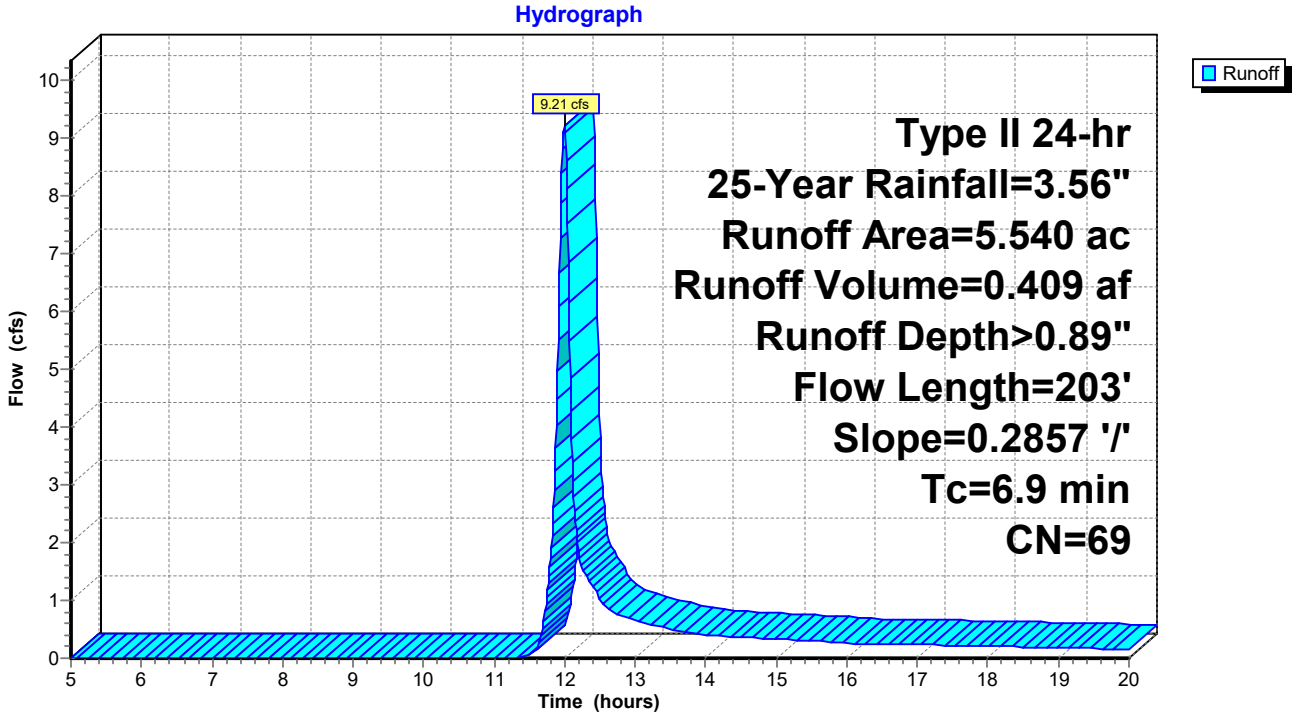
Runoff = 9.21 cfs @ 11.99 hrs, Volume= 0.409 af, Depth> 0.89"
Routed to Reach 32R : Reach 7-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	5.540	69	
	5.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	203	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 30S: Basin 7-2



Summary for Subcatchment 35S: Basin 8-1

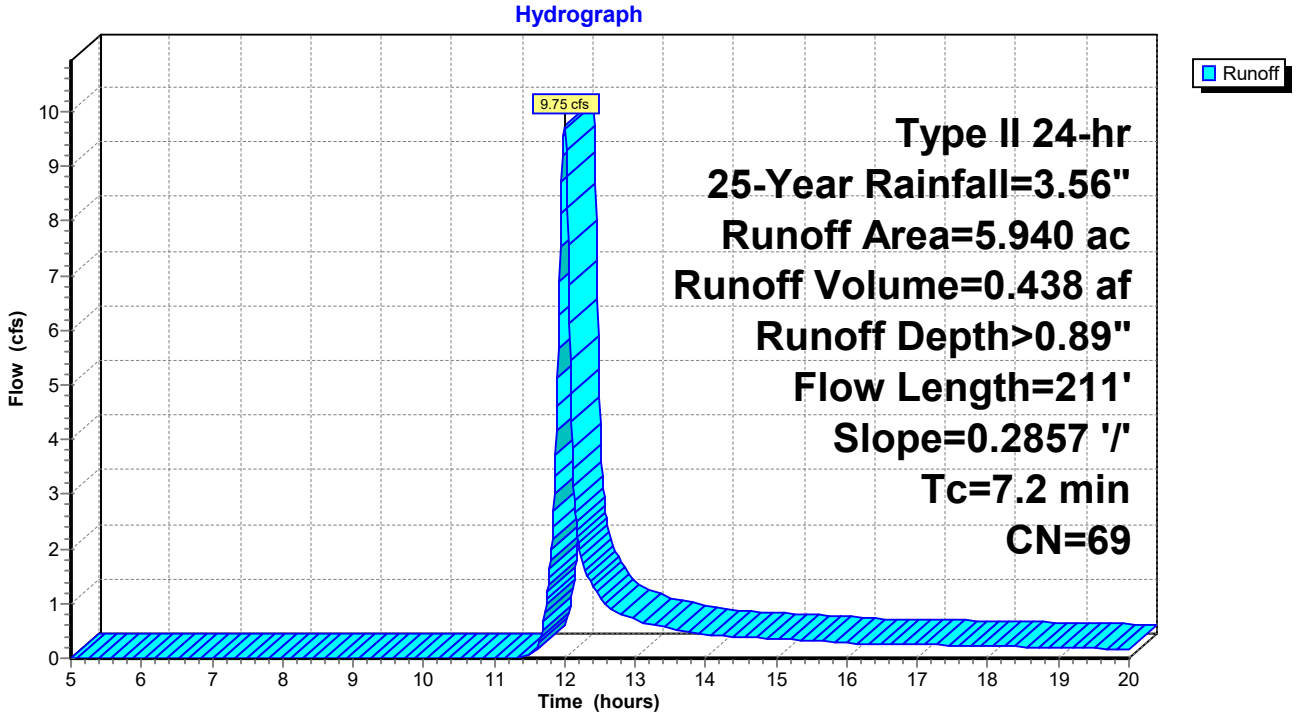
Runoff = 9.75 cfs @ 12.00 hrs, Volume= 0.438 af, Depth> 0.89"
Routed to Reach 36R : Reach 8-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	5.940	69	
	5.940		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	211	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 35S: Basin 8-1



Summary for Subcatchment 37S: Basin 4-2-4

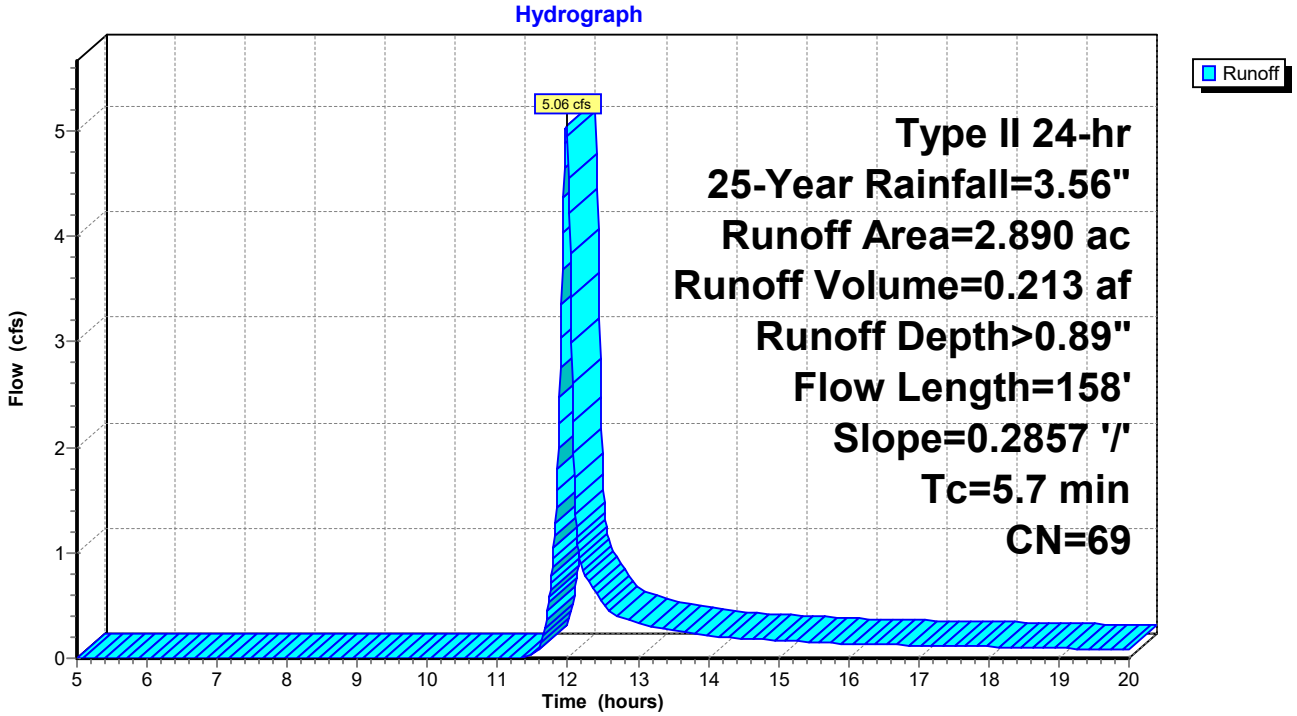
Runoff = 5.06 cfs @ 11.98 hrs, Volume= 0.213 af, Depth> 0.89"
Routed to Pond 34P : Southeast Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	2.890	69	
	2.890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	158	0.2857	0.46		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 37S: Basin 4-2-4



Summary for Subcatchment 38S: Basin 8-2

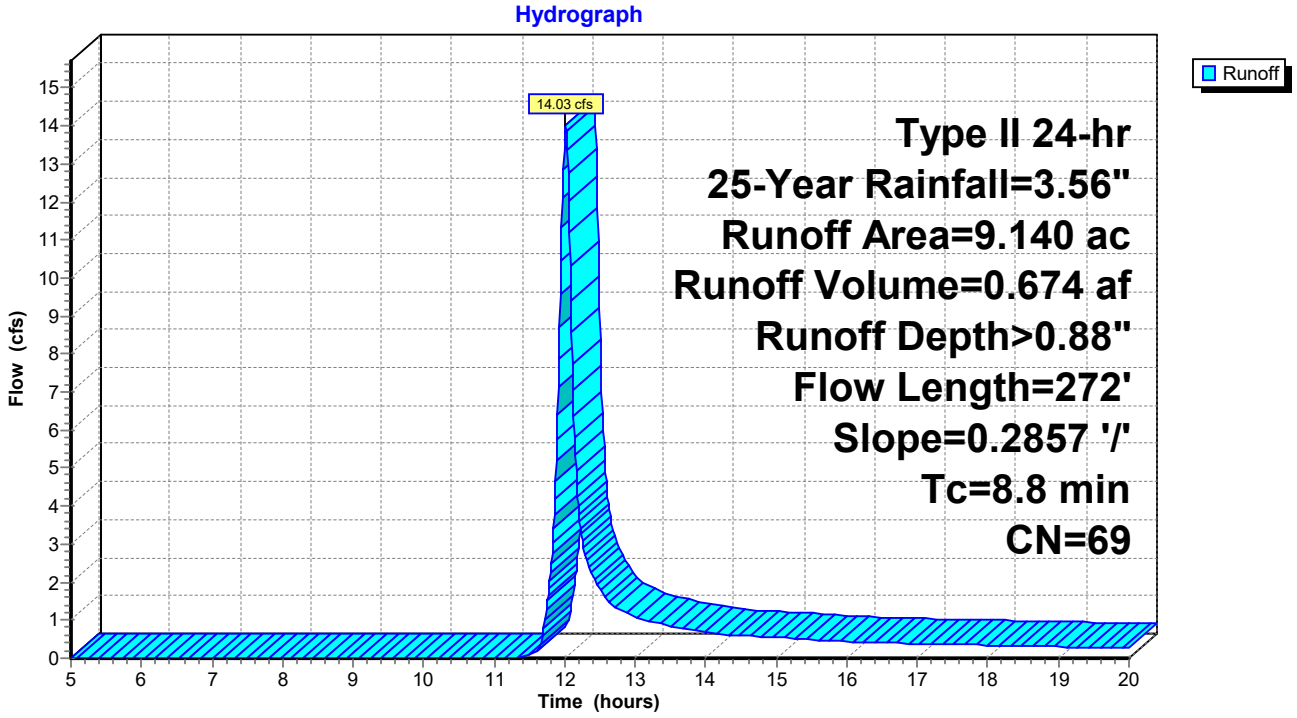
Runoff = 14.03 cfs @ 12.01 hrs, Volume= 0.674 af, Depth> 0.88"
Routed to Pond 34P : Southeast Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	9.140	69	
	9.140		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	272	0.2857	0.52		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 38S: Basin 8-2



Summary for Subcatchment 40S: Basin 4-2-3

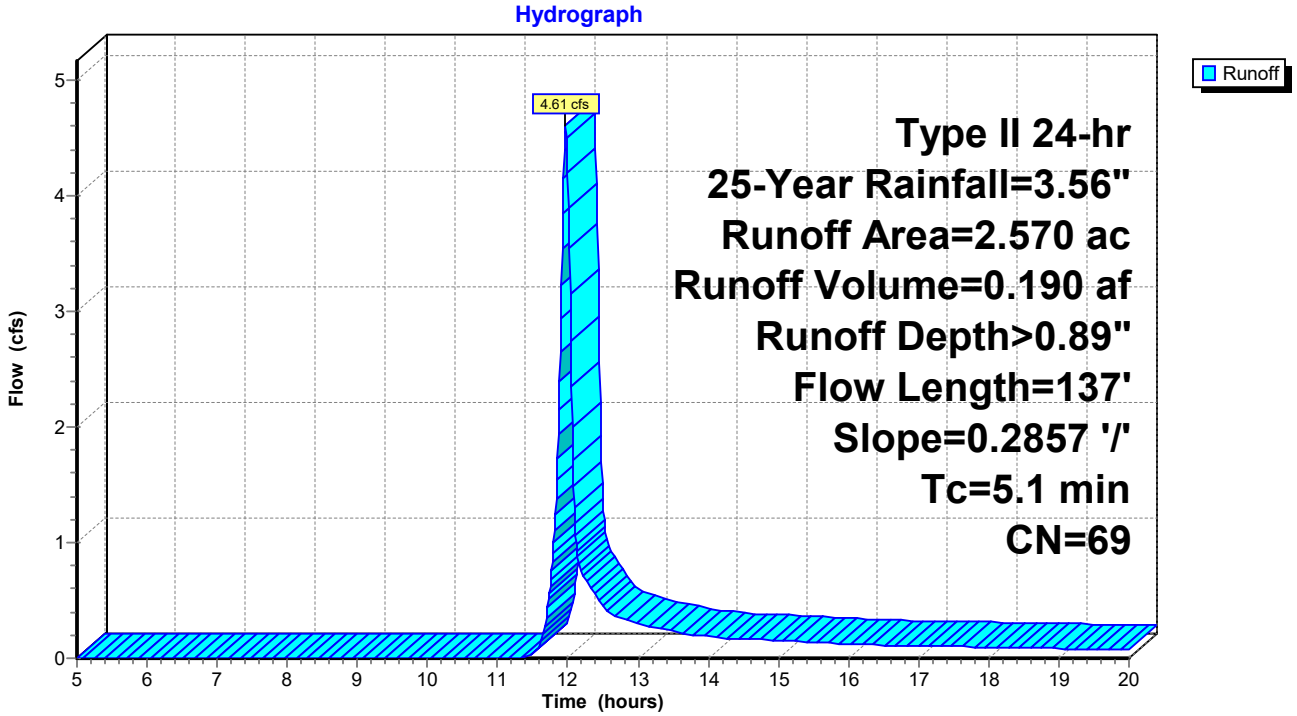
Runoff = 4.61 cfs @ 11.97 hrs, Volume= 0.190 af, Depth> 0.89"
Routed to Reach 39R : Reach 4-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	2.570	69	
	2.570		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	137	0.2857	0.45		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 40S: Basin 4-2-3



Summary for Subcatchment 43S: Basin 5-1-1

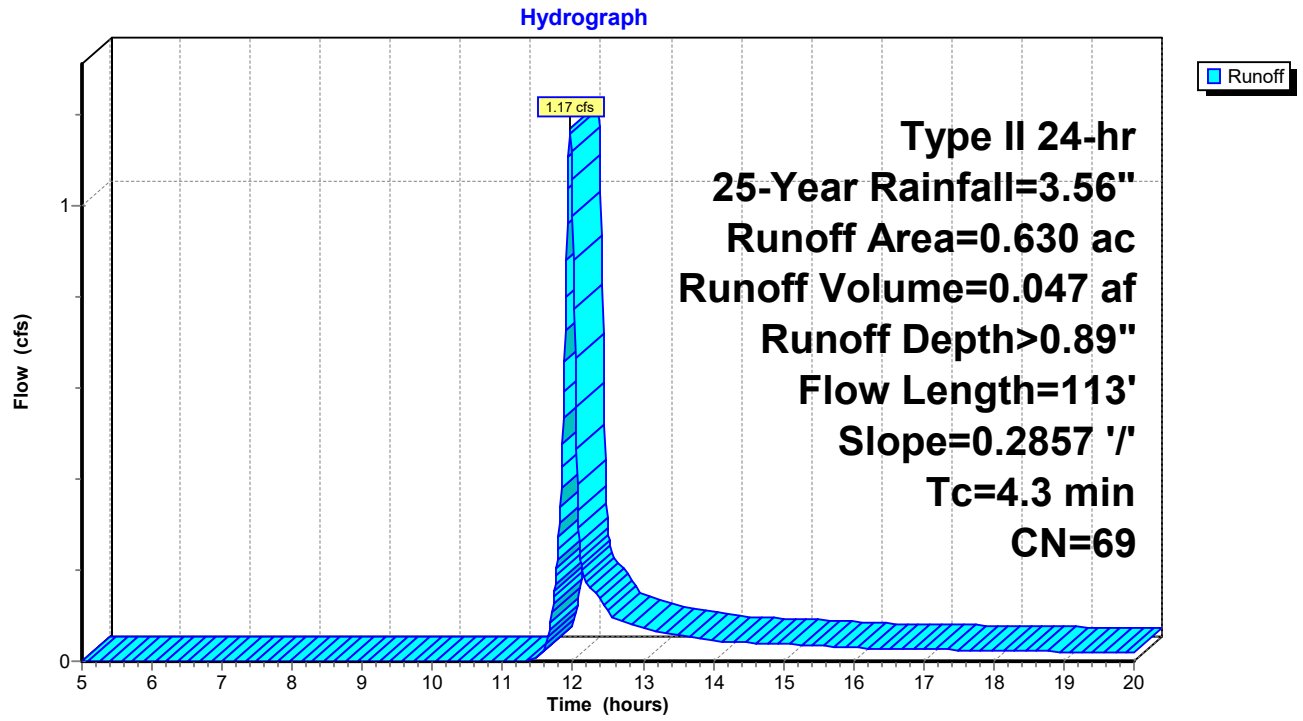
Runoff = 1.17 cfs @ 11.96 hrs, Volume= 0.047 af, Depth> 0.89"
Routed to Reach 44R : Reach 5-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	0.630	69	
	0.630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	113	0.2857	0.43		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 43S: Basin 5-1-1



Summary for Subcatchment 46S: Basin 5-1-2

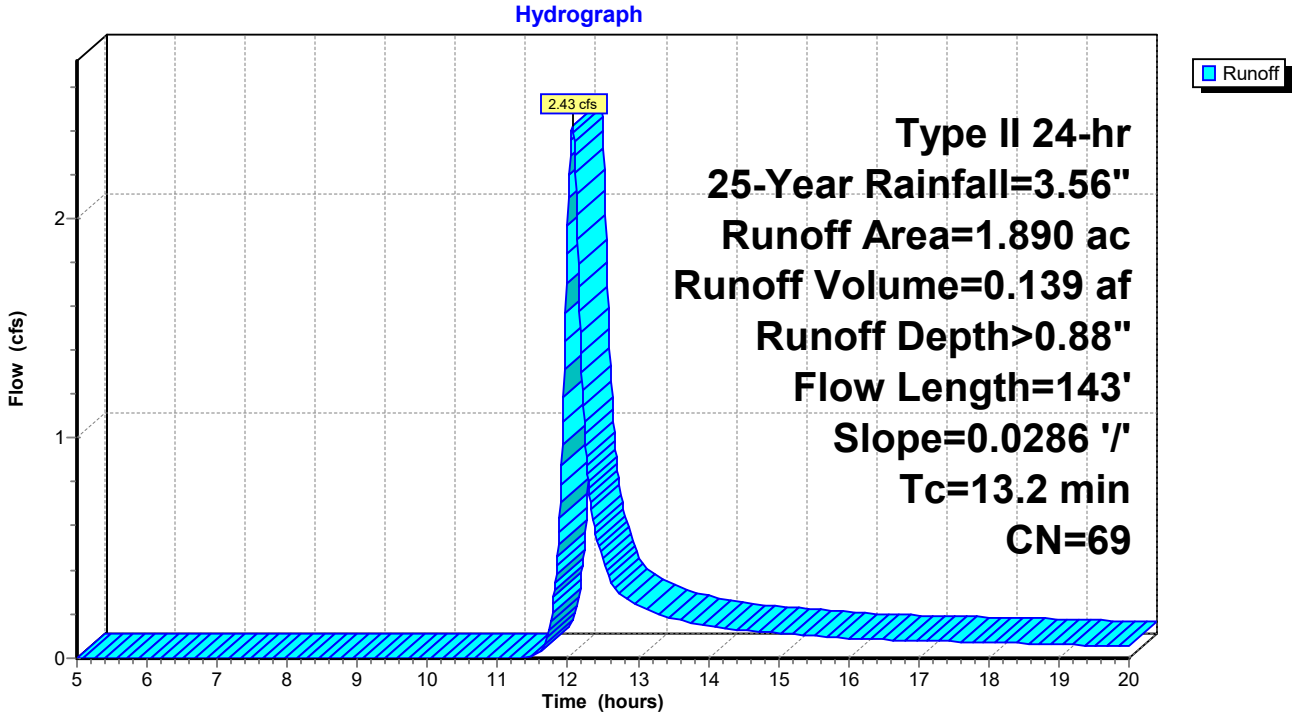
Runoff = 2.43 cfs @ 12.07 hrs, Volume= 0.139 af, Depth> 0.88"
Routed to Pond 45P : Southwest Pond-North Section

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	1.890	69	
	1.890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	143	0.0286	0.18		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 46S: Basin 5-1-2



Summary for Subcatchment 48S: Basin 5-2-2

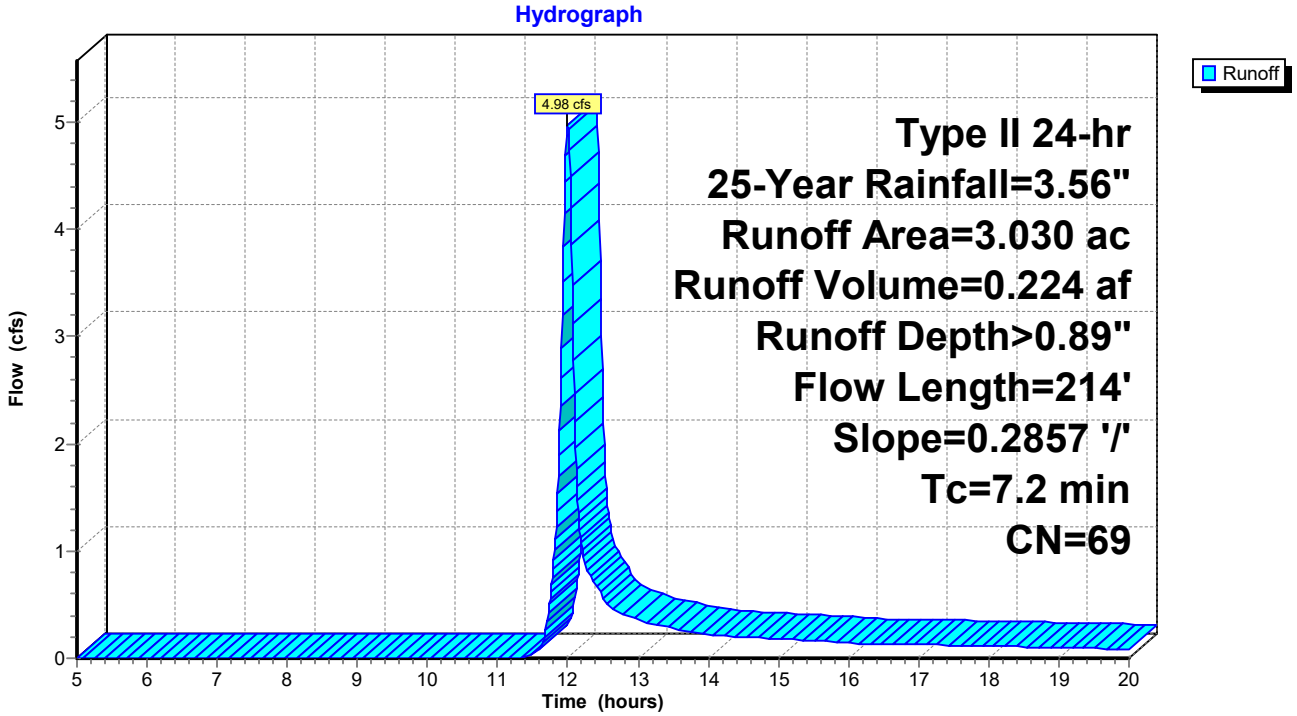
Runoff = 4.98 cfs @ 12.00 hrs, Volume= 0.224 af, Depth> 0.89"
Routed to Reach 49R : Reach 5-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	3.030	69	
	3.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	214	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 48S: Basin 5-2-2



Summary for Subcatchment 50S: Basin 5-2-1

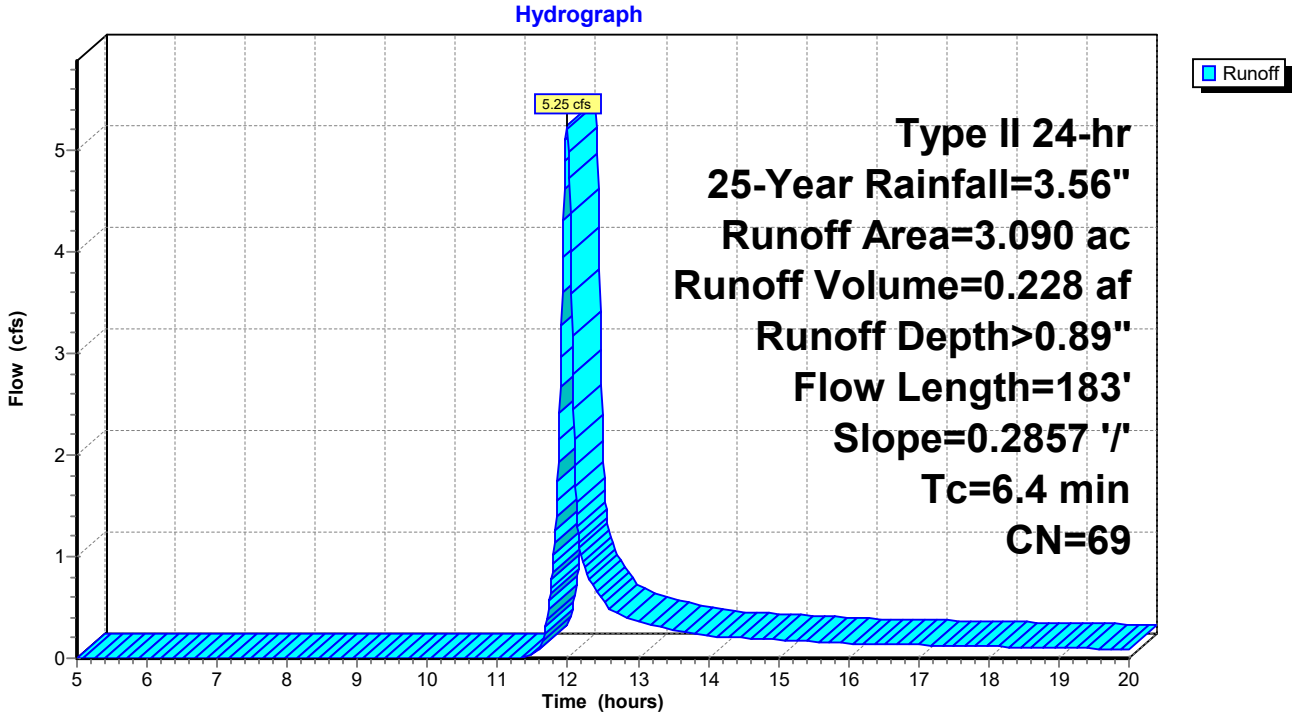
Runoff = 5.25 cfs @ 11.99 hrs, Volume= 0.228 af, Depth> 0.89"
Routed to Pond 55P : Southwest Pond-South Section

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	3.090	69	
	3.090		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	183	0.2857	0.48		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 50S: Basin 5-2-1



Summary for Subcatchment 52S: Basin 4-2-2

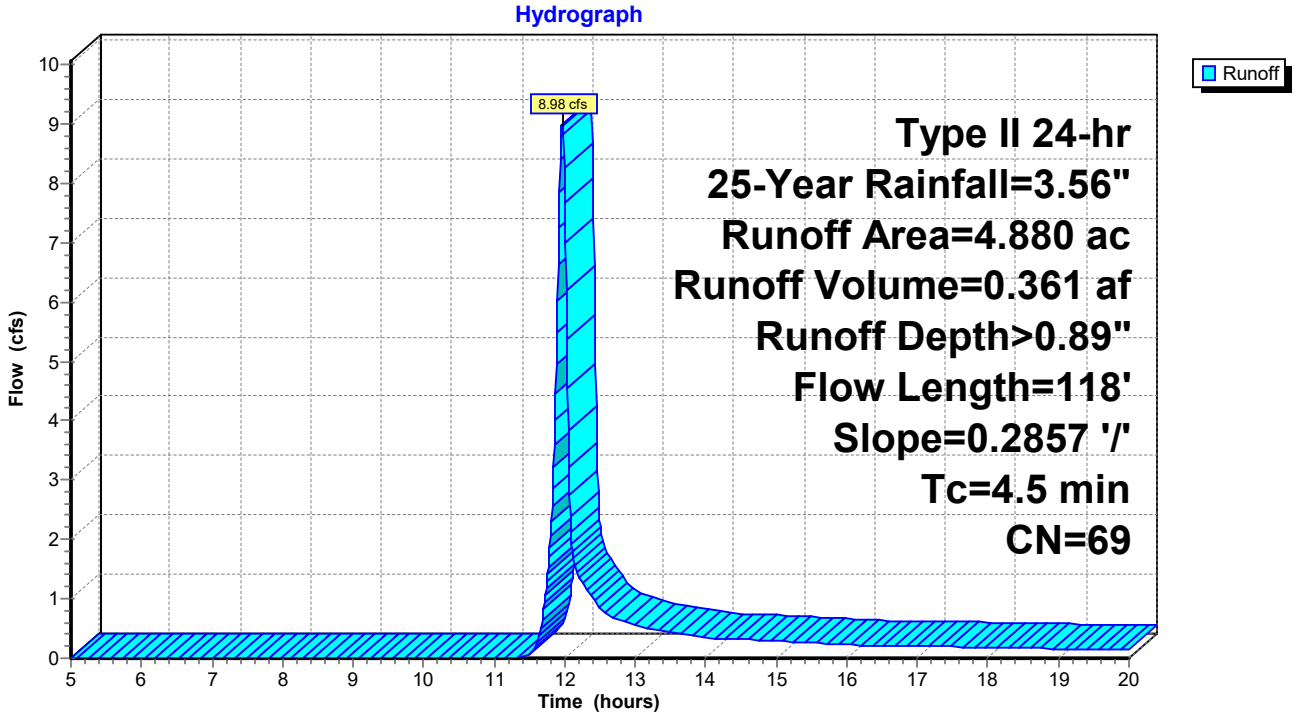
Runoff = 8.98 cfs @ 11.96 hrs, Volume= 0.361 af, Depth> 0.89"
Routed to Pond 15P : Northeast Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	4.880	69	
	4.880		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	118	0.2857	0.44		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 52S: Basin 4-2-2



Summary for Subcatchment 53S: Basin 4-1-3

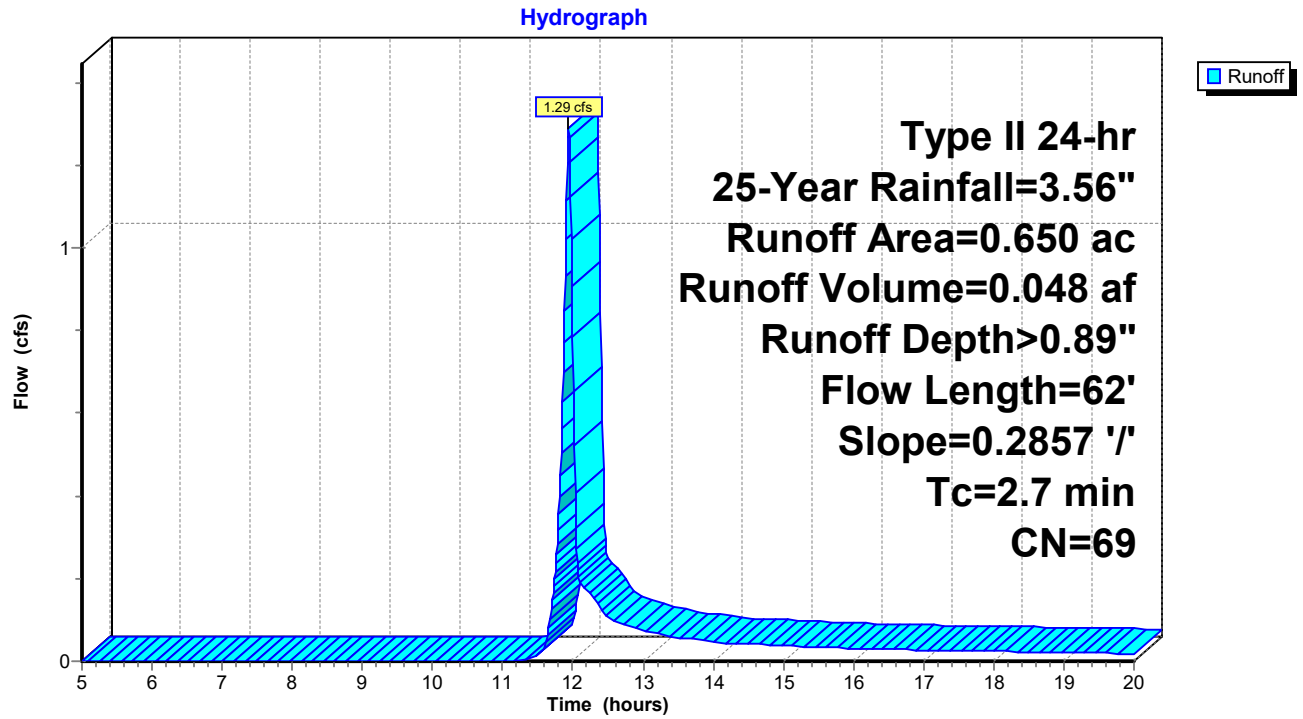
Runoff = 1.29 cfs @ 11.94 hrs, Volume= 0.048 af, Depth> 0.89"
Routed to Reach 42R : Pond to Outfall

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.56"

	Area (ac)	CN	Description
*	0.650	69	
	0.650		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	62	0.2857	0.38		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 53S: Basin 4-1-3



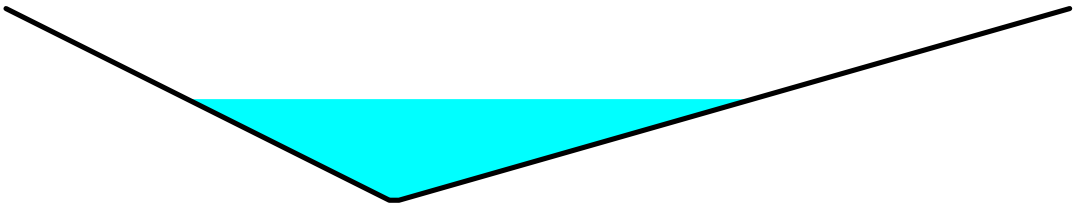
Summary for Reach 3R: Reach 1-1

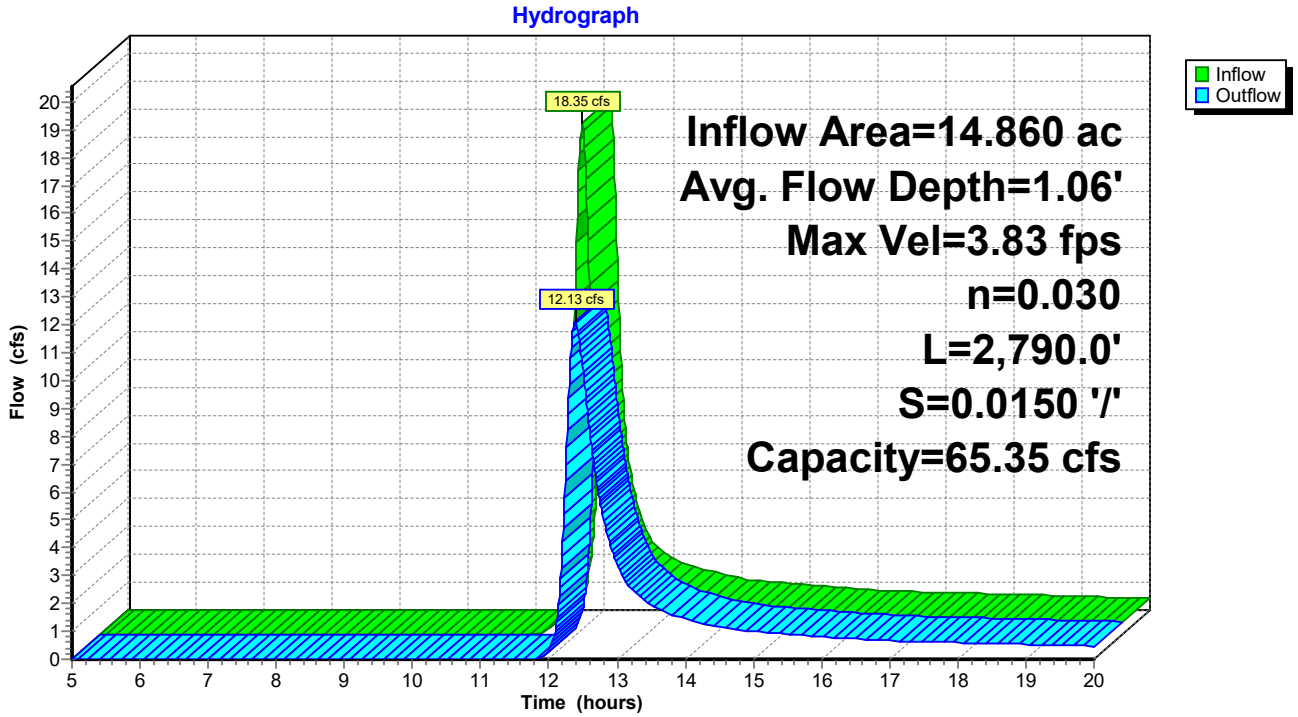
Inflow Area = 14.860 ac, 0.00% Impervious, Inflow Depth > 0.88" for 25-Year event
Inflow = 18.35 cfs @ 12.07 hrs, Volume= 1.093 af
Outflow = 12.13 cfs @ 12.39 hrs, Volume= 1.068 af, Atten= 34%, Lag= 18.9 min
Routed to Reach 5R : North Downchute Top

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.83 fps, Min. Travel Time= 12.1 min
Avg. Velocity = 2.03 fps, Avg. Travel Time= 22.9 min

Peak Storage= 8,838 cf @ 12.19 hrs
Average Depth at Peak Storage= 1.06' , Surface Width= 5.90'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.35 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 2,790.0' Slope= 0.0150 '/'
Inlet Invert= 5,479.25', Outlet Invert= 5,437.50'





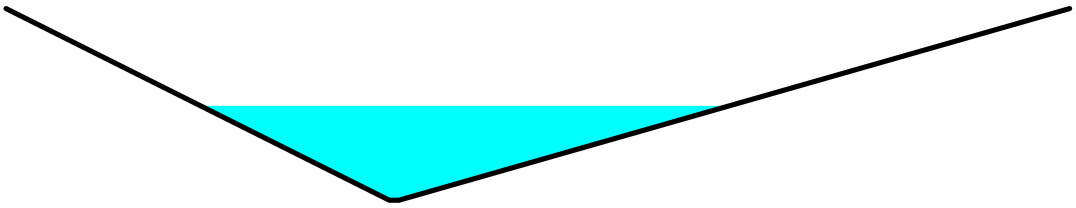
Summary for Reach 4R: Reach 1-2

Inflow Area = 10.030 ac, 0.00% Impervious, Inflow Depth > 0.88" for 25-Year event
Inflow = 12.39 cfs @ 12.07 hrs, Volume= 0.737 af
Outflow = 10.13 cfs @ 12.26 hrs, Volume= 0.728 af, Atten= 18%, Lag= 11.2 min
Routed to Reach 5R : North Downchute Top

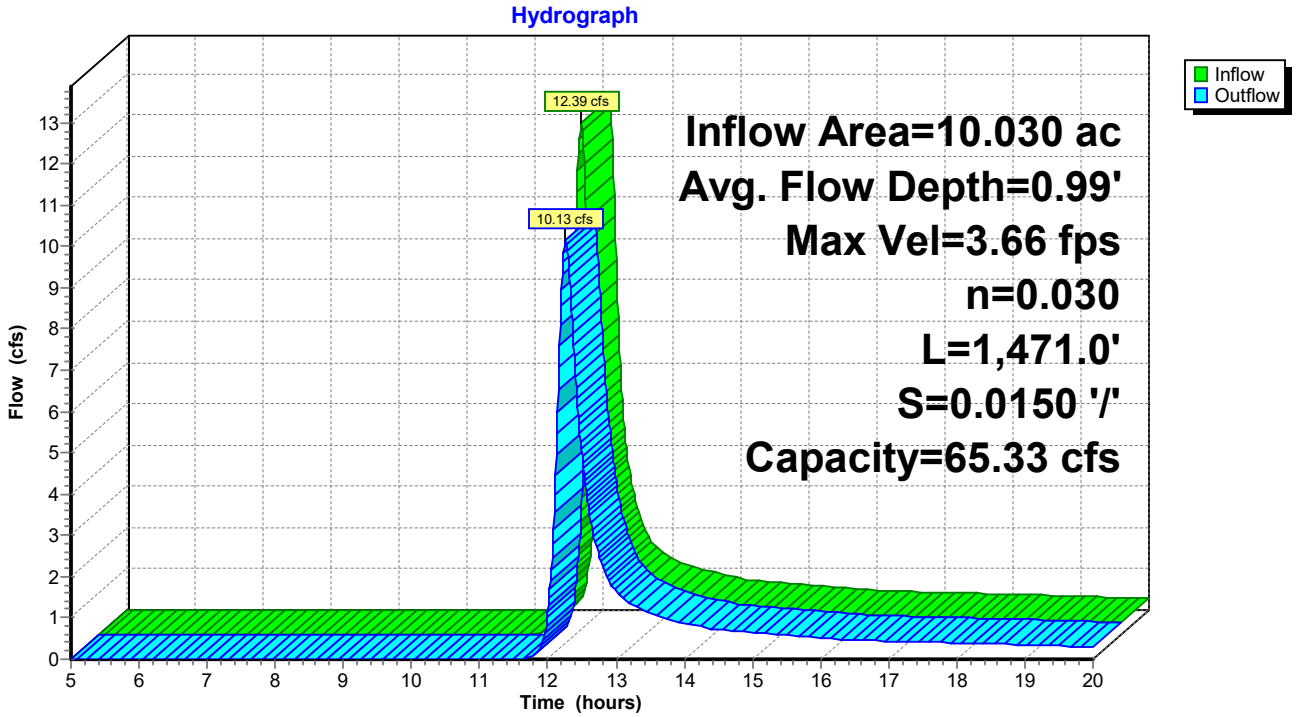
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.66 fps, Min. Travel Time= 6.7 min
Avg. Velocity = 1.84 fps, Avg. Travel Time= 13.4 min

Peak Storage= 4,070 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.99' , Surface Width= 5.52'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.33 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,471.0' Slope= 0.0150 '/'
Inlet Invert= 5,460.50', Outlet Invert= 5,438.50'



Reach 4R: Reach 1-2



Summary for Reach 5R: North Downchute Top

[62] Hint: Exceeded Reach 3R OUTLET depth by 1.00' @ 5.00 hrs
[61] Hint: Exceeded Reach 4R outlet invert by 0.19' @ 12.35 hrs

Inflow Area = 24.890 ac, 0.00% Impervious, Inflow Depth > 0.87" for 25-Year event
Inflow = 20.22 cfs @ 12.34 hrs, Volume= 1.796 af
Outflow = 20.18 cfs @ 12.37 hrs, Volume= 1.791 af, Atten= 0%, Lag= 1.6 min
Routed to Reach 6R : North Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.74 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.51 fps, Avg. Travel Time= 2.5 min

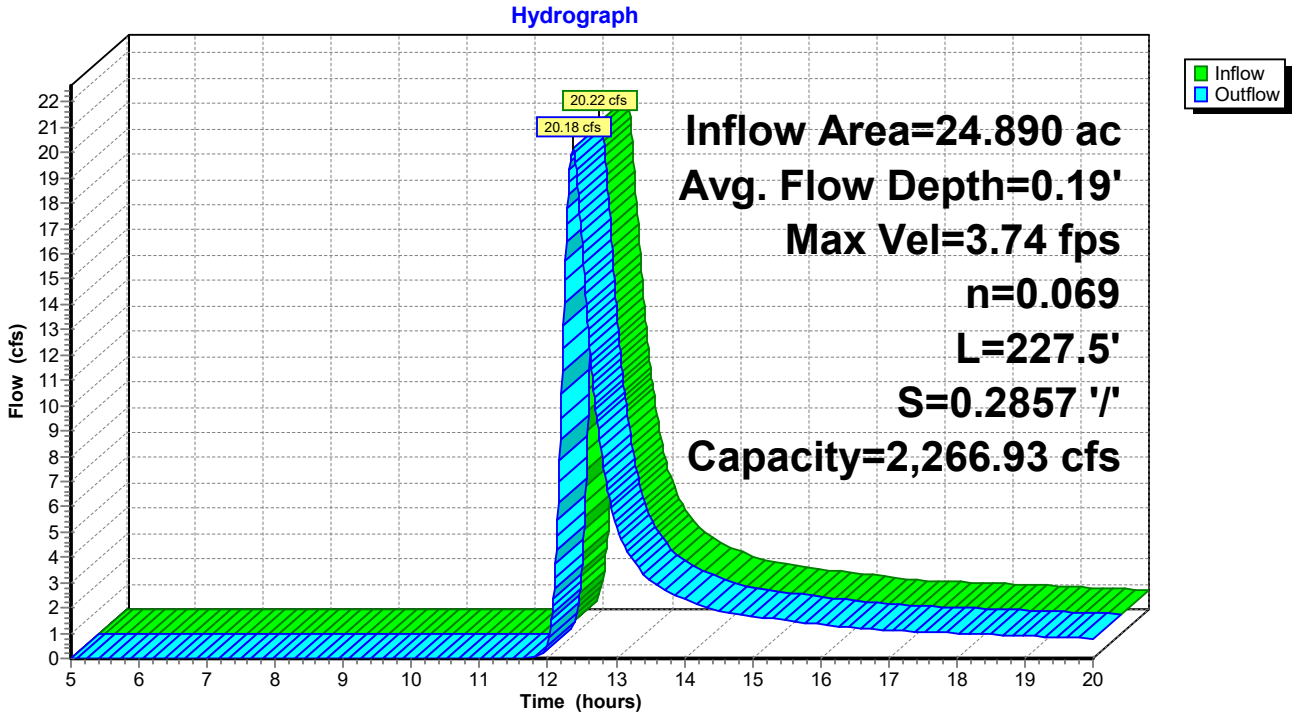
Peak Storage= 1,227 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.19' , Surface Width= 29.13'
Bank-Full Depth= 3.00' Flow Area= 111.0 sf, Capacity= 2,266.93 cfs

28.00' x 3.00' deep channel, n= 0.069
Side Slope Z-value= 3.0 '/' Top Width= 46.00'
Length= 227.5' Slope= 0.2857 '/'
Inlet Invert= 5,438.50', Outlet Invert= 5,373.50'



‡

Reach 5R: North Downchute Top



Summary for Reach 6R: North Downchute Bottom

[61] Hint: Exceeded Reach 5R outlet invert by 0.18' @ 12.35 hrs
[61] Hint: Exceeded Reach 9R outlet invert by 0.18' @ 12.35 hrs
[61] Hint: Exceeded Reach 10R outlet invert by 0.18' @ 12.35 hrs

Inflow Area = 54.870 ac, 0.00% Impervious, Inflow Depth > 0.86" for 25-Year event
Inflow = 44.57 cfs @ 12.34 hrs, Volume= 3.946 af
Outflow = 44.46 cfs @ 12.37 hrs, Volume= 3.935 af, Atten= 0%, Lag= 1.7 min
Routed to Pond 15P : Northeast Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.74 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.50 fps, Avg. Travel Time= 2.6 min

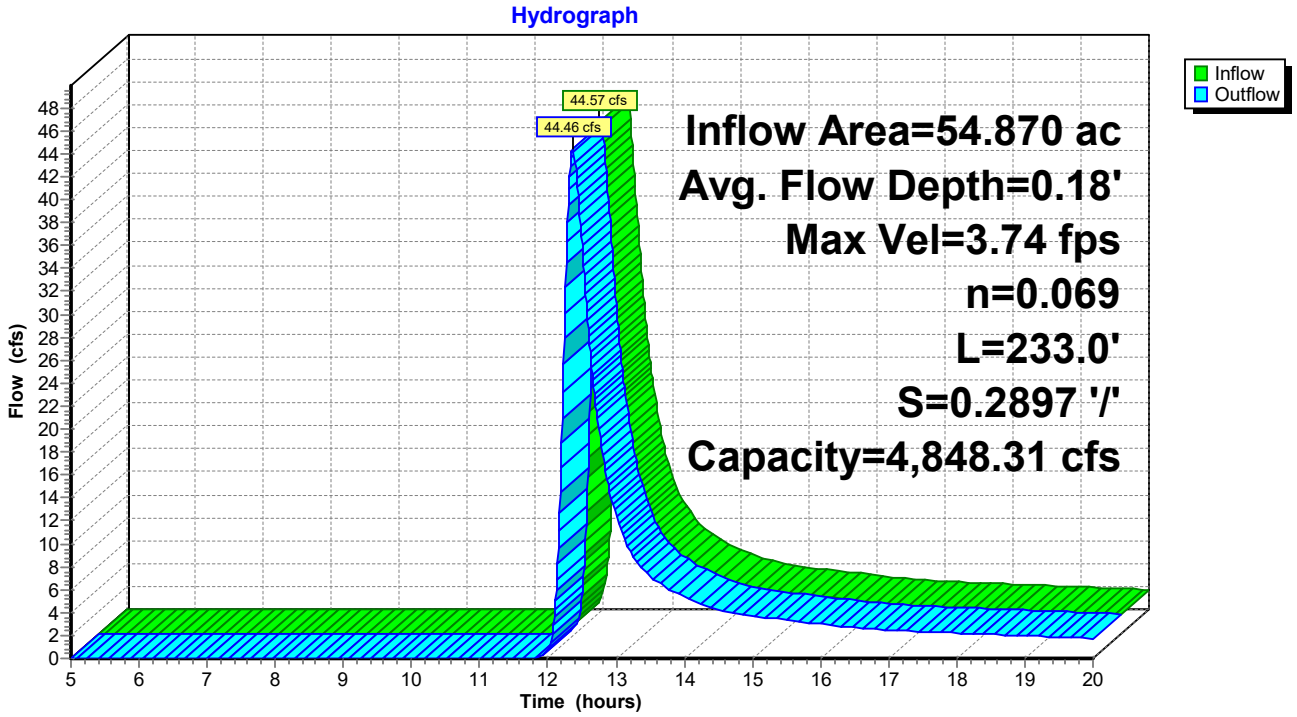
Peak Storage= 2,773 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.18' , Surface Width= 65.11'
Bank-Full Depth= 3.00' Flow Area= 219.0 sf, Capacity= 4,848.31 cfs

64.00' x 3.00' deep channel, n= 0.069
Side Slope Z-value= 3.0 '/' Top Width= 82.00'
Length= 233.0' Slope= 0.2897 '/'
Inlet Invert= 5,373.50', Outlet Invert= 5,306.00'



‡

Reach 6R: North Downchute Bottom



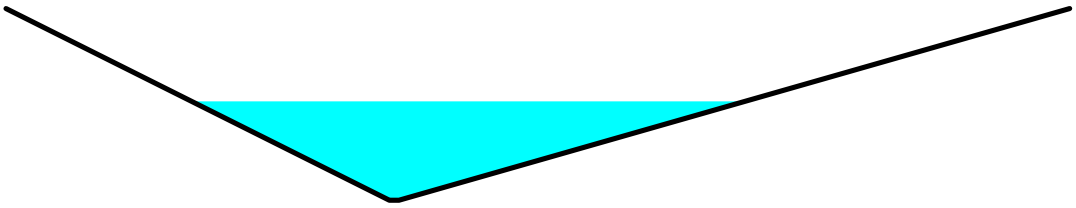
Summary for Reach 9R: Reach 2-1

Inflow Area = 14.450 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 23.84 cfs @ 12.00 hrs, Volume= 1.066 af
Outflow = 11.61 cfs @ 12.36 hrs, Volume= 1.034 af, Atten= 51%, Lag= 22.1 min
Routed to Reach 6R : North Downchute Bottom

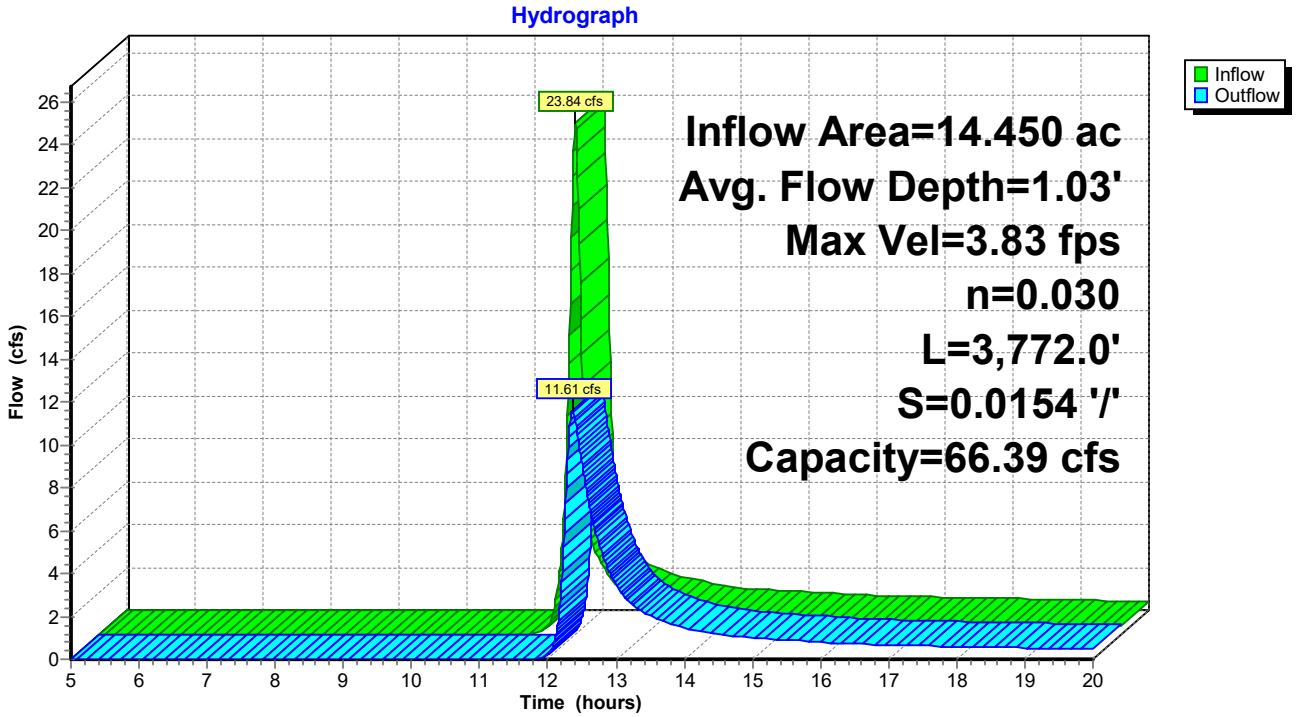
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.83 fps, Min. Travel Time= 16.4 min
Avg. Velocity = 2.05 fps, Avg. Travel Time= 30.7 min

Peak Storage= 11,425 cf @ 12.09 hrs
Average Depth at Peak Storage= 1.03' , Surface Width= 5.77'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 66.39 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 3,772.0' Slope= 0.0154 '/'
Inlet Invert= 5,431.75', Outlet Invert= 5,373.50'



Reach 9R: Reach 2-1



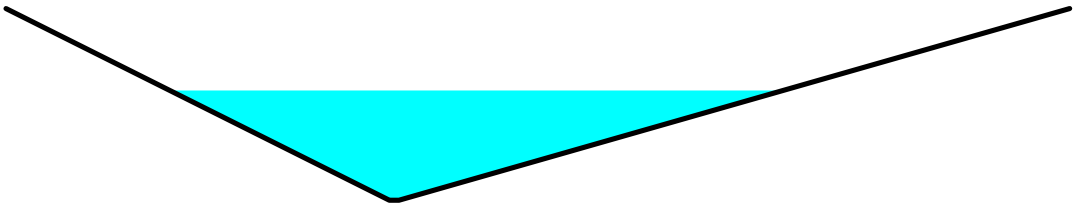
Summary for Reach 10R: Reach 2-2

Inflow Area = 15.530 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 25.09 cfs @ 12.00 hrs, Volume= 1.146 af
Outflow = 15.09 cfs @ 12.27 hrs, Volume= 1.121 af, Atten= 40%, Lag= 16.2 min
Routed to Reach 6R : North Downchute Bottom

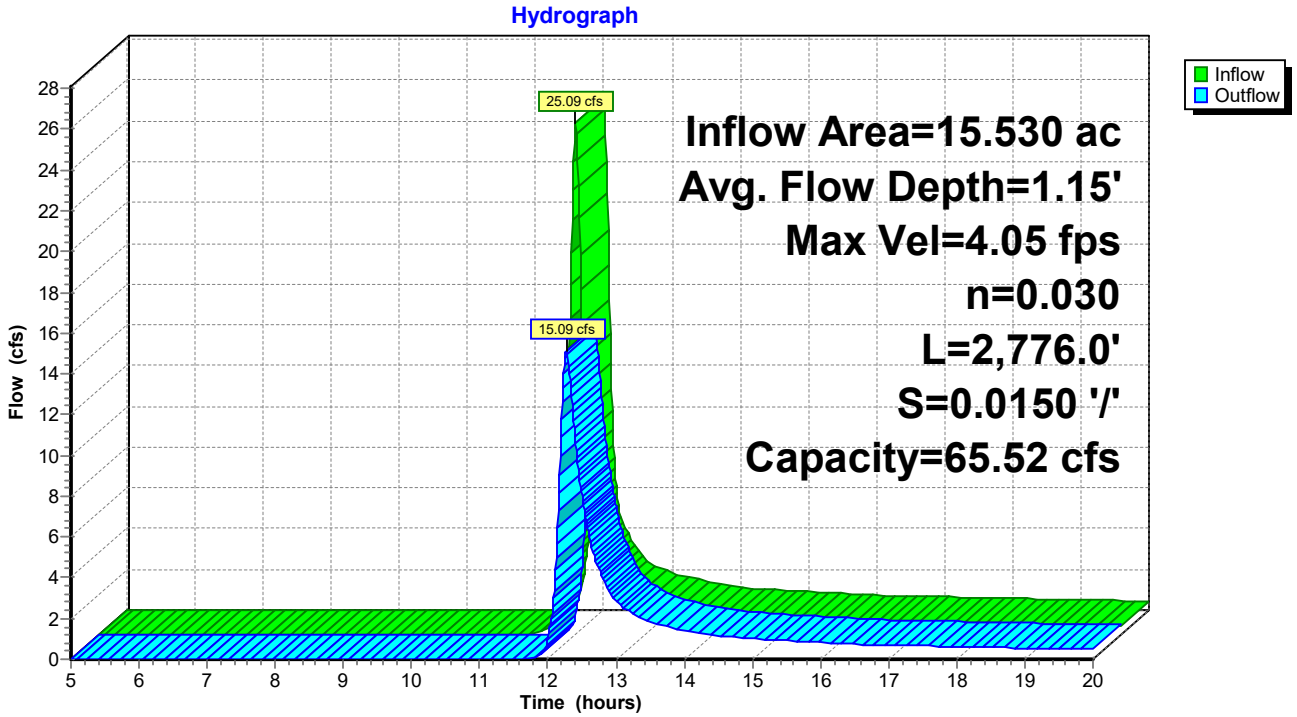
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.05 fps, Min. Travel Time= 11.4 min
Avg. Velocity = 2.06 fps, Avg. Travel Time= 22.5 min

Peak Storage= 10,333 cf @ 12.08 hrs
Average Depth at Peak Storage= 1.15' , Surface Width= 6.40'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.52 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 2,776.0' Slope= 0.0150 '/'
Inlet Invert= 5,415.25', Outlet Invert= 5,373.50'



Reach 10R: Reach 2-2



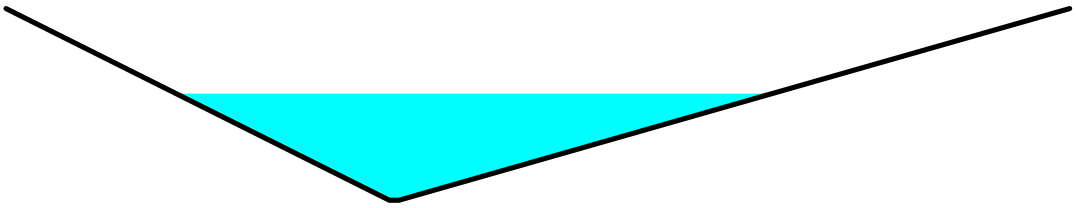
Summary for Reach 13R: Reach 3-1

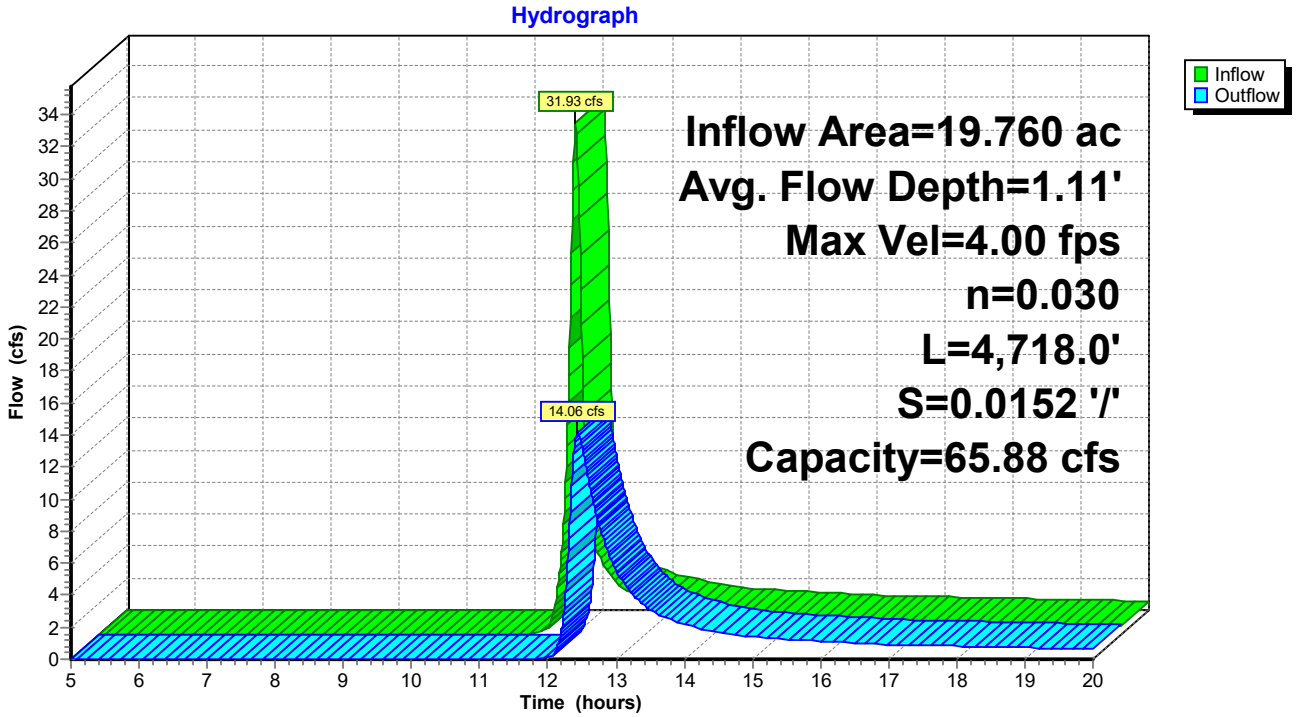
Inflow Area = 19.760 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 31.93 cfs @ 12.00 hrs, Volume= 1.458 af
Outflow = 14.06 cfs @ 12.44 hrs, Volume= 1.405 af, Atten= 56%, Lag= 26.1 min
Routed to Pond 15P : Northeast Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.00 fps, Min. Travel Time= 19.7 min
Avg. Velocity = 2.21 fps, Avg. Travel Time= 35.6 min

Peak Storage= 16,592 cf @ 12.11 hrs
Average Depth at Peak Storage= 1.11' , Surface Width= 6.22'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.88 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 4,718.0' Slope= 0.0152 '/'
Inlet Invert= 5,377.75', Outlet Invert= 5,306.00'





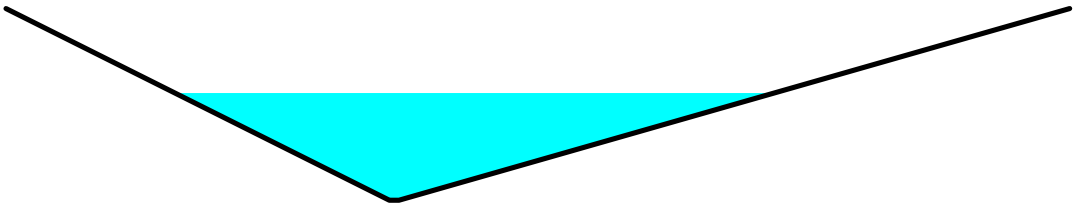
Summary for Reach 14R: Reach 3-2

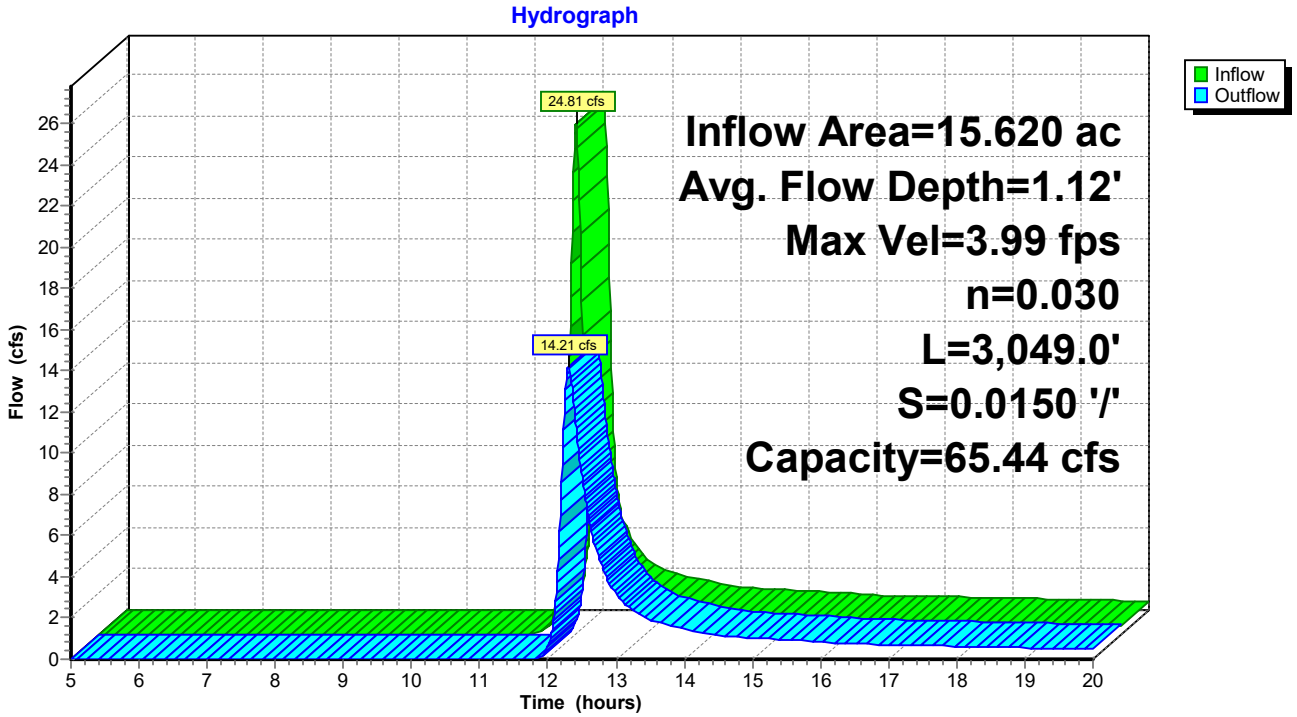
Inflow Area = 15.620 ac, 0.00% Impervious, Inflow Depth > 0.88" for 25-Year event
Inflow = 24.81 cfs @ 12.01 hrs, Volume= 1.152 af
Outflow = 14.21 cfs @ 12.30 hrs, Volume= 1.125 af, Atten= 43%, Lag= 17.9 min
Routed to Pond 15P : Northeast Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.99 fps, Min. Travel Time= 12.7 min
Avg. Velocity = 2.06 fps, Avg. Travel Time= 24.7 min

Peak Storage= 10,863 cf @ 12.09 hrs
Average Depth at Peak Storage= 1.12' , Surface Width= 6.26'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.44 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 3,049.0' Slope= 0.0150 '/'
Inlet Invert= 5,355.00', Outlet Invert= 5,309.25'





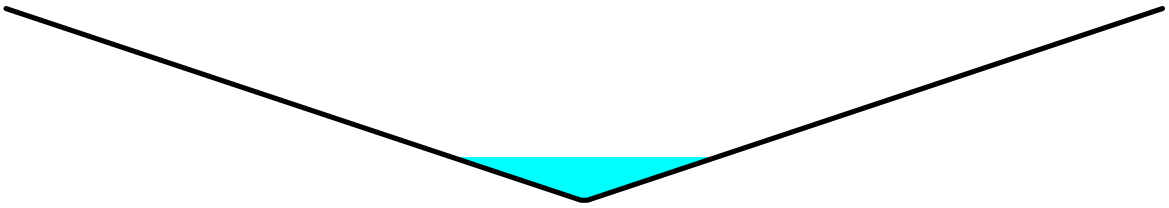
Summary for Reach 17R: Reach 4-1

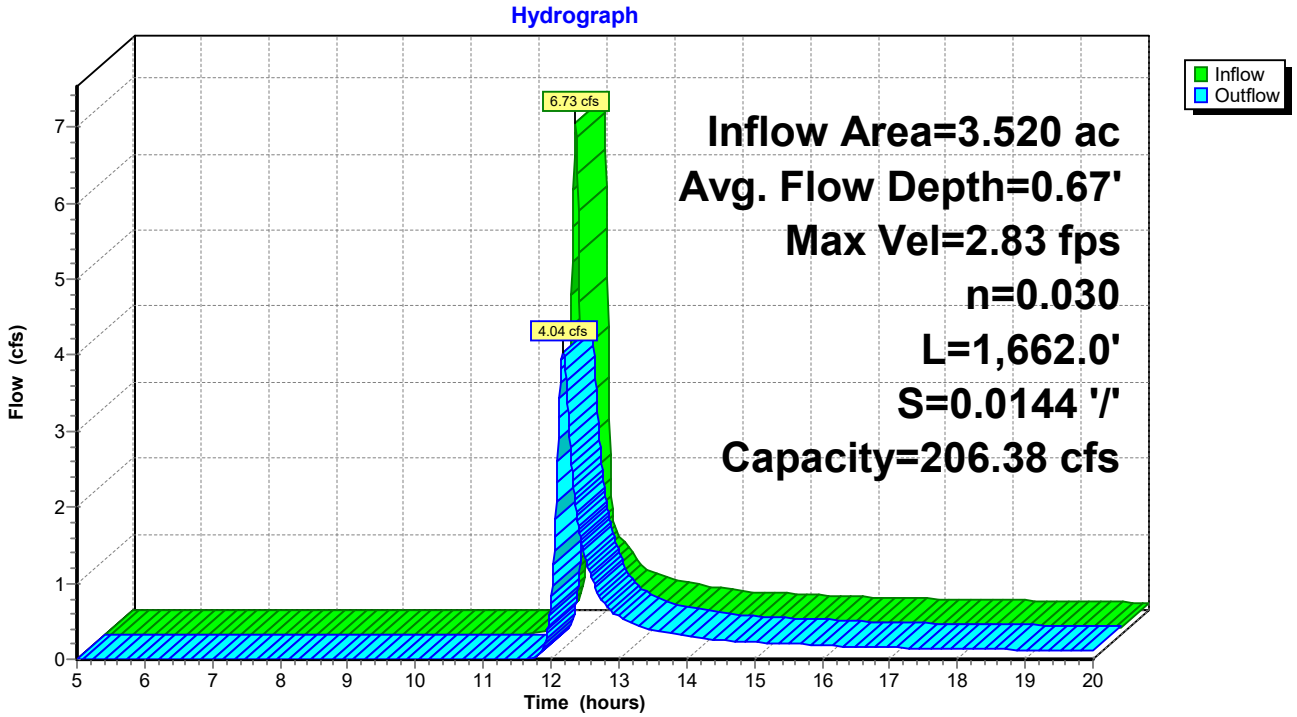
Inflow Area = 3.520 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 6.73 cfs @ 11.95 hrs, Volume= 0.260 af
Outflow = 4.04 cfs @ 12.18 hrs, Volume= 0.255 af, Atten= 40%, Lag= 13.6 min
Routed to Pond 18P : North Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.83 fps, Min. Travel Time= 9.8 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 20.1 min

Peak Storage= 2,377 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.67' , Surface Width= 4.14'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 206.38 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 1,662.0' Slope= 0.0144 '/'
Inlet Invert= 5,326.00', Outlet Invert= 5,302.00'





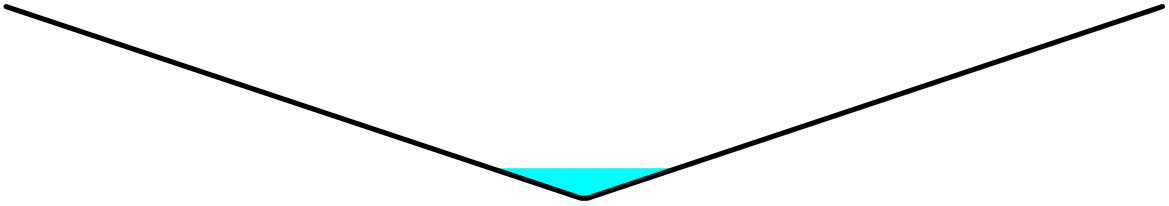
Summary for Reach 20R: Reach 4.2.1

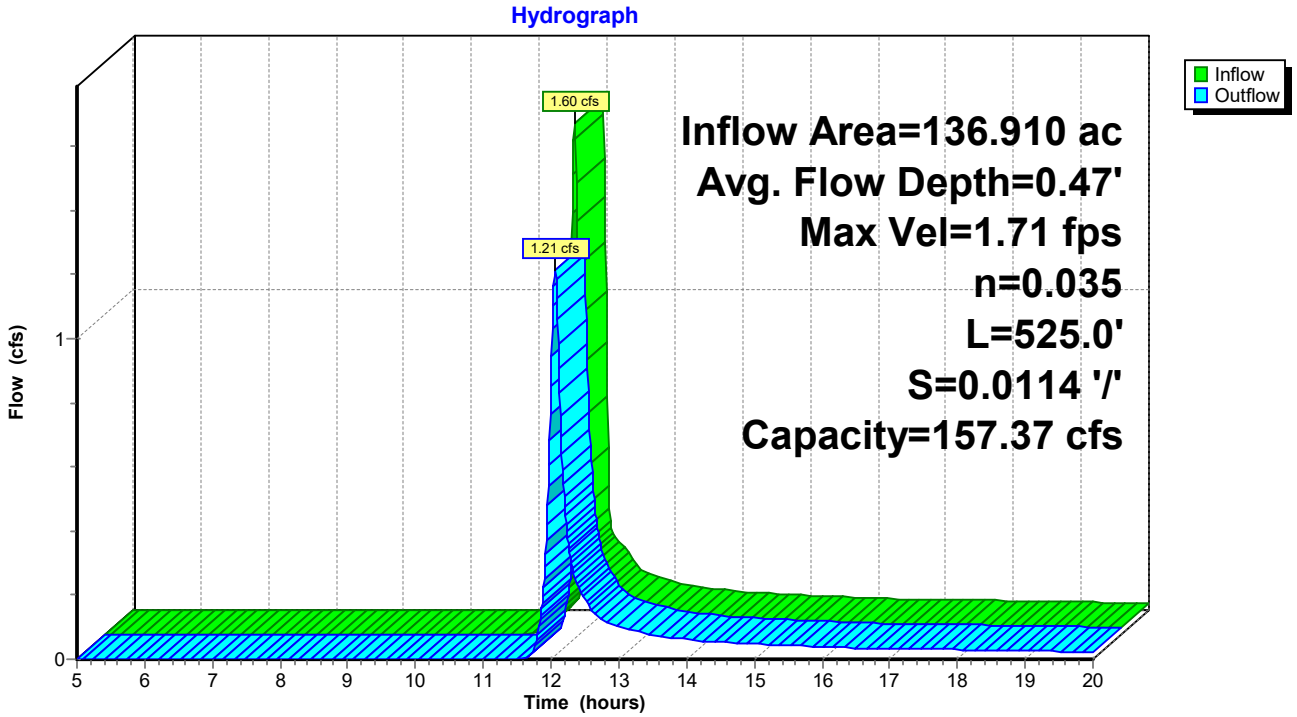
Inflow Area = 136.910 ac, 0.00% Impervious, Inflow Depth > 0.01" for 25-Year event
Inflow = 1.60 cfs @ 11.93 hrs, Volume= 0.058 af
Outflow = 1.21 cfs @ 12.06 hrs, Volume= 0.058 af, Atten= 24%, Lag= 7.7 min
Routed to Pond 23P : Storage in Perimeter Ditch

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.71 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 0.78 fps, Avg. Travel Time= 11.3 min

Peak Storage= 373 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.47' , Surface Width= 2.92'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 157.37 cfs

0.10' x 3.00' deep channel, n= 0.035 Increased from 0.03 to account for in-place detention weirs
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 525.0' Slope= 0.0114 '/'
Inlet Invert= 5,306.00', Outlet Invert= 5,300.00'





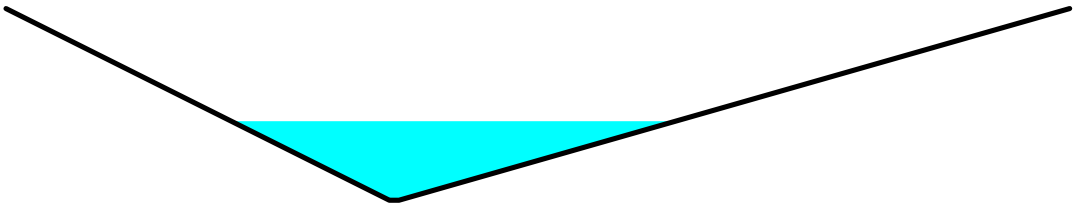
Summary for Reach 26R: Reach 6-1

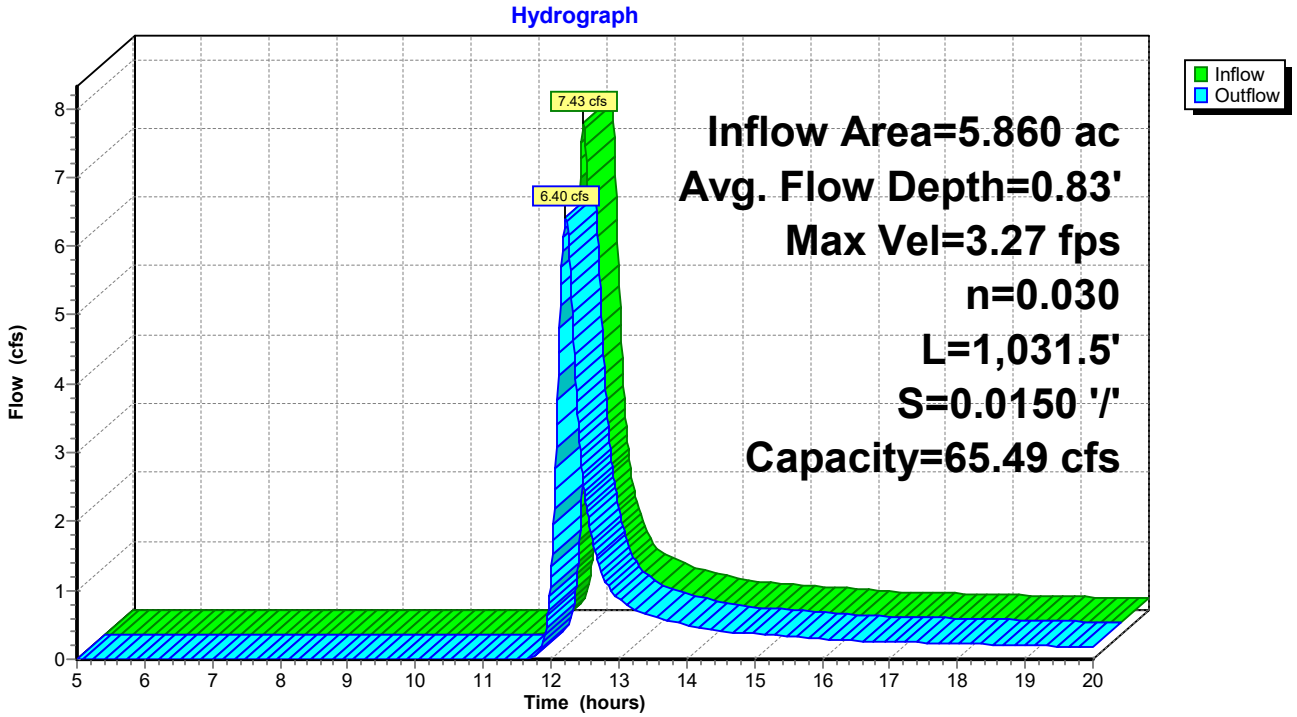
Inflow Area = 5.860 ac, 0.00% Impervious, Inflow Depth > 0.88" for 25-Year event
Inflow = 7.43 cfs @ 12.07 hrs, Volume= 0.431 af
Outflow = 6.40 cfs @ 12.21 hrs, Volume= 0.427 af, Atten= 14%, Lag= 8.8 min
Routed to Reach 28R : South Downchute Top

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.27 fps, Min. Travel Time= 5.3 min
Avg. Velocity = 1.61 fps, Avg. Travel Time= 10.7 min

Peak Storage= 2,020 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.83' , Surface Width= 4.64'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.49 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,031.5' Slope= 0.0150 '/'
Inlet Invert= 5,443.50', Outlet Invert= 5,428.00'





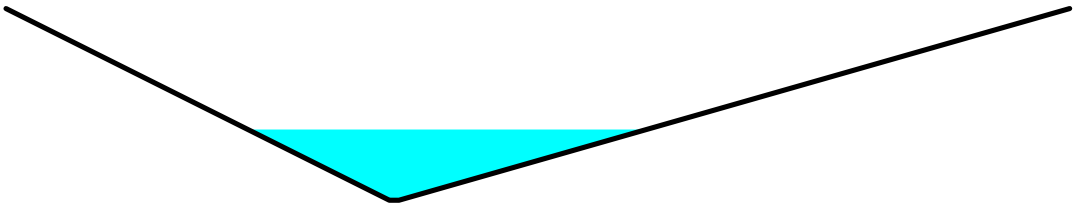
Summary for Reach 27R: Reach 6-2

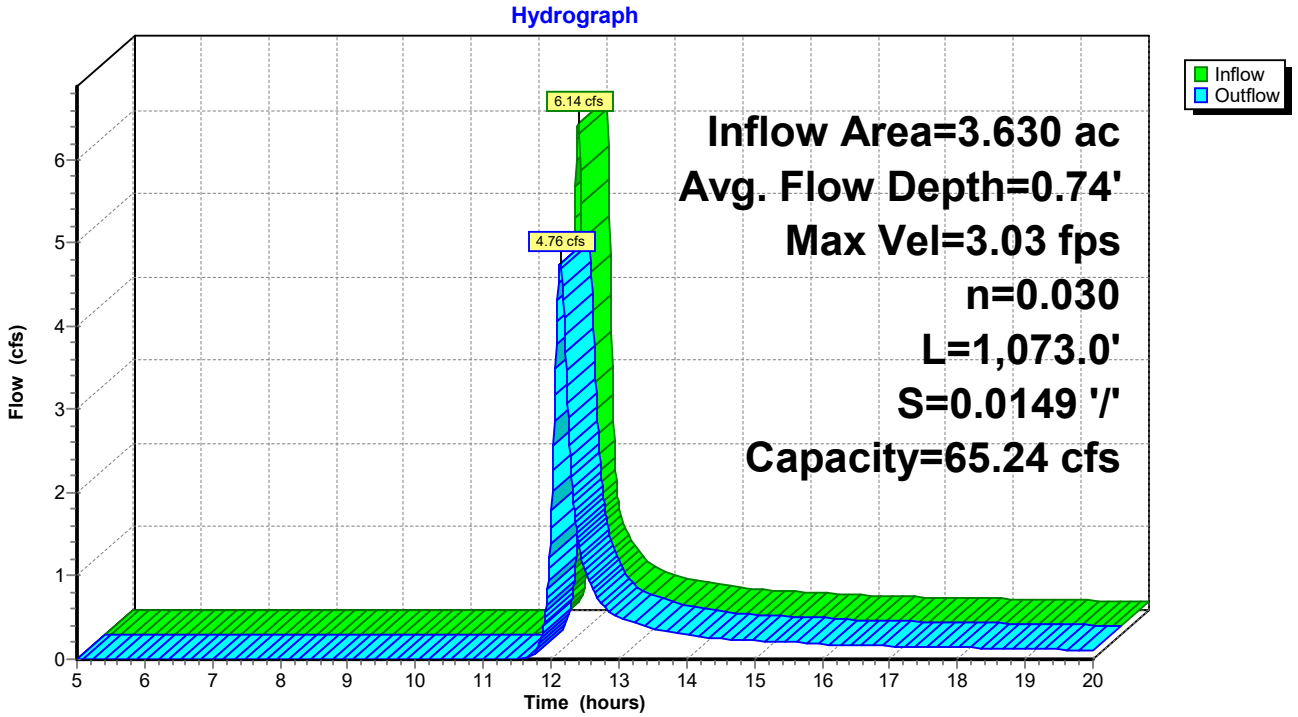
Inflow Area = 3.630 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 6.14 cfs @ 11.99 hrs, Volume= 0.268 af
Outflow = 4.76 cfs @ 12.14 hrs, Volume= 0.265 af, Atten= 22%, Lag= 9.0 min
Routed to Reach 28R : South Downchute Top

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.03 fps, Min. Travel Time= 5.9 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 12.6 min

Peak Storage= 1,688 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.74' , Surface Width= 4.16'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.24 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,073.0' Slope= 0.0149 '/'
Inlet Invert= 5,444.00', Outlet Invert= 5,428.00'





Summary for Reach 28R: South Downchute Top

[61] Hint: Exceeded Reach 26R outlet invert by 0.19' @ 12.19 hrs
[61] Hint: Exceeded Reach 27R outlet invert by 0.19' @ 12.19 hrs

Inflow Area = 9.490 ac, 0.00% Impervious, Inflow Depth > 0.87" for 25-Year event
Inflow = 10.43 cfs @ 12.18 hrs, Volume= 0.692 af
Outflow = 10.39 cfs @ 12.20 hrs, Volume= 0.690 af, Atten= 0%, Lag= 1.5 min
Routed to Reach 33R : South Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.73 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 2.5 min

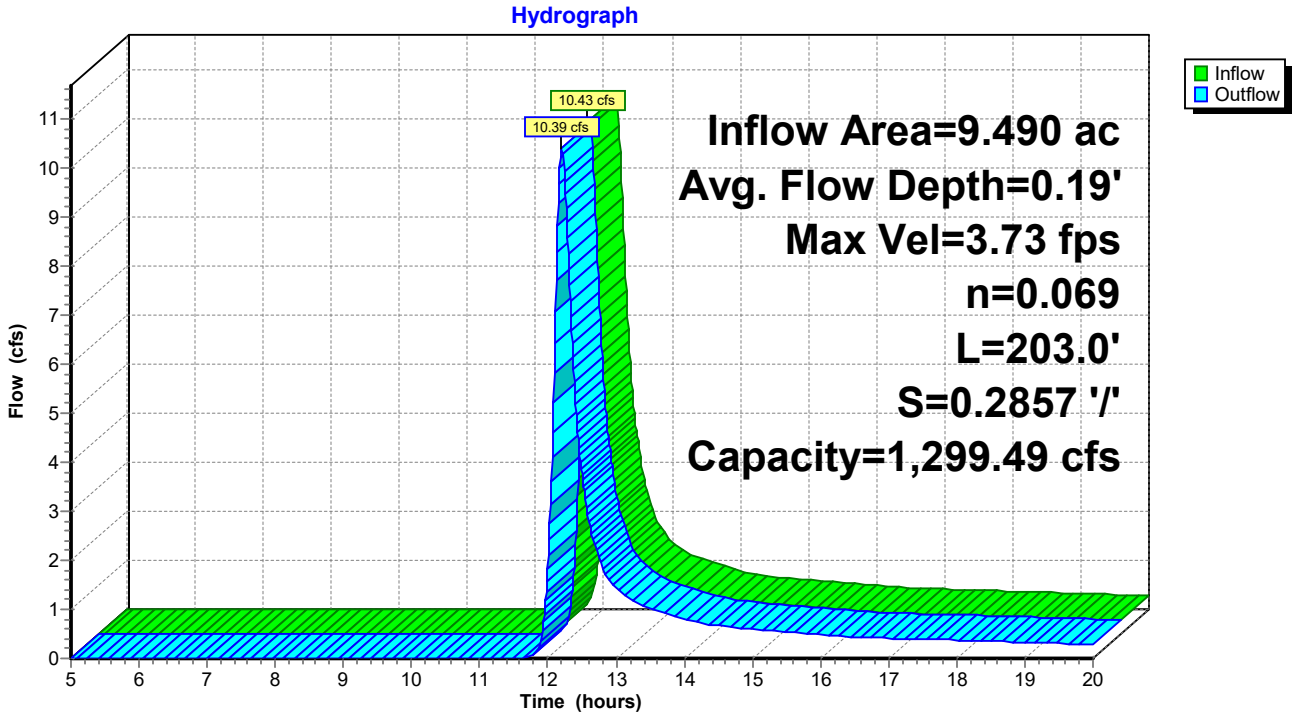
Peak Storage= 566 cf @ 12.19 hrs
Average Depth at Peak Storage= 0.19' , Surface Width= 15.15'
Bank-Full Depth= 3.00' Flow Area= 69.0 sf, Capacity= 1,299.49 cfs

14.00' x 3.00' deep channel, n= 0.069
Side Slope Z-value= 3.0 '/' Top Width= 32.00'
Length= 203.0' Slope= 0.2857 '/'
Inlet Invert= 5,428.00', Outlet Invert= 5,370.00'



‡

Reach 28R: South Downchute Top



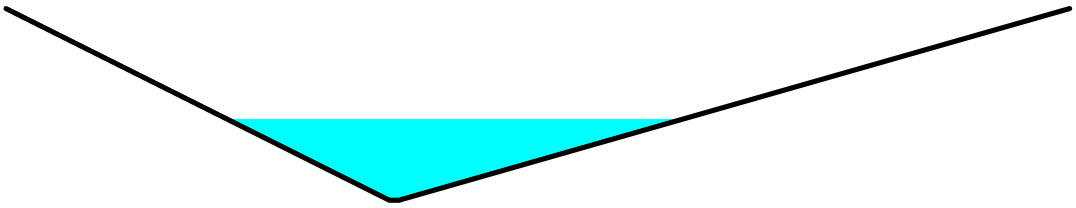
Summary for Reach 31R: Reach 7-1

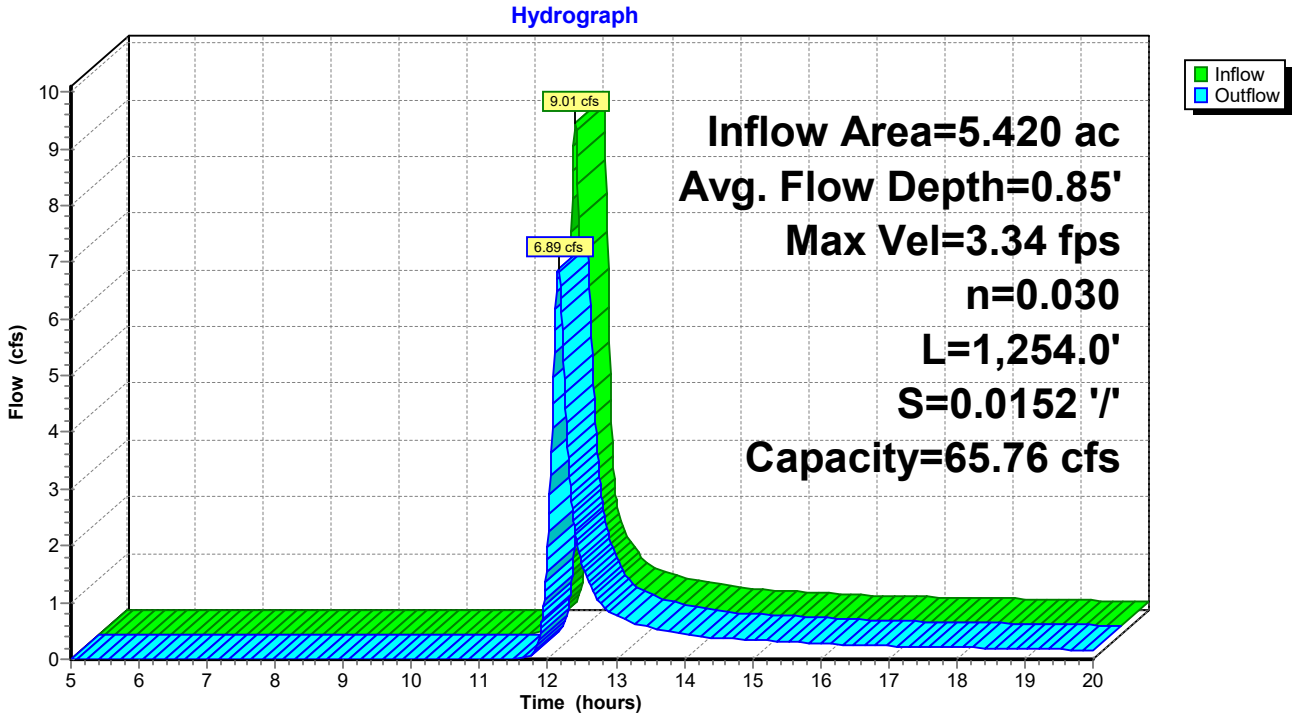
Inflow Area = 5.420 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 9.01 cfs @ 11.99 hrs, Volume= 0.400 af
Outflow = 6.89 cfs @ 12.15 hrs, Volume= 0.395 af, Atten= 24%, Lag= 9.5 min
Routed to Reach 33R : South Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.34 fps, Min. Travel Time= 6.3 min
Avg. Velocity = 1.58 fps, Avg. Travel Time= 13.2 min

Peak Storage= 2,589 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.85' , Surface Width= 4.77'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.76 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,254.0' Slope= 0.0152 '/'
Inlet Invert= 5,389.00', Outlet Invert= 5,370.00'





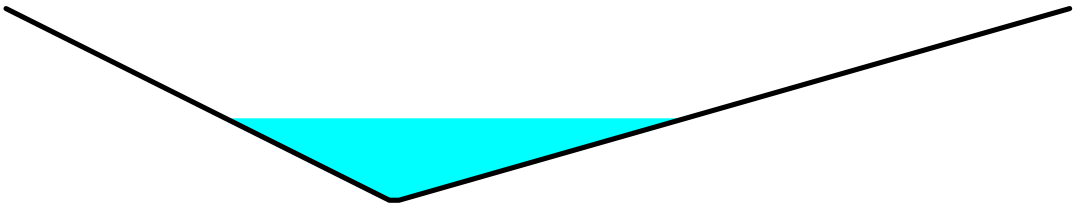
Summary for Reach 32R: Reach 7-2

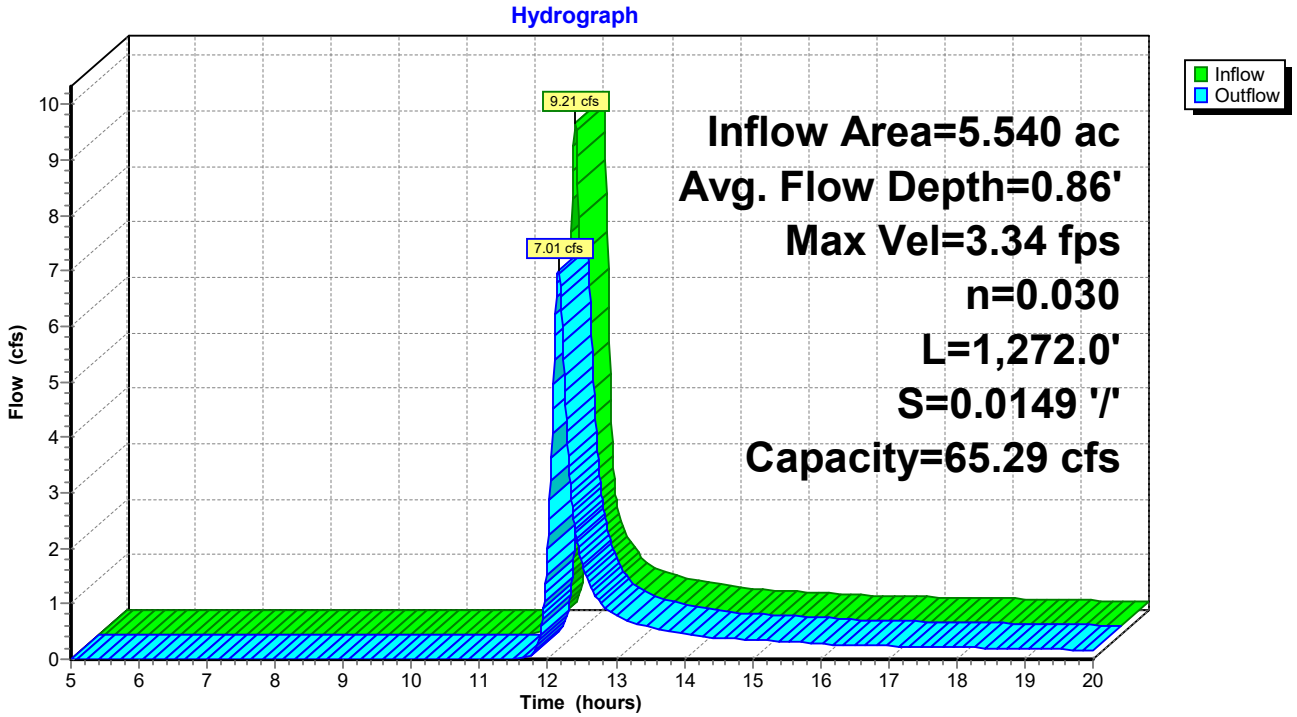
Inflow Area = 5.540 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 9.21 cfs @ 11.99 hrs, Volume= 0.409 af
Outflow = 7.01 cfs @ 12.15 hrs, Volume= 0.404 af, Atten= 24%, Lag= 9.6 min
Routed to Reach 33R : South Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.34 fps, Min. Travel Time= 6.3 min
Avg. Velocity = 1.58 fps, Avg. Travel Time= 13.4 min

Peak Storage= 2,673 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.86' , Surface Width= 4.81'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.29 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,272.0' Slope= 0.0149 '/'
Inlet Invert= 5,389.00', Outlet Invert= 5,370.00'





Summary for Reach 33R: South Downchute Bottom

[61] Hint: Exceeded Reach 28R outlet invert by 0.19' @ 12.18 hrs
[61] Hint: Exceeded Reach 31R outlet invert by 0.19' @ 12.18 hrs
[61] Hint: Exceeded Reach 32R outlet invert by 0.19' @ 12.18 hrs

Inflow Area = 20.450 ac, 0.00% Impervious, Inflow Depth > 0.87" for 25-Year event
Inflow = 23.64 cfs @ 12.17 hrs, Volume= 1.489 af
Outflow = 23.53 cfs @ 12.19 hrs, Volume= 1.486 af, Atten= 0%, Lag= 1.4 min
Routed to Pond 34P : Southeast Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.76 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.35 fps, Avg. Travel Time= 2.4 min

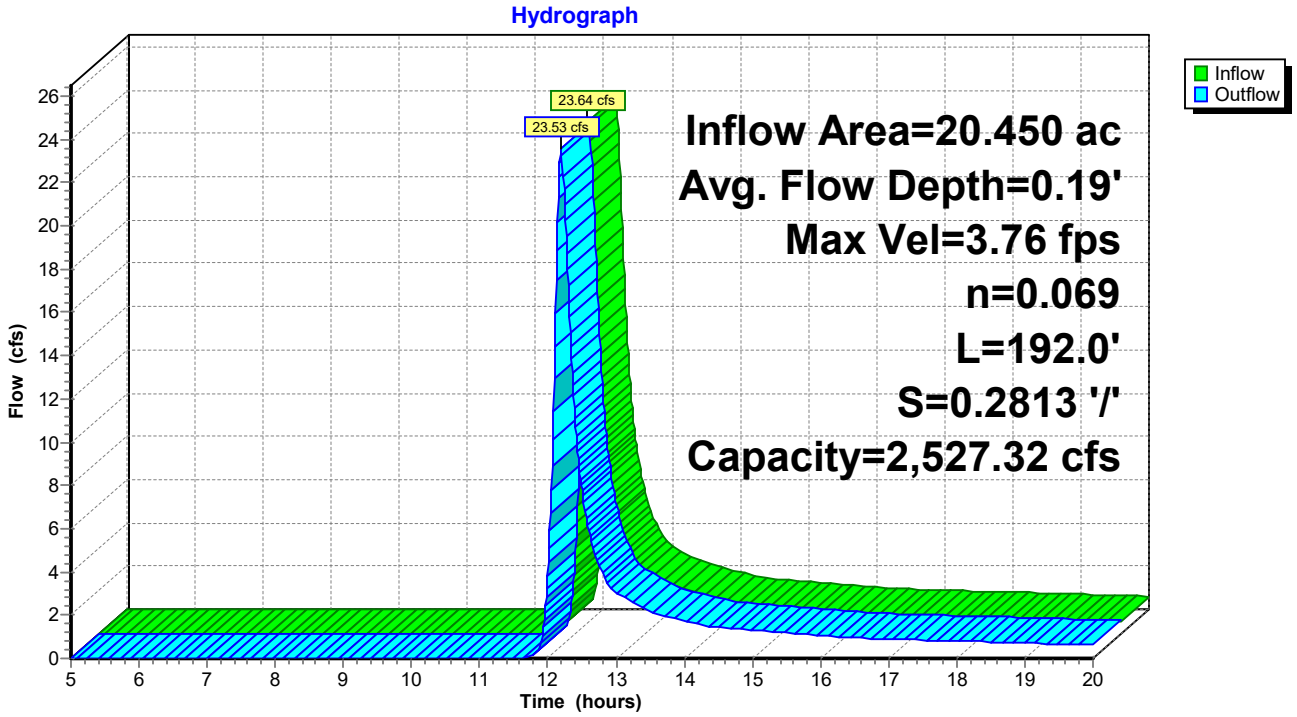
Peak Storage= 1,201 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.19' , Surface Width= 33.15'
Bank-Full Depth= 3.00' Flow Area= 123.0 sf, Capacity= 2,527.32 cfs

32.00' x 3.00' deep channel, n= 0.069
Side Slope Z-value= 3.0 '/' Top Width= 50.00'
Length= 192.0' Slope= 0.2813 '/'
Inlet Invert= 5,370.00', Outlet Invert= 5,316.00'



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Reach 33R: South Downchute Bottom



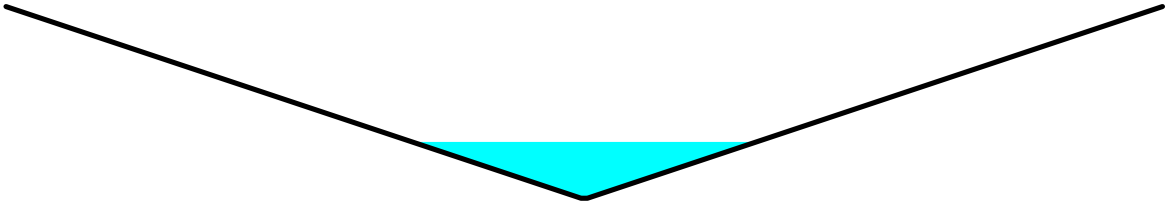
Summary for Reach 36R: Reach 8-1

Inflow Area = 5.940 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 9.75 cfs @ 12.00 hrs, Volume= 0.438 af
Outflow = 7.88 cfs @ 12.13 hrs, Volume= 0.434 af, Atten= 19%, Lag= 8.3 min
Routed to Pond 34P : Southeast Pond

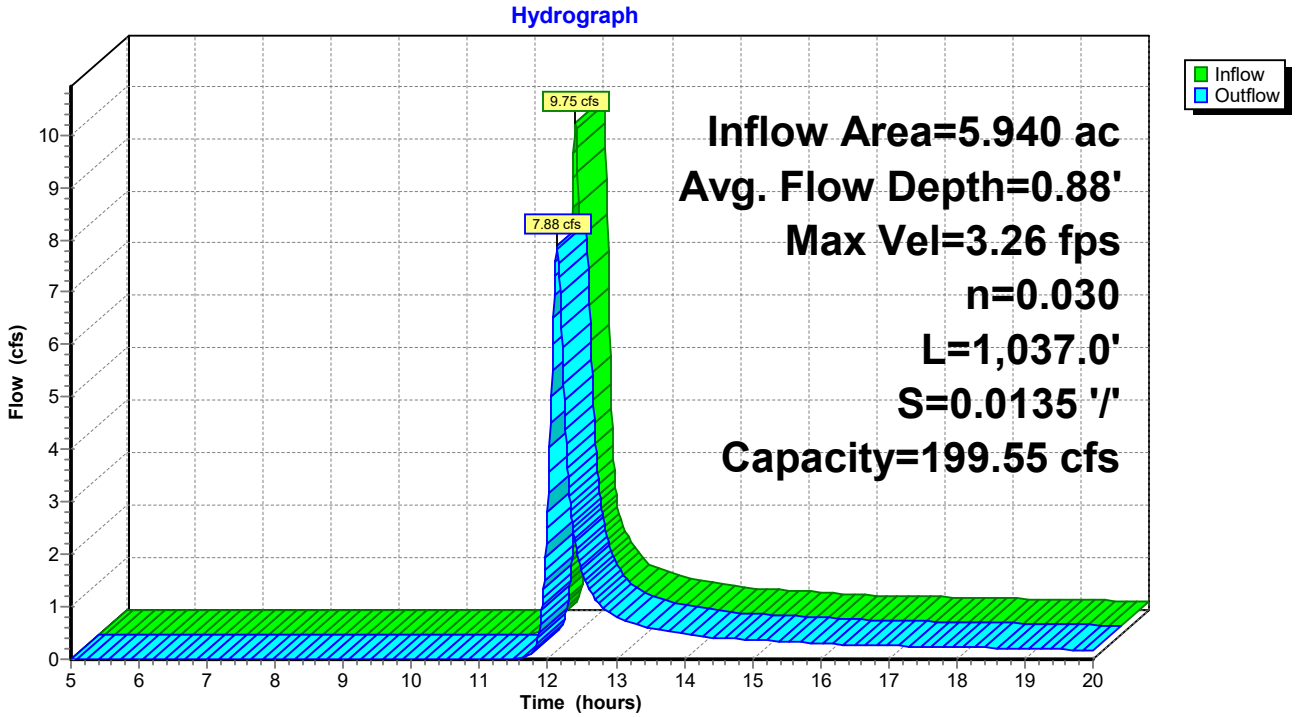
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.26 fps, Min. Travel Time= 5.3 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 11.3 min

Peak Storage= 2,508 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.88' , Surface Width= 5.39'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 199.55 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 1,037.0' Slope= 0.0135 '/'
Inlet Invert= 5,330.00', Outlet Invert= 5,316.00'



Reach 36R: Reach 8-1



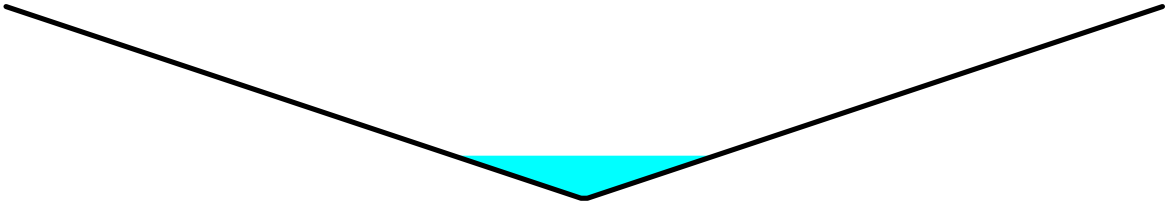
Summary for Reach 39R: Reach 4-2

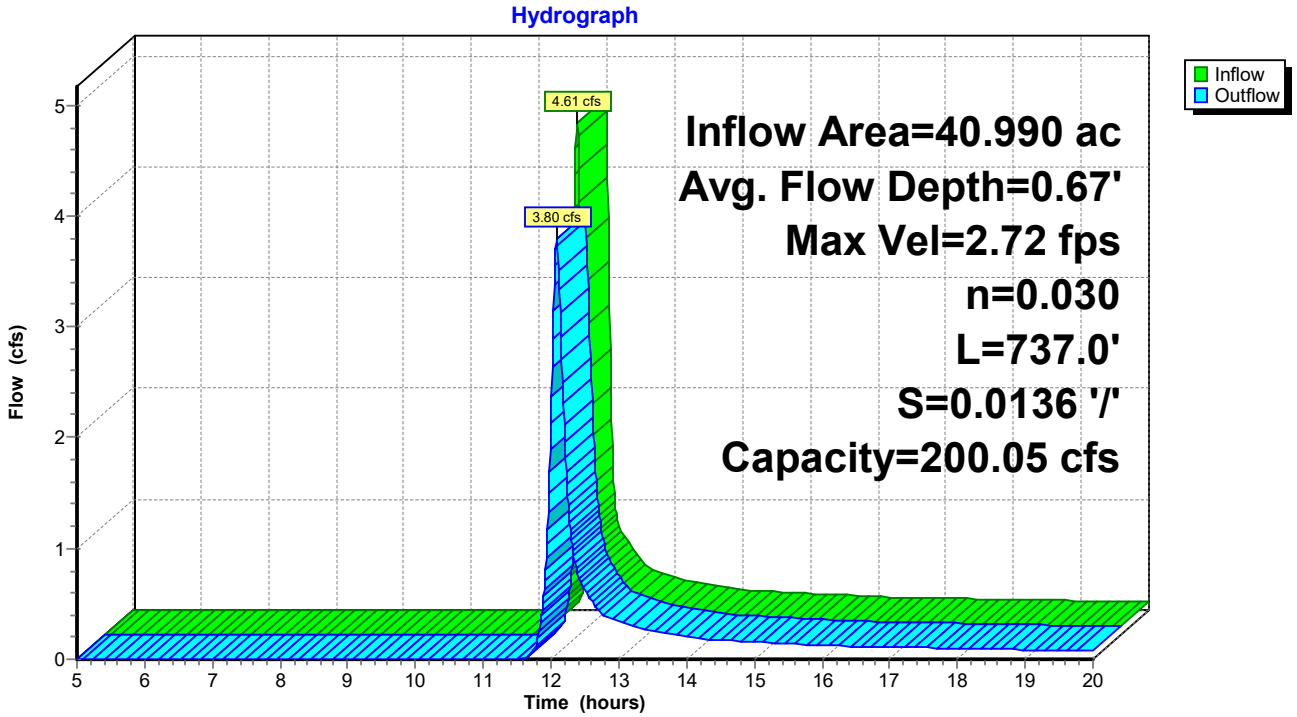
Inflow Area = 40.990 ac, 0.00% Impervious, Inflow Depth > 0.06" for 25-Year event
Inflow = 4.61 cfs @ 11.97 hrs, Volume= 0.190 af
Outflow = 3.80 cfs @ 12.09 hrs, Volume= 0.188 af, Atten= 18%, Lag= 7.0 min
Routed to Pond 15P : Northeast Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.72 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.24 fps, Avg. Travel Time= 9.9 min

Peak Storage= 1,030 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.67' , Surface Width= 4.10'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 200.05 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 737.0' Slope= 0.0136 '/'
Inlet Invert= 5,316.00', Outlet Invert= 5,306.00'





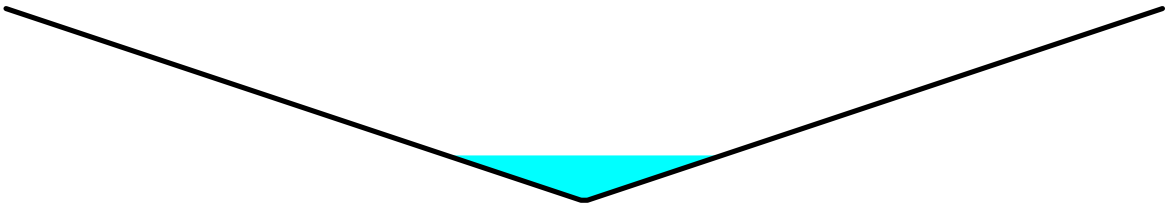
Summary for Reach 42R: Pond to Outfall

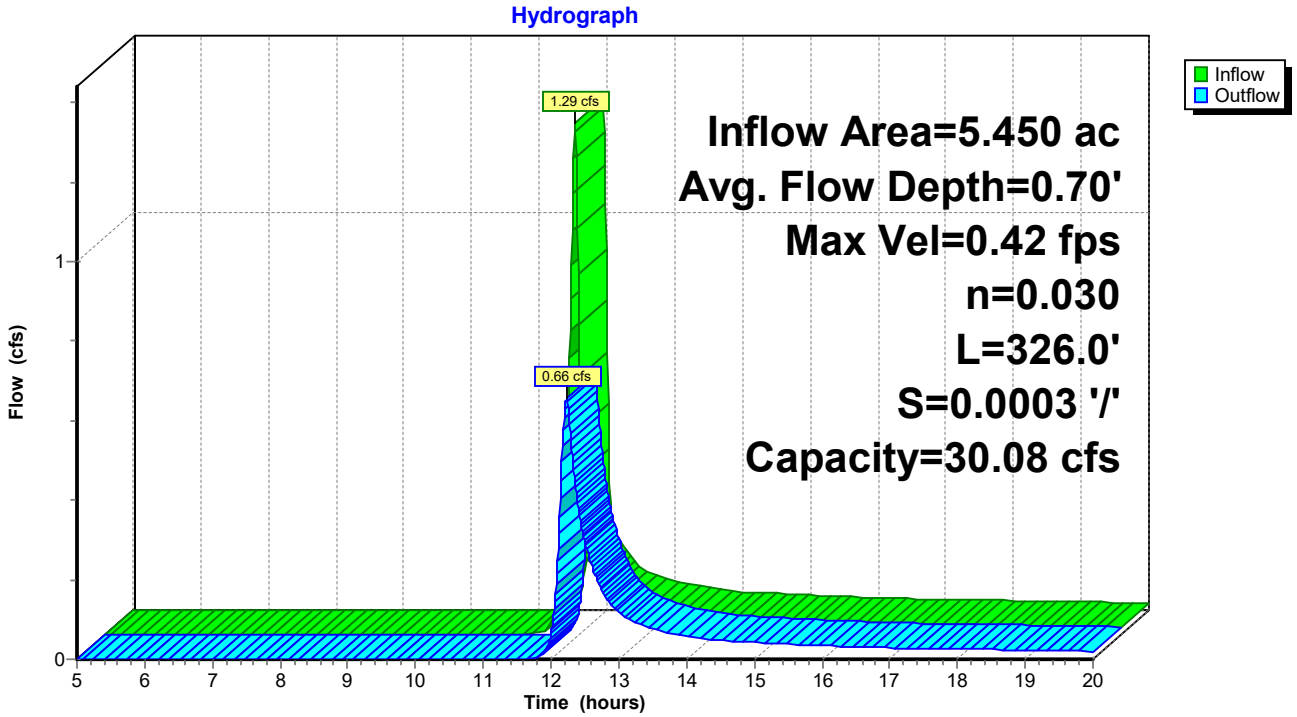
Inflow Area = 5.450 ac, 0.00% Impervious, Inflow Depth > 0.11" for 25-Year event
Inflow = 1.29 cfs @ 11.94 hrs, Volume= 0.048 af
Outflow = 0.66 cfs @ 12.22 hrs, Volume= 0.047 af, Atten= 49%, Lag= 17.0 min
Routed to Pond 57P : Storage in Perimeter Ditch

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.42 fps, Min. Travel Time= 12.8 min
Avg. Velocity = 0.21 fps, Avg. Travel Time= 25.4 min

Peak Storage= 505 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.70' , Surface Width= 4.31'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 30.08 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 326.0' Slope= 0.0003 '/'
Inlet Invert= 5,302.00', Outlet Invert= 5,301.90'





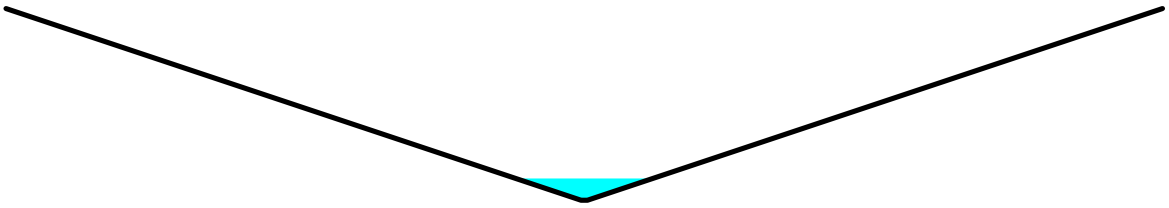
Summary for Reach 44R: Reach 5-1

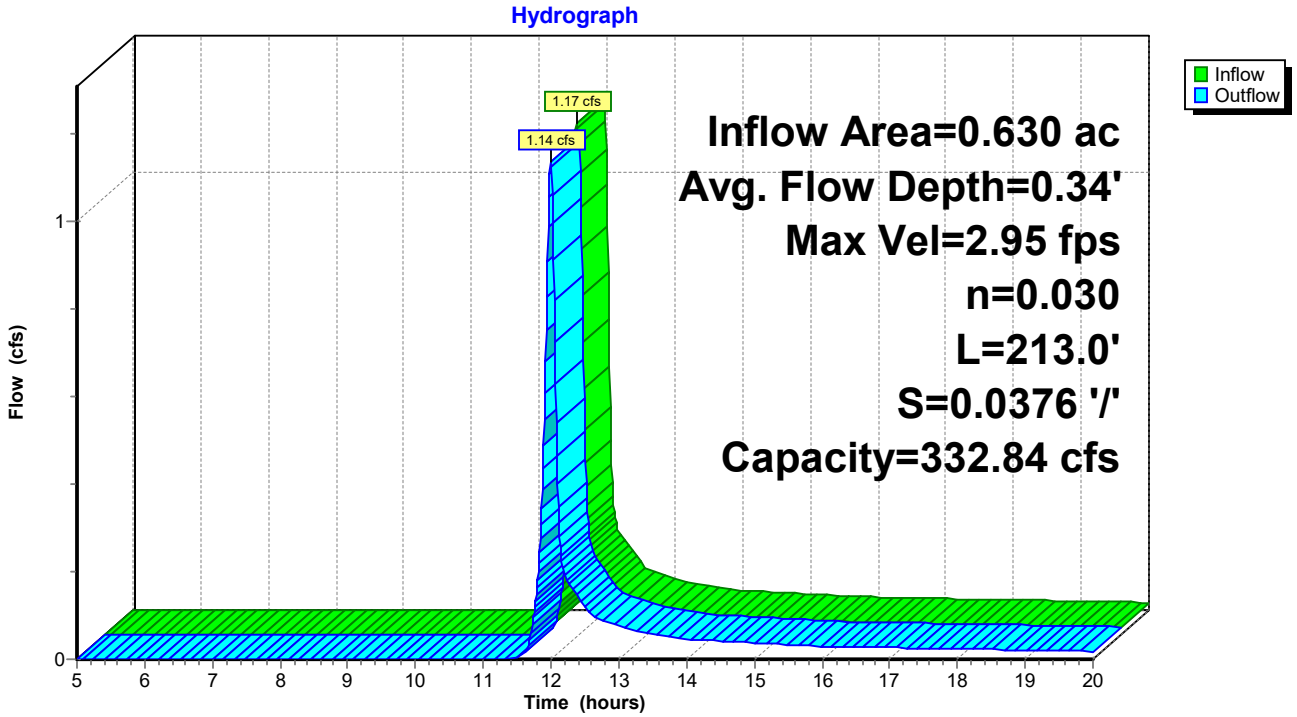
Inflow Area = 0.630 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 1.17 cfs @ 11.96 hrs, Volume= 0.047 af
Outflow = 1.14 cfs @ 12.00 hrs, Volume= 0.046 af, Atten= 3%, Lag= 2.1 min
Routed to Pond 45P : Southwest Pond-North Section

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.95 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 2.7 min

Peak Storage= 82 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.34' , Surface Width= 2.15'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 332.84 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 213.0' Slope= 0.0376 '/'
Inlet Invert= 5,328.00', Outlet Invert= 5,320.00'





Summary for Reach 47R: Outfall 2 SW

Inflow Area = 8.640 ac, 0.00% Impervious, Inflow Depth = 0.00" for 25-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

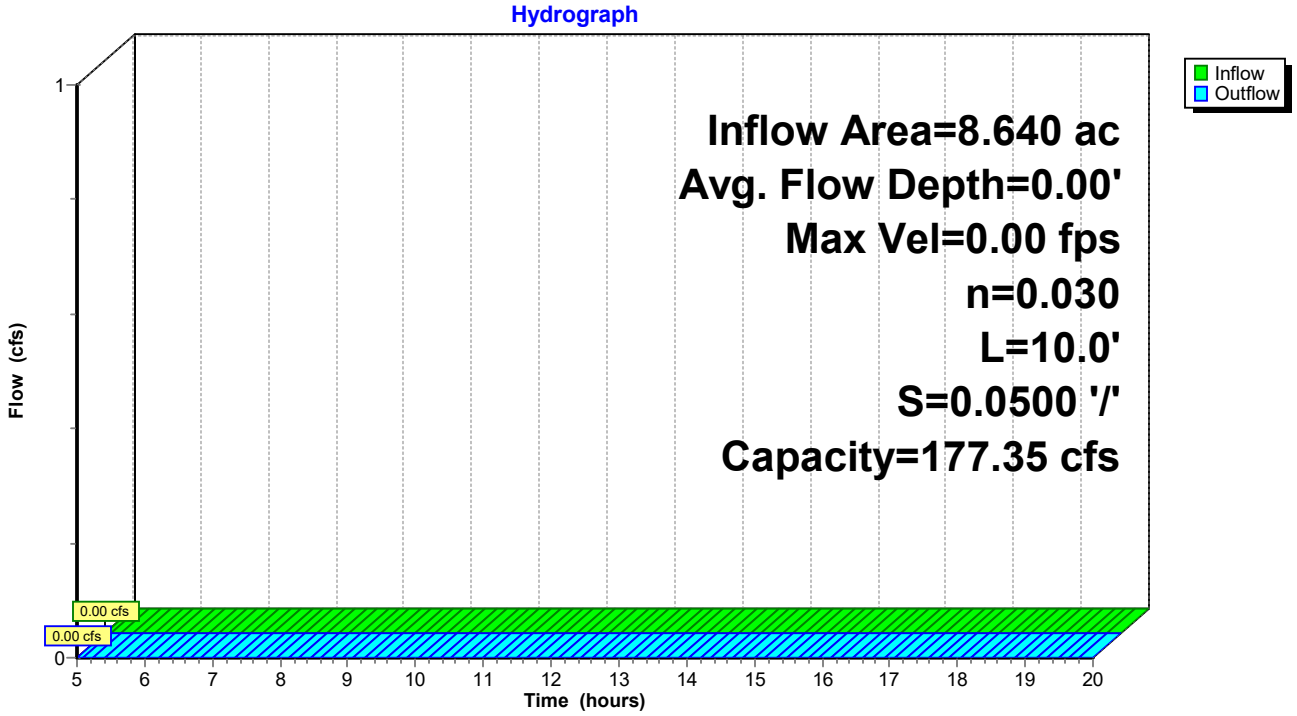
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 5.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 0.50' Flow Area= 26.3 sf, Capacity= 177.35 cfs

50.00' x 0.50' deep channel, n= 0.030
Side Slope Z-value= 5.0 '/' Top Width= 55.00'
Length= 10.0' Slope= 0.0500 '/'
Inlet Invert= 5,320.00', Outlet Invert= 5,319.50'



Reach 47R: Outfall 2 SW



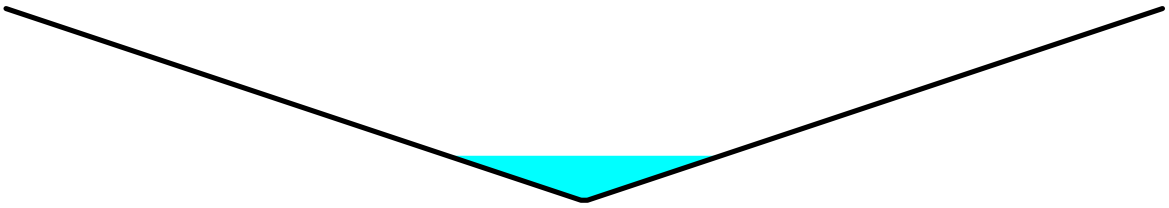
Summary for Reach 49R: Reach 5-2

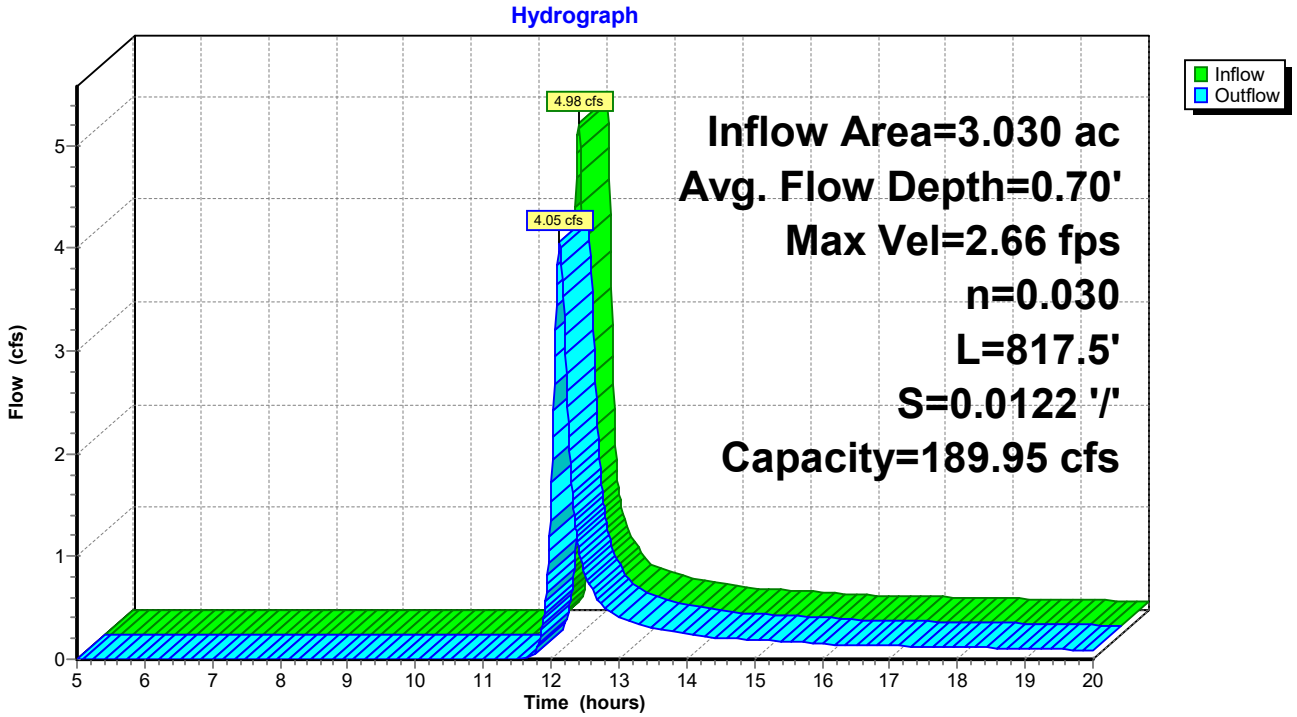
Inflow Area = 3.030 ac, 0.00% Impervious, Inflow Depth > 0.89" for 25-Year event
Inflow = 4.98 cfs @ 12.00 hrs, Volume= 0.224 af
Outflow = 4.05 cfs @ 12.13 hrs, Volume= 0.221 af, Atten= 19%, Lag= 8.0 min
Routed to Pond 55P : Southwest Pond-South Section

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.66 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 1.25 fps, Avg. Travel Time= 10.9 min

Peak Storage= 1,247 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.70' , Surface Width= 4.28'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 189.95 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 817.5' Slope= 0.0122 '/'
Inlet Invert= 5,330.00', Outlet Invert= 5,320.00'





Summary for Reach 56R: Outfall 1 NE

Inflow Area = 142.360 ac, 0.00% Impervious, Inflow Depth = 0.00" for 25-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

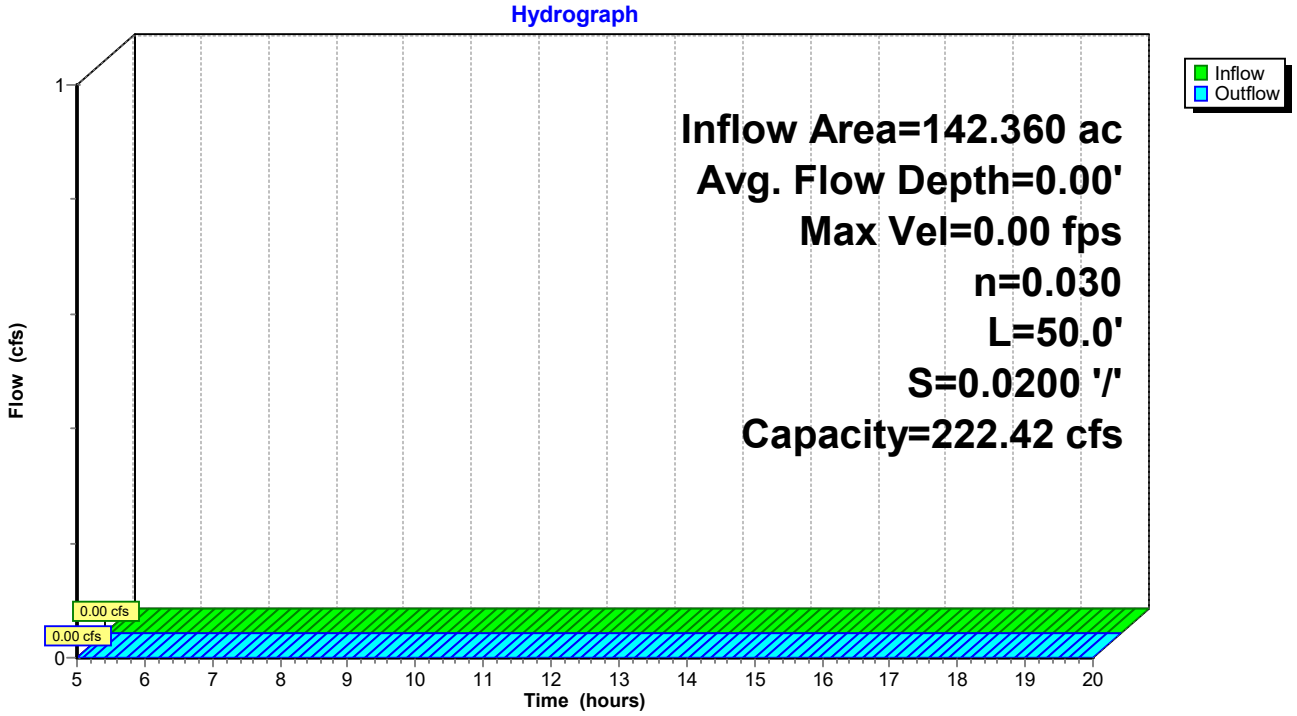
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 5.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 0.50' Flow Area= 51.3 sf, Capacity= 222.42 cfs

100.00' x 0.50' deep channel, n= 0.030
Side Slope Z-value= 5.0 '/' Top Width= 105.00'
Length= 50.0' Slope= 0.0200 '/'
Inlet Invert= 5,302.00', Outlet Invert= 5,301.00'



Reach 56R: Outfall 1 NE



Summary for Pond 15P: Northeast Pond

Inflow Area = 136.120 ac, 0.00% Impervious, Inflow Depth > 0.62" for 25-Year event
Inflow = 71.48 cfs @ 12.38 hrs, Volume= 7.014 af
Outflow = 1.54 cfs @ 20.00 hrs, Volume= 0.860 af, Atten= 98%, Lag= 457.3 min
Discarded = 1.54 cfs @ 20.00 hrs, Volume= 0.860 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach 20R : Reach 4.2.1

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,305.91' @ 20.00 hrs Surf.Area= 1.084 ac Storage= 6.153 af

Plug-Flow detention time= 254.8 min calculated for 0.860 af (12% of inflow)
Center-of-Mass det. time= 142.4 min (984.5 - 842.1)

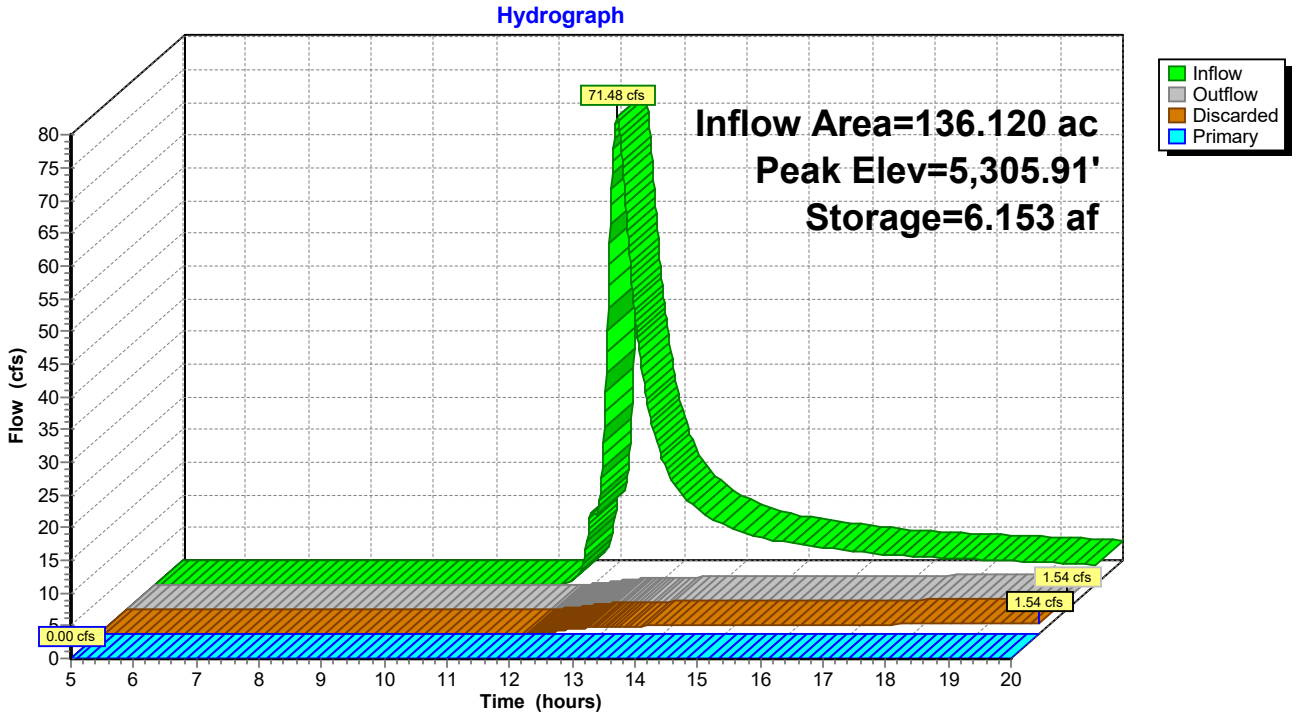
Volume	Invert	Avail.Storage	Storage Description
#1	5,294.51'	6.264 af	**2,048.00'L x 11.50'H Prismatoid Z=1.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,306.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,306.00'	**Channel/Reach** using Reach 20R: Reach 4.2.1
#2	Discarded	5,294.51'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=1.54 cfs @ 20.00 hrs HW=5,305.91' (Free Discharge)
↑—**2=Exfiltration** (Controls 1.54 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=5,294.51' (Free Discharge)
↑—**1=Channel/Reach** (Controls 0.00 cfs)

Pond 15P: Northeast Pond



Summary for Pond 18P: North Pond

Inflow Area = 4.800 ac, 0.00% Impervious, Inflow Depth > 0.87" for 25-Year event
Inflow = 4.40 cfs @ 12.18 hrs, Volume= 0.350 af
Outflow = 0.12 cfs @ 20.00 hrs, Volume= 0.073 af, Atten= 97%, Lag= 469.3 min
Discarded = 0.12 cfs @ 20.00 hrs, Volume= 0.073 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach 42R : Pond to Outfall

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,301.72' @ 20.00 hrs Surf.Area= 0.117 ac Storage= 0.277 af

Plug-Flow detention time= 253.5 min calculated for 0.073 af (21% of inflow)
Center-of-Mass det. time= 146.3 min (972.9 - 826.6)

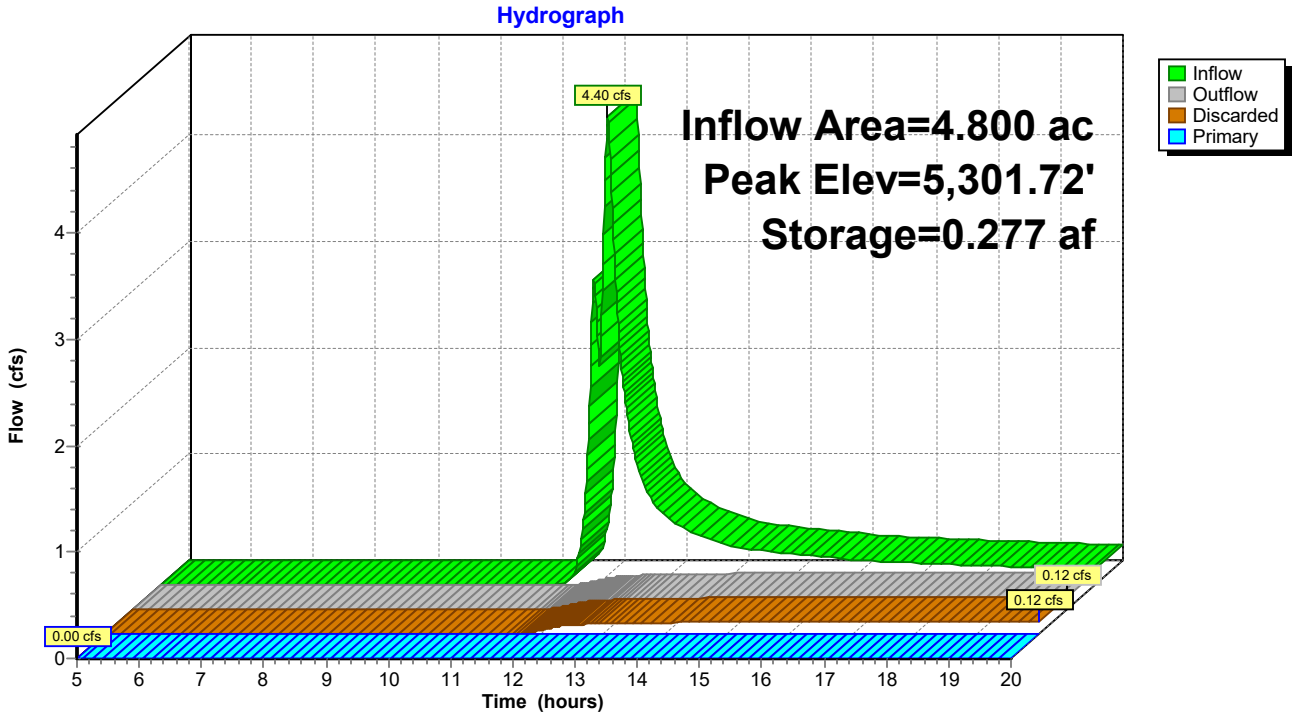
Volume	Invert	Avail.Storage	Storage Description
#1	5,297.01'	0.311 af	**0.10'W x 525.00'L x 5.00'H Prismatoid Z=1.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,302.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,302.00'	**Channel/Reach** using Reach 42R: Pond to Outfall
#2	Discarded	5,297.01'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=0.12 cfs @ 20.00 hrs HW=5,301.72' (Free Discharge)
↑**2=Exfiltration** (Controls 0.12 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=5,297.01' (Free Discharge)
↑**1=Channel/Reach** (Controls 0.00 cfs)

Pond 18P: North Pond



Summary for Pond 23P: Storage in Perimeter Ditch

[62] Hint: Exceeded Reach 20R OUTLET depth by 1.50' @ 19.99 hrs

Inflow Area = 136.910 ac, 0.00% Impervious, Inflow Depth > 0.01" for 25-Year event
Inflow = 1.21 cfs @ 12.06 hrs, Volume= 0.058 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach 56R : Outfall 1 NE

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,301.60' @ 20.00 hrs Surf.Area= 0.074 ac Storage= 0.058 af

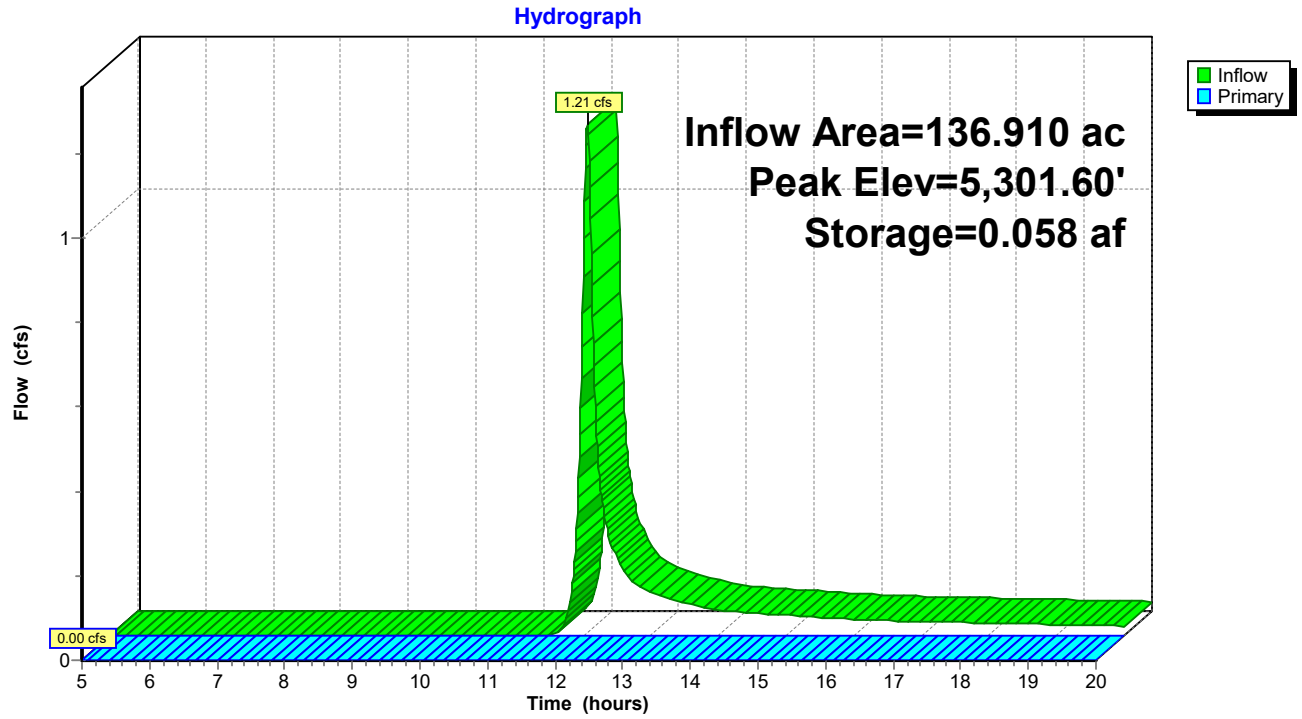
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	5,300.01'	0.092 af	**327.00'L x 2.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,302.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,302.00'	**Channel/Reach** using Reach 56R: Outfall 1 NE

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=5,300.01' (Free Discharge)
1=Channel/Reach (Controls 0.00 cfs)

Pond 23P: Storage in Perimeter Ditch



Summary for Pond 34P: Southeast Pond

Inflow Area = 38.420 ac, 0.00% Impervious, Inflow Depth > 0.88" for 25-Year event
Inflow = 35.73 cfs @ 12.17 hrs, Volume= 2.807 af
Outflow = 0.54 cfs @ 20.00 hrs, Volume= 0.315 af, Atten= 98%, Lag= 470.0 min
Discarded = 0.54 cfs @ 20.00 hrs, Volume= 0.315 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach 39R : Reach 4-2

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,310.91' @ 20.00 hrs Surf.Area= 0.680 ac Storage= 2.491 af

Plug-Flow detention time= 259.0 min calculated for 0.315 af (11% of inflow)
Center-of-Mass det. time= 149.4 min (975.1 - 825.7)

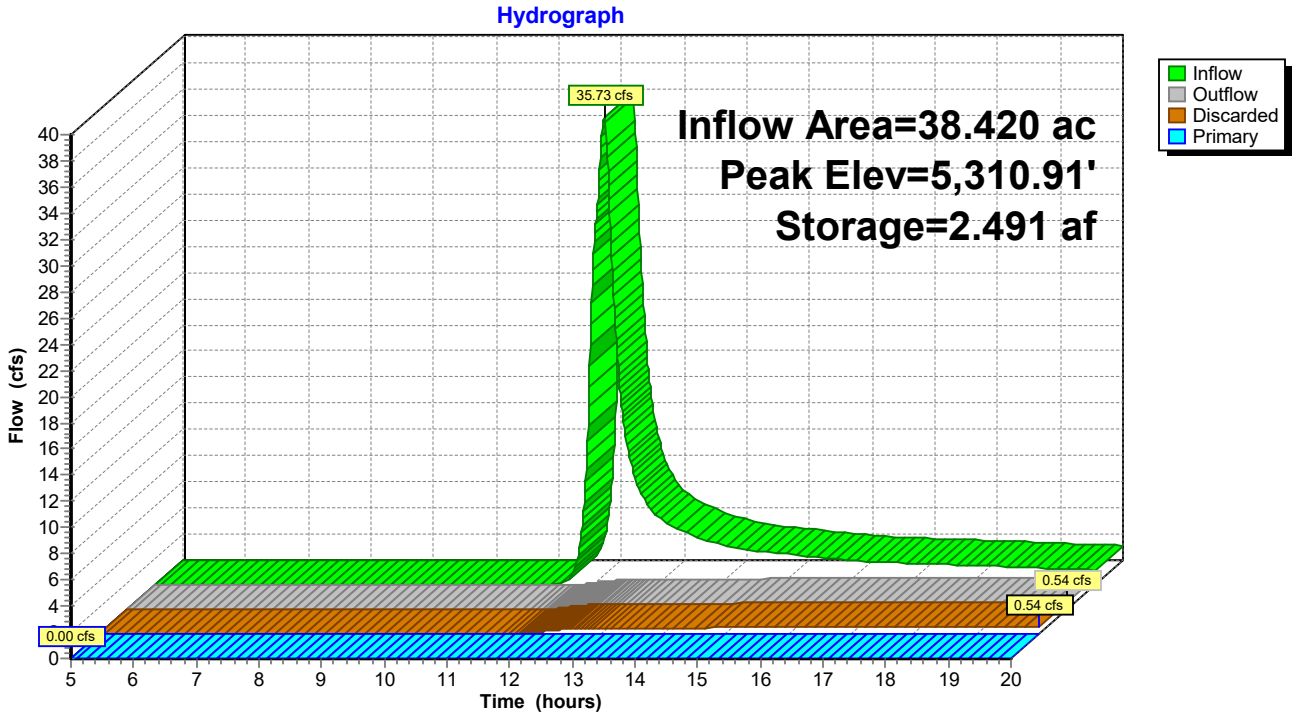
Volume	Invert	Avail.Storage	Storage Description
#1	5,303.51'	7.212 af	**972.00'L x 12.50'H Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,316.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,316.00'	**Channel/Reach** using Reach 39R: Reach 4-2
#2	Discarded	5,303.51'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=0.54 cfs @ 20.00 hrs HW=5,310.91' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.54 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=5,303.51' (Free Discharge)
↑—**1=Channel/Reach** (Controls 0.00 cfs)

Pond 34P: Southeast Pond



Summary for Pond 45P: Southwest Pond-North Section

Inflow Area = 2.520 ac, 0.00% Impervious, Inflow Depth > 0.88" for 25-Year event
Inflow = 3.28 cfs @ 12.03 hrs, Volume= 0.185 af
Outflow = 0.08 cfs @ 19.61 hrs, Volume= 0.048 af, Atten= 98%, Lag= 455.0 min
Discarded = 0.08 cfs @ 19.61 hrs, Volume= 0.048 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach 47R : Outfall 2 SW

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,319.87' @ 19.61 hrs Surf.Area= 0.089 ac Storage= 0.138 af

Plug-Flow detention time= 249.5 min calculated for 0.048 af (26% of inflow)
Center-of-Mass det. time= 148.0 min (967.3 - 819.3)

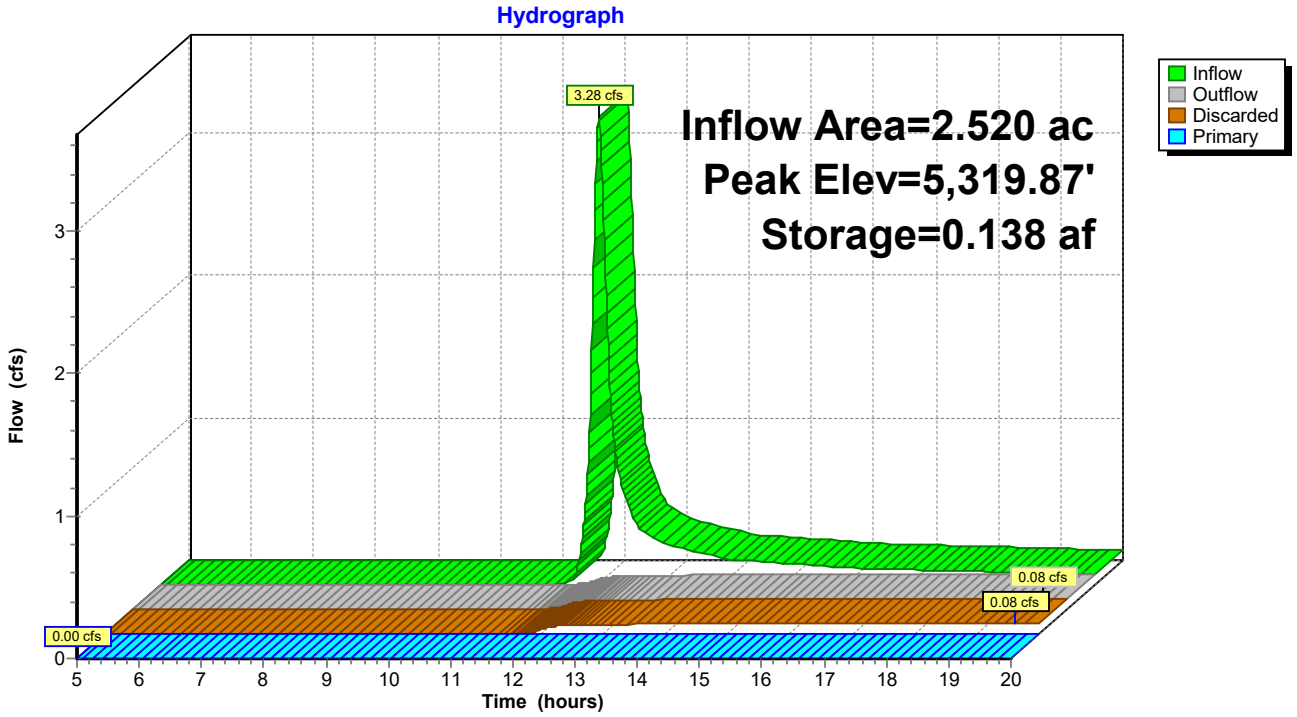
Volume	Invert	Avail.Storage	Storage Description
#1	5,316.75'	0.151 af	**613.00'L x 3.26'H Prismatoid Z=1.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,320.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,320.00'	**Channel/Reach** using Reach 47R: Outfall 2 SW
#2	Discarded	5,316.75'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=0.08 cfs @ 19.61 hrs HW=5,319.87' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=5,316.75' (Free Discharge)
↑—**1=Channel/Reach** (Controls 0.00 cfs)

Pond 45P: Southwest Pond-North Section



Summary for Pond 55P: Southwest Pond-South Section

Inflow Area = 6.120 ac, 0.00% Impervious, Inflow Depth > 0.88" for 25-Year event
Inflow = 6.71 cfs @ 12.01 hrs, Volume= 0.449 af
Outflow = 0.13 cfs @ 20.00 hrs, Volume= 0.082 af, Atten= 98%, Lag= 479.6 min
Discarded = 0.13 cfs @ 20.00 hrs, Volume= 0.082 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach 47R : Outfall 2 SW

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,319.61' @ 20.00 hrs Surf.Area= 0.152 ac Storage= 0.367 af

Plug-Flow detention time= 254.5 min calculated for 0.082 af (18% of inflow)
Center-of-Mass det. time= 149.3 min (969.7 - 820.4)

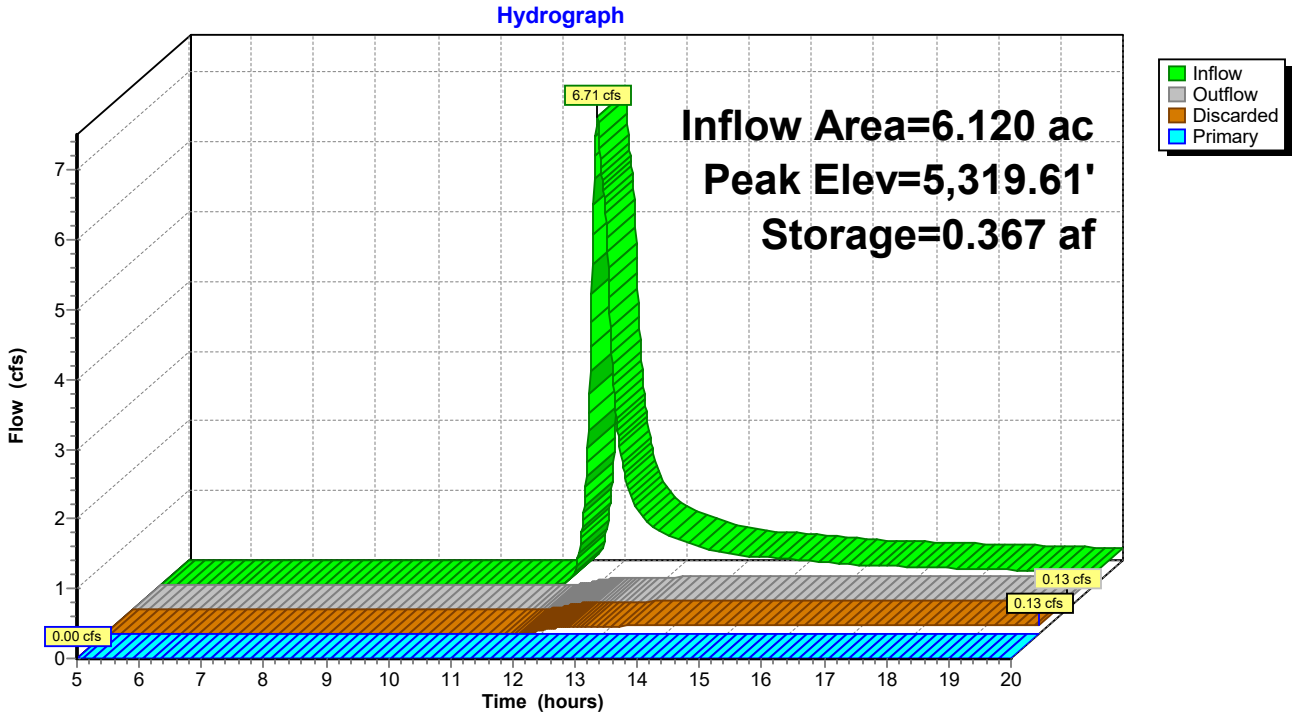
Volume	Invert	Avail.Storage	Storage Description
#1	5,314.76'	0.430 af	**672.00'L x 5.25'H Prismatoid Z=1.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,320.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,320.00'	**Channel/Reach** using Reach 47R: Outfall 2 SW
#2	Discarded	5,314.76'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=0.13 cfs @ 20.00 hrs HW=5,319.61' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.13 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=5,314.76' (Free Discharge)
↑—**1=Channel/Reach** (Controls 0.00 cfs)

Pond 55P: Southwest Pond-South Section



Summary for Pond 57P: Storage in Perimeter Ditch

Inflow Area = 5.450 ac, 0.00% Impervious, Inflow Depth > 0.10" for 25-Year event
Inflow = 0.66 cfs @ 12.22 hrs, Volume= 0.047 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach 56R : Outfall 1 NE

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,301.67' @ 20.00 hrs Surf.Area= 0.081 ac Storage= 0.047 af

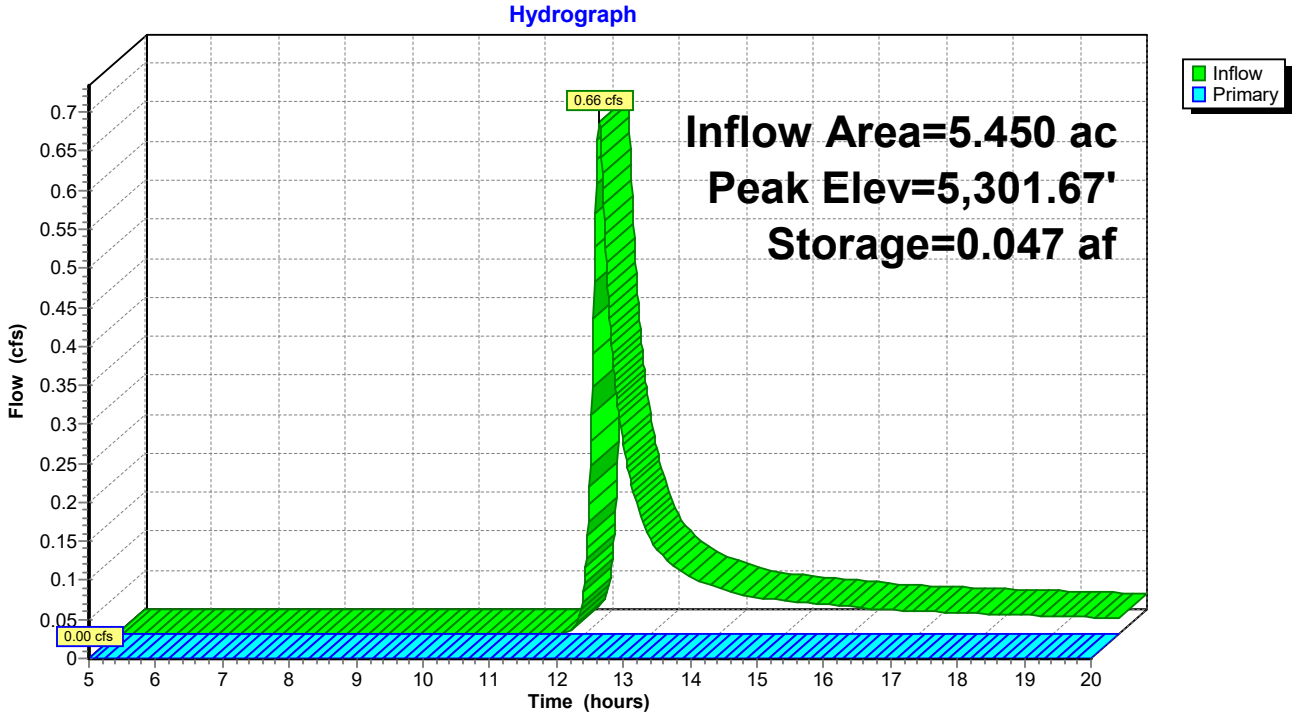
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	5,300.51'	0.078 af	**500.00'L x 1.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,302.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,302.00'	**Channel/Reach** using Reach 56R: Outfall 1 NE

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=5,300.51' (Free Discharge)
1=Channel/Reach (Controls 0.00 cfs)

Pond 57P: Storage in Perimeter Ditch



Time span=5.00-20.00 hrs, dt=0.01 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Basin 1-1 Runoff Area=14.860 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=444' Tc=14.2 min CN=69 Runoff=34.30 cfs 1.975 af

Subcatchment 2S: Basin 1-2 Runoff Area=10.030 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=445' Tc=14.2 min CN=69 Runoff=23.15 cfs 1.333 af

Subcatchment 7S: Basin 2-2 Runoff Area=15.530 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=229' Slope=0.2857 '/' Tc=7.6 min CN=69 Runoff=46.00 cfs 2.070 af

Subcatchment 8S: Basin 2-1 Runoff Area=14.450 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=209' Slope=0.2857 '/' Tc=7.1 min CN=69 Runoff=43.63 cfs 1.927 af

Subcatchment 11S: Basin 3-2 Runoff Area=15.620 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=241' Slope=0.2857 '/' Tc=8.0 min CN=69 Runoff=45.52 cfs 2.082 af

Subcatchment 12S: Basin 3-1 Runoff Area=19.760 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=227' Slope=0.2857 '/' Tc=7.6 min CN=69 Runoff=58.53 cfs 2.634 af

Subcatchment 16S: Basin 4-1-1 Runoff Area=3.520 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=88' Slope=0.2857 '/' Tc=3.6 min CN=69 Runoff=12.19 cfs 0.470 af

Subcatchment 19S: Basin 4-1-2 Runoff Area=1.280 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=81' Slope=0.2857 '/' Tc=3.3 min CN=69 Runoff=4.49 cfs 0.171 af

Subcatchment 22S: Basin 4-2-1 Runoff Area=0.790 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=48' Slope=0.2857 '/' Tc=2.2 min CN=69 Runoff=2.89 cfs 0.106 af

Subcatchment 24S: Basin 6-1 Runoff Area=5.860 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=399' Tc=13.5 min CN=69 Runoff=13.84 cfs 0.779 af

Subcatchment 25S: Basin 6-2 Runoff Area=3.630 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=188' Slope=0.2857 '/' Tc=6.5 min CN=69 Runoff=11.23 cfs 0.484 af

Subcatchment 29S: Basin 7-1 Runoff Area=5.420 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=203' Slope=0.2857 '/' Tc=6.9 min CN=69 Runoff=16.49 cfs 0.723 af

Subcatchment 30S: Basin 7-2 Runoff Area=5.540 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=203' Slope=0.2857 '/' Tc=6.9 min CN=69 Runoff=16.86 cfs 0.739 af

Subcatchment 35S: Basin 8-1 Runoff Area=5.940 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=211' Slope=0.2857 '/' Tc=7.2 min CN=69 Runoff=17.87 cfs 0.792 af

Subcatchment 37S: Basin 4-2-4 Runoff Area=2.890 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=158' Slope=0.2857 '/' Tc=5.7 min CN=69 Runoff=9.22 cfs 0.386 af

Subcatchment 38S: Basin 8-2 Runoff Area=9.140 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=272' Slope=0.2857 '/' Tc=8.8 min CN=69 Runoff=25.81 cfs 1.218 af

Subcatchment 40S: Basin 4-2-3 Runoff Area=2.570 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=137' Slope=0.2857 '/' Tc=5.1 min CN=69 Runoff=8.40 cfs 0.343 af

Subcatchment 43S: Basin 5-1-1 Runoff Area=0.630 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=113' Slope=0.2857 '/' Tc=4.3 min CN=69 Runoff=2.12 cfs 0.084 af

Subcatchment 46S: Basin 5-1-2 Runoff Area=1.890 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=143' Slope=0.0286 '/' Tc=13.2 min CN=69 Runoff=4.51 cfs 0.251 af

Subcatchment 48S: Basin 5-2-2 Runoff Area=3.030 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=214' Slope=0.2857 '/' Tc=7.2 min CN=69 Runoff=9.12 cfs 0.404 af

Subcatchment 50S: Basin 5-2-1 Runoff Area=3.090 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=183' Slope=0.2857 '/' Tc=6.4 min CN=69 Runoff=9.59 cfs 0.412 af

Subcatchment 52S: Basin 4-2-2 Runoff Area=4.880 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=118' Slope=0.2857 '/' Tc=4.5 min CN=69 Runoff=16.32 cfs 0.651 af

Subcatchment 53S: Basin 4-1-3 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth>1.60"
Flow Length=62' Slope=0.2857 '/' Tc=2.7 min CN=69 Runoff=2.33 cfs 0.087 af

Reach 3R: Reach 1-1 Avg. Flow Depth=1.39' Max Vel=4.60 fps Inflow=34.30 cfs 1.975 af
n=0.030 L=2,790.0' S=0.0150 '/' Capacity=65.35 cfs Outflow=25.12 cfs 1.942 af

Reach 4R: Reach 1-2 Avg. Flow Depth=1.28' Max Vel=4.34 fps Inflow=23.15 cfs 1.333 af
n=0.030 L=1,471.0' S=0.0150 '/' Capacity=65.33 cfs Outflow=20.00 cfs 1.320 af

Reach 5R: North Downchute Top Avg. Flow Depth=0.29' Max Vel=4.96 fps Inflow=41.93 cfs 3.262 af
n=0.069 L=227.5' S=0.2857 '/' Capacity=2,266.93 cfs Outflow=41.86 cfs 3.256 af

Reach 6R: North Downchute Bottom Avg. Flow Depth=0.29' Max Vel=5.02 fps Inflow=93.99 cfs 7.175 af
n=0.069 L=233.0' S=0.2897 '/' Capacity=4,848.31 cfs Outflow=93.80 cfs 7.161 af

Reach 9R: Reach 2-1 Avg. Flow Depth=1.38' Max Vel=4.65 fps Inflow=43.63 cfs 1.927 af
n=0.030 L=3,772.0' S=0.0154 '/' Capacity=66.39 cfs Outflow=25.03 cfs 1.883 af

Reach 10R: Reach 2-2 Avg. Flow Depth=1.51' Max Vel=4.87 fps Inflow=46.00 cfs 2.070 af
n=0.030 L=2,776.0' S=0.0150 '/' Capacity=65.52 cfs Outflow=31.36 cfs 2.037 af

Reach 13R: Reach 3-1 Avg. Flow Depth=1.50' Max Vel=4.87 fps Inflow=58.53 cfs 2.634 af
n=0.030 L=4,718.0' S=0.0152 '/' Capacity=65.88 cfs Outflow=30.83 cfs 2.563 af

Reach 14R: Reach 3-2 Avg. Flow Depth=1.49' Max Vel=4.80 fps Inflow=45.52 cfs 2.082 af
n=0.030 L=3,049.0' S=0.0150 '/' Capacity=65.44 cfs Outflow=29.84 cfs 2.044 af

Reach 17R: Reach 4-1 Avg. Flow Depth=0.89' Max Vel=3.39 fps Inflow=12.19 cfs 0.470 af
n=0.030 L=1,662.0' S=0.0144 '/' Capacity=206.38 cfs Outflow=8.29 cfs 0.463 af

Reach 20R: Reach 4.2.1 Avg. Flow Depth=1.81' Max Vel=4.13 fps Inflow=49.18 cfs 5.597 af
n=0.035 L=525.0' S=0.0114 '/' Capacity=157.37 cfs Outflow=41.35 cfs 5.570 af

Reach 26R: Reach 6-1 Avg. Flow Depth=1.07' Max Vel=3.86 fps Inflow=13.84 cfs 0.779 af
n=0.030 L=1,031.5' S=0.0150 '/' Capacity=65.49 cfs Outflow=12.46 cfs 0.773 af

Reach 27R: Reach 6-2 Avg. Flow Depth=0.96' Max Vel=3.58 fps Inflow=11.23 cfs 0.484 af
n=0.030 L=1,073.0' S=0.0149 '/' Capacity=65.24 cfs Outflow=9.32 cfs 0.480 af

Reach 28R: South Downchute Top Avg. Flow Depth=0.29' Max Vel=4.80 fps Inflow=20.41 cfs 1.253 af
n=0.069 L=203.0' S=0.2857 '/' Capacity=1,299.49 cfs Outflow=20.35 cfs 1.251 af

Reach 31R: Reach 7-1 Avg. Flow Depth=1.10' Max Vel=3.96 fps Inflow=16.49 cfs 0.723 af
n=0.030 L=1,254.0' S=0.0152 '/' Capacity=65.76 cfs Outflow=13.56 cfs 0.716 af

Reach 32R: Reach 7-2 Avg. Flow Depth=1.11' Max Vel=3.95 fps Inflow=16.86 cfs 0.739 af
n=0.030 L=1,272.0' S=0.0149 '/' Capacity=65.29 cfs Outflow=13.82 cfs 0.732 af

Reach 33R: South Downchute Bottom Avg. Flow Depth=0.29' Max Vel=4.91 fps Inflow=46.79 cfs 2.699 af
n=0.069 L=192.0' S=0.2813 '/' Capacity=2,527.32 cfs Outflow=46.66 cfs 2.694 af

Reach 36R: Reach 8-1 Avg. Flow Depth=1.14' Max Vel=3.85 fps Inflow=17.87 cfs 0.792 af
n=0.030 L=1,037.0' S=0.0135 '/' Capacity=199.55 cfs Outflow=15.30 cfs 0.786 af

Reach 39R: Reach 4-2 Avg. Flow Depth=0.85' Max Vel=3.20 fps Inflow=8.40 cfs 0.343 af
n=0.030 L=737.0' S=0.0136 '/' Capacity=200.05 cfs Outflow=7.29 cfs 0.341 af

Reach 42R: Pond to Outfall Avg. Flow Depth=0.99' Max Vel=0.53 fps Inflow=2.61 cfs 0.323 af
n=0.030 L=326.0' S=0.0003 '/' Capacity=30.08 cfs Outflow=1.62 cfs 0.318 af

Reach 44R: Reach 5-1 Avg. Flow Depth=0.43' Max Vel=3.43 fps Inflow=2.12 cfs 0.084 af
n=0.030 L=213.0' S=0.0376 '/' Capacity=332.84 cfs Outflow=2.08 cfs 0.084 af

Reach 47R: Outfall 2 SW Avg. Flow Depth=0.05' Max Vel=1.42 fps Inflow=3.40 cfs 0.417 af
n=0.030 L=10.0' S=0.0500 '/' Capacity=177.35 cfs Outflow=3.27 cfs 0.417 af

Reach 49R: Reach 5-2 Avg. Flow Depth=0.90' Max Vel=3.14 fps Inflow=9.12 cfs 0.404 af
n=0.030 L=817.5' S=0.0122 '/' Capacity=189.95 cfs Outflow=7.86 cfs 0.401 af

Reach 56R: Outfall 1 NE Avg. Flow Depth=0.18' Max Vel=2.24 fps Inflow=41.32 cfs 5.716 af
n=0.030 L=50.0' S=0.0200 '/' Capacity=222.42 cfs Outflow=41.26 cfs 5.710 af

Pond 15P: Northeast Pond Peak Elev=5,306.01' Storage=6.264 af Inflow=152.61 cfs 12.760 af
Discarded=1.55 cfs 1.003 af Primary=49.01 cfs 5.492 af Outflow=50.56 cfs 6.494 af

Pond 18P: North Pond Peak Elev=5,302.01' Storage=0.311 af Inflow=8.91 cfs 0.634 af
Discarded=0.13 cfs 0.087 af Primary=2.42 cfs 0.236 af Outflow=2.55 cfs 0.323 af

Pond 23P: Storage in Perimeter Ditch Peak Elev=5,302.01' Storage=0.092 af Inflow=41.35 cfs 5.570 af
Outflow=41.32 cfs 5.476 af

Pond 34P: Southeast Pond Peak Elev=5,313.54' Storage=4.616 af Inflow=73.25 cfs 5.083 af
Discarded=0.78 cfs 0.467 af Primary=0.00 cfs 0.000 af Outflow=0.78 cfs 0.467 af

Pond 45P: Southwest Pond-North Section Peak Elev=5,320.01' Storage=0.151 af Inflow=6.06 cfs 0.335 af
Discarded=0.08 cfs 0.054 af Primary=2.18 cfs 0.131 af Outflow=2.26 cfs 0.185 af

Pond 55P: Southwest Pond-South Peak Elev=5,320.01' Storage=0.430 af Inflow=13.62 cfs 0.813 af
Discarded=0.15 cfs 0.099 af Primary=2.30 cfs 0.285 af Outflow=2.45 cfs 0.384 af

Pond 57P: Storage in Perimeter Ditch Peak Elev=5,302.01' Storage=0.078 af Inflow=1.62 cfs 0.318 af
Outflow=1.55 cfs 0.240 af

Total Runoff Area = 151.000 ac Runoff Volume = 20.120 af Average Runoff Depth = 1.60"
100.00% Pervious = 151.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Basin 1-1

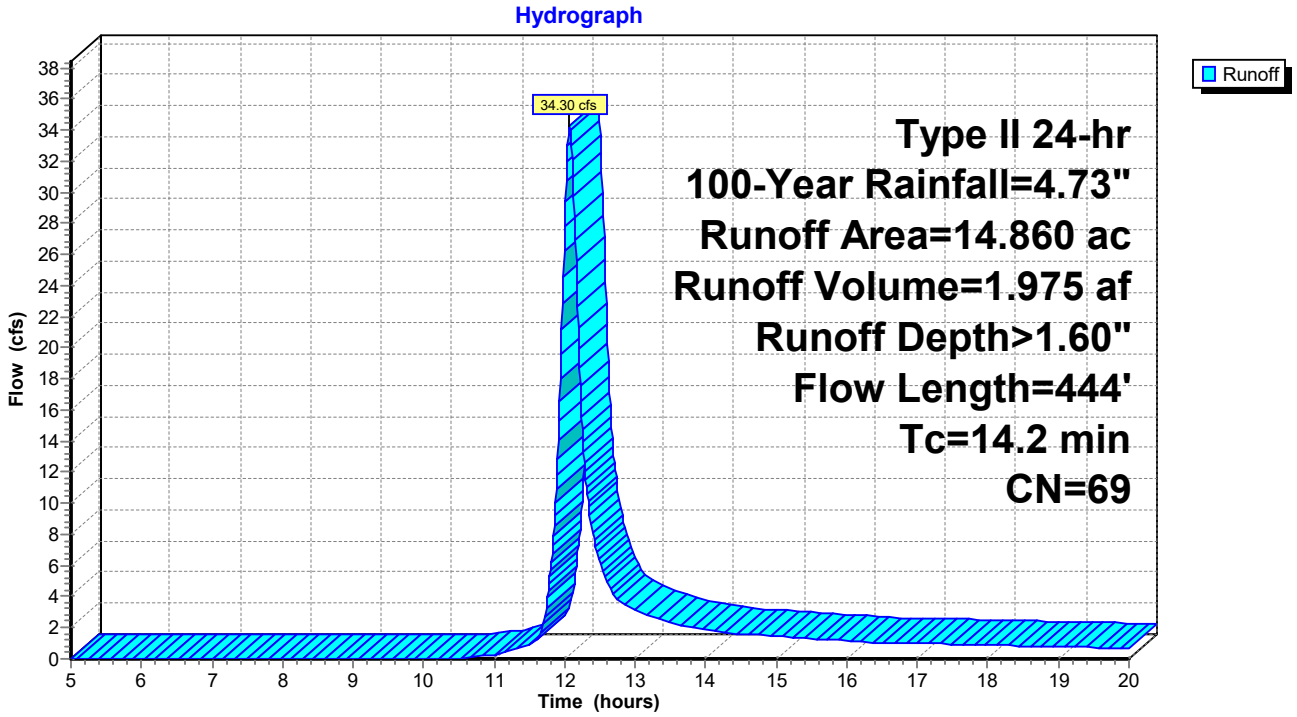
Runoff = 34.30 cfs @ 12.07 hrs, Volume= 1.975 af, Depth> 1.60"
Routed to Reach 3R : Reach 1-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

Area (ac)	CN	Description
14.860	69	Pasture/grassland/range, Fair, HSG B
14.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	172	0.0500	0.24		**Sheet Flow,** Range n= 0.130 P2= 1.88"
1.4	133	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	139	0.2857	3.74		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.2	444	Total			

Subcatchment 1S: Basin 1-1



Summary for Subcatchment 2S: Basin 1-2

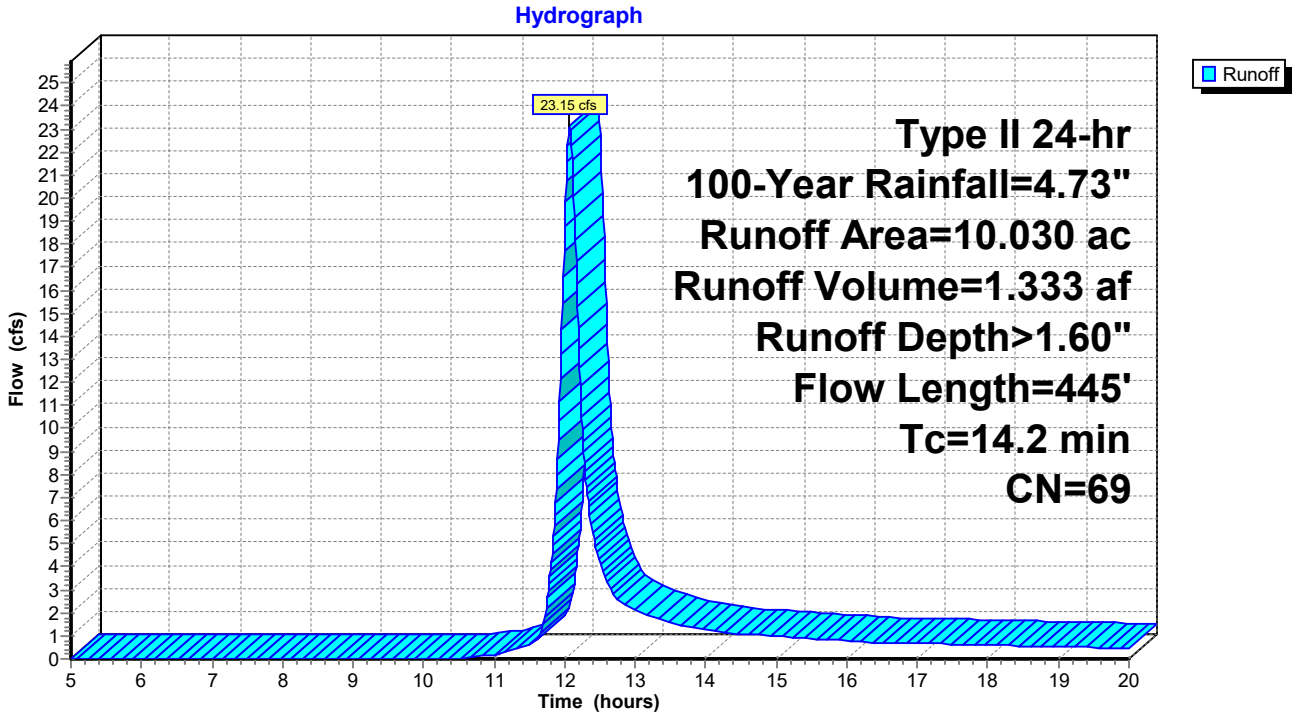
Runoff = 23.15 cfs @ 12.07 hrs, Volume= 1.333 af, Depth> 1.60"
Routed to Reach 4R : Reach 1-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

Area (ac)	CN	Description
10.030	69	Pasture/grassland/range, Fair, HSG B
10.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	172	0.0500	0.24		**Sheet Flow,** Range n= 0.130 P2= 1.88"
1.4	133	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	140	0.2857	3.74		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.2	445	Total			

Subcatchment 2S: Basin 1-2



Summary for Subcatchment 7S: Basin 2-2

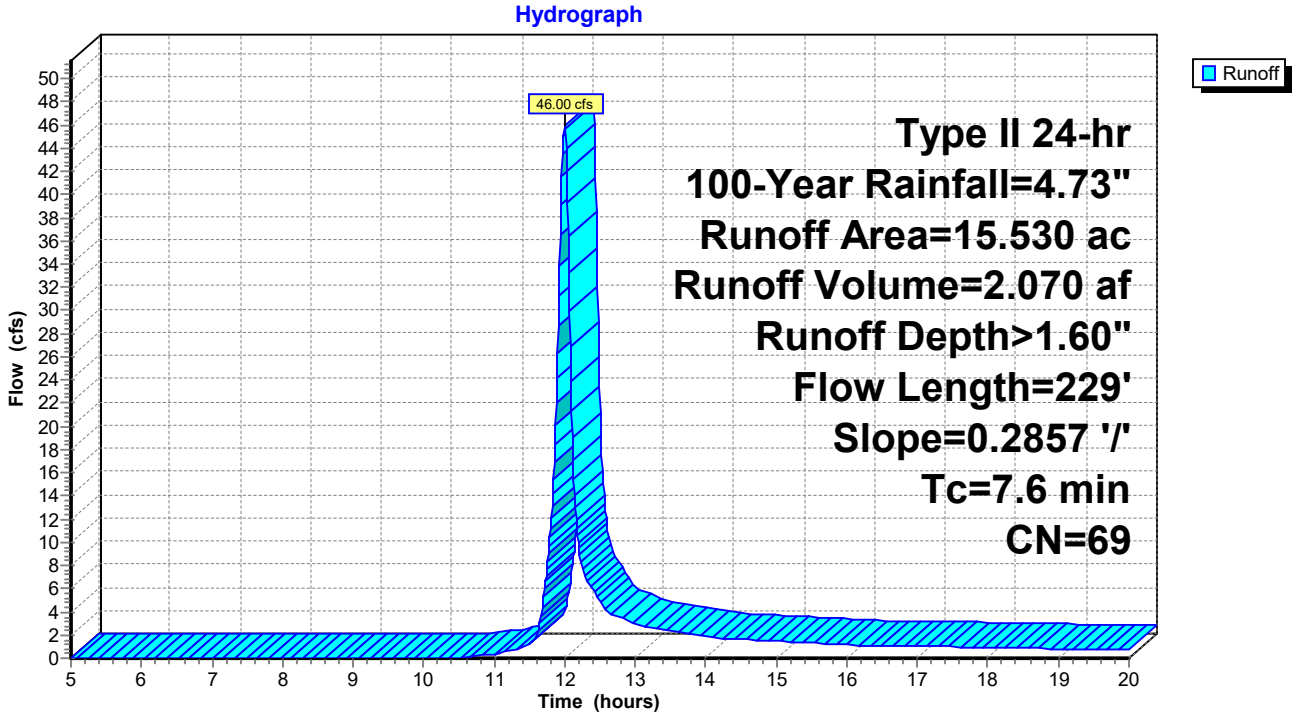
Runoff = 46.00 cfs @ 12.00 hrs, Volume= 2.070 af, Depth> 1.60"
Routed to Reach 10R : Reach 2-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	15.530	69	
	15.530		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	229	0.2857	0.50		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 7S: Basin 2-2



Summary for Subcatchment 8S: Basin 2-1

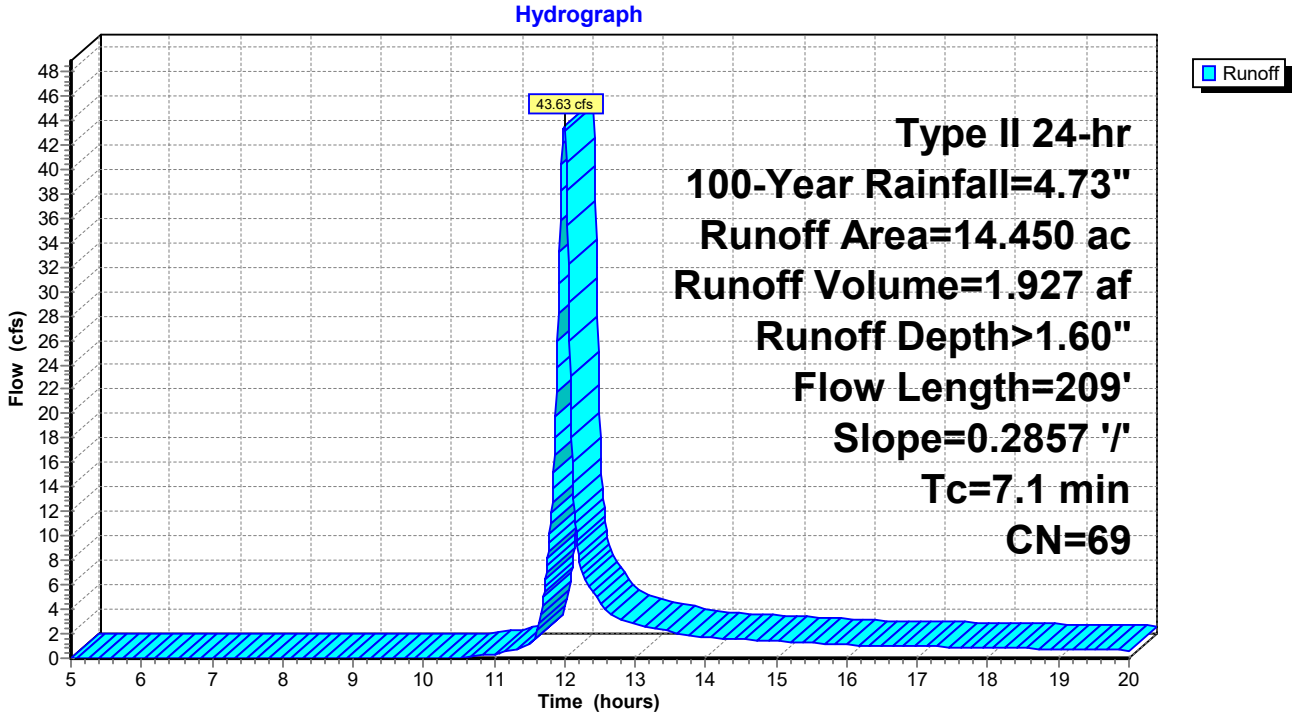
Runoff = 43.63 cfs @ 11.99 hrs, Volume= 1.927 af, Depth> 1.60"
Routed to Reach 9R : Reach 2-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

Area (ac)	CN	Description
14.450	69	Pasture/grassland/range, Fair, HSG B
14.450		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	209	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 8S: Basin 2-1



Summary for Subcatchment 11S: Basin 3-2

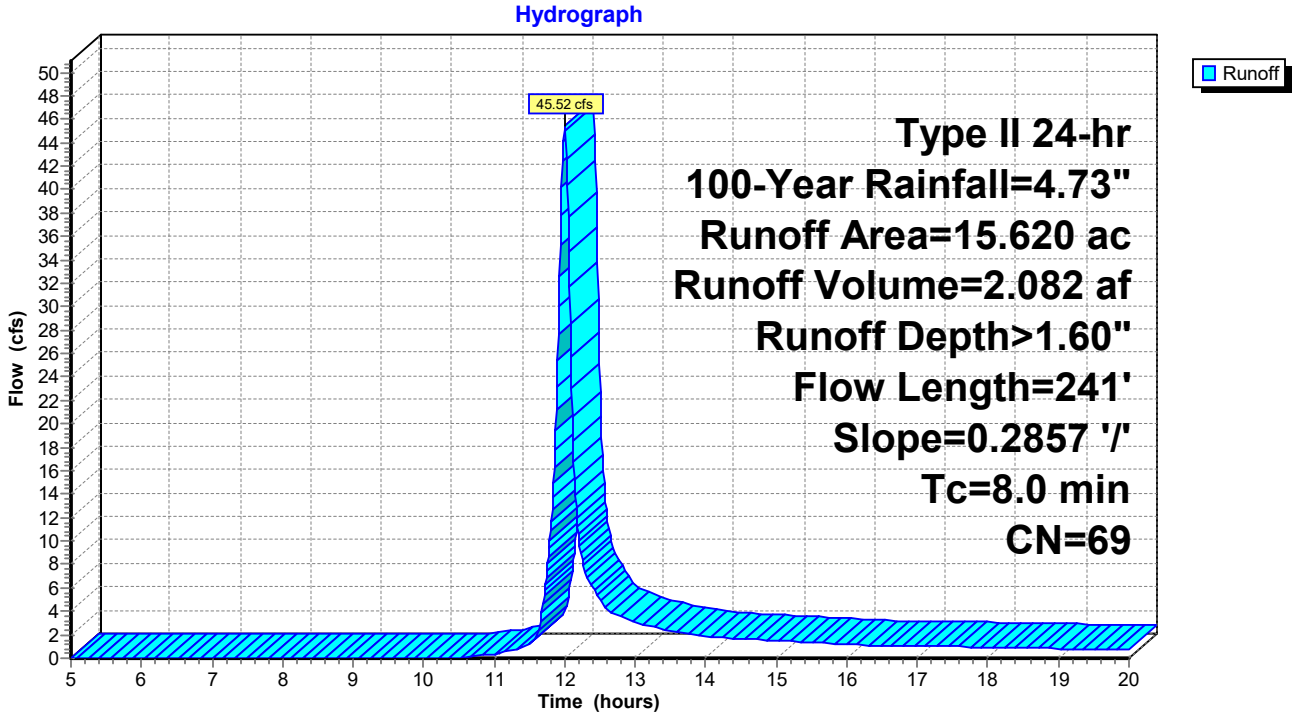
Runoff = 45.52 cfs @ 12.00 hrs, Volume= 2.082 af, Depth> 1.60"
Routed to Reach 14R : Reach 3-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	15.620	69	
	15.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	241	0.2857	0.50		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 11S: Basin 3-2



Summary for Subcatchment 12S: Basin 3-1

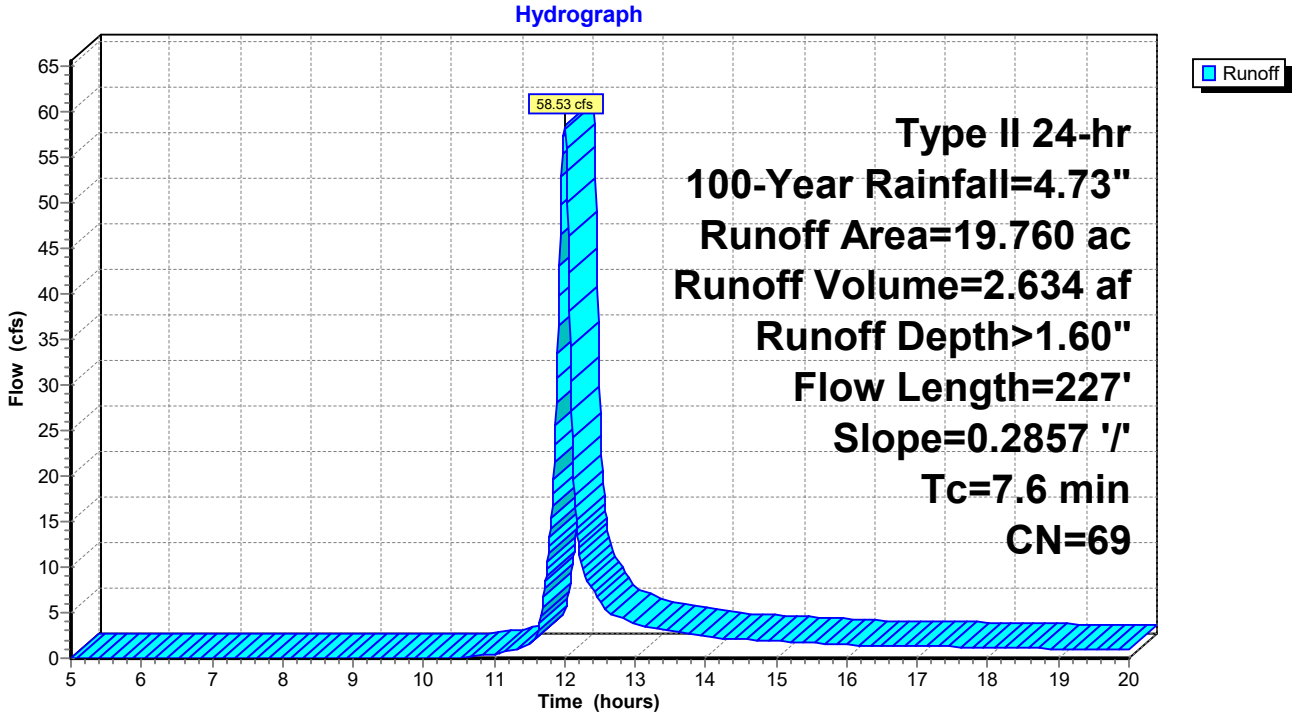
Runoff = 58.53 cfs @ 12.00 hrs, Volume= 2.634 af, Depth> 1.60"
Routed to Reach 13R : Reach 3-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	19.760	69	
	19.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	227	0.2857	0.50		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 12S: Basin 3-1



Summary for Subcatchment 16S: Basin 4-1-1

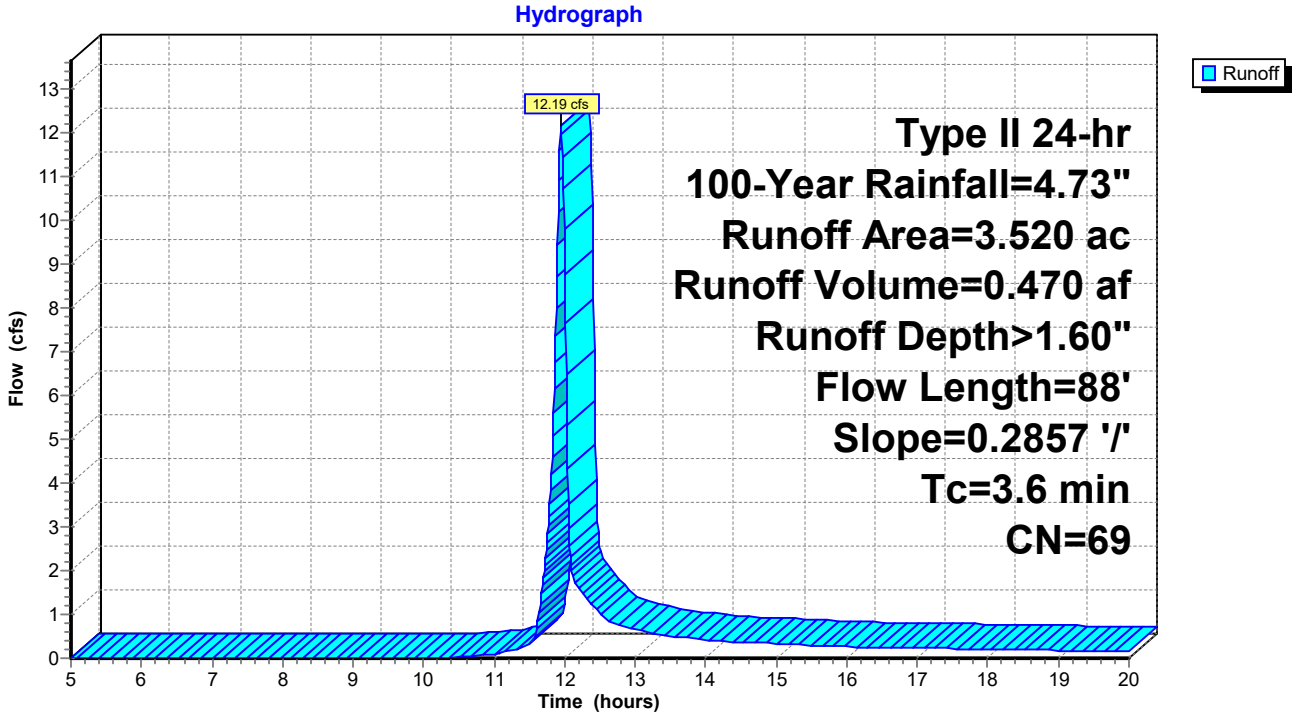
Runoff = 12.19 cfs @ 11.95 hrs, Volume= 0.470 af, Depth> 1.60"
Routed to Reach 17R : Reach 4-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	3.520	69	
	3.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	88	0.2857	0.41		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 16S: Basin 4-1-1



Summary for Subcatchment 19S: Basin 4-1-2

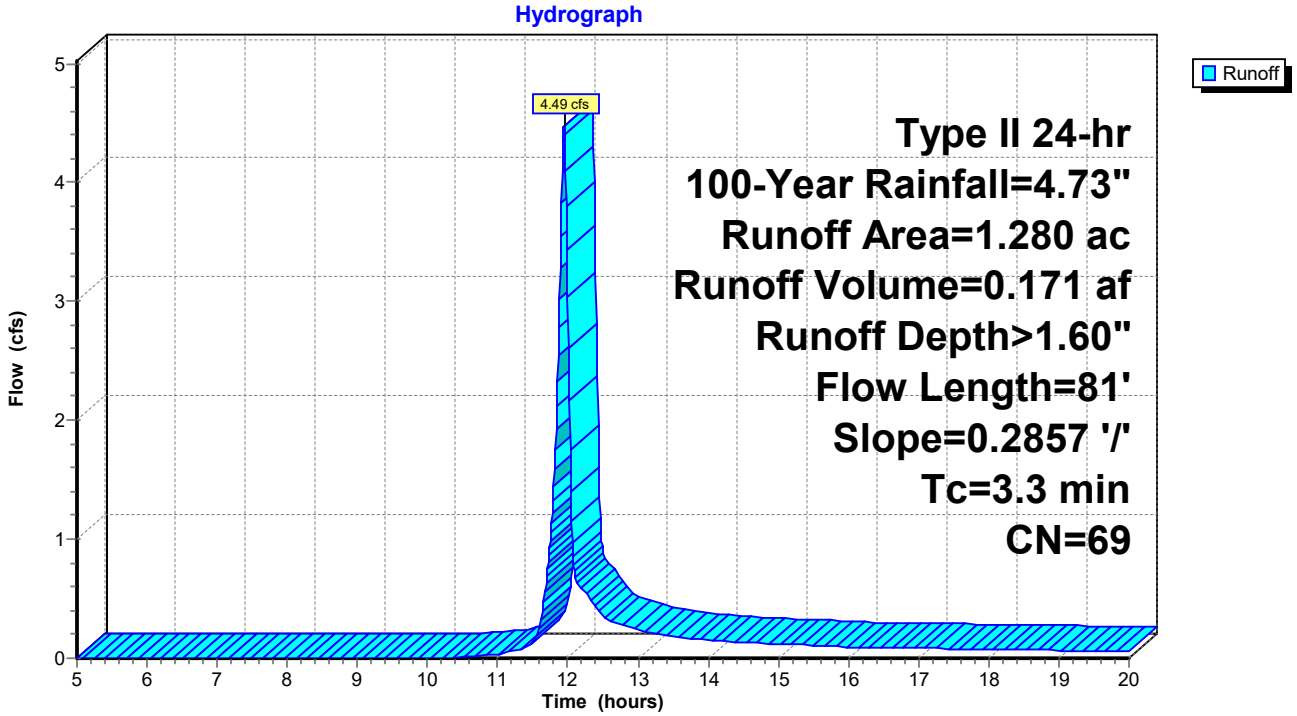
Runoff = 4.49 cfs @ 11.94 hrs, Volume= 0.171 af, Depth> 1.60"
Routed to Pond 18P : North Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	1.280	69	
	1.280		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	81	0.2857	0.41		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 19S: Basin 4-1-2



Summary for Subcatchment 22S: Basin 4-2-1

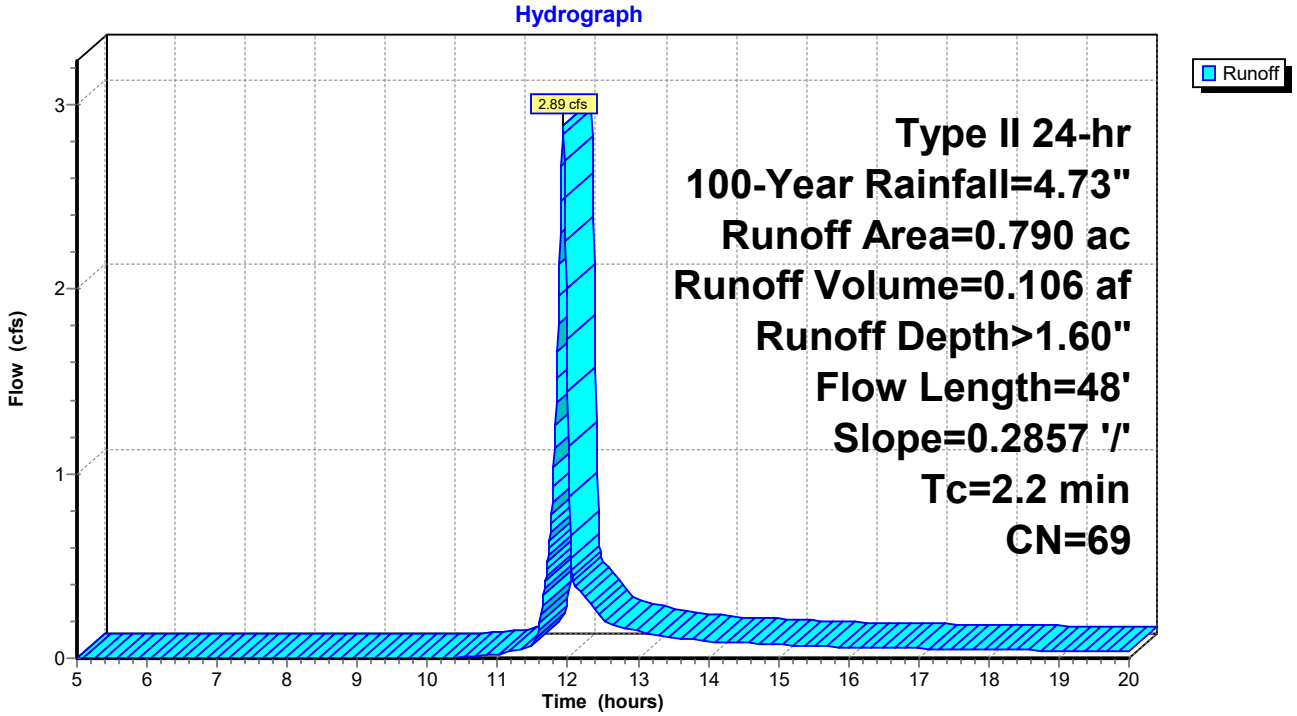
Runoff = 2.89 cfs @ 11.93 hrs, Volume= 0.106 af, Depth> 1.60"
Routed to Reach 20R : Reach 4.2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	0.790	69	
	0.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	48	0.2857	0.37		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 22S: Basin 4-2-1



Summary for Subcatchment 24S: Basin 6-1

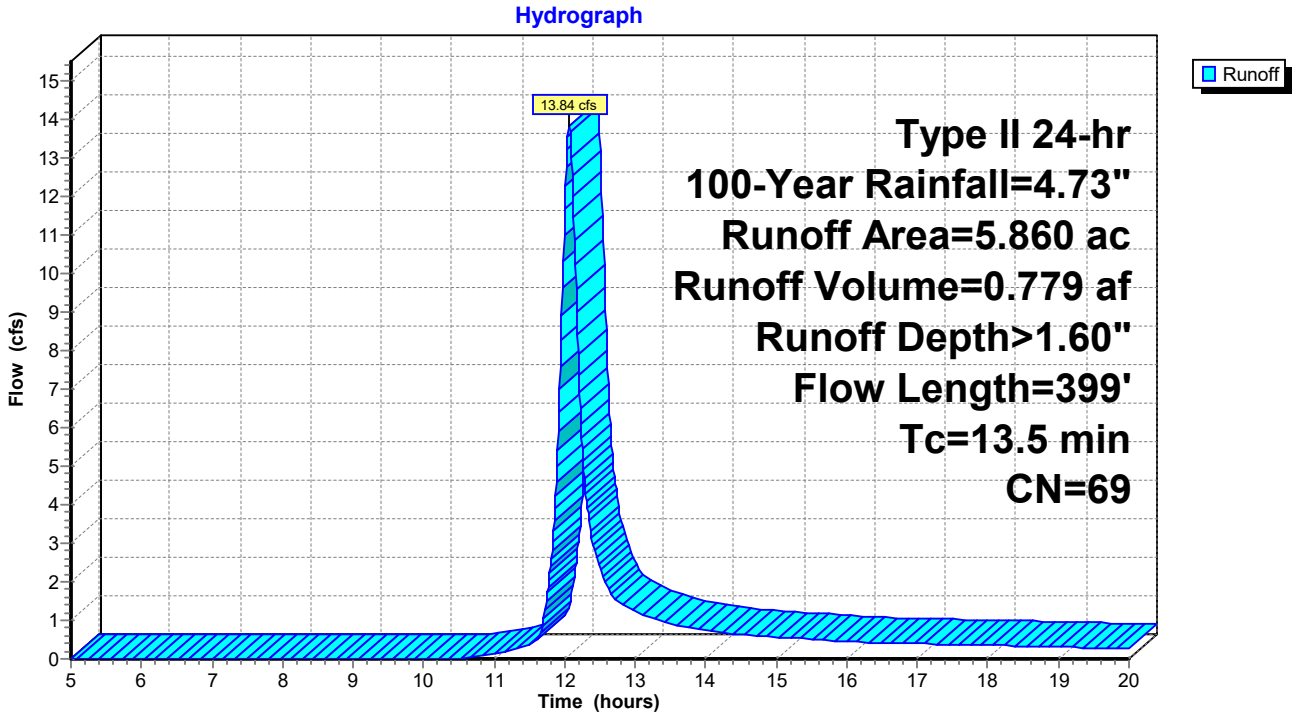
Runoff = 13.84 cfs @ 12.06 hrs, Volume= 0.779 af, Depth> 1.60"
Routed to Reach 26R : Reach 6-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	5.860	69	
	5.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	172	0.0500	0.24		**Sheet Flow,** Range n= 0.130 P2= 1.88"
0.6	61	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	166	0.2857	3.74		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.5	399	Total			

Subcatchment 24S: Basin 6-1



Summary for Subcatchment 25S: Basin 6-2

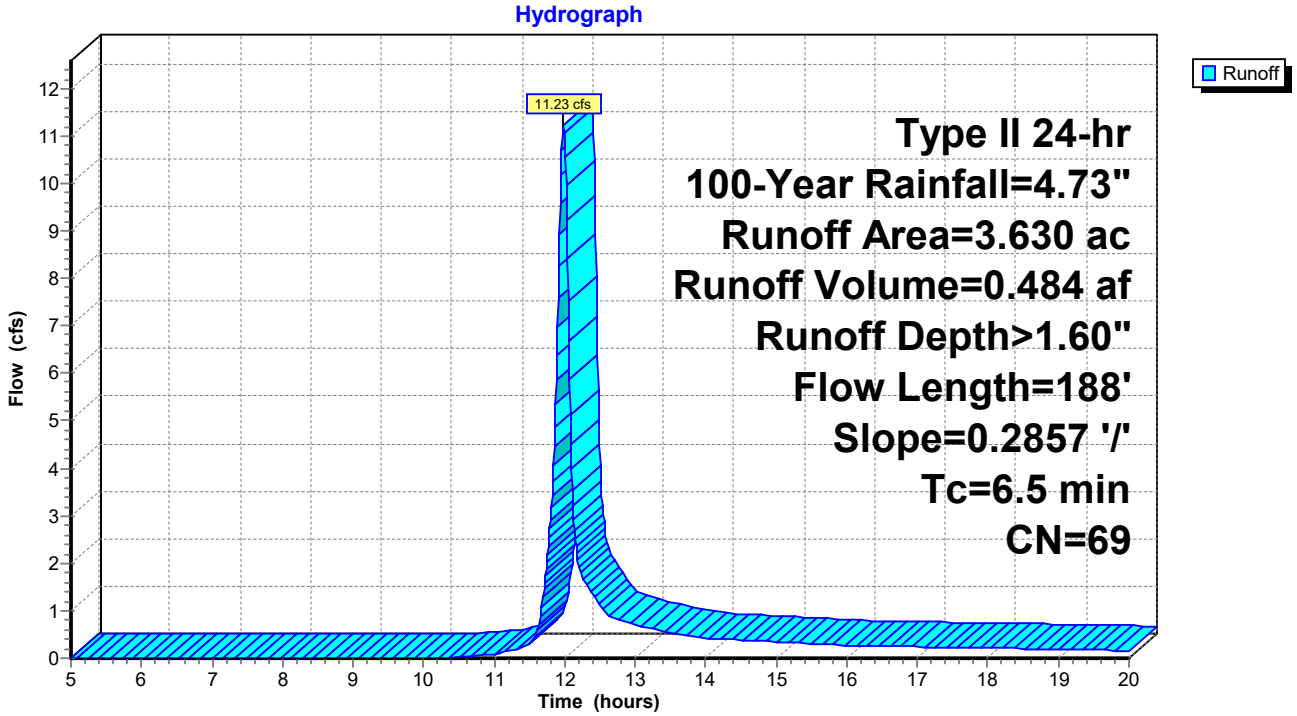
Runoff = 11.23 cfs @ 11.98 hrs, Volume= 0.484 af, Depth> 1.60"
Routed to Reach 27R : Reach 6-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	3.630	69	
	3.630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	188	0.2857	0.48		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 25S: Basin 6-2



Summary for Subcatchment 29S: Basin 7-1

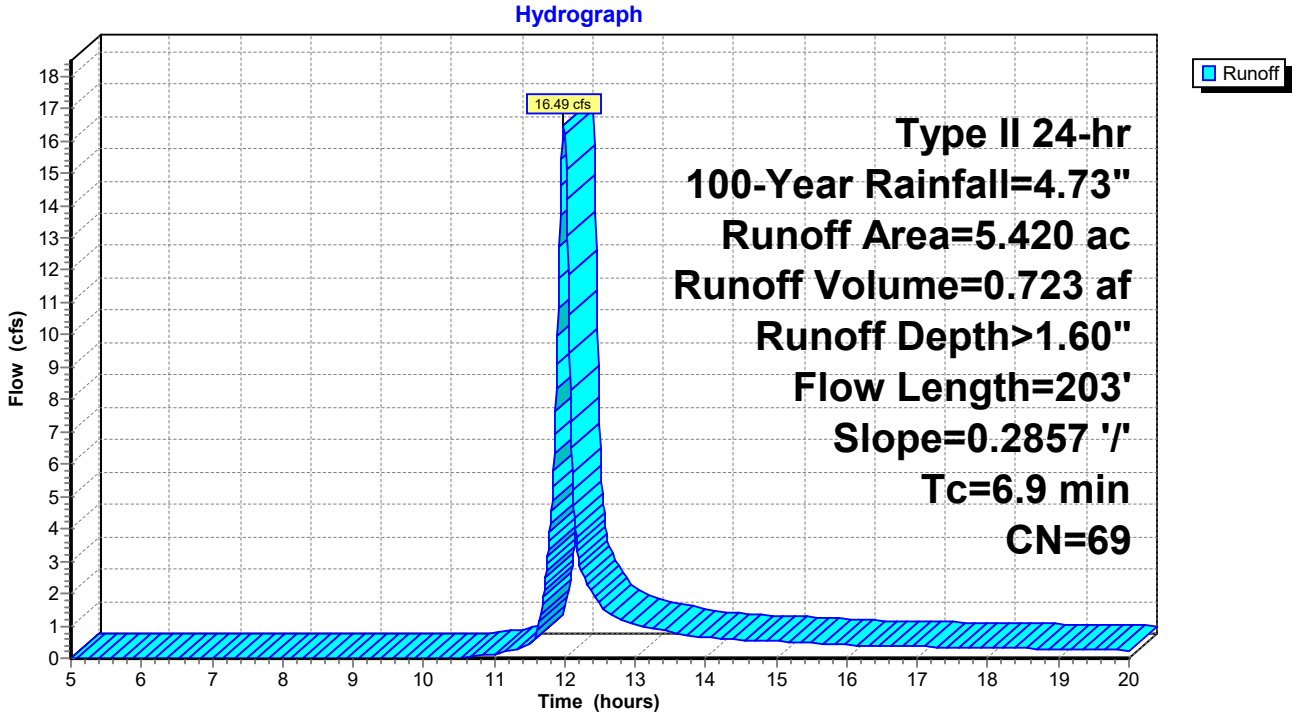
Runoff = 16.49 cfs @ 11.99 hrs, Volume= 0.723 af, Depth> 1.60"
Routed to Reach 31R : Reach 7-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	5.420	69	
	5.420		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	203	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 29S: Basin 7-1



Summary for Subcatchment 30S: Basin 7-2

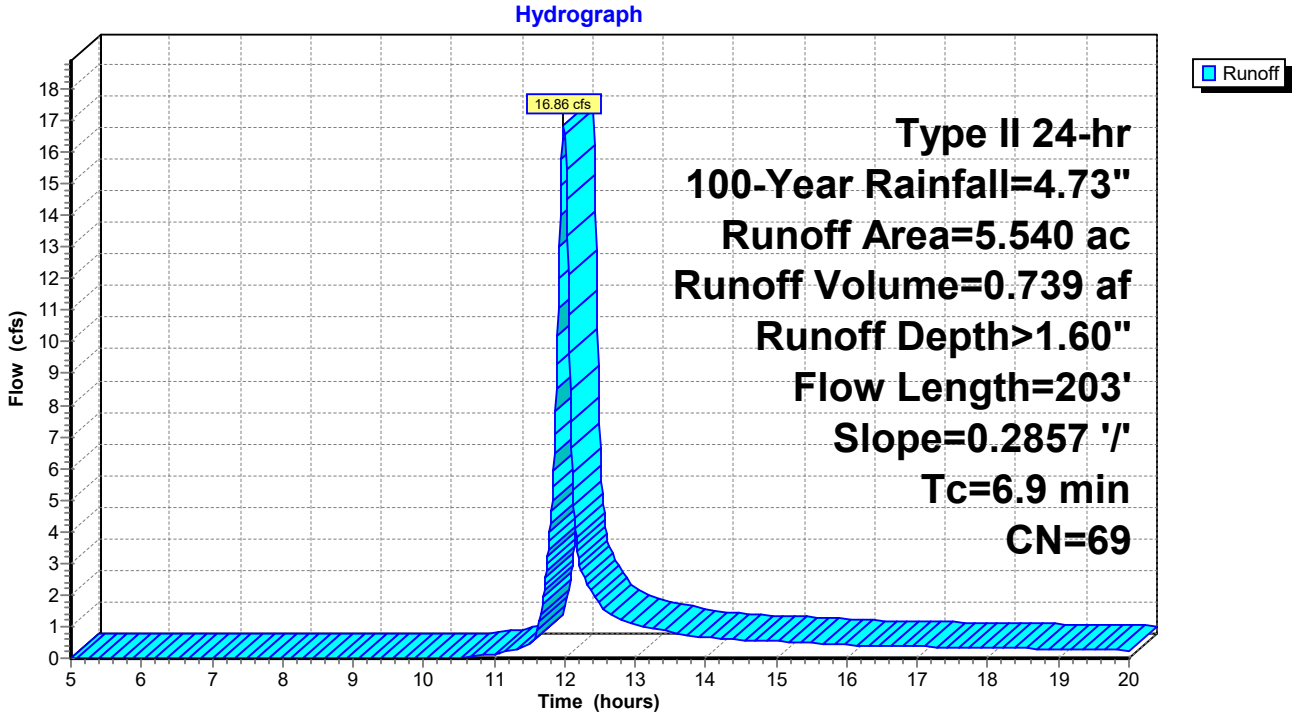
Runoff = 16.86 cfs @ 11.99 hrs, Volume= 0.739 af, Depth> 1.60"
Routed to Reach 32R : Reach 7-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	5.540	69	
	5.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	203	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 30S: Basin 7-2



Summary for Subcatchment 35S: Basin 8-1

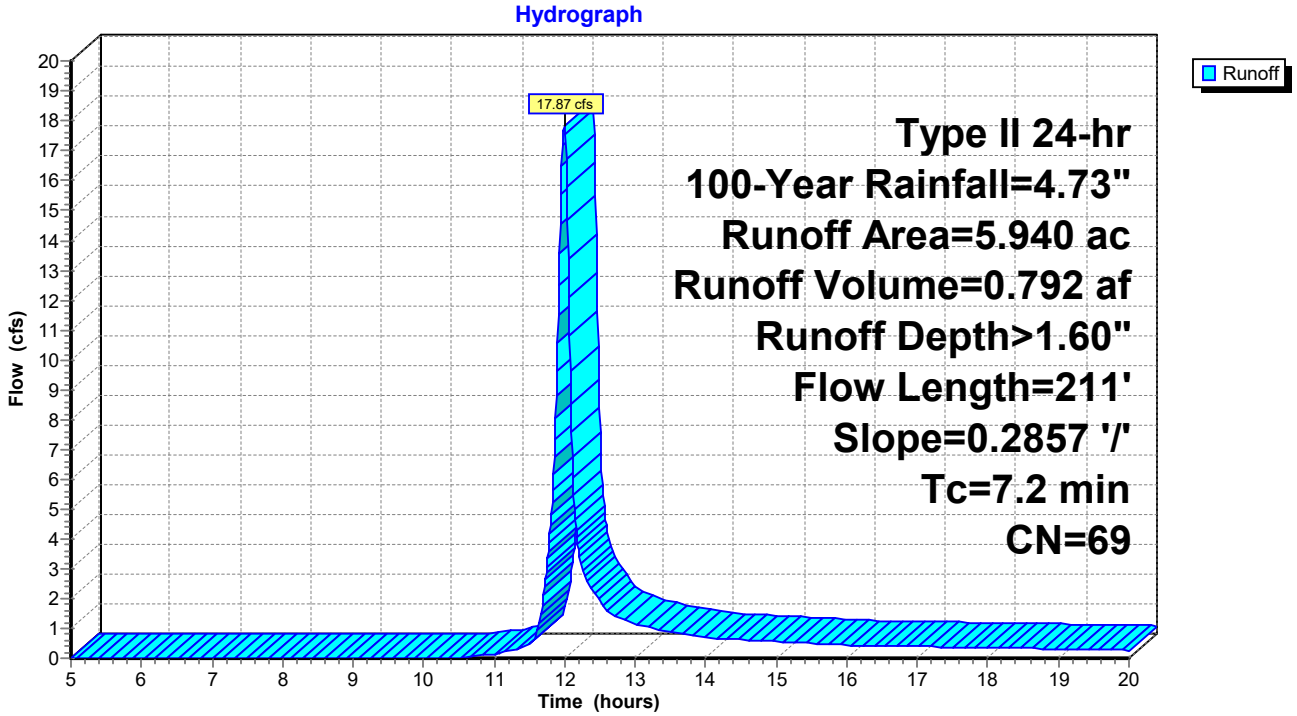
Runoff = 17.87 cfs @ 11.99 hrs, Volume= 0.792 af, Depth> 1.60"
Routed to Reach 36R : Reach 8-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	5.940	69	
	5.940		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	211	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 35S: Basin 8-1



Summary for Subcatchment 37S: Basin 4-2-4

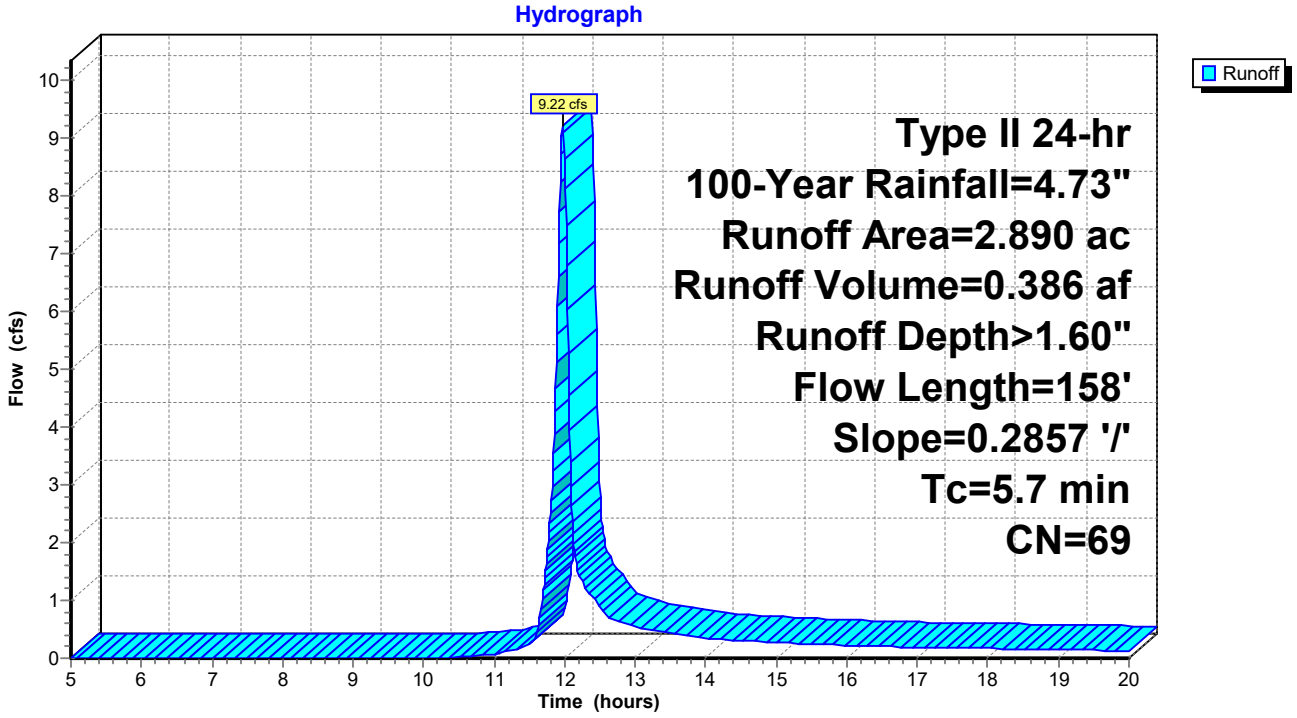
Runoff = 9.22 cfs @ 11.97 hrs, Volume= 0.386 af, Depth> 1.60"
Routed to Pond 34P : Southeast Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	2.890	69	
	2.890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	158	0.2857	0.46		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 37S: Basin 4-2-4



Summary for Subcatchment 38S: Basin 8-2

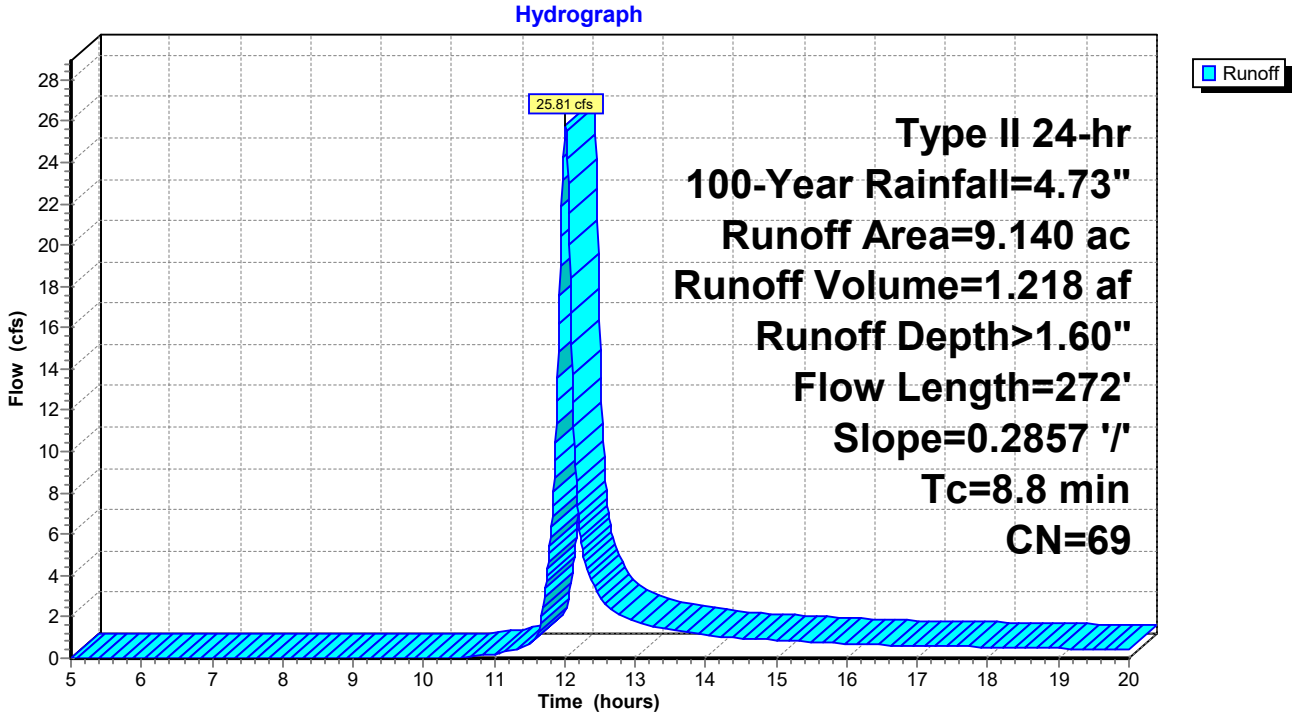
Runoff = 25.81 cfs @ 12.01 hrs, Volume= 1.218 af, Depth> 1.60"
Routed to Pond 34P : Southeast Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	9.140	69	
	9.140		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	272	0.2857	0.52		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 38S: Basin 8-2



Summary for Subcatchment 40S: Basin 4-2-3

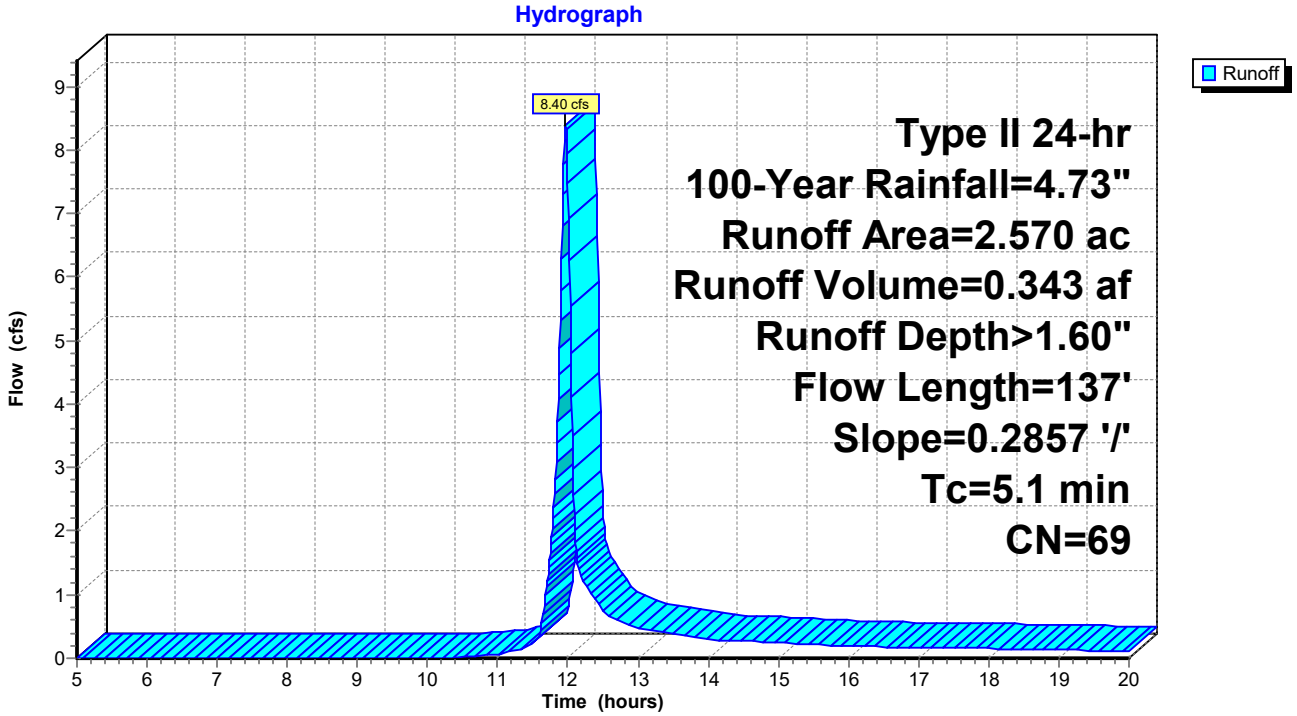
Runoff = 8.40 cfs @ 11.97 hrs, Volume= 0.343 af, Depth> 1.60"
Routed to Reach 39R : Reach 4-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	2.570	69	
	2.570		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	137	0.2857	0.45		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 40S: Basin 4-2-3



Summary for Subcatchment 43S: Basin 5-1-1

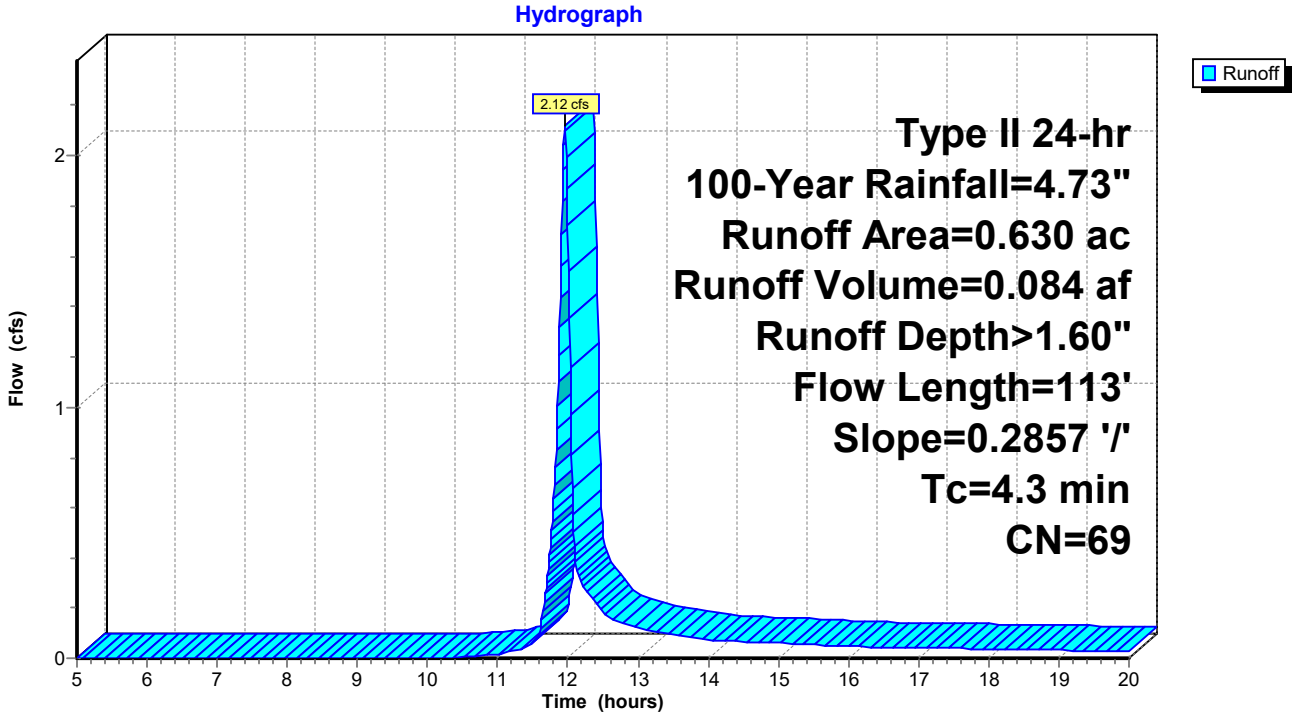
Runoff = 2.12 cfs @ 11.96 hrs, Volume= 0.084 af, Depth> 1.60"
Routed to Reach 44R : Reach 5-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	0.630	69	
	0.630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	113	0.2857	0.43		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 43S: Basin 5-1-1



Summary for Subcatchment 46S: Basin 5-1-2

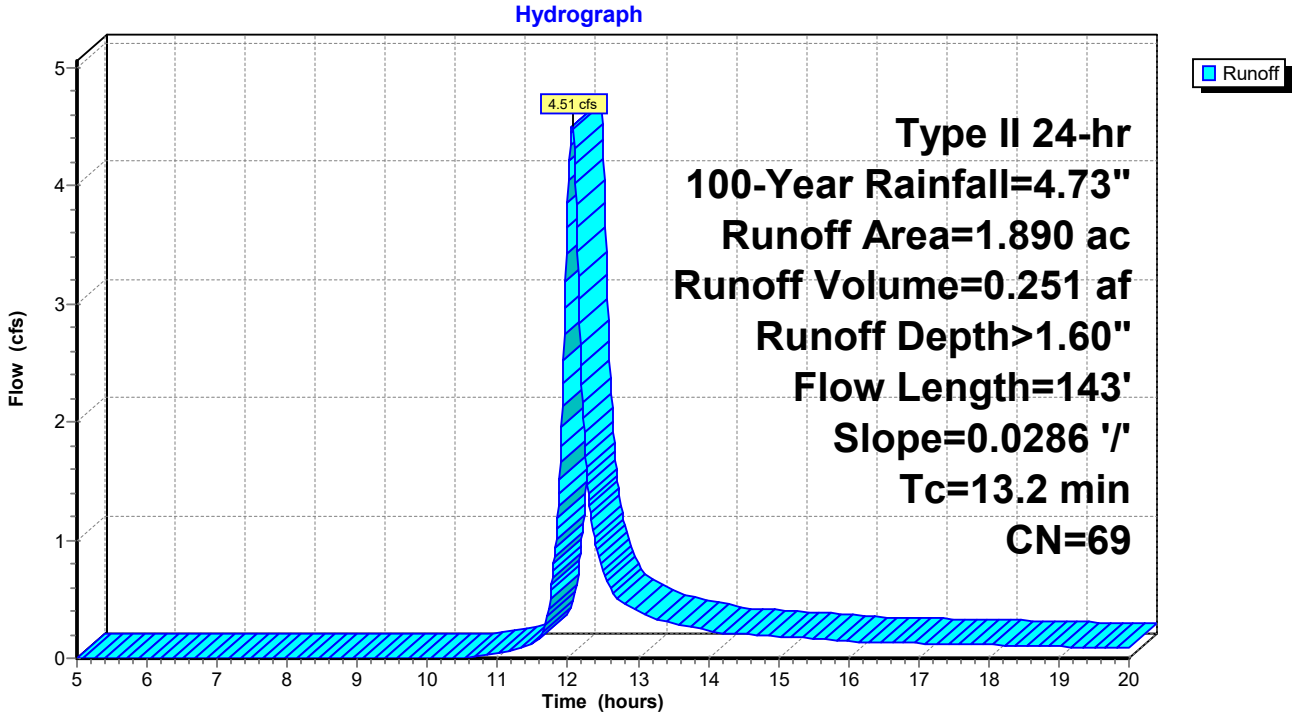
Runoff = 4.51 cfs @ 12.06 hrs, Volume= 0.251 af, Depth> 1.60"
Routed to Pond 45P : Southwest Pond-North Section

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	1.890	69	
	1.890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	143	0.0286	0.18		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 46S: Basin 5-1-2



Summary for Subcatchment 48S: Basin 5-2-2

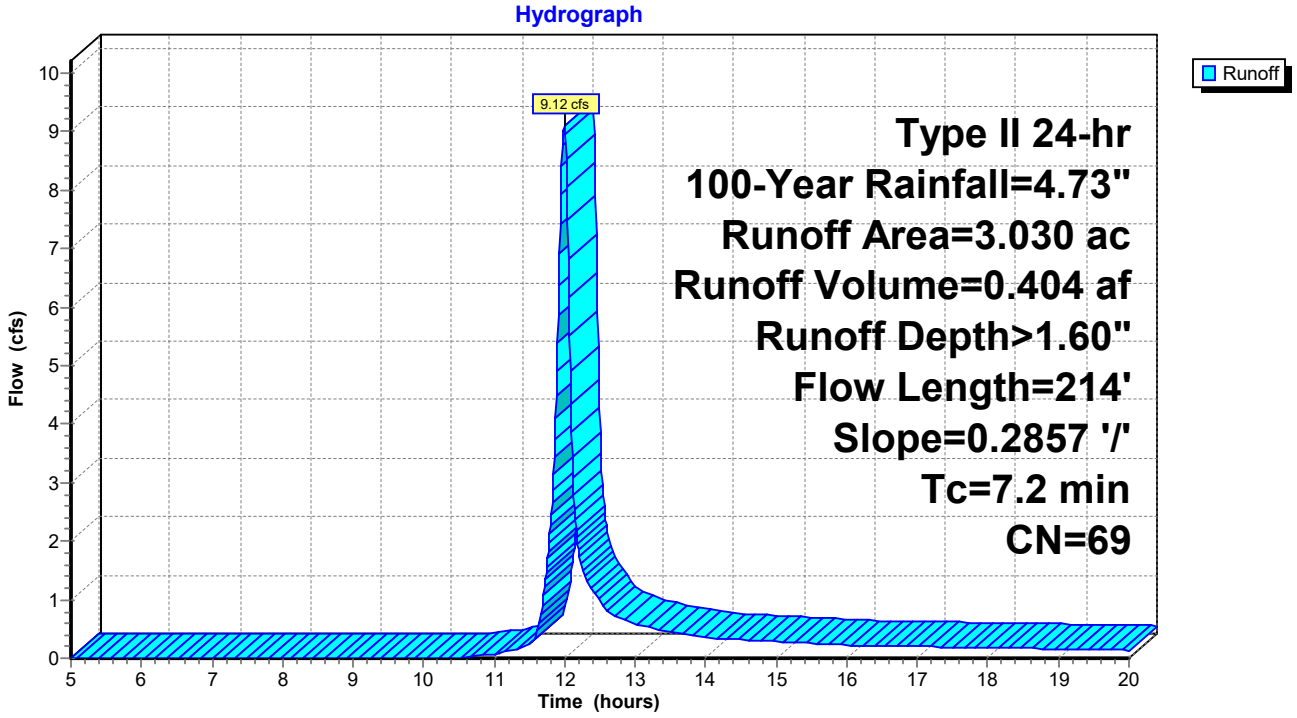
Runoff = 9.12 cfs @ 11.99 hrs, Volume= 0.404 af, Depth> 1.60"
Routed to Reach 49R : Reach 5-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	3.030	69	
	3.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	214	0.2857	0.49		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 48S: Basin 5-2-2



Summary for Subcatchment 50S: Basin 5-2-1

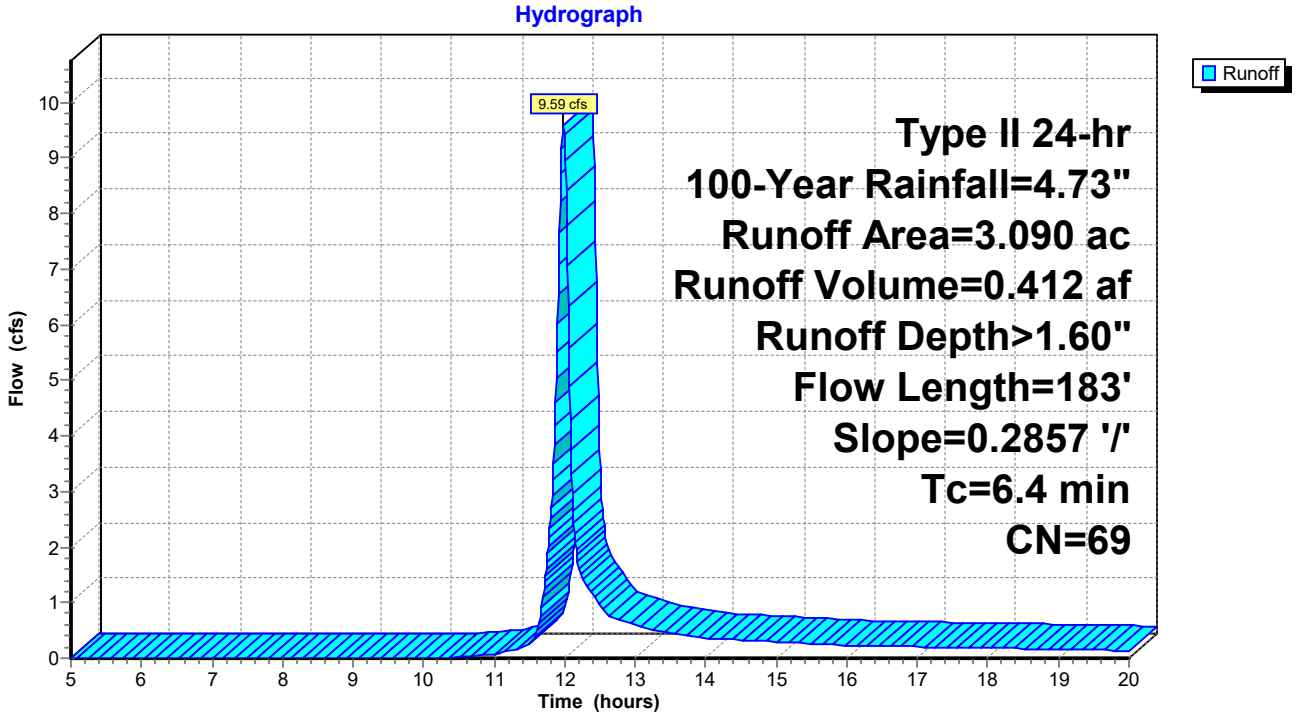
Runoff = 9.59 cfs @ 11.98 hrs, Volume= 0.412 af, Depth> 1.60"
Routed to Pond 55P : Southwest Pond-South Section

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	3.090	69	
	3.090		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	183	0.2857	0.48		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 50S: Basin 5-2-1



Summary for Subcatchment 52S: Basin 4-2-2

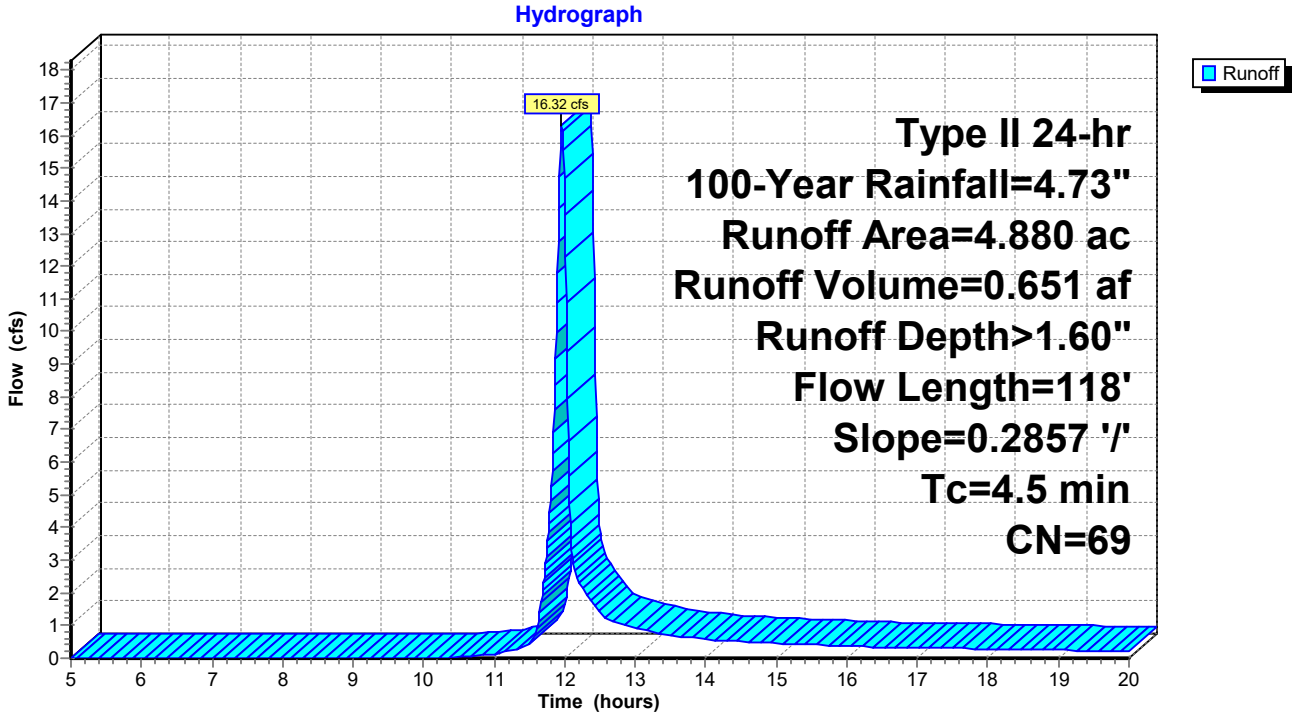
Runoff = 16.32 cfs @ 11.96 hrs, Volume= 0.651 af, Depth> 1.60"
Routed to Pond 15P : Northeast Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	4.880	69	
	4.880		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	118	0.2857	0.44		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 52S: Basin 4-2-2



Summary for Subcatchment 53S: Basin 4-1-3

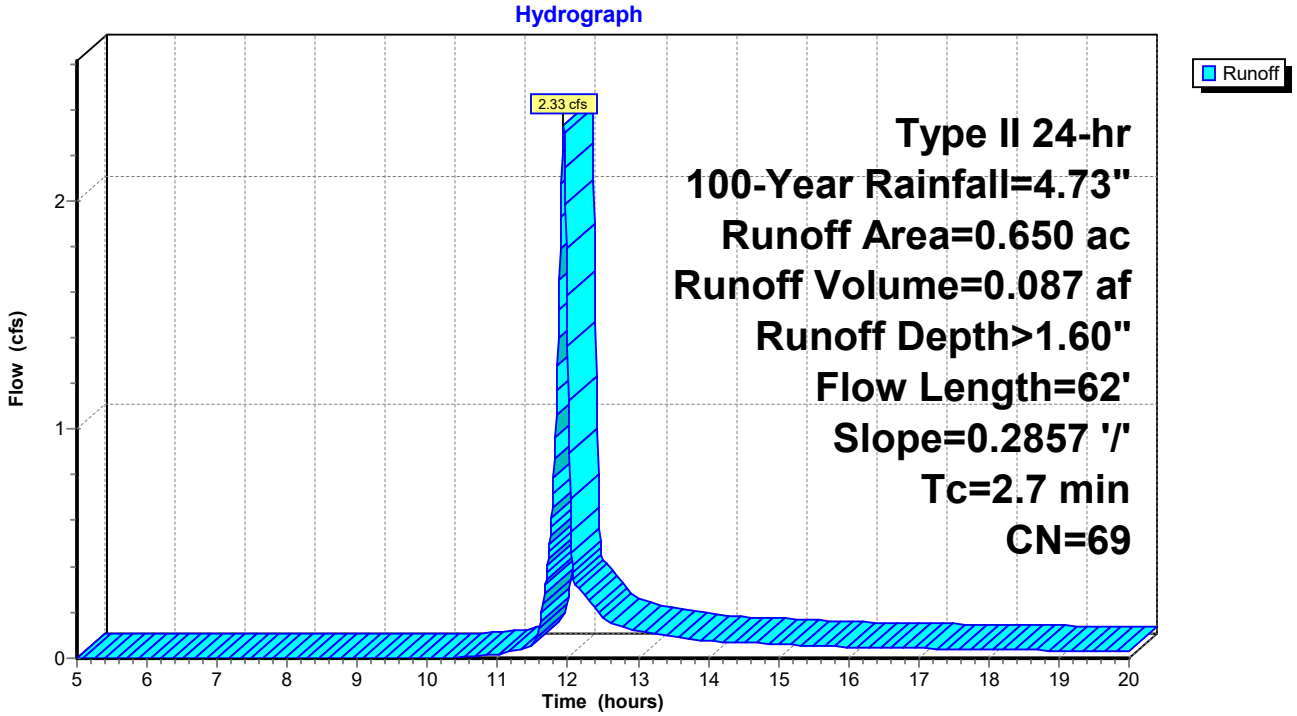
Runoff = 2.33 cfs @ 11.94 hrs, Volume= 0.087 af, Depth> 1.60"
Routed to Reach 42R : Pond to Outfall

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.73"

	Area (ac)	CN	Description
*	0.650	69	
	0.650		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	62	0.2857	0.38		**Sheet Flow,** Range n= 0.130 P2= 1.88"

Subcatchment 53S: Basin 4-1-3



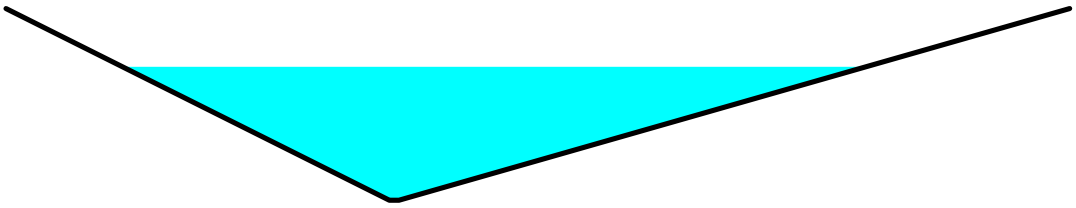
Summary for Reach 3R: Reach 1-1

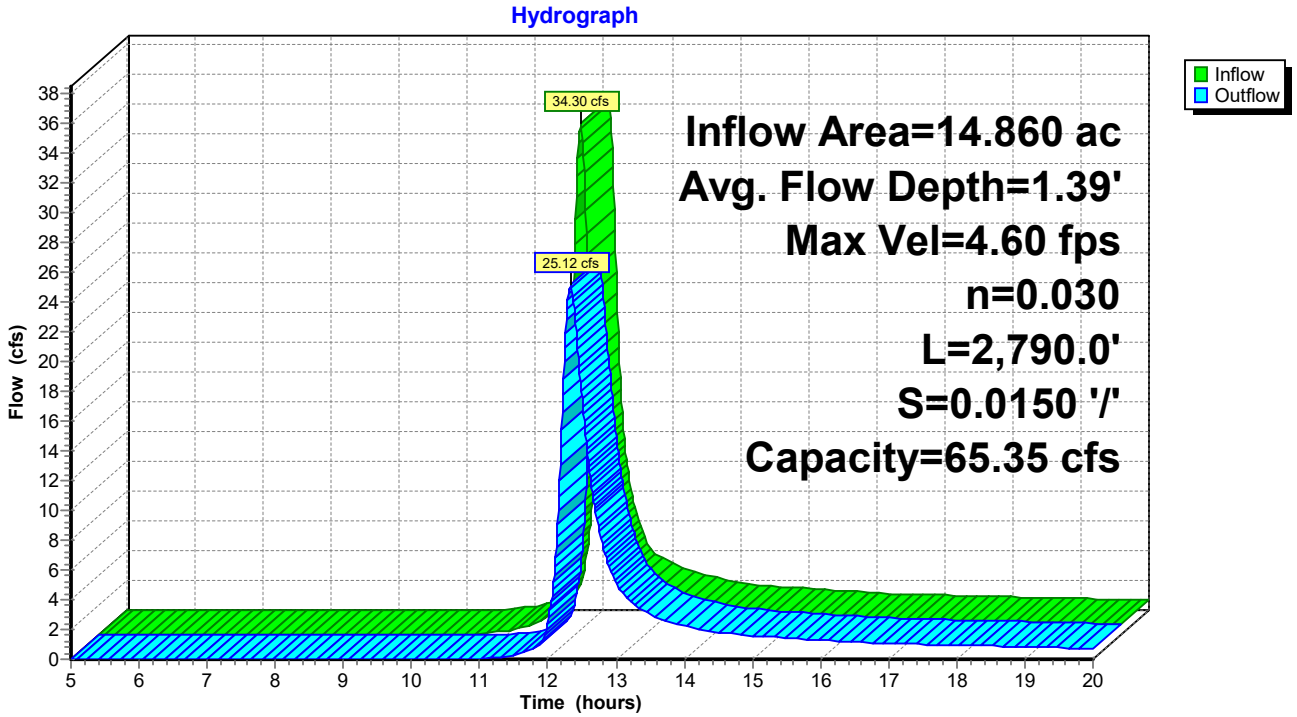
Inflow Area = 14.860 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 34.30 cfs @ 12.07 hrs, Volume= 1.975 af
Outflow = 25.12 cfs @ 12.33 hrs, Volume= 1.942 af, Atten= 27%, Lag= 15.7 min
Routed to Reach 5R : North Downchute Top

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.60 fps, Min. Travel Time= 10.1 min
Avg. Velocity = 2.21 fps, Avg. Travel Time= 21.0 min

Peak Storage= 15,256 cf @ 12.16 hrs
Average Depth at Peak Storage= 1.39' , Surface Width= 7.76'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.35 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 2,790.0' Slope= 0.0150 '/'
Inlet Invert= 5,479.25', Outlet Invert= 5,437.50'





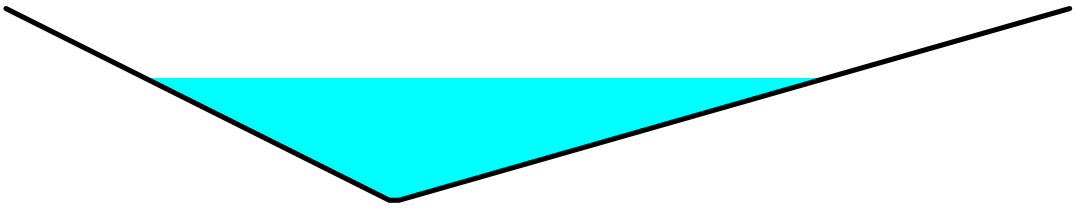
Summary for Reach 4R: Reach 1-2

Inflow Area = 10.030 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 23.15 cfs @ 12.07 hrs, Volume= 1.333 af
Outflow = 20.00 cfs @ 12.23 hrs, Volume= 1.320 af, Atten= 14%, Lag= 9.3 min
Routed to Reach 5R : North Downchute Top

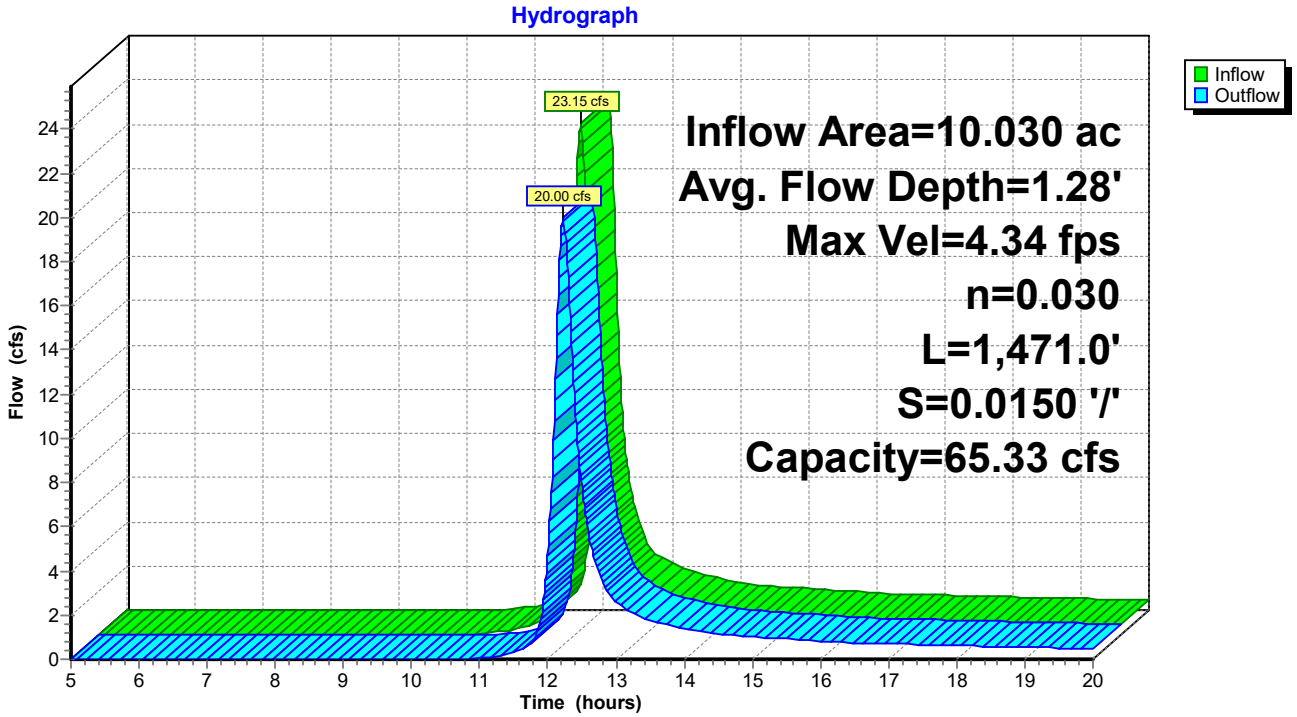
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.34 fps, Min. Travel Time= 5.6 min
Avg. Velocity = 2.01 fps, Avg. Travel Time= 12.2 min

Peak Storage= 6,782 cf @ 12.13 hrs
Average Depth at Peak Storage= 1.28' , Surface Width= 7.12'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.33 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,471.0' Slope= 0.0150 '/'
Inlet Invert= 5,460.50', Outlet Invert= 5,438.50'



Reach 4R: Reach 1-2



Summary for Reach 5R: North Downchute Top

[62] Hint: Exceeded Reach 3R OUTLET depth by 1.00' @ 5.00 hrs
[61] Hint: Exceeded Reach 4R outlet invert by 0.29' @ 12.30 hrs

Inflow Area = 24.890 ac, 0.00% Impervious, Inflow Depth > 1.57" for 100-Year event
Inflow = 41.93 cfs @ 12.29 hrs, Volume= 3.262 af
Outflow = 41.86 cfs @ 12.31 hrs, Volume= 3.256 af, Atten= 0%, Lag= 1.3 min
Routed to Reach 6R : North Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.96 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.77 fps, Avg. Travel Time= 2.1 min

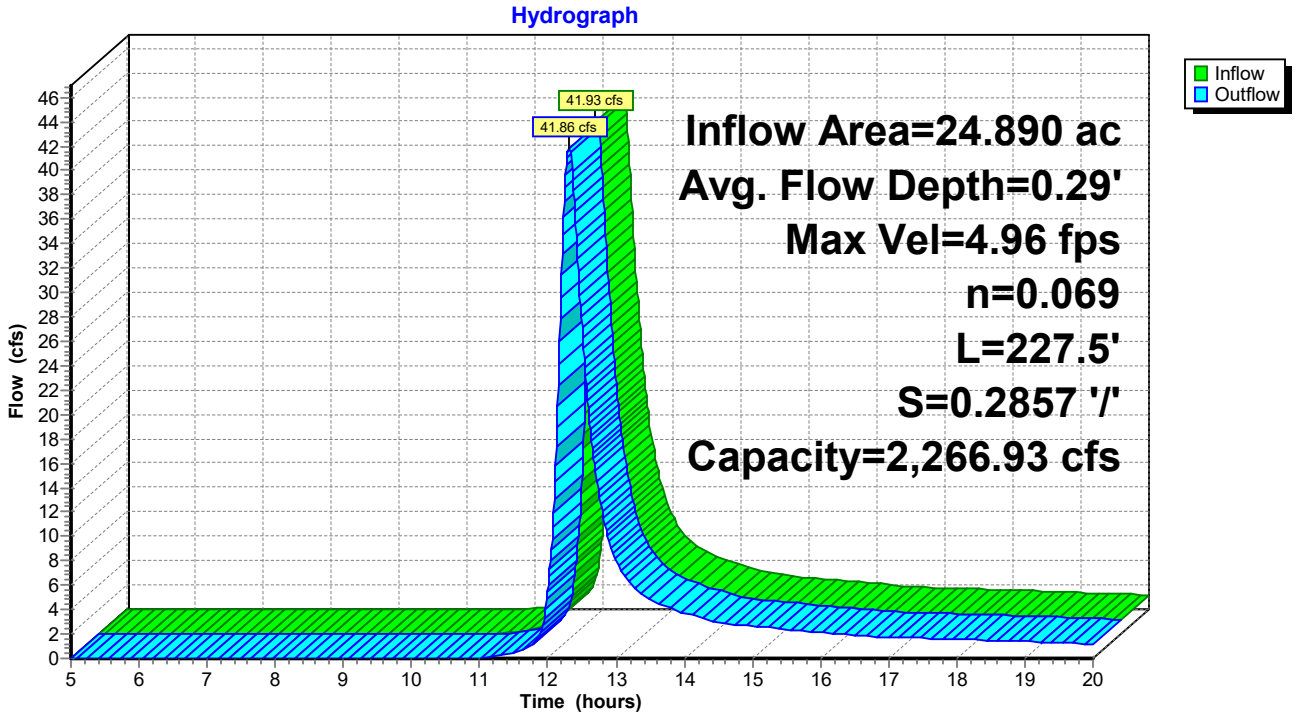
Peak Storage= 1,919 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.29' , Surface Width= 29.75'
Bank-Full Depth= 3.00' Flow Area= 111.0 sf, Capacity= 2,266.93 cfs

28.00' x 3.00' deep channel, n= 0.069
Side Slope Z-value= 3.0 '/' Top Width= 46.00'
Length= 227.5' Slope= 0.2857 '/'
Inlet Invert= 5,438.50', Outlet Invert= 5,373.50'



‡

Reach 5R: North Downchute Top



Summary for Reach 6R: North Downchute Bottom

[61] Hint: Exceeded Reach 5R outlet invert by 0.29' @ 12.29 hrs
[61] Hint: Exceeded Reach 9R outlet invert by 0.29' @ 12.29 hrs
[61] Hint: Exceeded Reach 10R outlet invert by 0.29' @ 12.29 hrs

Inflow Area = 54.870 ac, 0.00% Impervious, Inflow Depth > 1.57" for 100-Year event
Inflow = 93.99 cfs @ 12.28 hrs, Volume= 7.175 af
Outflow = 93.80 cfs @ 12.30 hrs, Volume= 7.161 af, Atten= 0%, Lag= 1.3 min
Routed to Pond 15P : Northeast Pond

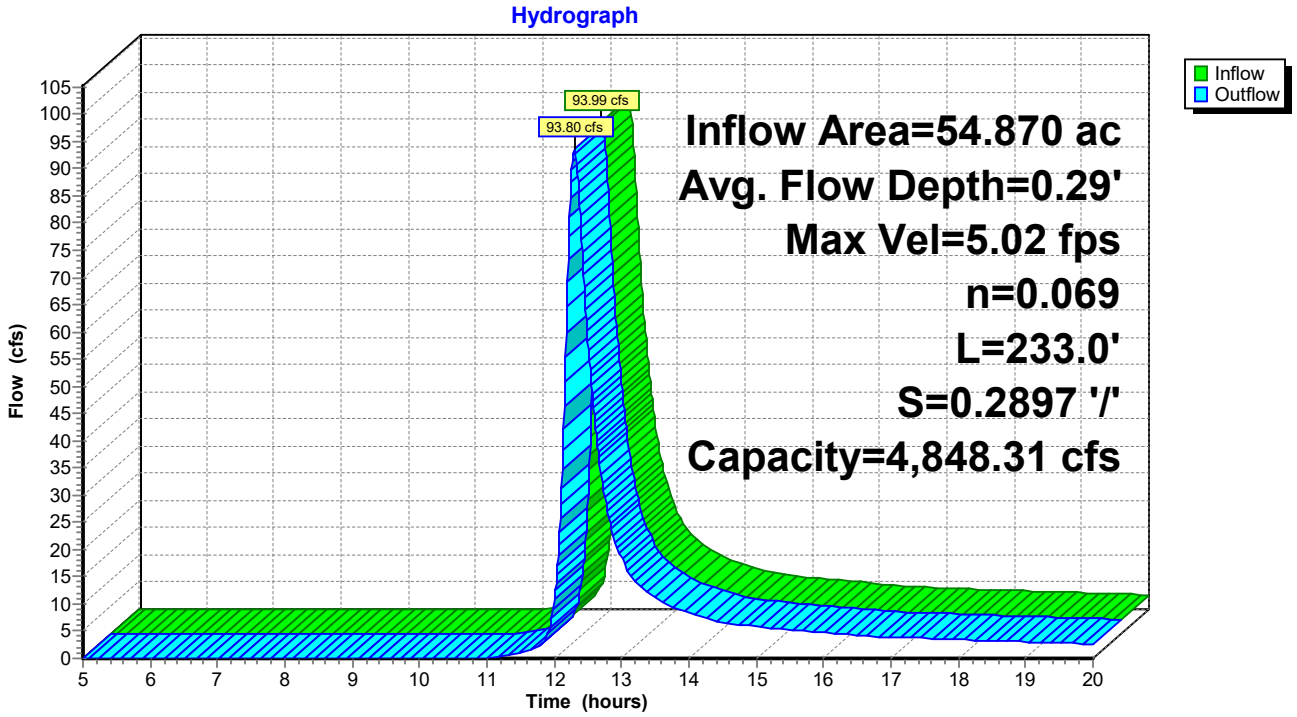
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.02 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.76 fps, Avg. Travel Time= 2.2 min

Peak Storage= 4,358 cf @ 12.29 hrs
Average Depth at Peak Storage= 0.29' , Surface Width= 65.73'
Bank-Full Depth= 3.00' Flow Area= 219.0 sf, Capacity= 4,848.31 cfs

64.00' x 3.00' deep channel, n= 0.069
Side Slope Z-value= 3.0 '/' Top Width= 82.00'
Length= 233.0' Slope= 0.2897 '/'
Inlet Invert= 5,373.50', Outlet Invert= 5,306.00'



Reach 6R: North Downchute Bottom



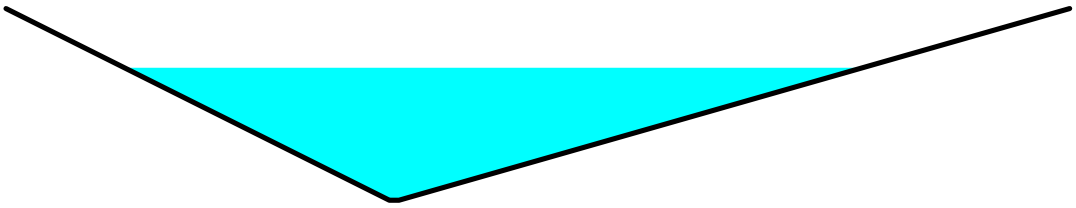
Summary for Reach 9R: Reach 2-1

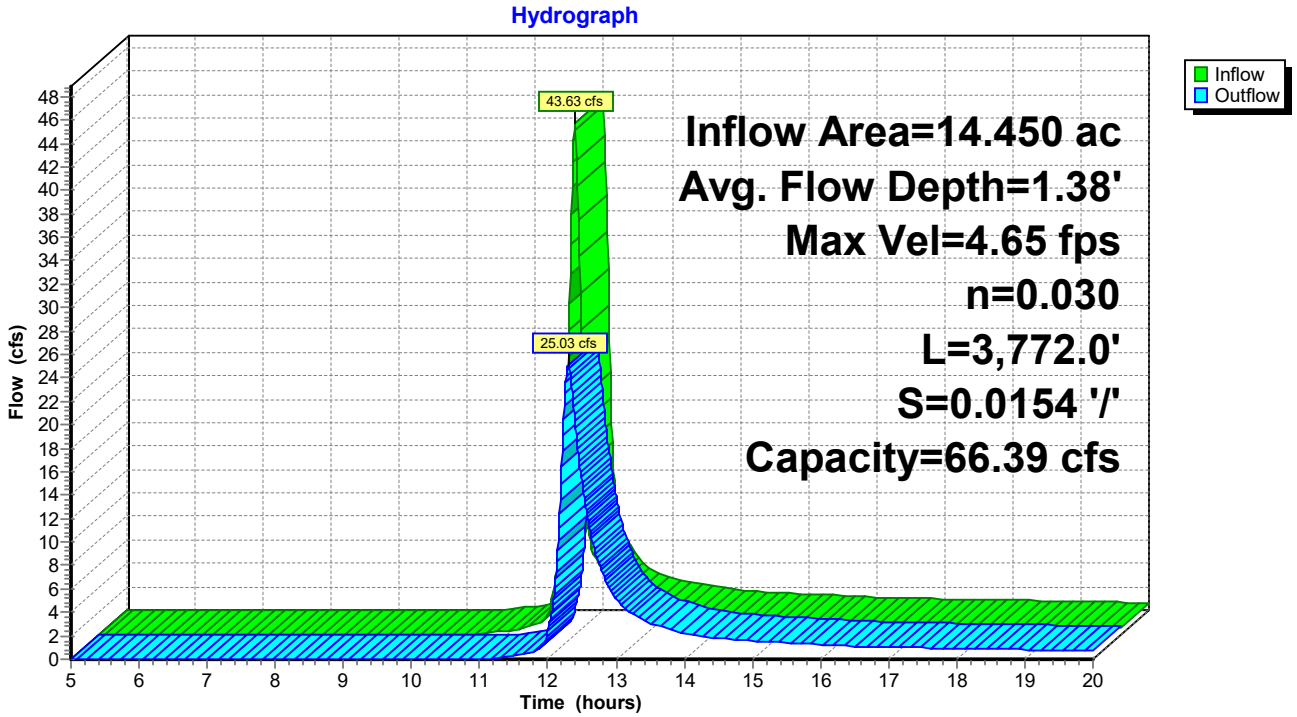
Inflow Area = 14.450 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 43.63 cfs @ 11.99 hrs, Volume= 1.927 af
Outflow = 25.03 cfs @ 12.30 hrs, Volume= 1.883 af, Atten= 43%, Lag= 18.5 min
Routed to Reach 6R : North Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.65 fps, Min. Travel Time= 13.5 min
Avg. Velocity = 2.23 fps, Avg. Travel Time= 28.2 min

Peak Storage= 20,340 cf @ 12.07 hrs
Average Depth at Peak Storage= 1.38' , Surface Width= 7.70'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 66.39 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 3,772.0' Slope= 0.0154 '/'
Inlet Invert= 5,431.75', Outlet Invert= 5,373.50'





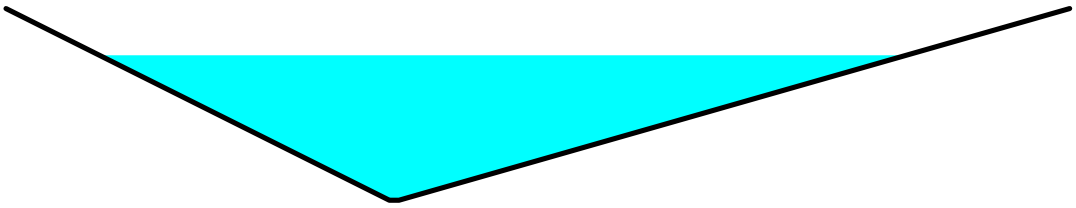
Summary for Reach 10R: Reach 2-2

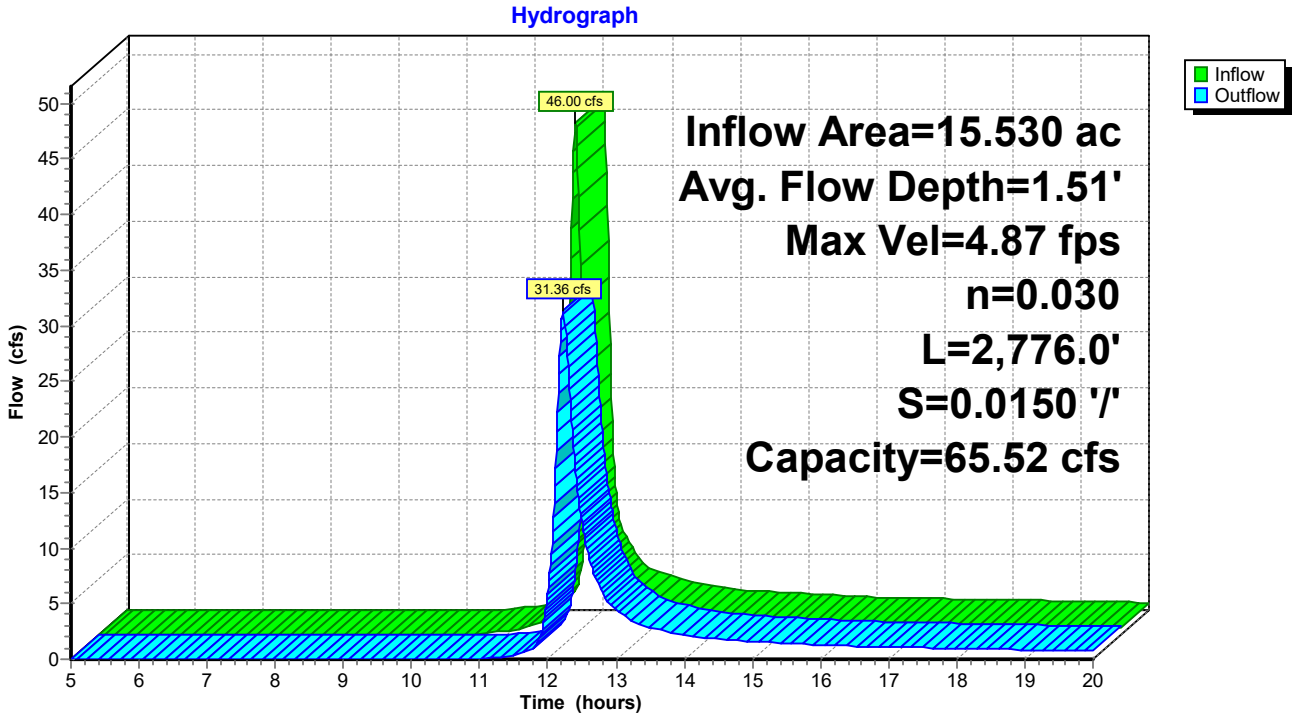
Inflow Area = 15.530 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 46.00 cfs @ 12.00 hrs, Volume= 2.070 af
Outflow = 31.36 cfs @ 12.22 hrs, Volume= 2.037 af, Atten= 32%, Lag= 13.7 min
Routed to Reach 6R : North Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.87 fps, Min. Travel Time= 9.5 min
Avg. Velocity = 2.24 fps, Avg. Travel Time= 20.7 min

Peak Storage= 17,895 cf @ 12.07 hrs
Average Depth at Peak Storage= 1.51' , Surface Width= 8.42'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.52 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 2,776.0' Slope= 0.0150 '/'
Inlet Invert= 5,415.25', Outlet Invert= 5,373.50'





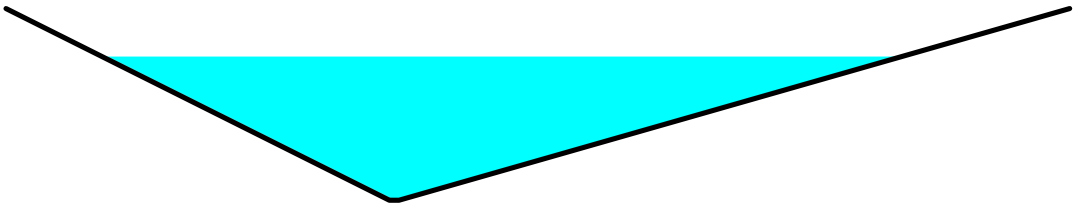
Summary for Reach 13R: Reach 3-1

Inflow Area = 19.760 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 58.53 cfs @ 12.00 hrs, Volume= 2.634 af
Outflow = 30.83 cfs @ 12.36 hrs, Volume= 2.563 af, Atten= 47%, Lag= 21.7 min
Routed to Pond 15P : Northeast Pond

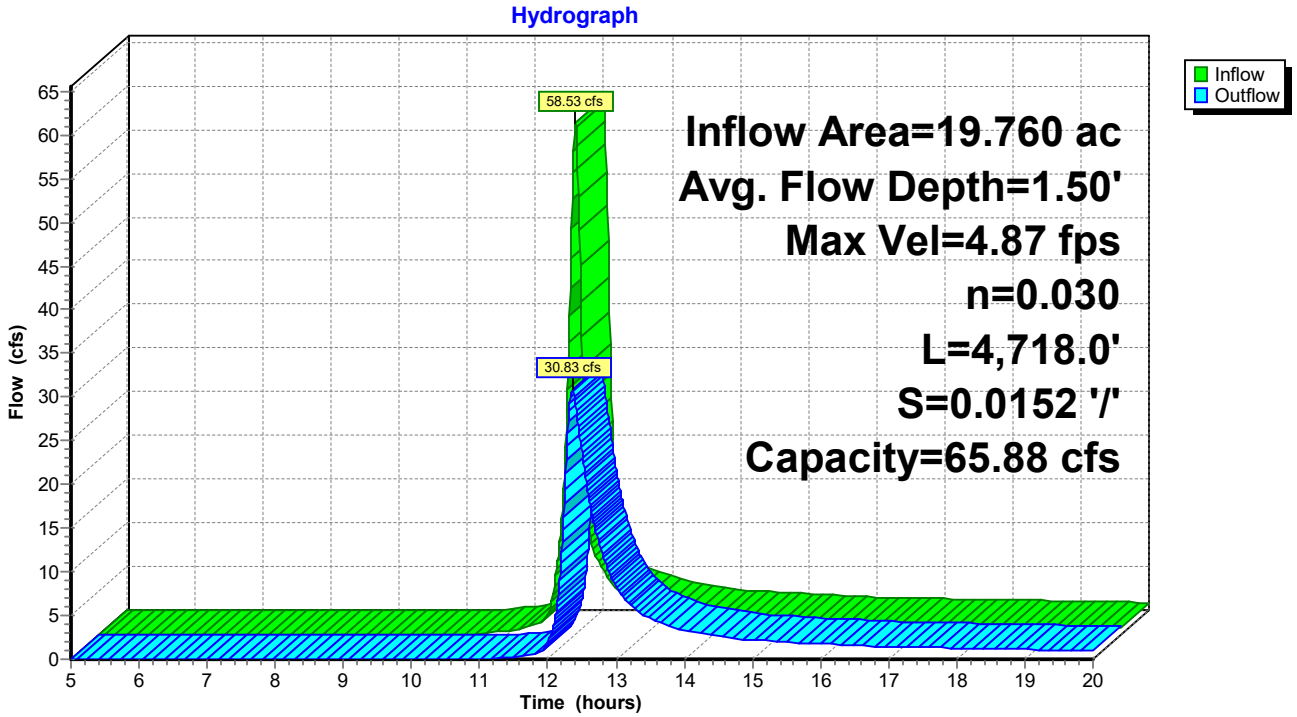
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.87 fps, Min. Travel Time= 16.2 min
Avg. Velocity = 2.39 fps, Avg. Travel Time= 32.8 min

Peak Storage= 29,903 cf @ 12.09 hrs
Average Depth at Peak Storage= 1.50' , Surface Width= 8.35'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.88 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 4,718.0' Slope= 0.0152 '/'
Inlet Invert= 5,377.75', Outlet Invert= 5,306.00'



Reach 13R: Reach 3-1



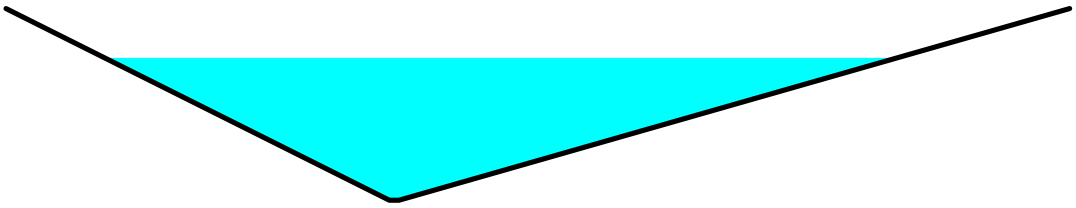
Summary for Reach 14R: Reach 3-2

Inflow Area = 15.620 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 45.52 cfs @ 12.00 hrs, Volume= 2.082 af
Outflow = 29.84 cfs @ 12.25 hrs, Volume= 2.044 af, Atten= 34%, Lag= 15.1 min
Routed to Pond 15P : Northeast Pond

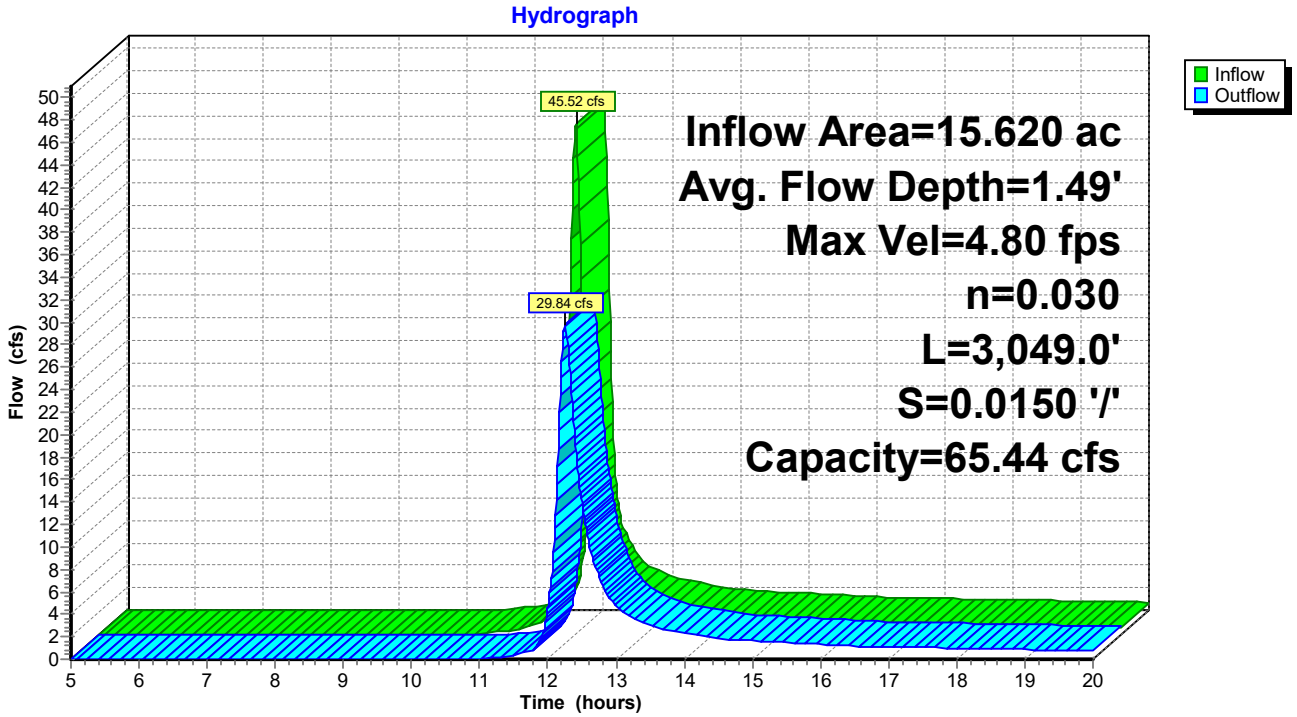
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.80 fps, Min. Travel Time= 10.6 min
Avg. Velocity = 2.24 fps, Avg. Travel Time= 22.7 min

Peak Storage= 18,959 cf @ 12.08 hrs
Average Depth at Peak Storage= 1.49' , Surface Width= 8.27'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.44 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 3,049.0' Slope= 0.0150 '/'
Inlet Invert= 5,355.00', Outlet Invert= 5,309.25'



Reach 14R: Reach 3-2



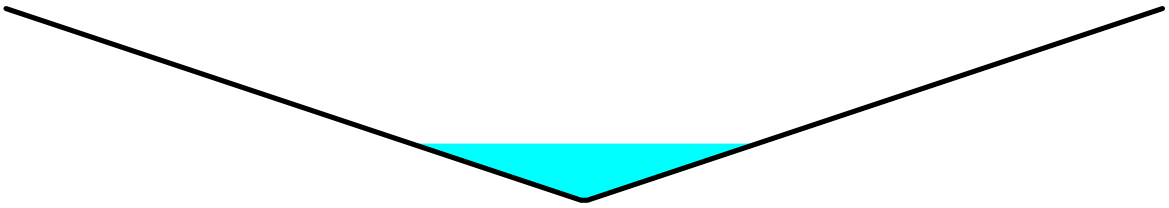
Summary for Reach 17R: Reach 4-1

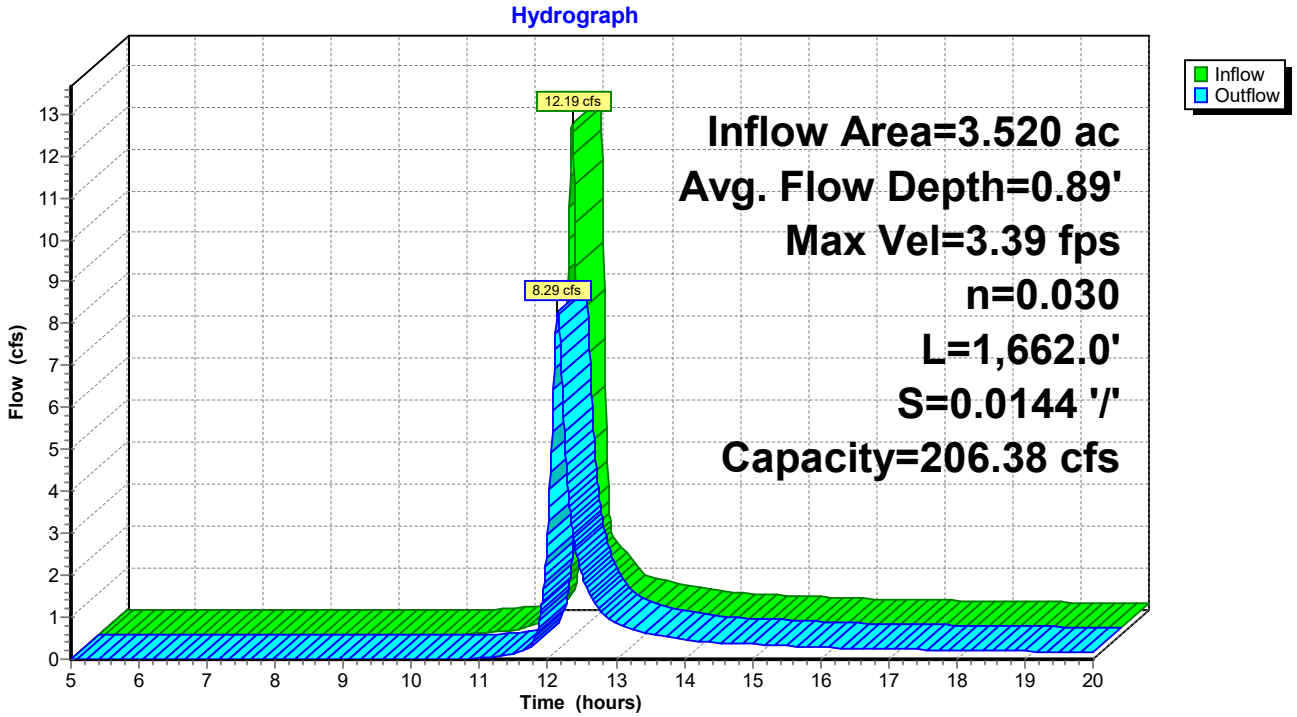
Inflow Area = 3.520 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 12.19 cfs @ 11.95 hrs, Volume= 0.470 af
Outflow = 8.29 cfs @ 12.14 hrs, Volume= 0.463 af, Atten= 32%, Lag= 11.5 min
Routed to Pond 18P : North Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.39 fps, Min. Travel Time= 8.2 min
Avg. Velocity = 1.51 fps, Avg. Travel Time= 18.4 min

Peak Storage= 4,073 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.89' , Surface Width= 5.42'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 206.38 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 1,662.0' Slope= 0.0144 '/'
Inlet Invert= 5,326.00', Outlet Invert= 5,302.00'





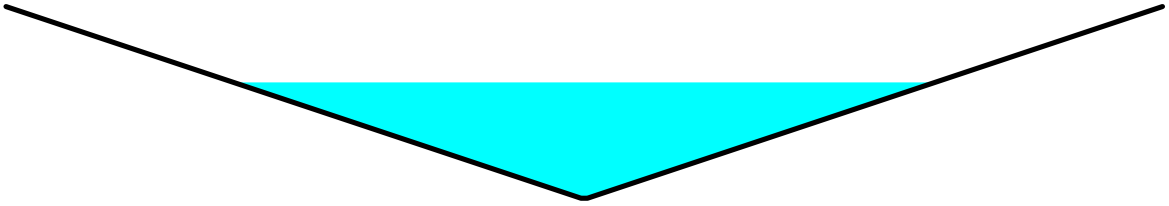
Summary for Reach 20R: Reach 4.2.1

Inflow Area = 136.910 ac, 0.00% Impervious, Inflow Depth > 0.49" for 100-Year event
Inflow = 49.18 cfs @ 12.77 hrs, Volume= 5.597 af
Outflow = 41.35 cfs @ 12.89 hrs, Volume= 5.570 af, Atten= 16%, Lag= 7.1 min
Routed to Pond 23P : Storage in Perimeter Ditch

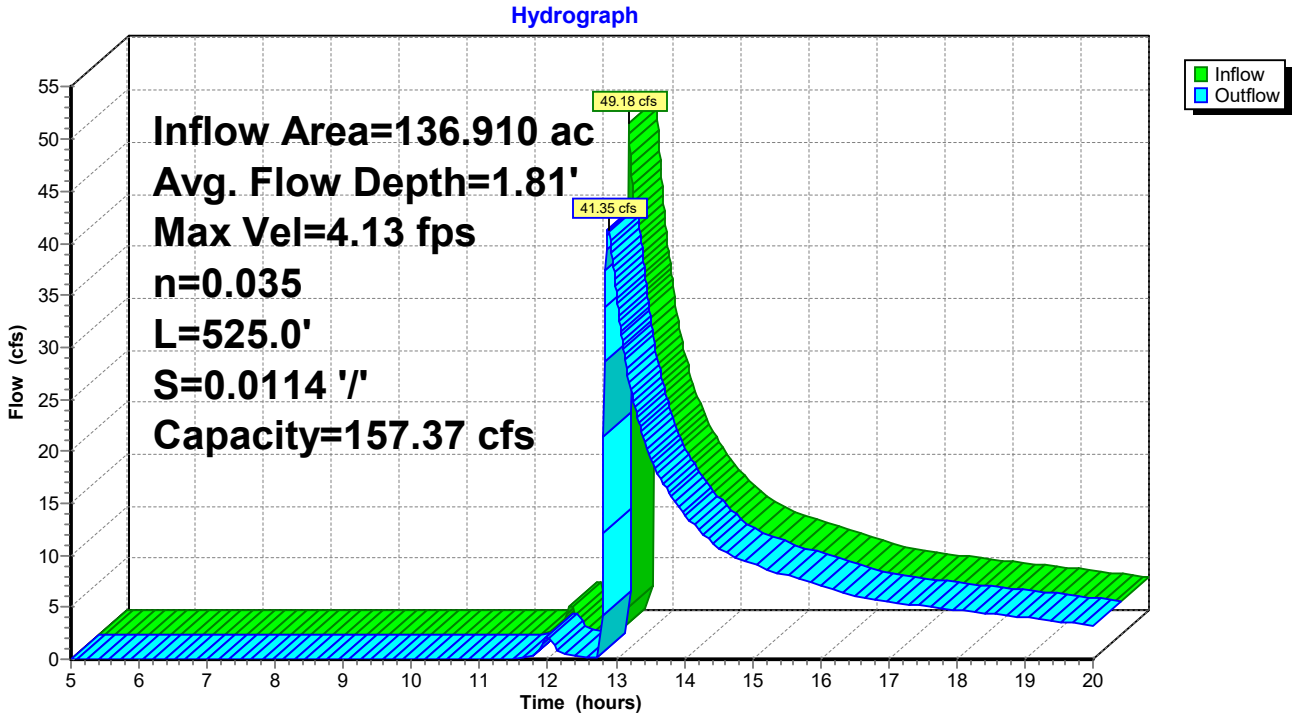
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.13 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 2.26 fps, Avg. Travel Time= 3.9 min

Peak Storage= 5,264 cf @ 12.85 hrs
Average Depth at Peak Storage= 1.81' , Surface Width= 10.97'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 157.37 cfs

0.10' x 3.00' deep channel, n= 0.035 Increased from 0.03 to account for in-place detention weirs
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 525.0' Slope= 0.0114 '/'
Inlet Invert= 5,306.00', Outlet Invert= 5,300.00'



Reach 20R: Reach 4.2.1



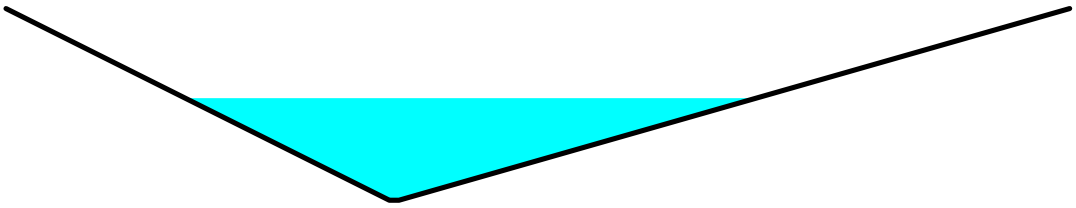
Summary for Reach 26R: Reach 6-1

Inflow Area = 5.860 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 13.84 cfs @ 12.06 hrs, Volume= 0.779 af
Outflow = 12.46 cfs @ 12.19 hrs, Volume= 0.773 af, Atten= 10%, Lag= 7.4 min
Routed to Reach 28R : South Downchute Top

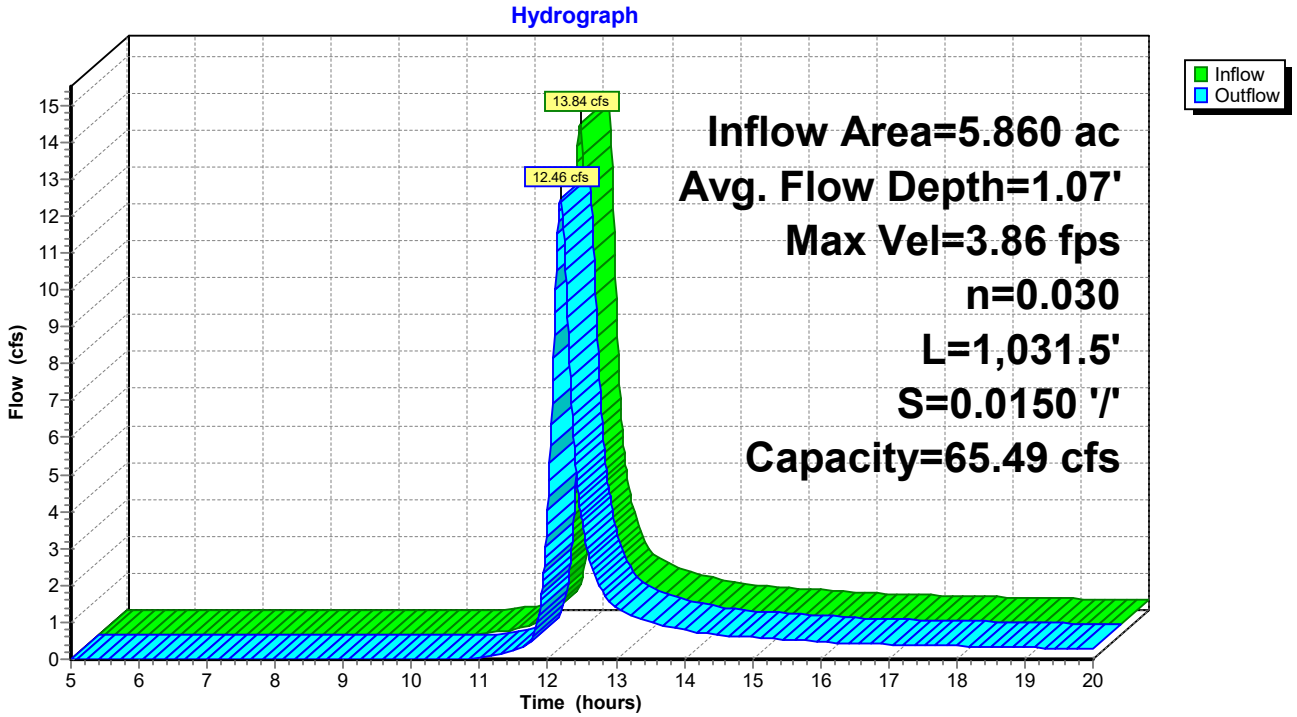
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.86 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.76 fps, Avg. Travel Time= 9.8 min

Peak Storage= 3,329 cf @ 12.11 hrs
Average Depth at Peak Storage= 1.07' , Surface Width= 5.96'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.49 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,031.5' Slope= 0.0150 '/'
Inlet Invert= 5,443.50', Outlet Invert= 5,428.00'



Reach 26R: Reach 6-1



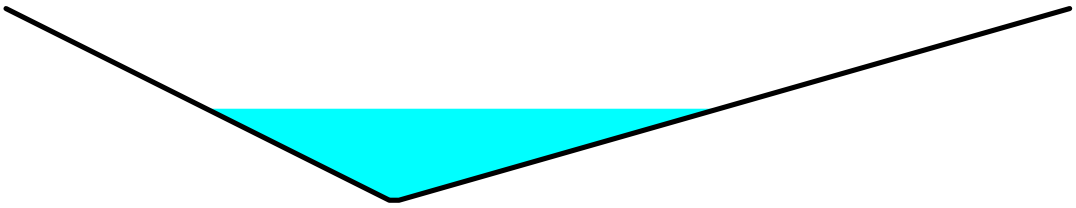
Summary for Reach 27R: Reach 6-2

Inflow Area = 3.630 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 11.23 cfs @ 11.98 hrs, Volume= 0.484 af
Outflow = 9.32 cfs @ 12.11 hrs, Volume= 0.480 af, Atten= 17%, Lag= 7.7 min
Routed to Reach 28R : South Downchute Top

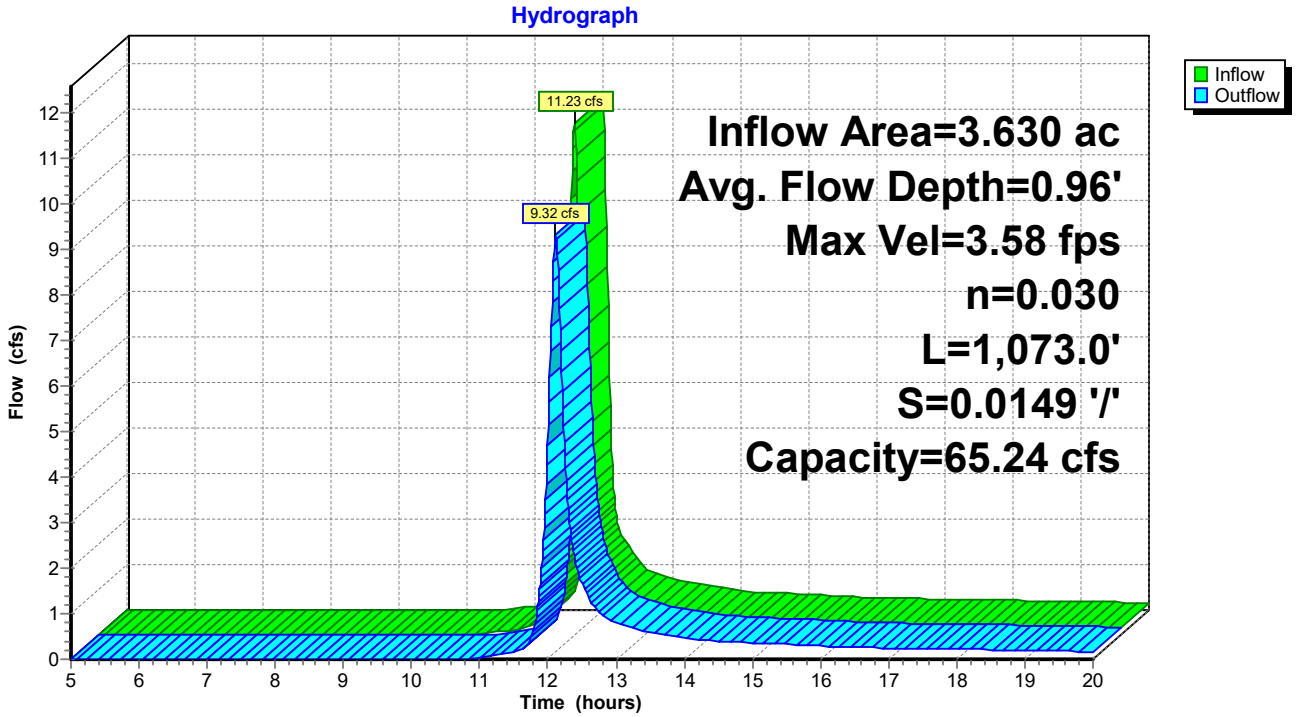
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.58 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 1.56 fps, Avg. Travel Time= 11.5 min

Peak Storage= 2,795 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.96' , Surface Width= 5.35'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.24 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,073.0' Slope= 0.0149 '/'
Inlet Invert= 5,444.00', Outlet Invert= 5,428.00'



Reach 27R: Reach 6-2



Summary for Reach 28R: South Downchute Top

[61] Hint: Exceeded Reach 26R outlet invert by 0.29' @ 12.15 hrs
[61] Hint: Exceeded Reach 27R outlet invert by 0.29' @ 12.15 hrs

Inflow Area = 9.490 ac, 0.00% Impervious, Inflow Depth > 1.58" for 100-Year event
Inflow = 20.41 cfs @ 12.15 hrs, Volume= 1.253 af
Outflow = 20.35 cfs @ 12.17 hrs, Volume= 1.251 af, Atten= 0%, Lag= 1.2 min
Routed to Reach 33R : South Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.80 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.57 fps, Avg. Travel Time= 2.1 min

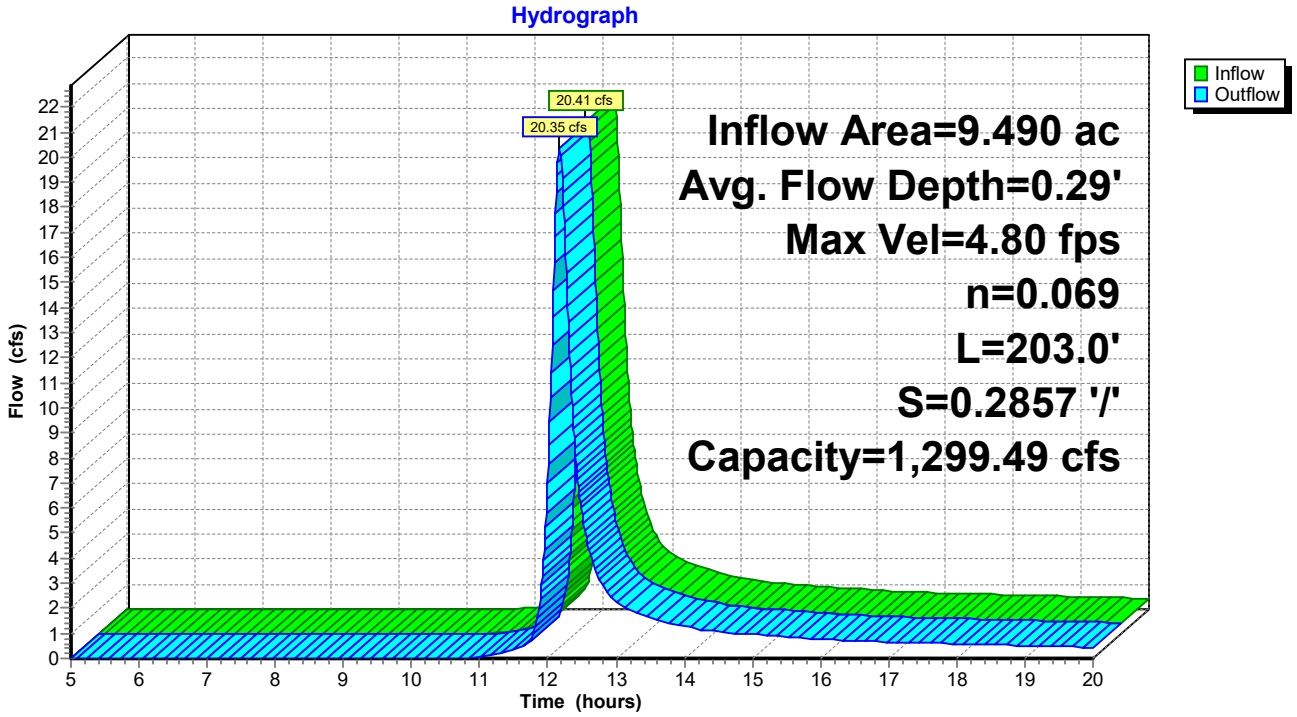
Peak Storage= 862 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.29' , Surface Width= 15.71'
Bank-Full Depth= 3.00' Flow Area= 69.0 sf, Capacity= 1,299.49 cfs

14.00' x 3.00' deep channel, n= 0.069
Side Slope Z-value= 3.0 '/' Top Width= 32.00'
Length= 203.0' Slope= 0.2857 '/'
Inlet Invert= 5,428.00', Outlet Invert= 5,370.00'



‡

Reach 28R: South Downchute Top



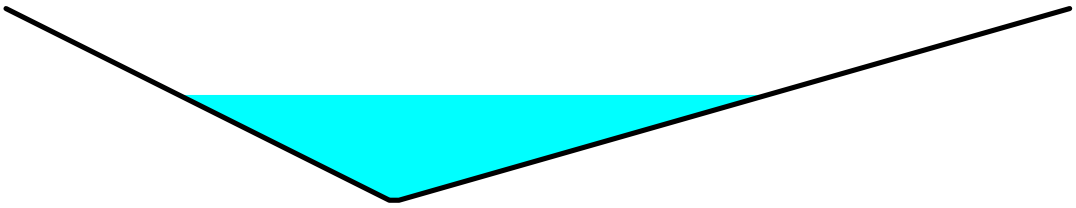
Summary for Reach 31R: Reach 7-1

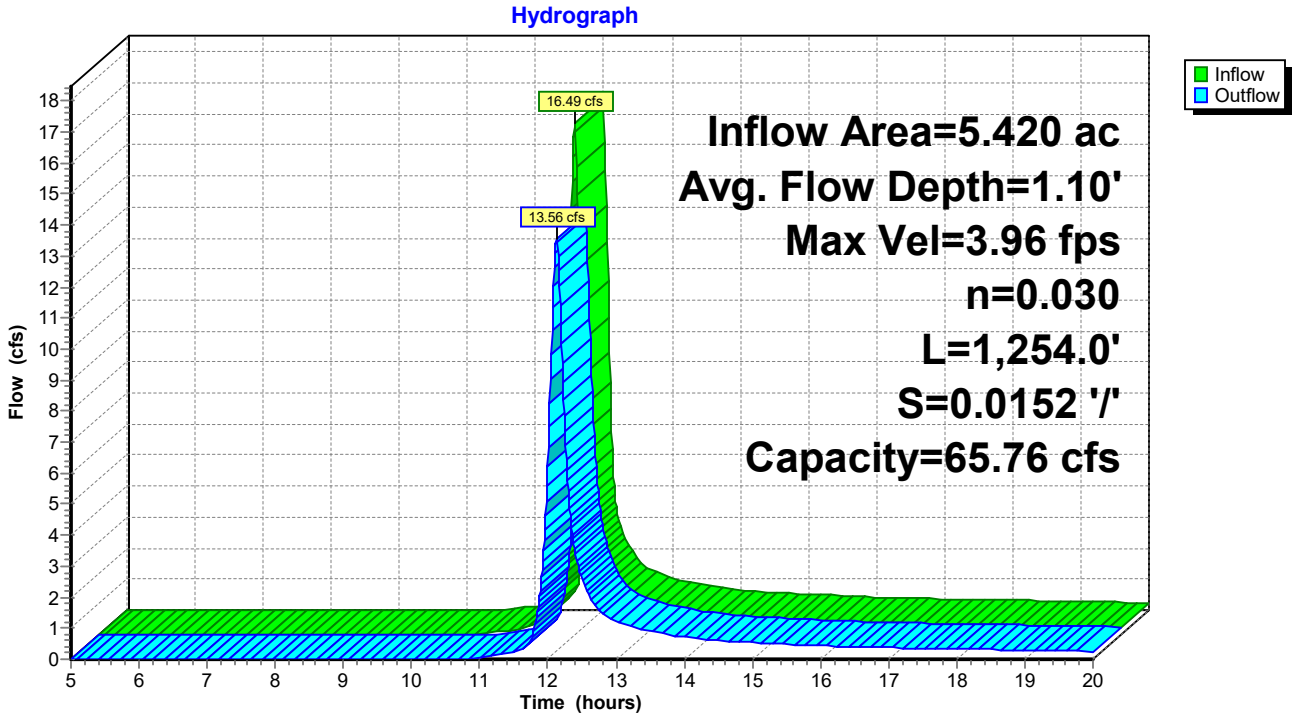
Inflow Area = 5.420 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 16.49 cfs @ 11.99 hrs, Volume= 0.723 af
Outflow = 13.56 cfs @ 12.12 hrs, Volume= 0.716 af, Atten= 18%, Lag= 8.1 min
Routed to Reach 33R : South Downchute Bottom

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.96 fps, Min. Travel Time= 5.3 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 12.1 min

Peak Storage= 4,301 cf @ 12.04 hrs
Average Depth at Peak Storage= 1.10' , Surface Width= 6.14'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.76 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,254.0' Slope= 0.0152 '/'
Inlet Invert= 5,389.00', Outlet Invert= 5,370.00'





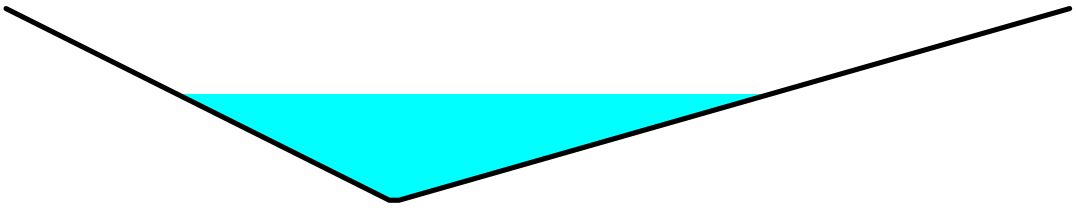
Summary for Reach 32R: Reach 7-2

Inflow Area = 5.540 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 16.86 cfs @ 11.99 hrs, Volume= 0.739 af
Outflow = 13.82 cfs @ 12.13 hrs, Volume= 0.732 af, Atten= 18%, Lag= 8.2 min
Routed to Reach 33R : South Downchute Bottom

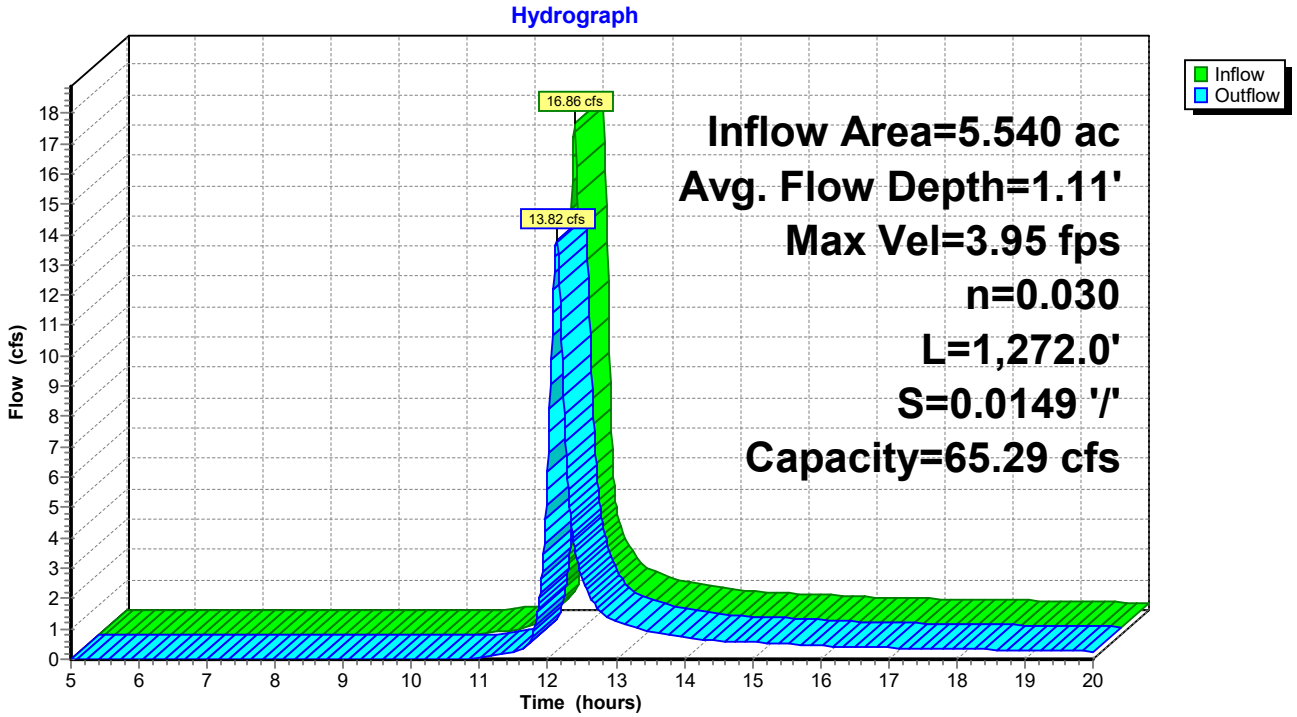
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.95 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 12.2 min

Peak Storage= 4,446 cf @ 12.04 hrs
Average Depth at Peak Storage= 1.11' , Surface Width= 6.20'
Bank-Full Depth= 2.00' Flow Area= 11.2 sf, Capacity= 65.29 cfs

0.10' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 3.5 '/' Top Width= 11.10'
Length= 1,272.0' Slope= 0.0149 '/'
Inlet Invert= 5,389.00', Outlet Invert= 5,370.00'



Reach 32R: Reach 7-2



Summary for Reach 33R: South Downchute Bottom

[62] Hint: Exceeded Reach 28R OUTLET depth by 0.01' @ 12.11 hrs
[61] Hint: Exceeded Reach 31R outlet invert by 0.29' @ 12.15 hrs
[61] Hint: Exceeded Reach 32R outlet invert by 0.29' @ 12.15 hrs

Inflow Area = 20.450 ac, 0.00% Impervious, Inflow Depth > 1.58" for 100-Year event
Inflow = 46.79 cfs @ 12.14 hrs, Volume= 2.699 af
Outflow = 46.66 cfs @ 12.16 hrs, Volume= 2.694 af, Atten= 0%, Lag= 1.1 min
Routed to Pond 34P : Southeast Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.91 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 2.1 min

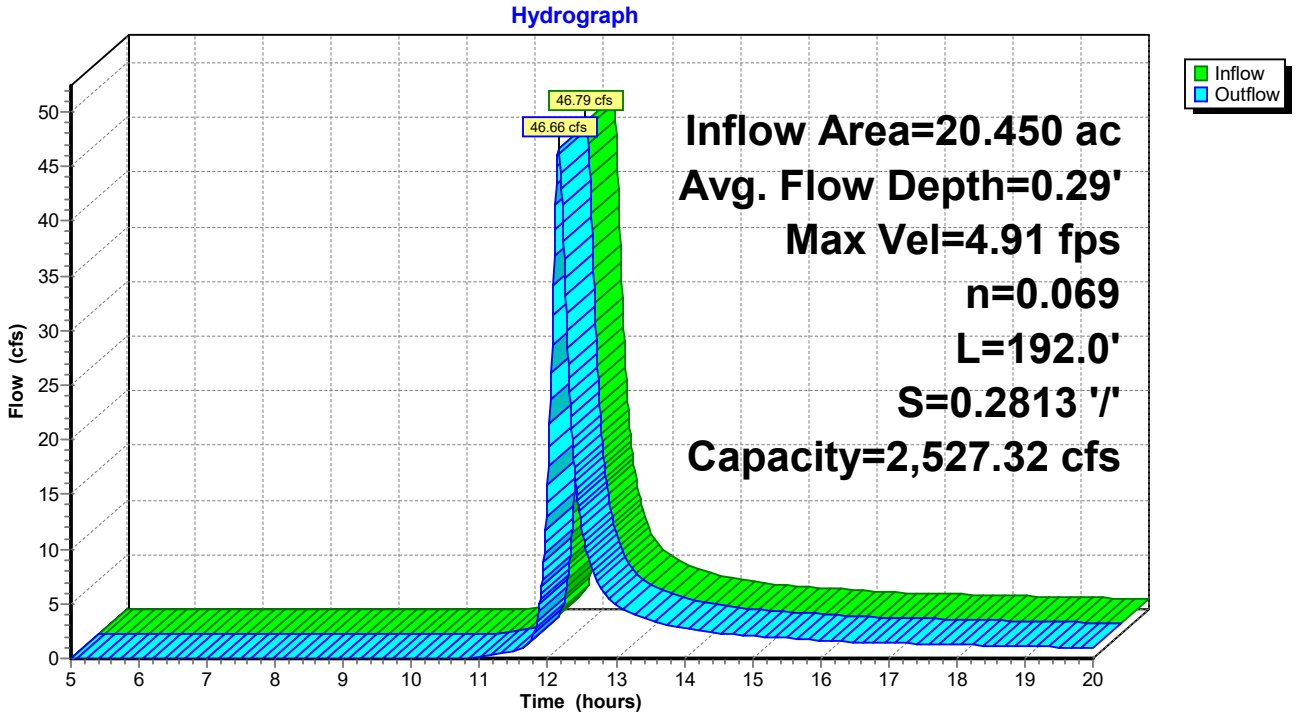
Peak Storage= 1,826 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.29' , Surface Width= 33.74'
Bank-Full Depth= 3.00' Flow Area= 123.0 sf, Capacity= 2,527.32 cfs

32.00' x 3.00' deep channel, n= 0.069
Side Slope Z-value= 3.0 '/' Top Width= 50.00'
Length= 192.0' Slope= 0.2813 '/'
Inlet Invert= 5,370.00', Outlet Invert= 5,316.00'



‡

Reach 33R: South Downchute Bottom



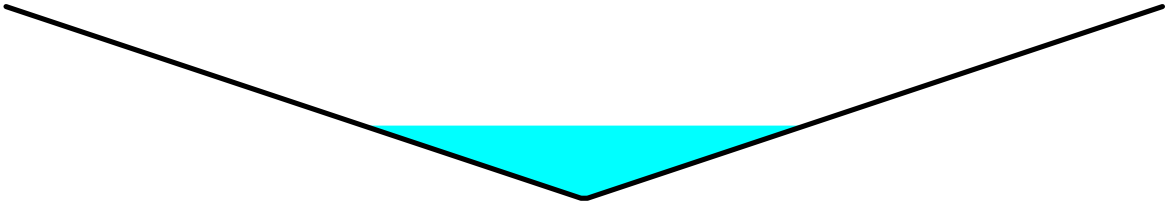
Summary for Reach 36R: Reach 8-1

Inflow Area = 5.940 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 17.87 cfs @ 11.99 hrs, Volume= 0.792 af
Outflow = 15.30 cfs @ 12.11 hrs, Volume= 0.786 af, Atten= 14%, Lag= 7.1 min
Routed to Pond 34P : Southeast Pond

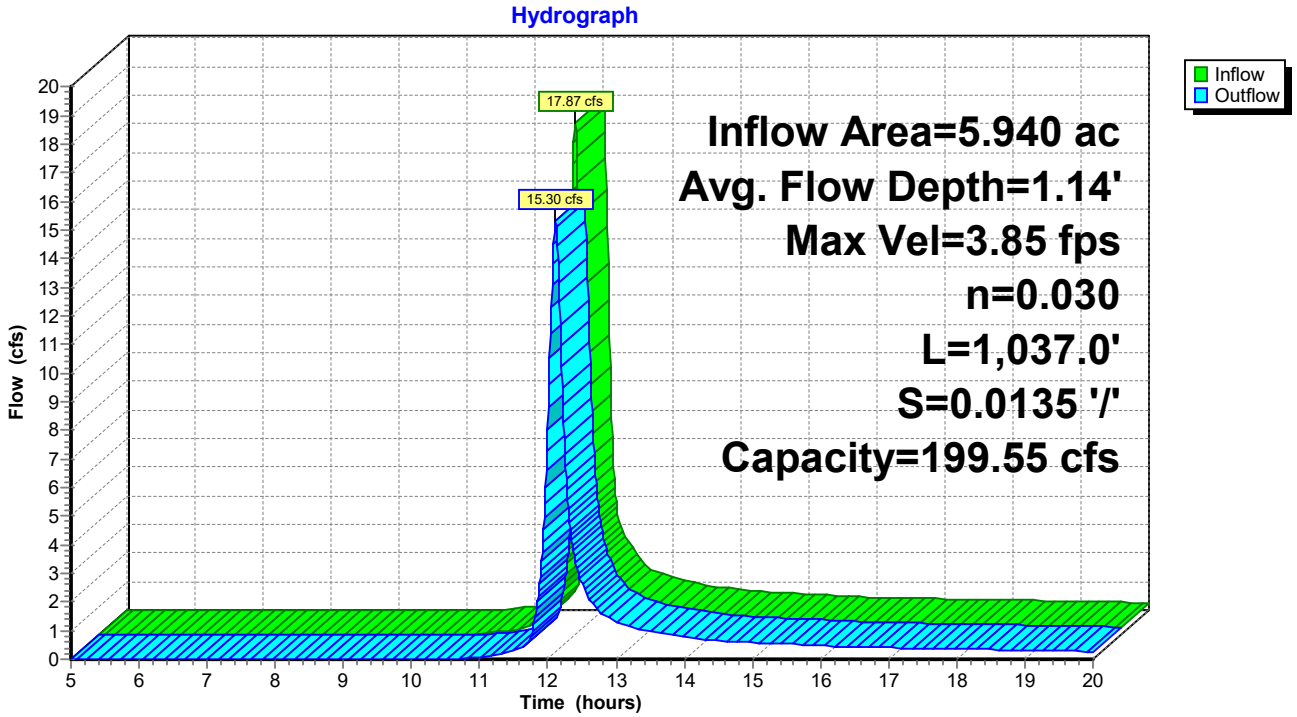
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.85 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.67 fps, Avg. Travel Time= 10.3 min

Peak Storage= 4,128 cf @ 12.03 hrs
Average Depth at Peak Storage= 1.14' , Surface Width= 6.91'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 199.55 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 1,037.0' Slope= 0.0135 '/'
Inlet Invert= 5,330.00', Outlet Invert= 5,316.00'



Reach 36R: Reach 8-1



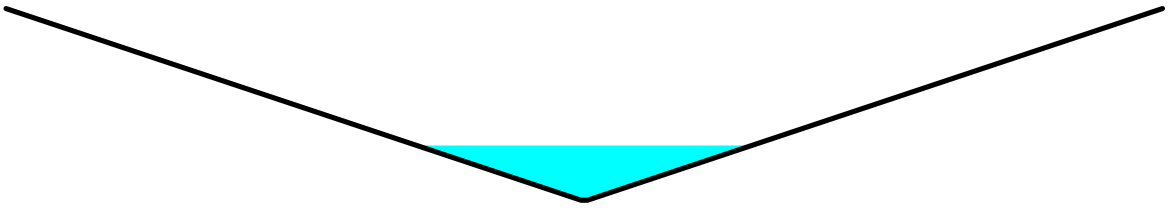
Summary for Reach 39R: Reach 4-2

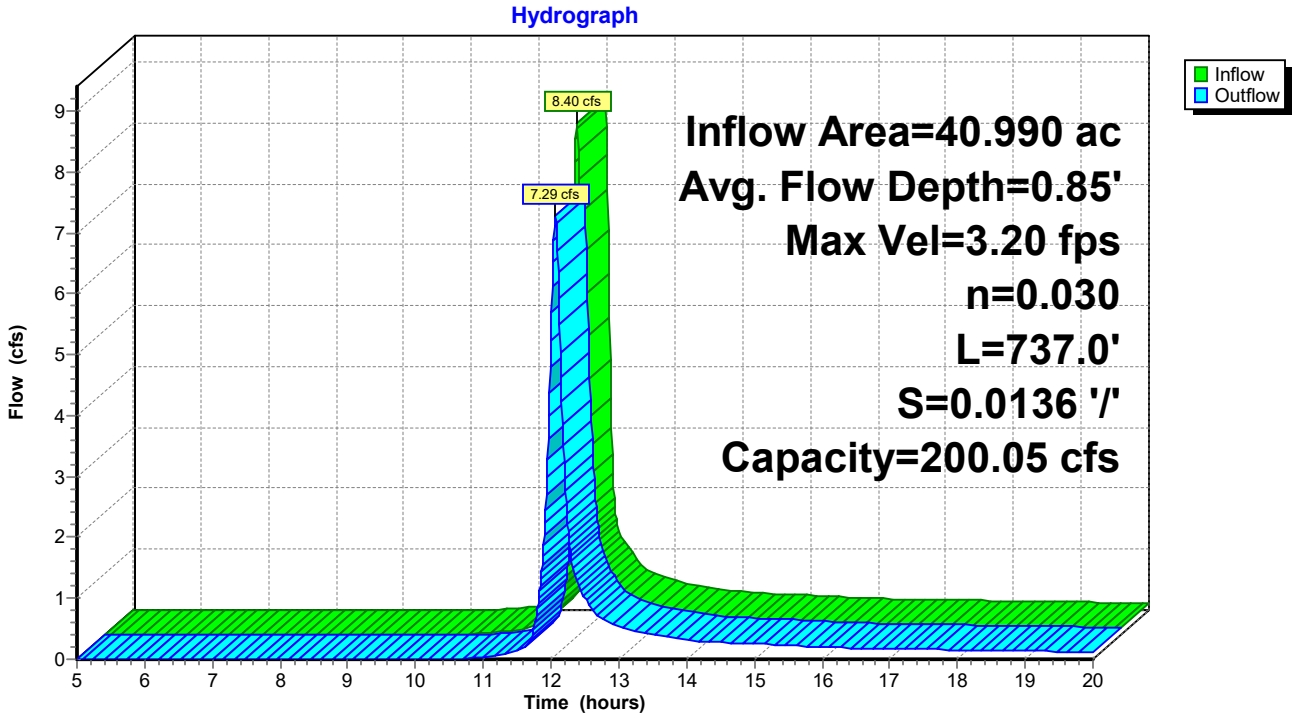
Inflow Area = 40.990 ac, 0.00% Impervious, Inflow Depth > 0.10" for 100-Year event
Inflow = 8.40 cfs @ 11.97 hrs, Volume= 0.343 af
Outflow = 7.29 cfs @ 12.07 hrs, Volume= 0.341 af, Atten= 13%, Lag= 6.0 min
Routed to Pond 15P : Northeast Pond

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.20 fps, Min. Travel Time= 3.8 min
Avg. Velocity = 1.36 fps, Avg. Travel Time= 9.0 min

Peak Storage= 1,679 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.85' , Surface Width= 5.23'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 200.05 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 737.0' Slope= 0.0136 '/'
Inlet Invert= 5,316.00', Outlet Invert= 5,306.00'





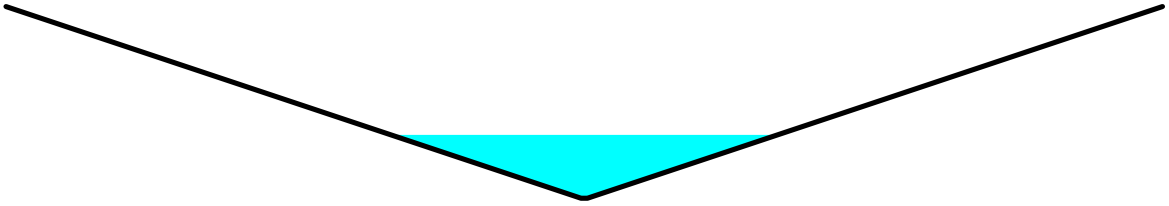
Summary for Reach 42R: Pond to Outfall

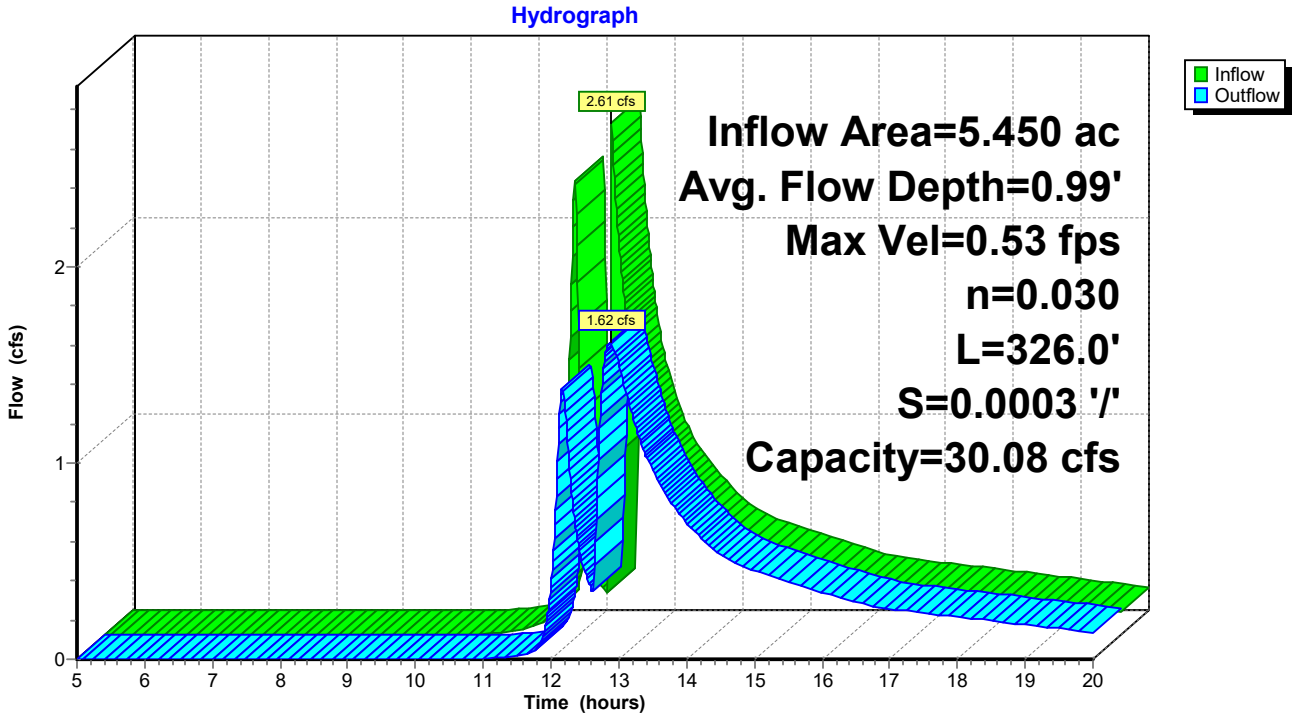
Inflow Area = 5.450 ac, 0.00% Impervious, Inflow Depth > 0.71" for 100-Year event
Inflow = 2.61 cfs @ 12.48 hrs, Volume= 0.323 af
Outflow = 1.62 cfs @ 12.87 hrs, Volume= 0.318 af, Atten= 38%, Lag= 23.4 min
Routed to Pond 57P : Storage in Perimeter Ditch

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.53 fps, Min. Travel Time= 10.2 min
Avg. Velocity = 0.34 fps, Avg. Travel Time= 16.2 min

Peak Storage= 994 cf @ 12.70 hrs
Average Depth at Peak Storage= 0.99' , Surface Width= 6.05'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 30.08 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 326.0' Slope= 0.0003 '/'
Inlet Invert= 5,302.00', Outlet Invert= 5,301.90'





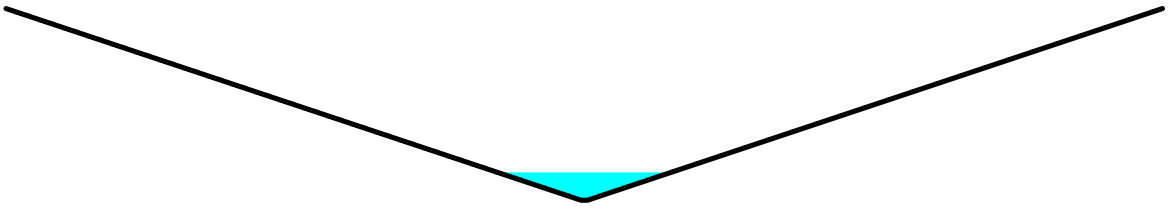
Summary for Reach 44R: Reach 5-1

Inflow Area = 0.630 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 2.12 cfs @ 11.96 hrs, Volume= 0.084 af
Outflow = 2.08 cfs @ 11.99 hrs, Volume= 0.084 af, Atten= 2%, Lag= 1.8 min
Routed to Pond 45P : Southwest Pond-North Section

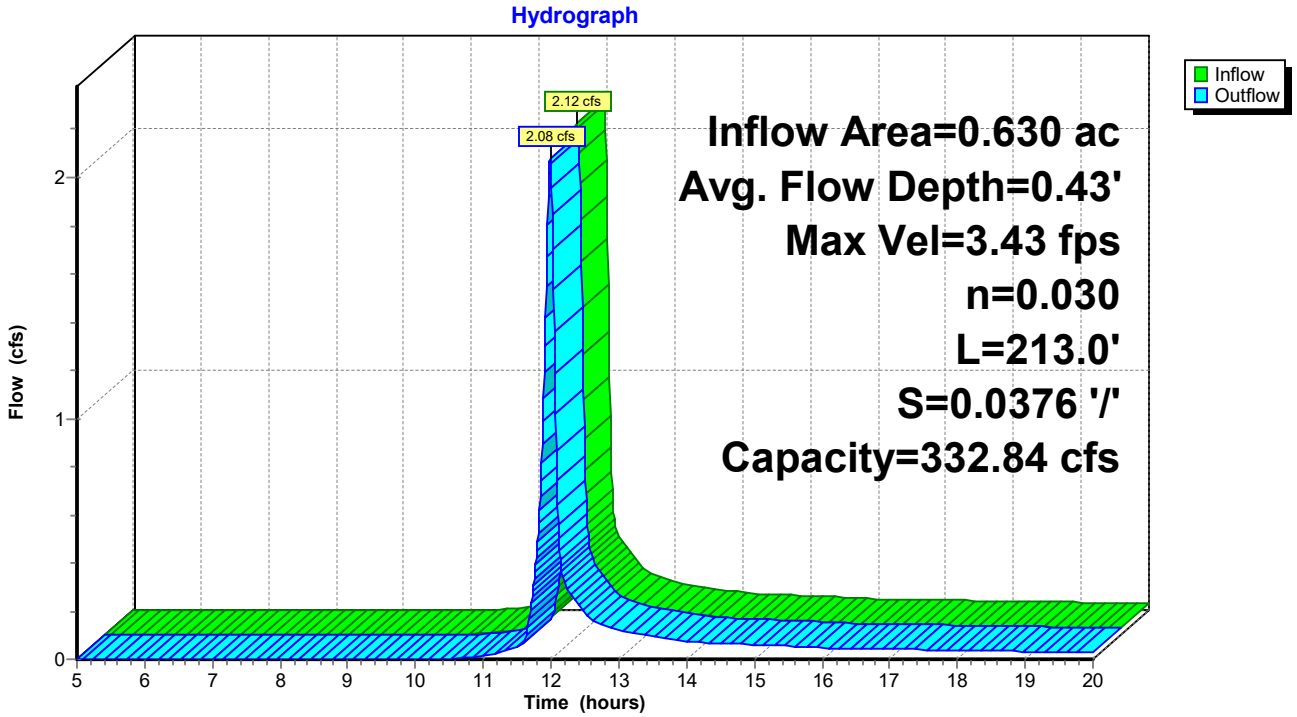
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.43 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 2.5 min

Peak Storage= 129 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.43' , Surface Width= 2.70'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 332.84 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 213.0' Slope= 0.0376 '/'
Inlet Invert= 5,328.00', Outlet Invert= 5,320.00'



Reach 44R: Reach 5-1



Summary for Reach 47R: Outfall 2 SW

Inflow Area = 8.640 ac, 0.00% Impervious, Inflow Depth > 0.58" for 100-Year event
Inflow = 3.40 cfs @ 12.47 hrs, Volume= 0.417 af
Outflow = 3.27 cfs @ 12.48 hrs, Volume= 0.417 af, Atten= 4%, Lag= 0.5 min

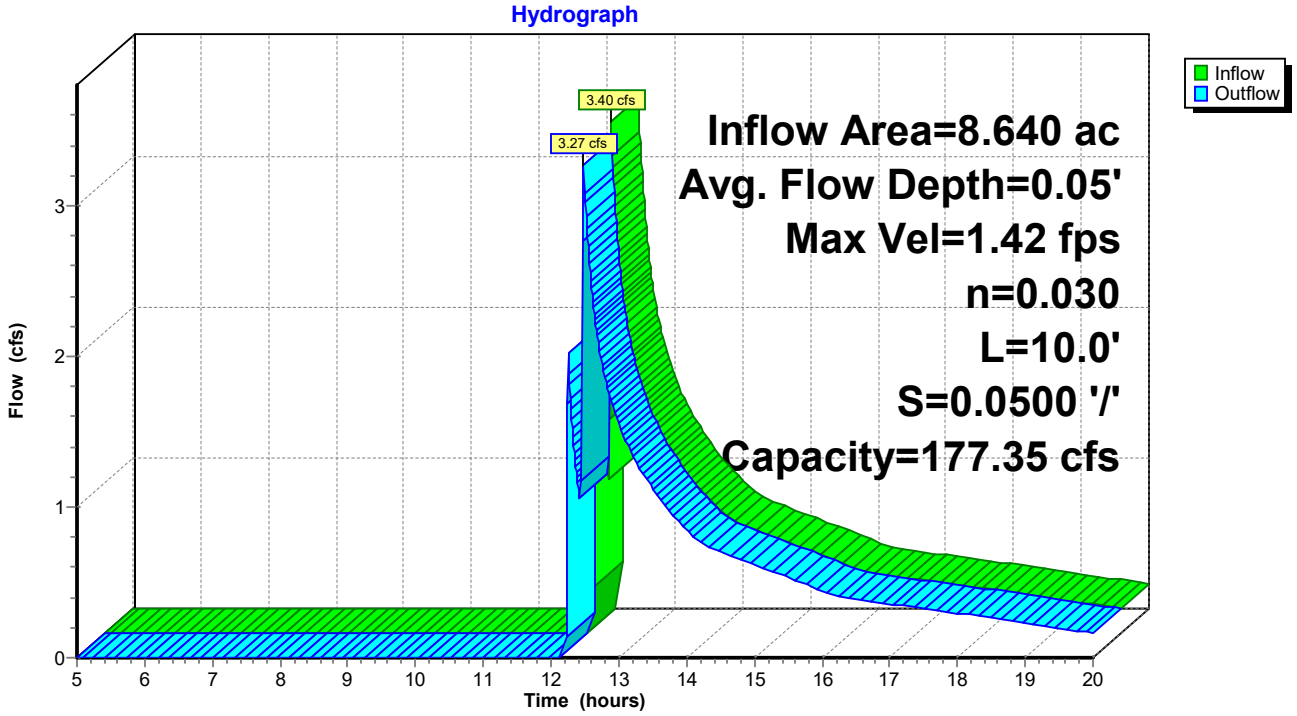
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.42 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 0.2 min

Peak Storage= 23 cf @ 12.48 hrs
Average Depth at Peak Storage= 0.05' , Surface Width= 50.46'
Bank-Full Depth= 0.50' Flow Area= 26.3 sf, Capacity= 177.35 cfs

50.00' x 0.50' deep channel, n= 0.030
Side Slope Z-value= 5.0 '/' Top Width= 55.00'
Length= 10.0' Slope= 0.0500 '/'
Inlet Invert= 5,320.00', Outlet Invert= 5,319.50'



Reach 47R: Outfall 2 SW



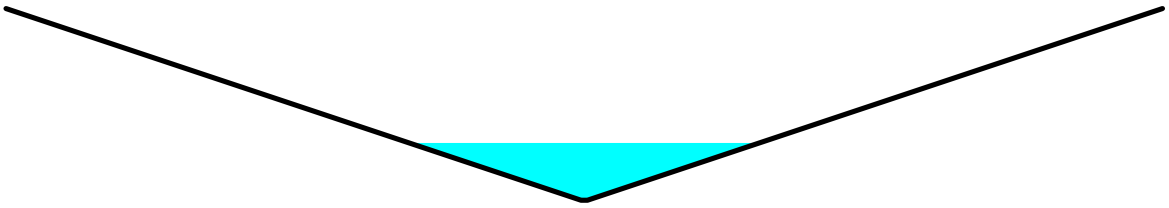
Summary for Reach 49R: Reach 5-2

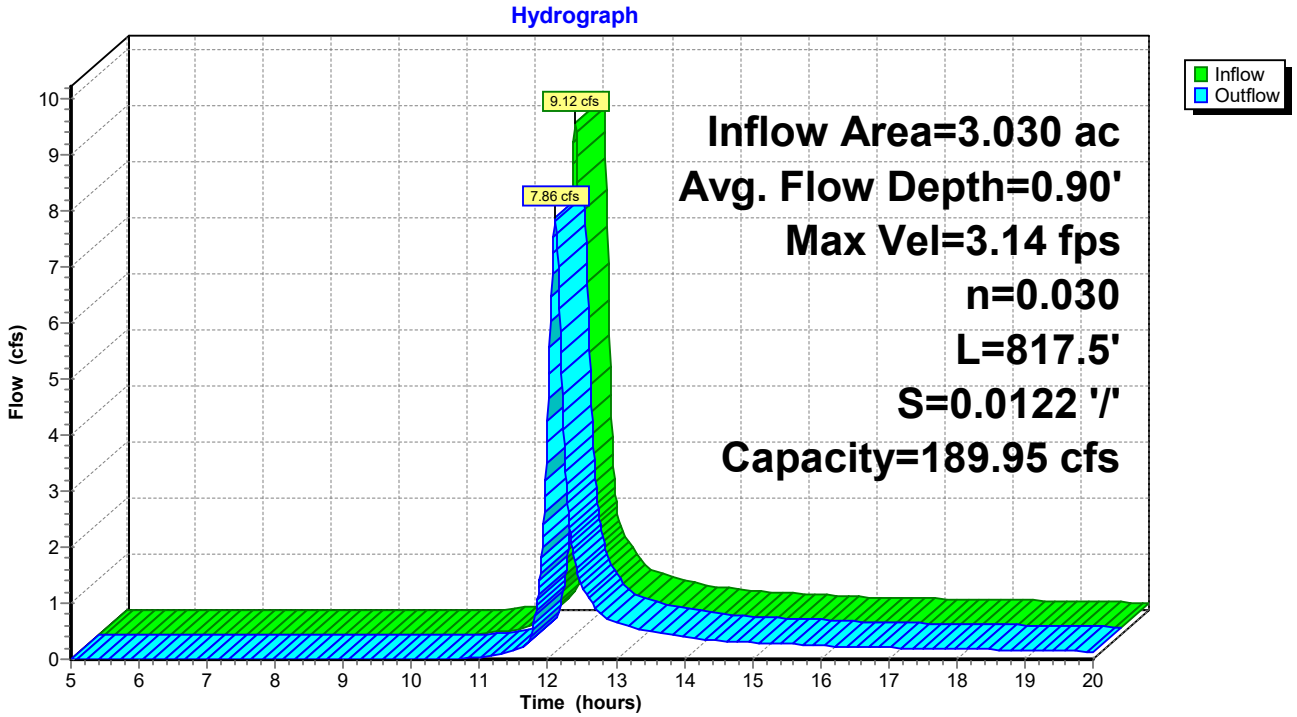
Inflow Area = 3.030 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 9.12 cfs @ 11.99 hrs, Volume= 0.404 af
Outflow = 7.86 cfs @ 12.11 hrs, Volume= 0.401 af, Atten= 14%, Lag= 6.8 min
Routed to Pond 55P : Southwest Pond-South Section

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.14 fps, Min. Travel Time= 4.3 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 10.0 min

Peak Storage= 2,049 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.90' , Surface Width= 5.49'
Bank-Full Depth= 3.00' Flow Area= 27.3 sf, Capacity= 189.95 cfs

0.10' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 18.10'
Length= 817.5' Slope= 0.0122 '/'
Inlet Invert= 5,330.00', Outlet Invert= 5,320.00'





Summary for Reach 56R: Outfall 1 NE

Inflow Area = 142.360 ac, 0.00% Impervious, Inflow Depth > 0.48" for 100-Year event
Inflow = 41.32 cfs @ 12.89 hrs, Volume= 5.716 af
Outflow = 41.26 cfs @ 12.90 hrs, Volume= 5.710 af, Atten= 0%, Lag= 0.6 min

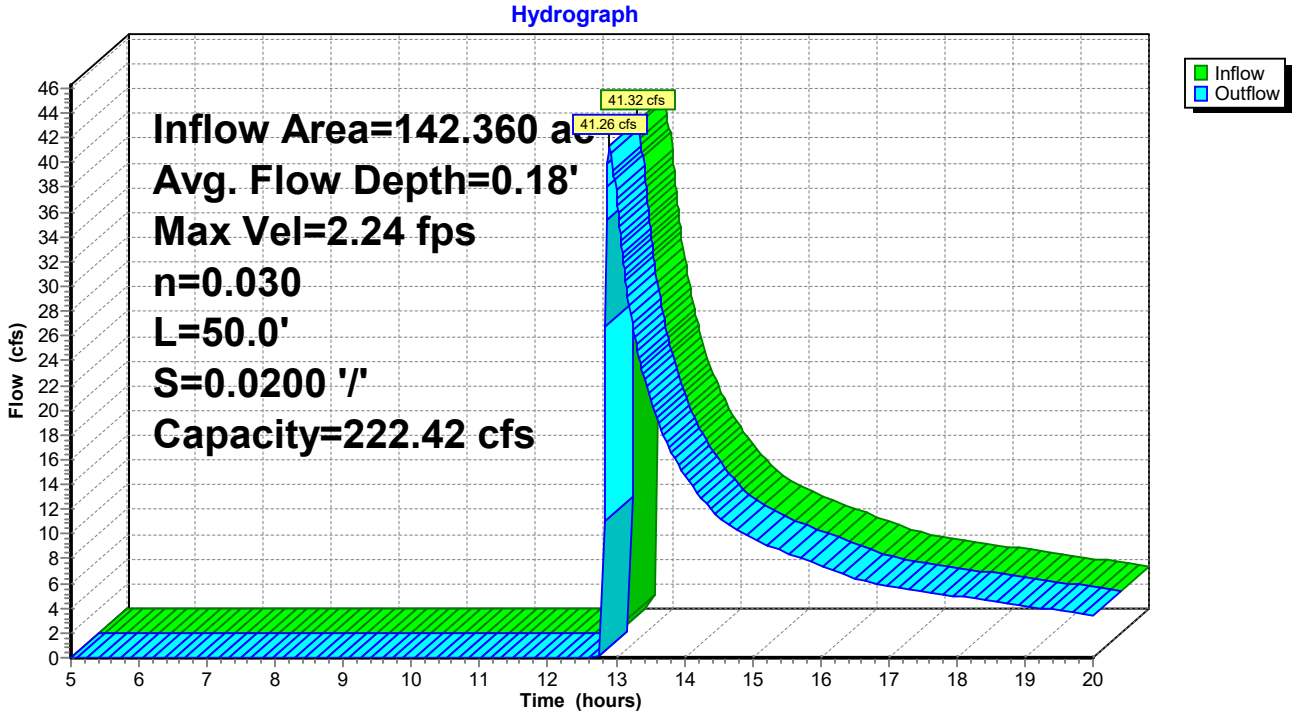
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.24 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.19 fps, Avg. Travel Time= 0.7 min

Peak Storage= 921 cf @ 12.90 hrs
Average Depth at Peak Storage= 0.18' , Surface Width= 101.83'
Bank-Full Depth= 0.50' Flow Area= 51.3 sf, Capacity= 222.42 cfs

100.00' x 0.50' deep channel, n= 0.030
Side Slope Z-value= 5.0 '/' Top Width= 105.00'
Length= 50.0' Slope= 0.0200 '/'
Inlet Invert= 5,302.00', Outlet Invert= 5,301.00'



Reach 56R: Outfall 1 NE



Summary for Pond 15P: Northeast Pond

[61] Hint: Exceeded Reach 6R outlet invert by 0.01' @ 12.76 hrs
[61] Hint: Exceeded Reach 13R outlet invert by 0.01' @ 12.76 hrs
[61] Hint: Exceeded Reach 39R outlet invert by 0.01' @ 12.76 hrs

Inflow Area = 136.120 ac, 0.00% Impervious, Inflow Depth > 1.12" for 100-Year event
Inflow = 152.61 cfs @ 12.31 hrs, Volume= 12.760 af
Outflow = 50.56 cfs @ 12.77 hrs, Volume= 6.494 af, Atten= 67%, Lag= 27.8 min
Discarded = 1.55 cfs @ 12.76 hrs, Volume= 1.003 af
Primary = 49.01 cfs @ 12.77 hrs, Volume= 5.492 af
Routed to Reach 20R : Reach 4.2.1

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,306.01' @ 12.76 hrs Surf.Area= 1.094 ac Storage= 6.264 af

Plug-Flow detention time= 169.0 min calculated for 6.490 af (51% of inflow)
Center-of-Mass det. time= 83.5 min (909.6 - 826.0)

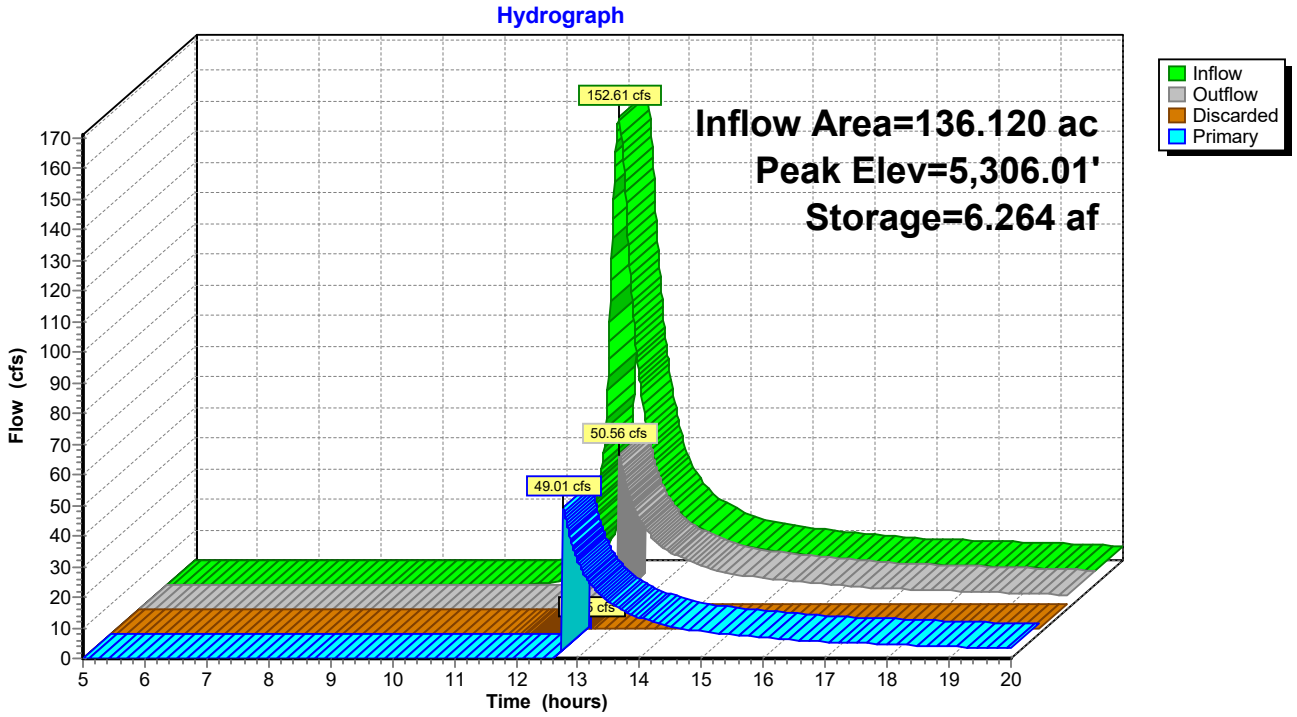
Volume	Invert	Avail.Storage	Storage Description
#1	5,294.51'	6.264 af	**2,048.00'L x 11.50'H Prismatoid Z=1.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,306.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,306.00'	**Channel/Reach** using Reach 20R: Reach 4.2.1
#2	Discarded	5,294.51'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=1.55 cfs @ 12.76 hrs HW=5,306.01' (Free Discharge)
↑—**2=Exfiltration** (Controls 1.55 cfs)

Primary OutFlow Max=0.00 cfs @ 12.77 hrs HW=5,306.01' (Free Discharge)
↑—**1=Channel/Reach** (Channel Controls 0.00 cfs @ 0.18 fps)

Pond 15P: Northeast Pond



Summary for Pond 18P: North Pond

[61] Hint: Exceeded Reach 17R outlet invert by 0.01' @ 12.47 hrs

Inflow Area = 4.800 ac, 0.00% Impervious, Inflow Depth > 1.59" for 100-Year event
Inflow = 8.91 cfs @ 12.14 hrs, Volume= 0.634 af
Outflow = 2.55 cfs @ 12.48 hrs, Volume= 0.323 af, Atten= 71%, Lag= 20.6 min
Discarded = 0.13 cfs @ 12.47 hrs, Volume= 0.087 af
Primary = 2.42 cfs @ 12.48 hrs, Volume= 0.236 af
Routed to Reach 42R : Pond to Outfall

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,302.01' @ 12.47 hrs Surf.Area= 0.124 ac Storage= 0.311 af

Plug-Flow detention time= 171.1 min calculated for 0.323 af (51% of inflow)
Center-of-Mass det. time= 84.3 min (896.5 - 812.1)

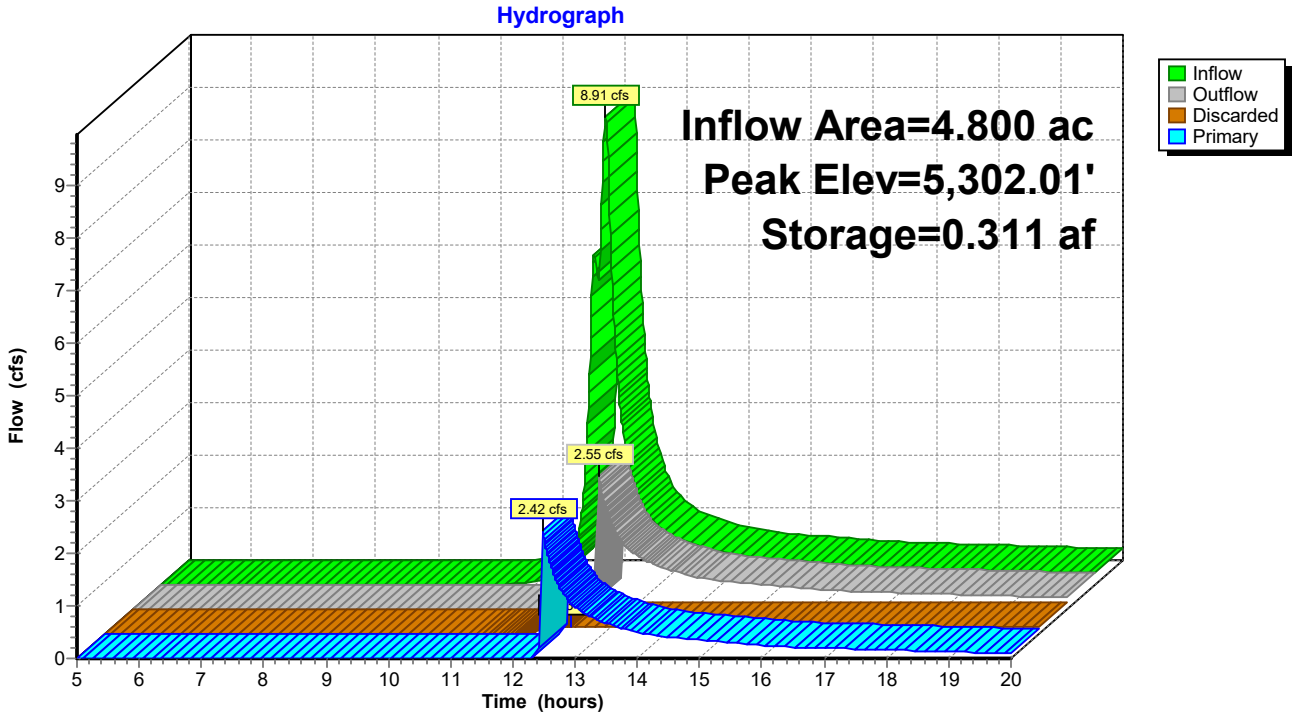
Volume	Invert	Avail.Storage	Storage Description
#1	5,297.01'	0.311 af	**0.10'W x 525.00'L x 5.00'H Prismatoid Z=1.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,302.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,302.00'	**Channel/Reach** using Reach 42R: Pond to Outfall
#2	Discarded	5,297.01'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=0.13 cfs @ 12.47 hrs HW=5,302.01' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.13 cfs)

Primary OutFlow Max=0.00 cfs @ 12.48 hrs HW=5,302.01' (Free Discharge)
↑—**1=Channel/Reach** (Channel Controls 0.00 cfs @ 0.03 fps)

Pond 18P: North Pond



Summary for Pond 23P: Storage in Perimeter Ditch

[62] Hint: Exceeded Reach 20R OUTLET depth by 1.43' @ 12.75 hrs

Inflow Area = 136.910 ac, 0.00% Impervious, Inflow Depth > 0.49" for 100-Year event
Inflow = 41.35 cfs @ 12.89 hrs, Volume= 5.570 af
Outflow = 41.32 cfs @ 12.89 hrs, Volume= 5.476 af, Atten= 0%, Lag= 0.3 min
Primary = 41.32 cfs @ 12.89 hrs, Volume= 5.476 af
Routed to Reach 56R : Outfall 1 NE

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,302.01' @ 12.83 hrs Surf.Area= 0.093 ac Storage= 0.092 af

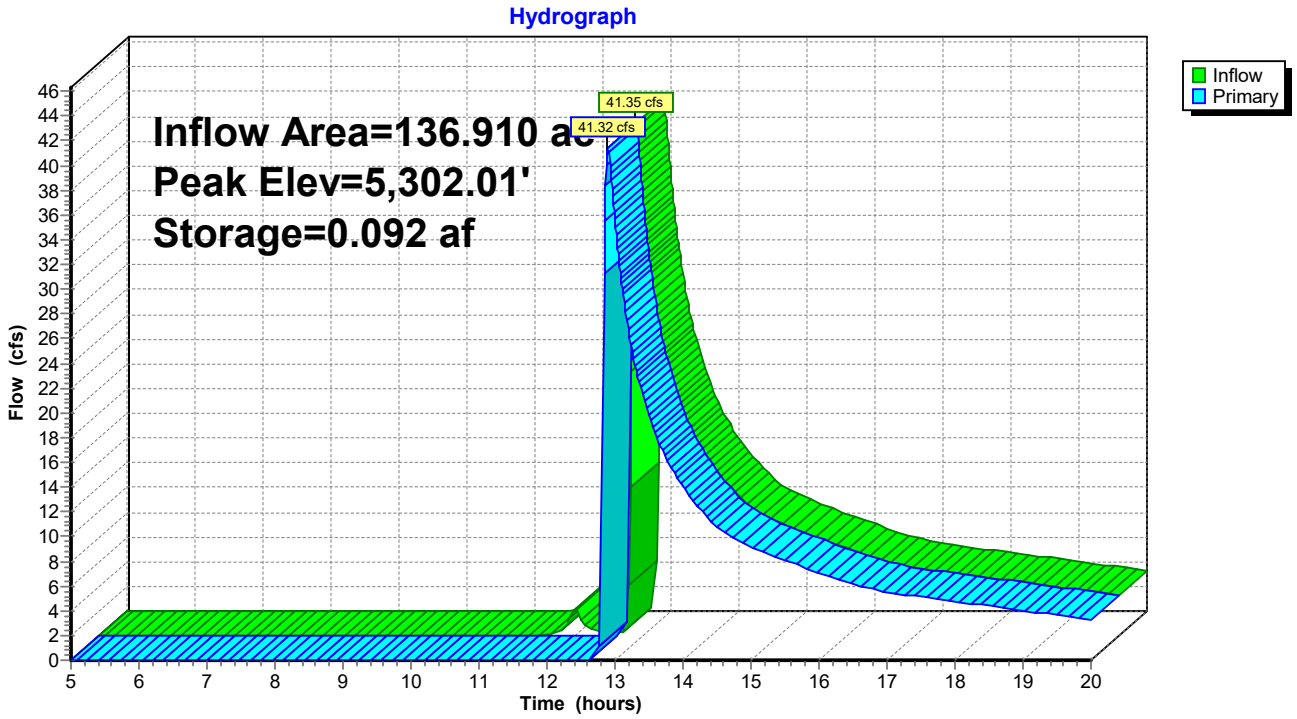
Plug-Flow detention time= 7.9 min calculated for 5.476 af (98% of inflow)
Center-of-Mass det. time= 3.0 min (904.1 - 901.1)

Volume	Invert	Avail.Storage	Storage Description
#1	5,300.01'	0.092 af	**327.00'L x 2.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,302.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,302.00'	**Channel/Reach** using Reach 56R: Outfall 1 NE

Primary OutFlow Max=0.33 cfs @ 12.89 hrs HW=5,302.01' (Free Discharge)
1=Channel/Reach (Channel Controls 0.33 cfs @ 0.33 fps)

Pond 23P: Storage in Perimeter Ditch



Summary for Pond 34P: Southeast Pond

Inflow Area = 38.420 ac, 0.00% Impervious, Inflow Depth > 1.59" for 100-Year event
Inflow = 73.25 cfs @ 12.12 hrs, Volume= 5.083 af
Outflow = 0.78 cfs @ 20.00 hrs, Volume= 0.467 af, Atten= 99%, Lag= 472.7 min
Discarded = 0.78 cfs @ 20.00 hrs, Volume= 0.467 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach 39R : Reach 4-2

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,313.54' @ 20.00 hrs Surf.Area= 0.932 ac Storage= 4.616 af

Plug-Flow detention time= 264.2 min calculated for 0.466 af (9% of inflow)
Center-of-Mass det. time= 158.5 min (970.2 - 811.7)

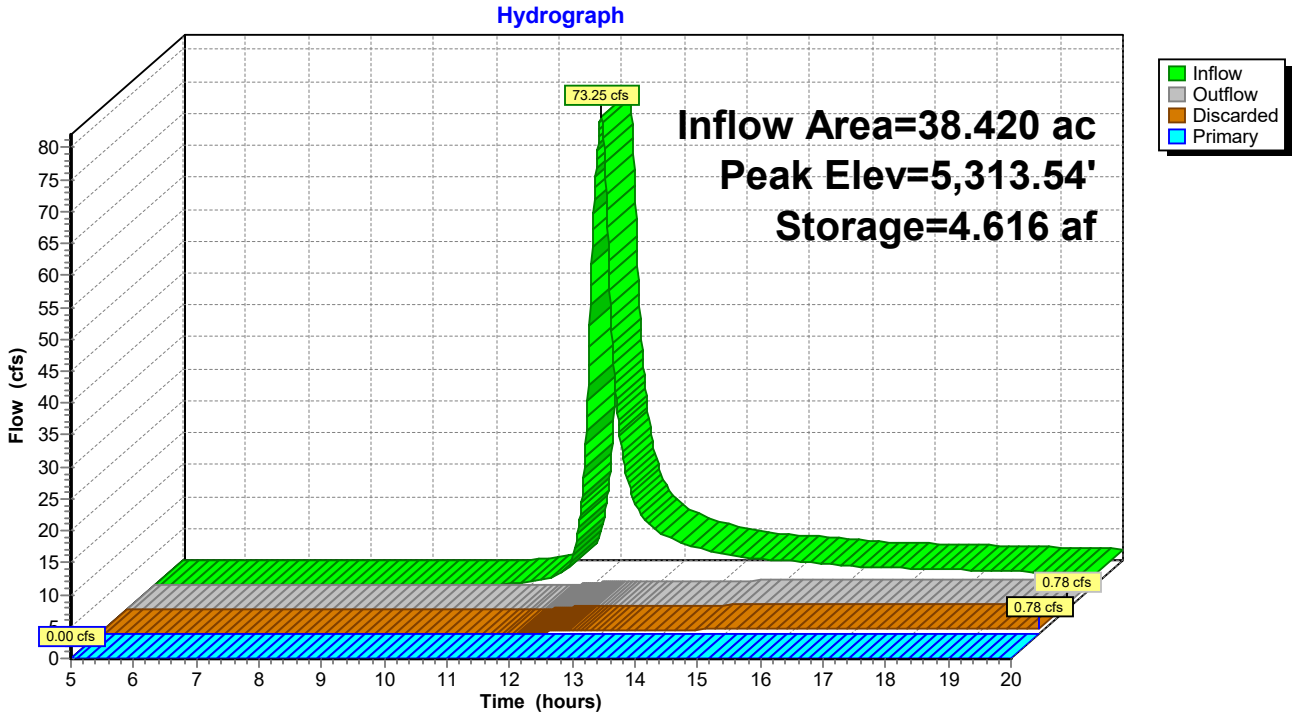
Volume	Invert	Avail.Storage	Storage Description
#1	5,303.51'	7.212 af	**972.00'L x 12.50'H Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,316.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,316.00'	**Channel/Reach** using Reach 39R: Reach 4-2
#2	Discarded	5,303.51'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=0.78 cfs @ 20.00 hrs HW=5,313.54' (Free Discharge)
↑└**2=Exfiltration** (Controls 0.78 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=5,303.51' (Free Discharge)
↑└**1=Channel/Reach** (Controls 0.00 cfs)

Pond 34P: Southeast Pond



Summary for Pond 45P: Southwest Pond-North Section

[61] Hint: Exceeded Reach 44R outlet invert by 0.01' @ 12.23 hrs

Inflow Area = 2.520 ac, 0.00% Impervious, Inflow Depth > 1.60" for 100-Year event
Inflow = 6.06 cfs @ 12.02 hrs, Volume= 0.335 af
Outflow = 2.26 cfs @ 12.24 hrs, Volume= 0.185 af, Atten= 63%, Lag= 13.2 min
Discarded = 0.08 cfs @ 12.23 hrs, Volume= 0.054 af
Primary = 2.18 cfs @ 12.24 hrs, Volume= 0.131 af
Routed to Reach 47R : Outfall 2 SW

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,320.01' @ 12.23 hrs Surf.Area= 0.093 ac Storage= 0.151 af

Plug-Flow detention time= 156.3 min calculated for 0.185 af (55% of inflow)
Center-of-Mass det. time= 72.1 min (878.6 - 806.5)

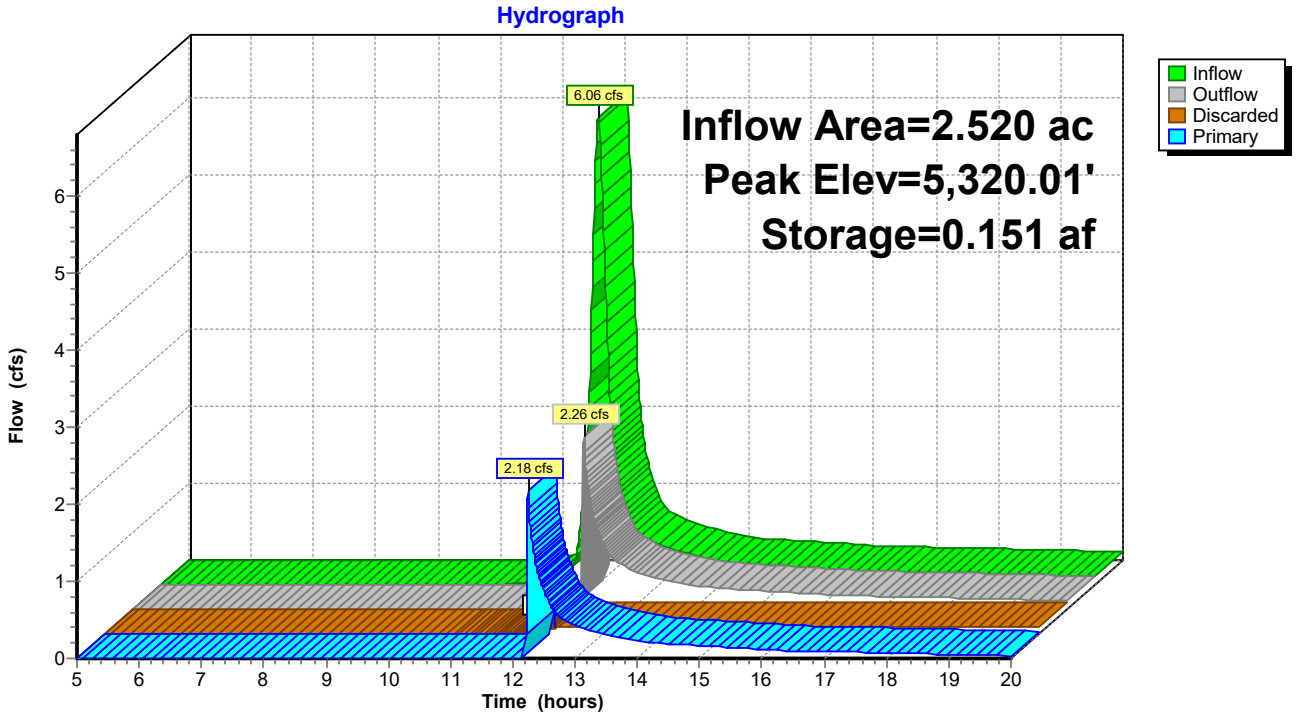
Volume	Invert	Avail.Storage	Storage Description
#1	5,316.75'	0.151 af	**613.00'L x 3.26'H Prismatoid Z=1.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,320.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,320.00'	**Channel/Reach** using Reach 47R: Outfall 2 SW
#2	Discarded	5,316.75'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=0.08 cfs @ 12.23 hrs HW=5,320.01' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.08 cfs)

Primary OutFlow Max=0.26 cfs @ 12.24 hrs HW=5,320.01' (Free Discharge)
↑—**1=Channel/Reach** (Channel Controls 0.26 cfs @ 0.51 fps)

Pond 45P: Southwest Pond-North Section



Summary for Pond 55P: Southwest Pond-South Section

[61] Hint: Exceeded Reach 49R outlet invert by 0.01' @ 12.46 hrs

Inflow Area = 6.120 ac, 0.00% Impervious, Inflow Depth > 1.59" for 100-Year event
Inflow = 13.62 cfs @ 12.01 hrs, Volume= 0.813 af
Outflow = 2.45 cfs @ 12.47 hrs, Volume= 0.384 af, Atten= 82%, Lag= 27.7 min
Discarded = 0.15 cfs @ 12.46 hrs, Volume= 0.099 af
Primary = 2.30 cfs @ 12.47 hrs, Volume= 0.285 af
Routed to Reach 47R : Outfall 2 SW

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,320.01' @ 12.46 hrs Surf.Area= 0.165 ac Storage= 0.430 af

Plug-Flow detention time= 184.0 min calculated for 0.384 af (47% of inflow)
Center-of-Mass det. time= 96.2 min (903.3 - 807.1)

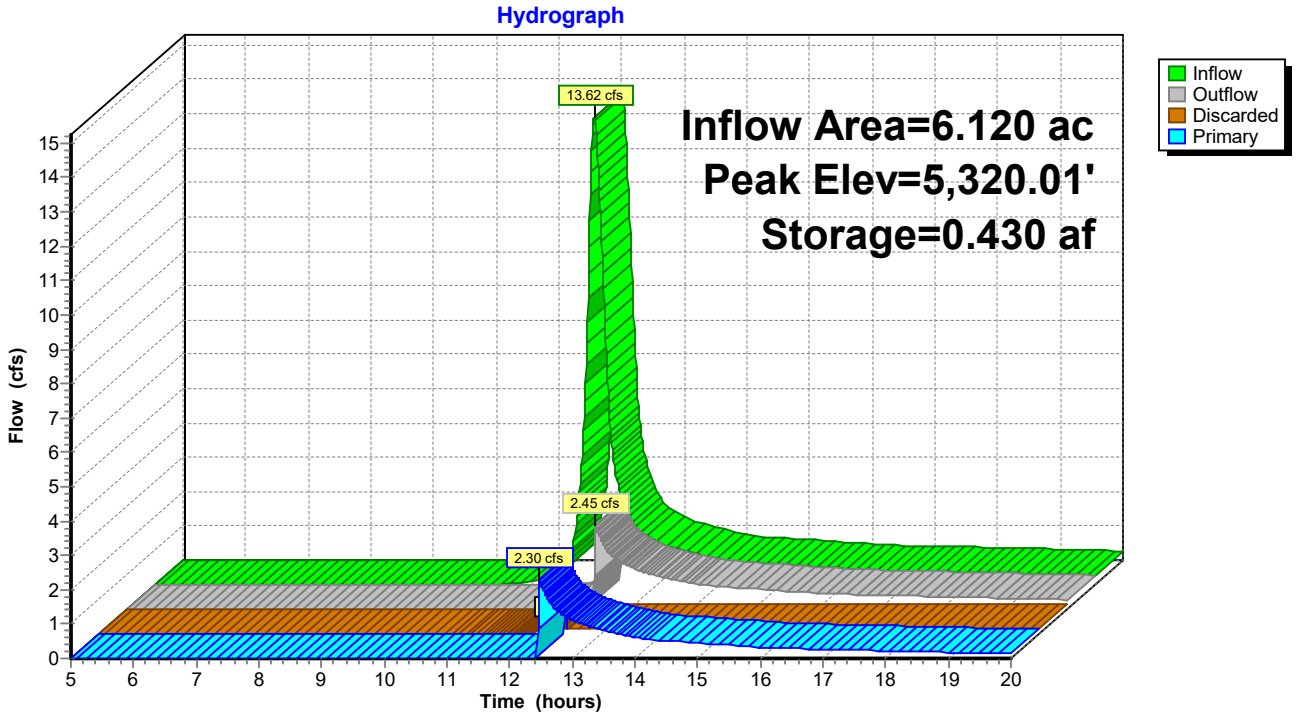
Volume	Invert	Avail.Storage	Storage Description
#1	5,314.76'	0.430 af	**672.00'L x 5.25'H Prismatoid Z=1.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,320.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,320.00'	**Channel/Reach** using Reach 47R: Outfall 2 SW
#2	Discarded	5,314.76'	**0.570 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 5,290.00'

Discarded OutFlow Max=0.15 cfs @ 12.46 hrs HW=5,320.01' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.15 cfs)

Primary OutFlow Max=0.26 cfs @ 12.47 hrs HW=5,320.01' (Free Discharge)
↑—**1=Channel/Reach** (Channel Controls 0.26 cfs @ 0.51 fps)

Pond 55P: Southwest Pond-South Section



Summary for Pond 57P: Storage in Perimeter Ditch

[61] Hint: Exceeded Reach 42R outlet invert by 0.11' @ 12.96 hrs

Inflow Area = 5.450 ac, 0.00% Impervious, Inflow Depth > 0.70" for 100-Year event
Inflow = 1.62 cfs @ 12.87 hrs, Volume= 0.318 af
Outflow = 1.55 cfs @ 12.97 hrs, Volume= 0.240 af, Atten= 4%, Lag= 5.8 min
Primary = 1.55 cfs @ 12.97 hrs, Volume= 0.240 af
Routed to Reach 56R : Outfall 1 NE

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Peak Elev= 5,302.01' @ 12.96 hrs Surf.Area= 0.105 ac Storage= 0.078 af

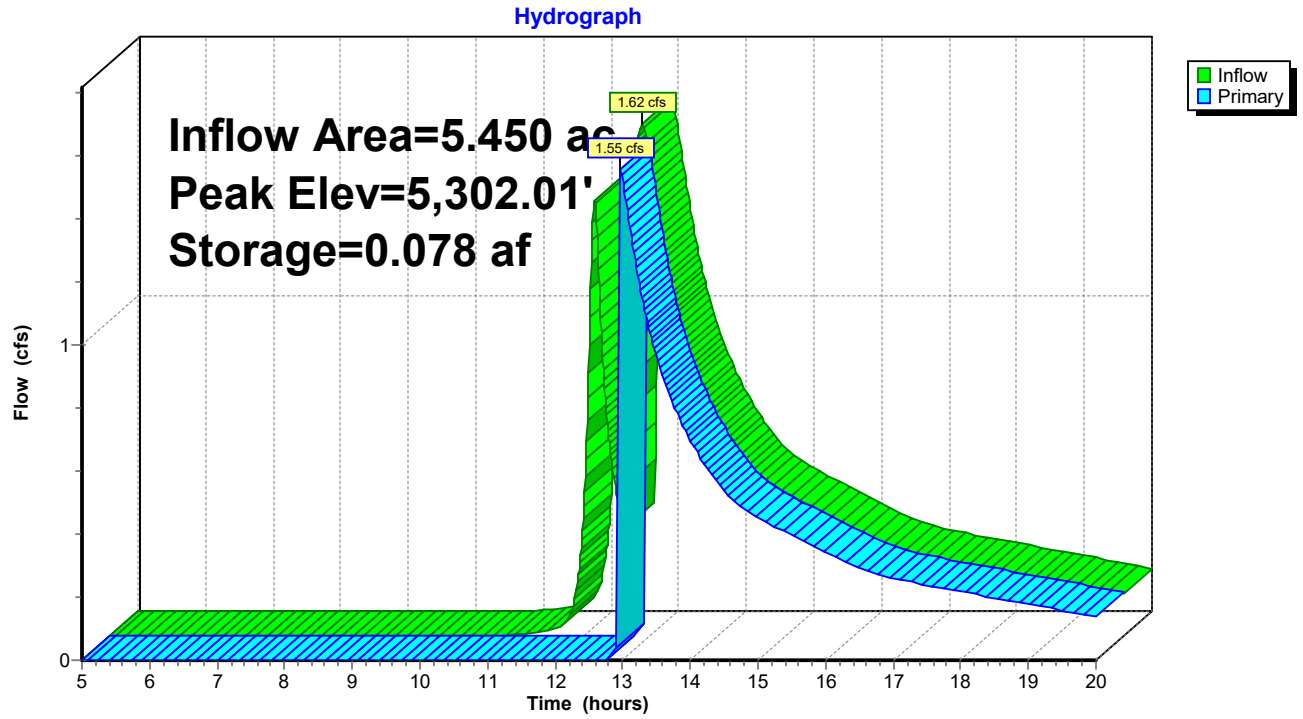
Plug-Flow detention time= 100.3 min calculated for 0.240 af (75% of inflow)
Center-of-Mass det. time= 40.6 min (912.8 - 872.2)

Volume	Invert	Avail.Storage	Storage Description
#1	5,300.51'	0.078 af	**500.00'L x 1.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#0	Primary	5,302.01'	**Automatic Storage Overflow** (Discharged without head)
#1	Primary	5,302.00'	**Channel/Reach** using Reach 56R: Outfall 1 NE

Primary OutFlow Max=0.33 cfs @ 12.97 hrs HW=5,302.01' (Free Discharge)
└**1=Channel/Reach** (Channel Controls 0.33 cfs @ 0.33 fps)

Pond 57P: Storage in Perimeter Ditch



Appendix F
Water Well Ownership

Receipt	Permit	WDID	CurrStatus	WellName	CaseNo	Div	WD	County	MgmtDist	DesigBasin	SubdivName	Filing	Lot	Block	CtyParclID	ParcelSize	PM	Township	Range	Section	Q160	Q40	Q10	CoordsEW
3643365	68842-F	0151501	Well Constructed		2057-BD	1	1	ADAMS	LOST CREEK	LOST CREEK						36.20000076	S	2 S	64 W	36	NW	SE		2666
3654511A	287827-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NE	SW		2570
10033507	88870-F		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK			A			40.11999893	S	2 S	64 W	27	SE	NE		425
3671415	299972-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	27	NE	NE		186
0089860	96618-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	63 W	18	SE	SW		
10011036	321758-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	64 W	27	SE	NW		2958
0506921G	251803-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						39.40000153	S	2 S	64 W	24	NW	NE		1880
0532240A	260706-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	MANILLA ESTATES		1			36	S	2 S	64 W	23	SW	SW		400
0041689	41689-MH		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	3 S	63 W	6	NW	NW		
0416237	203675-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	63 W	31	SW	NW		350
0450948A	53018-F	0151239	Well Constructed		26-BD	1	1	ADAMS	LOST CREEK	LOST CREEK						38	S	2 S	64 W	23	NE	NW		2440
0477228H	234080-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	PILAND PLAT		1			40	S	2 S	63 W	19	NW	NW		600
3682759	307028-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						38.65999985	S	2 S	64 W	35	SW	SW		127
0514675	252698-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	63 W	18	SW	SW		799
3678726	305204-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						36.43999863	S	2 S	63 W	31	NE	NW		3884
0499996	245007-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES	2	22			40.09999847	S	2 S	63 W	30	NW	NW		600
0482638	236720-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		10			36.09999847	S	2 S	63 W	19	SE	SW		3554
0307121G	36894-M		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NW	NW		1040
3674160	300988-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						56.61999893	S	2 S	63 W	18	SE	SE		758
3622046A	275567-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	SW	SE		2801
3655694	288760-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	63 W	19	NE	NW		3518
0484298	237842-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		7			36.09999847	S	2 S	63 W	19	SW	SE		1850
0477389	234443-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	CAVENDER PARCELS		3			40.09999847	S	2 S	63 W	19	NE	NE		1000
3686537	309959-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK					0172735300004	38.68000031	S	2 S	64 W	35	SW	SW		144
10011814	322347-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	SE	SE		26
0499987	245004-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES	2	25			40.09999847	S	2 S	63 W	30	NE	NW		3033
3680636	306322-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	27	NE	NW		2995
0517984	254256-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40.61999893	S	2 S	64 W	22	SE	SE		660
0413820	202686-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40.40000153	S	2 S	63 W	31	NW	NW		695
0518849	254567-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	22	NE	SE		650
0516345	253481-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						39.38000107	S	2 S	64 W	24	SW	SE		3353
3653504	287332-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	SE	SW		1335
3641349	68561-F	0151497	Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						164.5	S	2 S	64 W	25	SE	SE		500
0041722	41722-MH		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	35	SE	SE		
0506921E	251792-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK			2		0172724300001	39.40000153	S	2 S	64 W	24	SW	NE		1880
3654511D	287830-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2430
0444320	217870-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	36	NW	SE		1800
10022058	327732-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	PARCEL D					38.79999924	S	2 S	64 W	35	NW	SW		548
0440934	215743-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						41	S	2 S	64 W	36	SW	SE		2250
0463744	227874-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	36	NW	SE		3387
0543382	265468-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		30			36	S	3 S	64 W	2	NW	NW		300
3696787B	84318-F	0151805	Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK					0172735200003	40	S	2 S	64 W	35	NW	SW		484
0443902	217349-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	36	NW	NE		1245
3619356	274574-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						38	S	3 S	64 W	2	SW	NE		2070
10011815	322348-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	SE	SE		24
3650615D	285924-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2451
0507056P	249310-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	3 S	63 W	6	NW	NW		800
0415841	203673-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40.40000153	S	2 S	63 W	31	SW	SW		300
0499983	245001-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES	2	27			36.65999985	S	2 S	63 W	30	NE	NE		930
3680636	306322-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	27	NE	NW		2995
10024744	87554-F		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK					234443	40.09999847	S	2 S	63 W	19	NE	NE		978
0216382	120758-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2540
10016358	215418--A		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						41.95000076	S	2 S	64 W	36	SW	SE		2765
0474667	232797-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		16			40.09999847	S	2 S	64 W	24	NE	SE		440
0499988	245005-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES	2	24			35.59000015	S	2 S	63 W	30	NW	SW		600
0516345	253481-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						39.38000107	S	2 S	64 W	24	SW	SE		3353
0240113	134042-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	3 S	63 W	6	SW	SE		2000
0421078	206284-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						41	S	2 S	64 W	36	SE	NE		200
0041723	41723-MH		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	23	NW	NE		
0450969	221435-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	36	NW	NE		1550

Receipt	Permit	WDID	CurrStatus	WellName	CaseNo	Div	WD	County	MgmtDist	DesigBasin	SubdivName	Filing	Lot	Block	CtyParclID	ParcelSize	PM	Township	Range	Section	Q160	Q40	Q10	CoordsEW
0478166	234635-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	36	NE	SE		900
0506921E	251792-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK			2		0172724300001	39.40000153	S	2 S	64 W	24	SW	NE		1880
3654511E	287831-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2430
3680466	306076-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						44.40000153	S	2 S	63 W	31	NE	NW		3129
0460185	226063-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SCHUMAKER FARMS		A			35	S	2 S	64 W	13	SE	SE		330
0326183	41002-F	0151191	Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NW	NE		2500
0440934	215743-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						41	S	2 S	64 W	36	SW	SE		2250
0441952	217103-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK					0172736400003	36.5	S	2 S	64 W	36	SE	SW		2123
0456866A	224462-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		5			40	S	2 S	64 W	23	NE	SW		2460
0465988	228711-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		10			40.00999832	S	2 S	64 W	26	NE	SW		1700
9003346	31096-	0105895	Well Constructed		W5824	1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	26	NE	NE		
10010423	321435-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40.09999847	S	3 S	64 W	2	NE	SE		545
0448990	220628-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	36	NE	SE		340
0463092	227547-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NE	NE		775
0307121B	36889-M		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NE	NW		1360
0499985	245002-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES	2	28			36.63000107	S	2 S	63 W	30	NW	NW		300
3654511B	287828-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NE	SW		2580
3650615A	285921-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2445
10033134	332810-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	64 W	24	SE	SW		3229
0089860	96618-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	63 W	18	SE	SW		
0446037B	218746-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK			8			41	S	2 S	64 W	36	SW	NE		2123
3641887	232988--A		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	64 W	24	SE	SE		880
0507056S	249349-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	63 W	32	SE	NW		2640
3680499	306077-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	64 W	22	SE	NE		333
3647013	283833-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	SE	NW		1520
0529095	258953-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	MANILLA ESTATES		2			36	S	2 S	64 W	23	SW	SE		1900
0462756	227402-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		1			44	S	2 S	64 W	23	SE	SW		1950
9000561	3839-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	63 W	31	NE	NE		
3678726	305204-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						36.43999863	S	2 S	63 W	31	NE	NW		3884
0537279	262828-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40.09999847	S	3 S	64 W	2	NE	NW		1900
3622046B	275568-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NW	SE		2746
0458465	225341-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	MANILLA ESTATES		B			35.02000046	S	2 S	64 W	26	NW	NW		125
0470988	231364-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SCHUMAKER FARMS		N			40	S	2 S	64 W	13	SW	SE		2325
3650615B	285922-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2345
0507056N	249309-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	35	SE	SE		1050
0021292P	177775-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	SE	NE		65
0477389	234443-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	CAVENDER PARCELS		3			40.09999847	S	2 S	63 W	19	NE	NE		1000
0446037B	218746-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK			8			41	S	2 S	64 W	36	SW	NE		2123
0443794	217884-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	36	NE	SE		250
0052537	52537-MH		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2624
3609874	271330-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	FLINT RIDGE ESTATES		4			35	S	2 S	64 W	27	NE	SW		2007
0506921E	251792-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK			2		0172724300001	39.40000153	S	2 S	64 W	24	SW	NE		1880
0477228A	234079-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	PILAND PLAT		2			40	S	2 S	63 W	19	NW	NE		1700
3654511C	287829-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2550
0535022	261833-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	MANILLA ESTATES		5			37.41999817	S	2 S	64 W	23	NW	SW		300
0507056T	249351-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	23	NW	NE		2640
0470087	230998-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SCHUMAKER FARMS		L			40	S	2 S	64 W	13	SW	NE		2300
0464876	228261-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SCHUMAKER FARMS		B			36	S	2 S	64 W	13	SE	NE		630
3696787B	84318-F	0151805	Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK					0172735200003	40	S	2 S	64 W	35	NW	SW		484
0451771	221883-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	36	NE	NE		700
0465986	228709-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		2			40.02999878	S	2 S	64 W	23	SE	SW		2100
0440934	215743-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						41	S	2 S	64 W	36	SW	SE		2250
0527803	258468-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		11			40	S	2 S	64 W	26	NE	SE		1100
3677708	304167-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	FLINT RIDGE ESTATES		2			35.34000015	S	2 S	64 W	27	NE	NW		3762
0463090	227545-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NE	NW		2400
3679061B	237840--A		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		15			36.72999954	S	2 S	64 W	24	NE	SE		564
0307121E	36892-M		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NW	NE		3380
3662758	293168-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						36	S	2 S	64 W	27	NE	NW		2878
3606196	269768-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		23			35.56999969	S	2 S	63 W	30	NW	SW		600
3607305	270132-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						36	S	2 S	63 W	18	SW	NE		2225
0499983	245001-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES	2	27			36.65999985	S	2 S	63 W	30	NE	NE		930
10033507	88870-F		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK			A			40.11999893	S	2 S	64 W	27	SE	NE		425
0507056K	249306-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	22	SE	SW		2640
0445406	218206-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	26	NW	NW		150

Receipt	Permit	WDID	CurrStatus	WellName	CaseNo	Div	WD	County	MgmtDist	DesigBasin	SubdivName	Filing	Lot	Block	CtyParclID	ParcelSize	PM	Township	Range	Section	Q160	Q40	Q10	CoordsEW
0089859	96619-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	63 W	18	SE	SE		
10011036	321758-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	64 W	27	SE	NW		2958
3683175	307575-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	35	SW	NW		205
0477228D	234084-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	PILAND PLAT		5			40	S	2 S	63 W	31	NW	NW		200
0532240B	260707-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	MANILLA ESTATES		7			40.02000046	S	2 S	64 W	23	NW	NW		400
0506921F	251802-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						39.40000153	S	2 S	64 W	24	NW	SE		1880
10016706	324838-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						36.40000153	S	3 S	64 W	2	NW	SE		3203
0031030	97234-VE		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	63 W	20	SW	SW		113
10006658	319464-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						39.77000046	S	3 S	63 W	6	SE	SE		1257
0460506	226234-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		7			35.02999878	S	2 S	64 W	23	NE	NW		2200
0486025	238669-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35	S	2 S	64 W	22	NE	SW		1330
3607968	270565-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35.70000076	S	2 S	63 W	18	SE	SW		2600
0465989	228712-		Well Constructed		W5824	1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		12			39.04999924	S	2 S	64 W	26	NE	SE		500
0456866B	224463-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		3			40	S	2 S	64 W	23	SE	NW		2400
3682758	307027-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						38.63999939	S	2 S	64 W	35	SW	NW		240
0412772	202135-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40.43000031	S	2 S	63 W	31	SE	SW		1710
0487327A	238882-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	CAVANDER PARCELS		4			35.20000076	S	2 S	63 W	19	NE	NE		300
0482639	236721-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		11			40.09999847	S	2 S	63 W	19	SE	SE		1016
0358916F	177774-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NE	NE		95
0049835A	285732-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2611
0417614B	204229-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	63 W	20	SW	SW		125
0448770	220478-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35.09000015	S	2 S	63 W	31	SW	SE		2000
9003398	31616-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	14	SW	NE		3298
0484301	237667-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		6			40.09999847	S	2 S	63 W	19	SW	SW		440
0400114	196054-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	64 W	36	SE	NE		1320
0437790	214327-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	63 W	31	SE	NE		665
3696015	228711--A		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40	S	2 S	64 W	26	NE	NW		3415
3645165	283010-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40.65000153	S	2 S	64 W	22	NE	NE		809
3628617	277394-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		8			35	S	2 S	63 W	19	SW	SE		2500
0499986	245003-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES	2	26			40.09999847	S	2 S	63 W	30	NE	NW		1570
0478632	234658-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						36.16999817	S	2 S	63 W	31	NW	SW		519
3617192	273799-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	MANILLA ESTATES		6			37.43000031	S	2 S	64 W	23	NW	SW		400
3607305	270132-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						36	S	2 S	63 W	18	SW	NE		2225
0477228E	234083-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	PILAND PLAT		6			40	S	2 S	63 W	31	NW	NE		1910
3679805	306045-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						36	S	2 S	63 W	31	NE	NE		1202
0531882	260607-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	MANILLA ESTATES		8			40.02000046	S	2 S	64 W	23	NW	NW		400
0454132	222906-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						43	S	2 S	64 W	26	NW	SW		120
9004353	70774-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	36	NE	SE		300
0464604	228203-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SCHUMAKER FARMS		Q			35	S	2 S	64 W	13	SE	NW		1850
0302693	155417-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NE	NW		1523
0446037B	218746-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK			8			41	S	2 S	64 W	36	SW	NE		2123
0464631	228204-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SCHUMAKER FARMS		P			35	S	2 S	64 W	13	SE	SW		1774
0482640	236722-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		12			40.09999847	S	2 S	63 W	19	SE	SE		338
0465979	228708-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SCHUMAKER FARMS		O			40	S	2 S	64 W	13	SW	SE		2500
3622046C	275602-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NE	SW		1501
0457399	224850-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		6				S	2 S	64 W	23	NE	NW		2400
3650615C	285923-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	34	NW	SE		2495
3670850	299336-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		35			40.04999924	S	3 S	64 W	2	NE	SE		149
0474667	232797-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		16			40.09999847	S	2 S	64 W	24	NE	SE		440
10024744	87554-F		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK					234443	40.09999847	S	2 S	63 W	19	NE	NE		978
0477228B	234077-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	PILAND PLAT		3			36.49000168	S	2 S	63 W	19	NW	SW		250
0041688	41688-MH		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	63 W	32	NW	SE		
0441952	217103-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK					0172736400003	36.5	S	2 S	64 W	36	SE	SW		2123
0465987	228710-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		9			35.00999832	S	2 S	64 W	26	NE	NW		2500
0467553	229741-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SCHUMAKER FARMS		M			40	S	2 S	64 W	13	SW	SE		2325
0493217	241846-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	LOST CREEK TRAILS		4			40.68999863	S	2 S	64 W	23	SE	NW		1850
0482637	236728-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		18			40.09999847	S	2 S	64 W	24	SE	NE		440
0484296	237841-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		9			36.09999847	S	2 S	63 W	19	SE	SW		2292
0446351	219321-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						35.09000015	S	2 S	63 W	31	SW	NW		120
0480021	235384-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK						40.09999847	S	2 S	64 W	24	SE	SW		2000
0520490	255285-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	SUNRISE ACRES		1			40	S	2 S	63 W	19	NE	NW		2402
0307121F	36893-M		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NW	NW		980
0463091	227546-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK							S	2 S	64 W	25	NE	NE		250
0456973	224487-		Well Constructed			1	1	ADAMS	LOST CREEK	LOST CREEK	MANILLA ESTATES					43	S	2 S	64 W	26	NW	NE		2400

Receipt	Permit	CoordsEWdir	CoordsNS	CoordsNSdir	UTMX	UTMY	LocAccuracy	LatDecDeg	LongDecDeg	Use1	Use2	SpecialUse	Aquifer1	Aquifer2
3643365	68842-F	E	3945	S	542884	4409668	User supplied	39.835941	-104.498817	Irrigation	Other		UPPER ARAPAHOE	
3654511A	287827-	E	2305	N	539698.8	4409421.6	Spotted from section lines	39.83388	-104.536054	Monitoring/Sampling			ALLUVIAL	
10033507	88870-F	E	3713	N	540351	4410593	User supplied	39.844399	-104.528363	Stock			UPPER ARAPAHOE	
3671415	299972-	E	521	N	540419	4411565	User supplied	39.853154	-104.527508	Domestic			ARAPAHOE	
0089860	96618-				544683.4	4413498.8	Spotted from quarters	39.870362	-104.477526	Domestic	Stock		ALL UNNAMED AQUIFERS	
10011036	321758-	W	2879	N	539768	4410856	User supplied	39.846796	-104.535161	Domestic			ARAPAHOE	
0506921G	251803-	W	4500	S	542668.3	4413054.3	Spotted from section lines	39.866459	-104.501121	Domestic			UPPER ARAPAHOE	
0532240A	260706-	W	400	S	540596.3	4411842.3	Spotted from section lines	39.855641	-104.525422	Domestic			UPPER ARAPAHOE	
0041689	41689-MH				543902.2	4408252.9	Spotted from quarters	39.82314	-104.487012	Monitoring/Sampling			QUATERNARY ALLUVIUM	
0416237	203675-	W	2400	S	543804.3	4409195.7	Spotted from section lines	39.831642	-104.488097	Domestic			DENVER	
0450948A	53018-F	E	450	N	541351.4	4413168.8	Spotted from section lines	39.86756	-104.516512	Irrigation			UPPER ARAPAHOE	
0477228H	234080-	W	200	N	543880.6	4413229.6	Spotted from section lines	39.867983	-104.486926	Domestic	Stock		ARAPAHOE	
3682759	307028-	W	973	S	540520	4408783	User supplied	39.828084	-104.526499	Domestic			UPPER ARAPAHOE	
0514675	252698-	W	400	S	543940.9	4413412.8	User supplied	39.869628	-104.486213	Domestic	Stock		ARAPAHOE	
3678726	305204-	W	193	N	544880	4410010	User supplied	39.838919	-104.475467	Domestic			UPPER ARAPAHOE	
0499996	245007-	W	1028	N	543874.8	4411361.7	Spotted from section lines	39.851153	-104.487122	Domestic			UPPER ARAPAHOE	
0482638	236720-	W	439	S	544775	4411819.3	User supplied	39.855224	-104.47657	Domestic	Stock		UPPER ARAPAHOE	
0307121G	36894-M	W	1000	N	542417.8	4411380.2	Spotted from section lines	39.851389	-104.504152	Monitoring/Sampling			DENVER	
3674160	300988-	E	450	S	545056	4413438	User supplied	39.869795	-104.473174	Domestic	Stock		ALL UNNAMED AQUIFERS	
3622046A	275567-	E	40	S	542842.2	4410077.1	Spotted from section lines	39.839628	-104.499281	Monitoring/Sampling			ALLUVIAL	
3655694	288760-	W	349	N	544770	4413192	User supplied	39.867594	-104.476535	Domestic	Stock		UPPER ARAPAHOE	
0484298	237842-	W	185	S	544255.2	4411735.7	Spotted from section lines	39.854503	-104.482655	Domestic	Stock		UPPER ARAPAHOE	
0477389	234443-	E	100	N	544983.3	4413269.8	Spotted from section lines	39.868286	-104.474039	Domestic			DENVER	
3686537	309959-	W	566	S	540525	4408659	User supplied	39.826966	-104.526449	Domestic			ALL UNNAMED AQUIFERS	
10011814	322347-	E	1282	S	543687	4410437	User supplied	39.842829	-104.489381	Monitoring/Sampling			DENVER	
0499987	245004-	W	602	N	544615.8	4411500.2	User supplied	39.852358	-104.478451	Domestic			UPPER ARAPAHOE	
3680636	306322-	W	1264	N	539780	4411348	User supplied	39.851229	-104.534991	Domestic	Stock		UPPER ARAPAHOE	
0517984	254256-	E	1249	S	540271.9	4412106.8	Spotted from section lines	39.858044	-104.529193	Domestic			DENVER	
0413820	202686-	W	320	N	543908	4409952.5	Spotted from section lines	39.838457	-104.486831	Domestic			DENVER	
0518849	254567-	E	3812	S	540271.3	4412887.8	User supplied	39.865081	-104.529156	Domestic	Stock		DENVER	
0516345	253481-	E	651	S	542669.9	4411880.8	User supplied	39.855891	-104.501174	Domestic	Stock		UPPER ARAPAHOE	
3653504	287332-	E	1220	S	543287.9	4410427	Spotted from section lines	39.842759	-104.494045	Monitoring/Sampling			ALL UNNAMED AQUIFERS	
3641349	68561-F	E	1300	S	543542.4	4410445.7	Spotted from section lines	39.842917	-104.491075	Industrial	Irrigation		LARAMIE FOX HILLS	
0041722	41722-MH				541904.8	4408670.3	Spotted from quarters	39.827001	-104.510324	Monitoring/Sampling			QUATERNARY ALLUVIUM	
0506921E	251792-	W	2079	S	542669.2	4412316.3	Spotted from section lines	39.85981	-104.501157	Domestic	Stock		UPPER ARAPAHOE	
3654511D	287830-	W	2385	N	539608.9	4409399.5	Spotted from section lines	39.833677	-104.537108	Monitoring/Sampling			ALLUVIAL	
0444320	217870-	W	1760	N	542661.2	4409532.4	Spotted from section lines	39.834727	-104.501432	Domestic			DENVER	
10022058	327732-	W	2835	S	540649	4409349	User supplied	39.833177	-104.524957	Domestic	Stock		UPPER ARAPAHOE	
0440934	215743-	W	1120	S	542792.6	4408807.1	Spotted from section lines	39.828189	-104.499937	Domestic			DENVER	
0463744	227874-	E	2805	S	542665	4409321.2	User supplied	39.832826	-104.501399	Domestic			DENVER	
0543382	265468-	W	945	N	540572.3	4408197.8	Spotted from section lines	39.822811	-104.525928	Domestic			DENVER	
3696787B	84318-F	W	3848	S	540630	4409658	User supplied	39.835962	-104.52516	Domestic	Irrigati		UPPER ARAPAHOE	
0443902	217349-	W	264	N	542495.8	4409992.1	Spotted from section lines	39.83888	-104.50333	Domestic	Stock		ARAPAHOE	
3619356	274574-	W	2130	S	541111.3	4407534.2	Spotted from section lines	39.816802	-104.519672	Domestic			DENVER	
10011815	322348-	E	610	S	543688	4410232	User supplied	39.840982	-104.489383	Monitoring/Sampling			DENVER	
3650615D	285924-	W	2245	N	539615.1	4409442	Spotted from section lines	39.834064	-104.537035	Monitoring/Sampling			ALL UNNAMED AQUIFERS	
0507056P	249310-	W	1060	N	543945.8	4408141.2	Spotted from section lines	39.822129	-104.486508	Monitoring/Sampling			ALLUVIAL	
0415841	203673-	W	150	S	543790.4	4408509.8	Spotted from section lines	39.825462	-104.488306	Domestic			DENVER	
0499983	245001-	E	1000	N	545009.2	4411383	Spotted from section lines	39.851283	-104.473865	Domestic			UPPER ARAPAHOE	
3680636	306322-	W	1264	N	539780	4411348	User supplied	39.851229	-104.534991	Domestic	Stock		UPPER ARAPAHOE	
10024744	87554-F	E	123	N	544990	4413263	User supplied	39.868222	-104.473958	Augmentation	Commercial,		LOWER ARAPAHOE	
0216382	120758-	W	1920	N	539641.8	4409540.4	Spotted from section lines	39.834946	-104.536713	Domestic			ALL UNNAMED AQUIFERS	
10016358	215418--A	E	418	S	542856	4408593	User supplied	39.826257	-104.499215	Commercial			UPPER ARAPAHOE	
0474667	232797-	E	2210	N	543561	4412615.5	Spotted from section lines	39.862458	-104.490709	Domestic			UPPER ARAPAHOE	
0499988	245005-	W	3059	S	543876.3	4410981.8	User supplied	39.847729	-104.487136	Domestic			UPPER ARAPAHOE	
0516345	253481-	E	651	S	542669.9	4411880.8	User supplied	39.855891	-104.501174	Domestic	Stock		UPPER ARAPAHOE	
0240113	134042-	W	660	S	544321.6	4407050.5	Spotted from section lines	39.81228	-104.482189	Domestic	Stock		ALL UNNAMED AQUIFERS	
0421078	206284-	E	2330	S	543636.7	4409174.3	Spotted from section lines	39.831452	-104.49005	Domestic	Stock		DENVER	
0041723	41723-MH				541089.7	4413114.2	Spotted from quarters	39.867079	-104.51957	Monitoring/Sampling			QUATERNARY ALLUVIUM	
0450969	221435-	W	750	N	542587.5	4409841.9	Spotted from section lines	39.837524	-104.502265	Domestic			DENVER	

Receipt	Permit	CoordsEWdir	CoordsNS	CoordsNSdir	UTMX	UTMY	LocAccuracy	LatDecDeg	LongDecDeg	Use1	Use2	SpecialUse	Aquifer1	Aquifer2
0478166	234635-	E	2300	N	543423	4409350.8	Spotted from section lines	39.833058	-104.492539	Domestic	Stock		DENVER	
0506921E	251792-	W	2079	S	542669.2	4412316.3	Spotted from section lines	39.85981	-104.501157	Domestic	Stock		UPPER ARAPAHOE	
3654511E	287831-	W	2250	N	539608.7	4409440.7	Spotted from section lines	39.834055	-104.537105	Monitoring/Sampling			ALLUVIAL	
3680466	306076-	W	648	N	544650	4409867	User supplied	39.837643	-104.478165	Domestic	Stock			
0460185	226063-	E	360	S	543597	4413398.8	Spotted from section lines	39.86952	-104.490236	Domestic	Stock		ALL UNNAMED AQUIFERS	
0326183	41002-F	W	350	N	542860.5	4411574.1	Spotted from section lines	39.853115	-104.498973	Commercial			UPPER ARAPAHOE	
0440934	215743-	W	1120	S	542792.6	4408807.1	Spotted from section lines	39.828189	-104.499937	Domestic			DENVER	
0441952	217103-	E	1114	S	543051.3	4408804.8	Spotted from section lines	39.828157	-104.496922	Domestic			DENVER	
0456866A	224462-	E	2070	N	541346	4412675	Spotted from section lines	39.86311	-104.516601	Domestic			DENVER	
0465988	228711-	E	1400	N	541584	4411272.3	Spotted from section lines	39.850458	-104.513908	Domestic			UPPER ARAPAHOE	
9003346	31096-				541898.5	4411492.1	Spotted from quarters	39.852425	-104.510218	Domestic	Stock		ALL UNNAMED AQUIFERS	
10010423	321435-	E	3001	S	541937	4407780	User supplied	39.818978	-104.510005	Domestic	Stock		UPPER ARAPAHOE	
0448990	220628-	E	1700	N	543593.3	4409530	Spotted from section lines	39.834662	-104.49054	Domestic			DENVER	
0463092	227547-	E	1000	N	543455.7	4411370.4	Spotted from section lines	39.851247	-104.492019	Monitoring/Sampling			DENVER	
0307121B	36889-M	E	100	N	543276.6	4411646.4	Spotted from section lines	39.853743	-104.494093	Monitoring/Sampling			DENVER	
0499985	245002-	W	900	N	543783.3	4411399.7	Spotted from section lines	39.8515	-104.488195	Domestic			UPPER ARAPAHOE	
3654511B	287828-	E	2450	N	539695.7	4409377.4	Spotted from section lines	39.833474	-104.536092	Monitoring/Sampling			ALLUVIAL	
3650615A	285921-	W	2439	N	539613.5	4409382.9	Spotted from section lines	39.833532	-104.53705	Monitoring/Sampling			ALL UNNAMED AQUIFERS	
10033134	332810-	W	198	S	543081	4411739	User supplied	39.85459	-104.496378	Domestic			UPPER ARAPAHOE	
0089860	96618-				544683.4	4413498.8	Spotted from quarters	39.870362	-104.477526	Domestic	Stock		ALL UNNAMED AQUIFERS	
0446037B	218746-	W	2425	S	542757.1	4409204.9	Spotted from section lines	39.831776	-104.500331	Domestic	Stock		DENVER	
3641887	232988--A	E	146	S	543423	4411720	User supplied	39.854402	-104.492382	Domestic	Stock		UPPER ARAPAHOE	
0507056S	249349-	E	2640	S	546098.8	4409282.2	Spotted from section lines	39.832295	-104.461271	Monitoring/Sampling			ALLUVIAL	
3680499	306077-	E	2949	N	540370	4412428	User supplied	39.860931	-104.528027	Domestic			UPPER ARAPAHOE	
3647013	283833-	E	1350	S	543231.4	4410467.9	Spotted from section lines	39.843131	-104.494709	Monitoring/Sampling			DENVER	
0529095	258953-	W	500	S	541053.4	4411863	Spotted from section lines	39.855808	-104.520078	Domestic			UPPER ARAPAHOE	
0462756	227402-	E	250	S	541502.5	4411777	Spotted from section lines	39.855011	-104.514823	Domestic			DENVER	
9000561	3839-				545099.7	4409873.9	Spotted from quarters	39.837681	-104.472909	Stock			ALL UNNAMED AQUIFERS	
3678726	305204-	W	193	N	544880	4410010	User supplied	39.838919	-104.475467	Domestic			UPPER ARAPAHOE	
0537279	262828-	E	400	N	541524.7	4408352.2	Spotted from section lines	39.824152	-104.514783	Domestic	Stock		DENVER	
3622046B	275568-	E	2642	S	542856.5	4410870.1	Spotted from section lines	39.846772	-104.499065	Monitoring/Sampling			ALLUVIAL	
0458465	225341-	W	1200	N	540514.9	4411356.3	Spotted from section lines	39.851266	-104.526398	Domestic			DENVER	
0470988	231364-	W	1050	S	542800.7	4413609.6	Spotted from section lines	39.871462	-104.499529	Domestic			DENVER	
3650615B	285922-	W	2364	N	539582.9	4409406.6	Spotted from section lines	39.83375	-104.537411	Monitoring/Sampling			ALL UNNAMED AQUIFERS	
0507056N	249309-	E	200	S	541784.5	4408531.9	Spotted from section lines	39.825761	-104.511745	Monitoring/Sampling			ALLUVIAL	
0021292P	177775-	E	2150	S	543674.2	4410702	Spotted from section lines	39.845217	-104.489515	Monitoring/Sampling			DENVER	
0477389	234443-	E	100	N	544983.3	4413269.8	Spotted from section lines	39.868286	-104.474039	Domestic			DENVER	
0446037B	218746-	W	2425	S	542757.1	4409204.9	Spotted from section lines	39.831776	-104.500331	Domestic	Stock		DENVER	
0443794	217884-	E	1300	N	543620.5	4409651.3	Spotted from section lines	39.835751	-104.490205	Domestic	Stock		UPPER ARAPAHOE	
0052537	52537-MH	W	2291	N	539667.9	4409426.6	Spotted from section lines	39.833926	-104.536416	Monitoring/Sampling			ALL UNNAMED AQUIFERS	
3609874	271330-	E	2283	N	539866.7	4411036.1	Spotted from section lines	39.848414	-104.533993	Domestic			DENVER	
0506921E	251792-	W	2079	S	542669.2	4412316.3	Spotted from section lines	39.85981	-104.501157	Domestic	Stock		UPPER ARAPAHOE	
0477228A	234079-	W	200	N	544215.9	4413232.6	Spotted from section lines	39.867992	-104.483009	Domestic	Stock		UPPER ARAPAHOE	
3654511C	287829-	W	2530	N	539645.6	4409354.3	Spotted from section lines	39.83327	-104.536678	Monitoring/Sampling			ALLUVIAL	
0535022	261833-	W	2276	N	540561.9	4412629.1	Spotted from section lines	39.862733	-104.52577	Domestic			UPPER ARAPAHOE	
0507056T	249351-	W	10	N	541271.8	4413304.6	Spotted from section lines	39.868789	-104.517427	Monitoring/Sampling			ALLUVIAL	
0470087	230998-	W	1600	S	542791.6	4413777.2	Spotted from section lines	39.872967	-104.499623	Domestic			DENVER	
0464876	228261-	E	1470	S	543504.3	4413737.2	Spotted from section lines	39.87257	-104.491301	Domestic			DENVER	
3696787B	84318-F	W	3848	S	540630	4409658	User supplied	39.835962	-104.52516	Domestic	Irrigati		UPPER ARAPAHOE	
0451771	221883-	E	450	N	543482.9	4409913.5	Spotted from section lines	39.838127	-104.4918	Domestic	Stock		ARAPAHOE	
0465986	228709-	E	1050	S	541456.5	4412021.9	Spotted from section lines	39.857221	-104.515345	Domestic			UPPER ARAPAHOE	
0440934	215743-	W	1120	S	542792.6	4408807.1	Spotted from section lines	39.828189	-104.499937	Domestic			DENVER	
0527803	258468-	E	1500	N	541767.3	4411237.8	Spotted from section lines	39.850142	-104.511771	Domestic			DENVER	
3677708	304167-	W	859	N	540014	4411468	User supplied	39.852299	-104.532248	Domestic			UPPER ARAPAHOE	
0463090	227545-	E	150	N	542959.6	4411634.2	Spotted from section lines	39.853651	-104.4978	Monitoring/Sampling			ALL UNNAMED AQUIFERS	
3679061B	237840--A	E	3607	S	543524	4412774	User supplied	39.863893	-104.491131	Domestic	Stock		ARAPAHOE	
0307121E	36892-M	E	100	N	542660.8	4411652.2	Spotted from section lines	39.853828	-104.501294	Monitoring/Sampling			DENVER	
3662758	293168-	W	390	N	539745	4411615	User supplied	39.853636	-104.535384	Domestic			UPPER ARAPAHOE	
3606196	269768-	W	1712	N	543875.5	4411153.2	Spotted from section lines	39.84927	-104.487136	Domestic			UPPER ARAPAHOE	
3607305	270132-	W	1950	S	544373.9	4413889.3	Spotted from section lines	39.873895	-104.481117	Domestic	Stock		UPPER ARAPAHOE	
0499983	245001-	E	1000	N	545009.2	4411383	Spotted from section lines	39.851283	-104.473865	Domestic			UPPER ARAPAHOE	
10033507	88870-F	E	3713	N	540351	4410593	User supplied	39.844399	-104.528363	Stock			UPPER ARAPAHOE	
0507056K	249306-	E	150	S	539670	4411780.7	Spotted from section lines	39.855135	-104.53625	Monitoring/Sampling			ALLUVIAL	
0445406	218206-	W	350	N	540521.3	4411615.3	Spotted from section lines	39.853599	-104.526312	Domestic			ALL UNNAMED AQUIFERS	

Receipt	Permit	CoordsEWdir	CoordsNS	CoordsNSdir	UTMX	UTMY	LocAccuracy	LatDecDeg	LongDecDeg	Use1	Use2	SpecialUse	Aquifer1	Aquifer2
0089859	96619-				545085.8	4413502.4	Spotted from quarters	39.870374	-104.472821	Domestic	Stock		ALL UNNAMED AQUIFERS	
10011036	321758-	W	2879	N	539768	4410856	User supplied	39.846796	-104.535161	Domestic			ARAPAHOE	
3683175	307575-	W	3566	N	540544	4409016	User supplied	39.830182	-104.526204	Domestic	Stock		UPPER ARAPAHOE	
0477228D	234084-	W	600	N	543757.3	4409864.3	Spotted from section lines	39.837663	-104.488601	Domestic	Stock		ARAPAHOE	
0532240B	260707-	W	1002	N	540590.5	4413016.9	Spotted from section lines	39.866228	-104.525419	Domestic			UPPER ARAPAHOE	
0506921F	251802-	W	3300	S	542668.8	4412688.5	Spotted from section lines	39.86317	-104.501133	Domestic			UPPER ARAPAHOE	
10016706	324838-	E	3685	S	541127	4408008	User supplied	39.821072	-104.519455	Domestic			ARAPAHOE	
0031030	97234-VE	W	408	S	545325.2	4411815.4	Spotted from section lines	39.855158	-104.470141	Domestic	Stock		ALL UNNAMED AQUIFERS	
10006658	319464-	E	798	S	544936	4407109	User supplied	39.812779	-104.475011	Domestic			UPPER ARAPAHOE	
0460506	226234-	E	840	N	541424.7	4413048.3	Spotted from section lines	39.866467	-104.515654	Domestic			DENVER	
0486025	238669-	E	2440	N	540065.3	4412590	Spotted from section lines	39.862405	-104.531583	Domestic	Stock		DENVER	
3607968	270565-	E	1175	S	544492.9	4413654.2	Spotted from section lines	39.871771	-104.479742	Domestic			UPPER ARAPAHOE	
0465989	228712-	E	1600	N	541950.6	4411203.4	Spotted from section lines	39.849818	-104.509622	Domestic			UPPER ARAPAHOE	
0456866B	224463-	E	1770	S	541364.8	4412243.4	Spotted from section lines	39.859217	-104.516406	Domestic			DENVER	
3682758	307027-	W	3159	N	540555	4409140	User supplied	39.831299	-104.526068	Domestic			UPPER ARAPAHOE	
0412772	202135-	E	350	S	544787.2	4408572	Spotted from section lines	39.825968	-104.476652	Domestic	Stock		DENVER	
0487327A	238882-	E	100	N	545196.6	4413271.7	Spotted from section lines	39.868292	-104.471537	Domestic	Stock		DENVER	
0482639	236721-	E	441	S	544981.1	4411822	User supplied	39.85524	-104.474162	Domestic	Stock		UPPER ARAPAHOE	
0358916F	177774-	E	120	N	543662.2	4411636.7	Spotted from section lines	39.853642	-104.489593	Monitoring/Sampling			DENVER	
0049835A	285732-	W	2301	N	539663.9	4409423.7	Spotted from section lines	39.833899	-104.536463	Monitoring/Sampling			DENVER	
0417614B	204229-	W	396	S	545328.9	4411811.8	Spotted from section lines	39.855131	-104.470094	Domestic			DENVER	
0448770	220478-	W	900	S	544308.1	4408739.1	Spotted from section lines	39.827498	-104.482238	Domestic			DENVER	
9003398	31616-	E	3355	N	541083.7	4413915.2	User supplied	39.874295	-104.519586	Domestic			ALL UNNAMED AQUIFERS	
0484301	237667-	W	660	S	543826	4411875.7	Spotted from section lines	39.855787	-104.48766	Domestic	Stock		UPPER ARAPAHOE	
0400114	196054-	E	1800	S	543295.6	4409013.4	Spotted from section lines	39.830019	-104.494045	Domestic	Stock		UPPER ARAPAHOE	
0437790	214327-	E	2500	S	545102	4409227.7	Spotted from section lines	39.831862	-104.472926	Domestic	Stock		DENVER	
3696015	228711--A	W	1274	N	541518	4411312	User supplied	39.850821	-104.514677	Domestic			DENVER	
3645165	283010-	E	212	N	540220.7	4413265.8	Spotted from section lines	39.868489	-104.529718	Domestic			DENVER	
3628617	277394-	W	300	S	544453.4	4411773	Spotted from section lines	39.854826	-104.480337	Domestic			UPPER ARAPAHOE	
0499986	245003-	E	600	N	544813.5	4411502.7	Spotted from section lines	39.852374	-104.476136	Domestic			UPPER ARAPAHOE	
0478632	234658-	W	3638	S	543855.4	4409573	User supplied	39.835036	-104.487475	Domestic	Stock		DENVER	
3617192	273799-	W	1649	N	540591.4	4412819.6	Spotted from section lines	39.864453	-104.525419	Commercial	Domestic		UPPER ARAPAHOE	
3607305	270132-	W	1950	S	544373.9	4413889.3	Spotted from section lines	39.873895	-104.481117	Domestic	Stock		UPPER ARAPAHOE	
0477228E	234083-	W	275	N	544278.3	4409973.4	Spotted from section lines	39.838618	-104.482505	Domestic	Stock		ARAPAHOE	
3679805	306045-	E	197	N	544934	4410010	User supplied	39.838917	-104.474836	Domestic	Stock		ARAPAHOE	
0531882	260607-	W	330	N	540589.4	4413221.8	Spotted from section lines	39.868075	-104.525418	Domestic			UPPER ARAPAHOE	
0454132	222906-	W	1895	N	540514.4	4411144.4	Spotted from section lines	39.849356	-104.526423	Domestic			DENVER	
9004353	70774-	E	2200	N	543605.8	4409377.3	Spotted from section lines	39.833283	-104.490398	Domestic			ALL UNNAMED AQUIFERS	
0464604	228203-	E	1400	S	543132.5	4413716.1	Spotted from section lines	39.8724	-104.49564	Domestic			DENVER	
0302693	155417-	E	203	N	543227	4411615.5	Spotted from section lines	39.853466	-104.49468	Industrial			DENVER	
0446037B	218746-	W	2425	S	542757.1	4409204.9	Spotted from section lines	39.831776	-104.500331	Domestic	Stock		DENVER	
0464631	228204-	E	1129	S	543156	4413633.5	Spotted from section lines	39.871651	-104.495377	Domestic			DENVER	
0482640	236722-	E	440	S	545187.7	4411824	Spotted from section lines	39.855247	-104.471742	Domestic	Stock		UPPER ARAPAHOE	
0465979	228708-	W	600	S	542855.4	4413472.4	Spotted from section lines	39.870216	-104.498907	Domestic			DENVER	
3622046C	275602-	E	2639	S	543236	4410860.8	Spotted from section lines	39.846672	-104.494624	Monitoring/Sampling			DENVER	
0457399	224850-	E	1135	N	541363.9	4412959.7	Spotted from section lines	39.865677	-104.516373	Domestic			DENVER	
3650615C	285923-	W	2345	N	539628.6	4409411.2	Spotted from section lines	39.833784	-104.536873	Monitoring/Sampling			ALL UNNAMED AQUIFERS	
3670850	299336-	E	3841	S	542058	4408033	GPS	39.821252	-104.508575	Domestic	Stock		UPPER ARAPAHOE	
0474667	232797-	E	2210	N	543561	4412615.5	Spotted from section lines	39.862458	-104.490709	Domestic			UPPER ARAPAHOE	
10024744	87554-F	E	123	N	544990	4413263	User supplied	39.868222	-104.473958	Augmentation	Commercial,		LOWER ARAPAHOE	
0477228B	234077-	W	1660	N	543772	4412783.7	Spotted from section lines	39.86397	-104.488231	Domestic	Stock		UPPER ARAPAHOE	
0041688	41688-MH				545897.3	4409480.7	Spotted from quarters	39.834096	-104.463614	Monitoring/Sampling			QUATERNARY ALLUVIUM	
0441952	217103-	E	1114	S	543051.3	4408804.8	Spotted from section lines	39.828157	-104.496922	Domestic			DENVER	
0465987	228710-	E	1200	N	541339.3	4411338.5	Spotted from section lines	39.851073	-104.516768	Domestic			UPPER ARAPAHOE	
0467553	229741-	W	1275	S	542800.1	4413678.2	Spotted from section lines	39.872074	-104.499536	Domestic	Stock		UPPER ARAPAHOE	
0493217	241846-	E	2557	S	541532.1	4412479.7	Spotted from section lines	39.861344	-104.514439	Domestic	Stock		DENVER	
0482637	236728-	E	3626	N	543559.1	4412184	User supplied	39.858575	-104.490761	Domestic	Stock		UPPER ARAPAHOE	
0484296	237841-	E	440	S	544592.2	4411817.3	Spotted from section lines	39.855215	-104.47871	Domestic	Stock		UPPER ARAPAHOE	
0446351	219321-	W	1600	S	543734.7	4408951.7	Spotted from section lines	39.829447	-104.488919	Domestic			DENVER	
0480021	235384-	E	200	S	543081.7	4411739.7	Spotted from section lines	39.854599	-104.496367	Domestic			UPPER ARAPAHOE	
0520490	255285-	E	200	N	544556	4413235.6	Spotted from section lines	39.868002	-104.479034	Domestic			UPPER ARAPAHOE	
0307121F	36893-M	W	60	N	542396	4411666.9	Spotted from section lines	39.853976	-104.504391	Monitoring/Sampling			DENVER	
0463091	227546-	E	700	N	543615.5	4411460.3	Spotted from section lines	39.852049	-104.490155	Monitoring/Sampling			DENVER	
0456973	224487-	W	150	N	541206.8	4411661.5	Spotted from section lines	39.853981	-104.51829	Domestic			DENVER	

Receipt	Permit	PermitArea	PermitUnits	AnnAppropriation	PermIssued	PermExpires	WellConstructed	FirstBeneficial	PumpInstalled	WellPlugged	Comment
3643365	68842-F	36.20000076	ACRES		2009-12-11		2010-03-04		2010-04-01		GEOPHYSICAL LOG WAIVER DENIED 2/16/10 DAM
3654511A	287827-				2012-04-02		2012-02-01				
10033507	88870-F			1.5	2024-02-05		2024-05-15		2024-05-25		
3671415	299972-				2016-01-26		2016-04-14		2016-04-14		
0089860	96618-				1978-02-21		1978-05-21				
10011036	321758-	1000	SQ FT	3	2021-05-11		2022-08-12		2022-08-16		
0506921G	251803-	1	ACRES		2003-07-18		2003-11-03		2003-11-05		
0532240A	260706-	1	ACRES		2004-12-06		2005-02-14		2005-04-28		
0041689	41689-MH				2003-01-09		2003-01-18				
0416237	203675-		ACRES		1997-06-24		1997-09-30		1997-10-03		
0450948A	53018-F	38	ACRES		1999-12-15		2000-11-29		2001-02-26		
0477228H	234080-	1	ACRES		2001-06-15		2003-12-15		2004-01-07		
3682759	307028-			0.33000001	2017-09-28		2018-09-08		2018-09-09		
0514675	252698-	1	ACRES		2003-09-02		2003-12-31		2004-01-09		
3678726	305204-				2017-04-20		2017-11-06		2017-11-07		DEED - NO DENVER IN LOST CREEK
0499996	245007-	1	ACRES		2002-10-17		2004-10-16		2005-05-10		
0482638	236720-	1	ACRES		2001-10-09		2003-05-14		2003-05-16		
0307121G	36894-M		ACRES		1990-05-22			1990-06-01			
3674160	300988-				2016-05-05		2016-08-07		2015-12-08		
3622046A	275567-				2007-10-10		2007-09-06				
3655694	288760-	1	ACRES		2012-07-03		2012-08-03		2013-08-31		43110 E 96TH
0484298	237842-	1	ACRES		2001-11-21		2003-05-19		2003-05-22		
0477389	234443-	1	ACRES		2001-07-13		2002-02-04		2002-05-14		
3686537	309959-	1	ACRES		2018-06-28		2019-02-15		2019-02-19		
10011814	322347-				2021-06-16		2021-03-31				
0499987	245004-	1	ACRES		2002-10-17		2004-03-15		2004-03-17		
3680636	306322-	1	ACRES	3	2017-08-01		2018-04-11		2018-04-13		
0517984	254256-	1	ACRES		2003-11-28		2004-06-29		2005-09-09		
0413820	202686-		ACRES		1997-05-14		1997-07-25		1997-08-13		
0518849	254567-	1	ACRES		2003-12-31		2004-07-08		2004-07-09		
0516345	253481-	1	ACRES		2003-10-15		2004-02-23		2004-03-29		
3653504	287332-				2012-01-09		2011-11-01				
3641349	68561-F	164.5	ACRES		2009-08-19		2009-11-23		2009-11-26		REAPPLICATION
0041722	41722-MH				2003-01-22		2003-01-24				1 HOLE
0506921E	251792-	1	ACRES		2003-07-17		2003-12-19		2003-12-22		
3654511D	287830-				2012-04-02		2012-01-31				
0444320	217870-	1	ACRES		1999-05-27		1999-09-20		1999-11-01		7925 SHUMAKER RD
10022058	327732-	1000	SQ FT	0.40000001	2022-07-19		2022-09-16		2022-10-12		
0440934	215743-		ACRES		1999-02-16		1999-03-26		1999-04-17		
0463744	227874-	1	ACRES		2000-08-15		2001-03-02		2024-05-22		
0543382	265468-	1	ACRES		2005-09-09		2005-09-14		2005-09-20		
3696787B	84318-F			10.19999981	2020-05-20		2020-11-01		2021-12-11		
0443902	217349-		ACRES		1999-05-07		1999-06-28		1999-07-13		NO PUMP TEST
3619356	274574-	1	ACRES		2007-07-27		2007-07-31		2007-08-02		
10011815	322348-				2021-06-16		2021-03-26				
3650615D	285924-				2011-06-14		2011-05-27				
0507056P	249310-				2003-04-11		2003-01-18				
0415841	203673-		ACRES		1997-06-24		1997-10-02		1997-10-06		
0499983	245001-	1	ACRES		2002-10-17		2005-10-14		2005-10-17		43600 E 88TH AVE
3680636	306322-	1	ACRES	3	2017-08-01		2018-04-11		2018-04-13		
10024744	87554-F			6.1500001	2022-10-13		2023-07-28		2023-08-17		
0216382	120758-				1981-07-07		1981-11-07		1981-11-07		
10016358	215418--A			5	2021-10-25		2022-06-02		2022-07-06		
0474667	232797-	1	ACRES		2001-04-17		2002-12-02		2002-12-03		
0499988	245005-	1	ACRES		2002-10-17		2003-10-23		2003-10-27		
0516345	253481-	1	ACRES		2003-10-15		2004-02-23		2004-03-29		
0240113	134042-				1983-12-28		1984-01-26				
0421078	206284-		ACRES		1997-10-29		1998-01-27		1998-01-29		
0041723	41723-MH				2003-01-22		2003-01-23				1 HOLE SEE 41653-MH
0450969	221435-	1	ACRES		1999-10-21		2000-06-10		2000-06-13		

Receipt	Permit	PermitArea	PermitUnits	AnnAppropriation	PermIssued	PermExpires	WellConstructed	FirstBeneficial	PumpInstalled	WellPlugged	Comment
0478166	234635-	1	ACRES		2001-07-13		2003-05-02		2003-05-05		
0506921E	251792-	1	ACRES		2003-07-17		2003-12-19		2003-12-22		
3654511E	287831-				2012-04-02		2012-01-31				
3680466	306076-			3	2017-07-12		2018-02-16		2018-02-16		
0460185	226063-						2000-08-14		2000-08-30		
0326183	41002-F		ACRES		1992-03-11		1992-05-14	1992-05-15	1992-05-15		SEE HEARING: 91-GW-06
0440934	215743-		ACRES		1999-02-16		1999-03-26		1999-04-17		
0441952	217103-		ACRES		1999-04-22		1999-07-22		1999-07-23		
0456866A	224462-	1	ACRES		2000-03-23		2000-09-04		2000-09-10		
0465988	228711-	1	ACRES		2000-09-14		2001-11-14		2002-05-23		
9003346	31096-						1920-12-31	1920-12-31			WINDMILL, FIRST USED BEFORE 1920.
10010423	321435-	1	ACRES	0.40000001	2021-04-21		2022-08-28		2022-08-30		
0448990	220628-	1	ACRES		1999-09-21		2000-05-04		2000-08-04		
0463092	227547-				2000-07-31		2000-01-26				
0307121B	36889-M		ACRES		1990-05-22			1990-06-01			
0499985	245002-	1	ACRES		2002-10-17		2003-04-14		2003-04-15		
3654511B	287828-				2012-04-02		2012-02-01				
3650615A	285921-				2011-06-14		2011-05-25				
10033134	332810-	1000	SQ FT	1	2023-12-22		2001-09-24		2001-12-28		
0089860	96618-				1978-02-21		1978-05-21				
0446037B	218746-	1	ACRES		1999-07-02		1999-08-18				
3641887	232988--A	1	ACRES		2009-07-28		2009-11-11		2009-11-17		
0507056S	249349-				2003-04-15		2003-01-20				
3680499	306077-	1	ACRES	1	2017-07-13		2017-08-25				
3647013	283833-				2010-08-24		2010-07-26				
0529095	258953-	1	ACRES		2004-08-31		2005-03-07		2005-03-17		
0462756	227402-	1	ACRES		2000-07-20		2000-10-23		2000-10-24		
9000561	3839-				1959-07-08		1959-07-22	1959-07-22			
3678726	305204-				2017-04-20		2017-11-06		2017-11-07		DEED - NO DENVER IN LOST CREEK
0537279	262828-	1	ACRES		2005-04-14		2005-11-07		2005-11-23		
3622046B	275568-				2007-10-10		2007-09-05				
0458465	225341-	1	ACRES		2000-04-28		2000-10-05		2000-10-08		
0470988	231364-	1	ACRES		2001-02-05		2001-05-25		2001-05-29		WELL LOCATION = 41470 E 98TH AVE., BENNETT.
3650615B	285922-				2011-06-14		2011-05-26				
0507056N	249309-				2003-04-11		2003-01-24				
0021292P	177775-		ACRES		1994-05-05		1992-10-07				
0477389	234443-	1	ACRES		2001-07-13		2002-02-04		2002-05-14		
0446037B	218746-	1	ACRES		1999-07-02		1999-08-18				
0443794	217884-		ACRES		1999-05-27		1999-12-06		1999-12-07		
0052537	52537-MH				2014-05-22		2014-07-14				6 HOLES. SIX WCR RECEIVED.
3609874	271330-	1	ACRES		2006-10-25		2007-05-02		2007-05-10		8441 FLINT RIDGE ST
0506921E	251792-	1	ACRES		2003-07-17		2003-12-19		2003-12-22		
0477228A	234079-	1	ACRES		2001-06-15		2004-02-13		2004-03-04		
3654511C	287829-				2012-04-02		2012-01-30				
0535022	261833-	1	ACRES		2005-02-17		2006-01-06		2006-01-09		
0507056T	249351-				2003-04-15		2003-01-23				SEE 41653-MH
0470087	230998-	1	ACRES		2001-01-09		2001-01-26		2001-02-01		
0464876	228261-	1	ACRES		2000-08-28		2002-08-08		2002-08-09		
3696787B	84318-F			10.19999981	2020-05-20		2020-11-01		2021-12-11		
0451771	221883-	1	ACRES		1999-11-12		2000-05-10				
0465986	228709-	1	ACRES		2000-09-14		2000-10-27		2000-10-28		
0440934	215743-		ACRES		1999-02-16		1999-03-26		1999-04-17		
0527803	258468-	1	ACRES		2004-07-30		2004-05-20				
3677708	304167-				2017-01-12	2019-01-02	2019-09-01		2019-09-04		
0463090	227545-				2000-07-31		2000-01-26				
3679061B	237840--A	1	ACRES		2017-04-18		2018-01-05		2018-01-06		PO BOX 15, BENNETT CO 80102
0307121E	36892-M		ACRES		1990-05-22			1990-06-01			
3662758	293168-	1400	SQ FT		2014-01-06		2014-05-02				
3606196	269768-	1	ACRES		2006-07-17		2007-03-07		2007-03-09		
3607305	270132-	1	ACRES		2006-08-09		2006-11-03		2006-12-01		43201 E 96TH AVE, BENNETT, 80102
0499983	245001-	1	ACRES		2002-10-17		2005-10-14		2005-10-17		43600 E 88TH AVE
10033507	88870-F			1.5	2024-02-05		2024-05-15		2024-05-25		
0507056K	249306-				2003-04-11		2003-02-09				
0445406	218206-	1	ACRES		1999-06-08		1999-09-14		1999-09-17		WELL LOCATED AT 8700 N. MANILLA RD.

Receipt	Permit	PermitArea	PermitUnits	AnnAppropriation	PermIssued	PermExpires	WellConstructed	FirstBeneficial	PumpInstalled	WellPlugged	Comment
0089859	96619-				1978-02-21		1978-05-25				
10011036	321758-	1000	SQ FT	3	2021-05-11		2022-08-12		2022-08-16		
3683175	307575-	1000	SQ FT	0.40000001	2017-11-14		2018-08-13		2018-08-15		
0477228D	234084-	1	ACRES		2001-06-15		2004-09-15				
0532240B	260707-	1	ACRES		2004-12-06		2005-08-18		2005-08-20		
0506921F	251802-	1	ACRES		2003-07-18		2003-11-05		2003-12-01		
10016706	324838-	2000	SQ FT	0.80000001	2021-12-15		2022-06-19		2022-06-26		
0031030	97234-VE		ACRES		1997-06-27		1997-06-30		1997-07-02		
10006658	319464-	1000	SQ FT	0.40000001	2020-11-10		2021-08-11		2021-08-13		
0460506	226234-	1	SQ FT		2000-06-08		2001-03-15		2001-03-16		
0486025	238669-	1	ACRES		2002-01-17		2002-12-12				
3607968	270565-	1	ACRES		2006-09-06		2006-10-24		2006-11-01		43303 E 96TH AVE,BENNETT,80102
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0487327A	238882-	1	ACRES		2002-02-08		2002-05-09		2002-07-09		
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0041688	41688-MH				2003-01-09		2003-01-20				
0441952	217103-		ACRES		1999-04-22		1999-07-22		1999-07-23		
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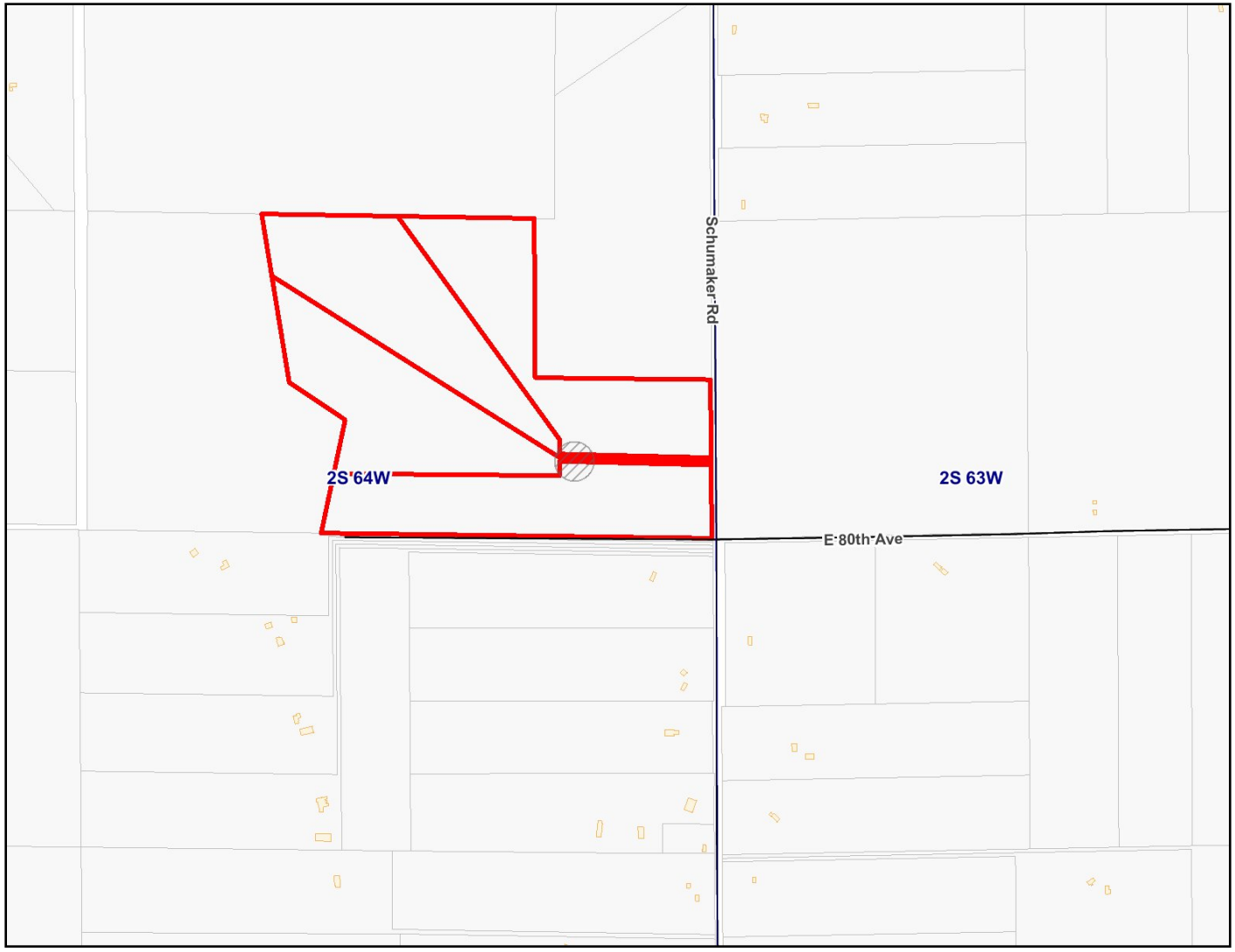
Receipt	Permit	Elev	WellDepth	TopPerfCasing	BotPerfCasing	Yield	StaticWL	ApplicantName	CompleteWell	OGCC_API	OGJobBatch	DispUTMX	DispUTMY
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3654511A	287827-		110	90	110			KERR MCGEE GATHERING LLC	1			539698.8	4409421.6
10033507	88870-F		560	480	560	11	180	RAMIREZ, MARIA	1			540351	4410593
3671415	299972-		540			12	145	ZUNIGA RAMIRO RIVAS	1			540419	4411565
0089860	96618-		315	215	315		92	SPIES, NATHAN	1			544683.4	4413498.8
10011036	321758-		580	480	580	9	180	SOTO, JOSA O.	1			539768	4410856
0506921G	251803-	5280	380	310	380	15	90	CHU, AN K.	1			542668.3	4413054.3
0532240A	260706-	5330	635	420	635	10	240	DELFIN, SERGIO	1			540596.3	4411842.3
0041689	41689-MH		29	18	28		25	US GEOLOGICAL SURVEY	1			543902.2	4408252.9
0416237	203675-		307	200	307	10	100	GOODER, HAWLEY K	1			543804.3	4409195.7
0450948A	53018-F		500	380	500	15	115	MATTISON, ANDREW L	1			541351.4	4413168.8
0477228H	234080-	5250	440	300	440	10	120	BARTSCH JOACHIM & VERONICA D MARSHALL	1			543880.6	4413229.6
3682759	307028-		580			13	135	CMH HOMES INC	1			540520	4408783
0514675	252698-		390	260	390	15	80	PADILLA JOSE JESSE	1			543940.9	4413412.8
3678726	305204-		480			12	280	BITZ, AUSTIN	1			544880	4410010
0499996	245007-	5295	420	340	420	11	95	CAVENDER, NORLIN	1			543874.8	4411361.7
0482638	236720-		380	320	380	10	185	TRUONG, CUONG	1			544775	4411819.3
0307121G	36894-M							SPANO, PHIL	1			542417.8	4411380.2
3674160	300988-		460	300	460	15	90	GUTIERREZ, BLAZ	1			545056	4413438
3622046A	275567-		29	14	29		18	FIVE PART DEVELOPMENT LLC	1			542842.2	4410077.1
3655694	288760-		485	400	480	15	100	CASILLAS, NICANOR	1			544770	4413192
0484298	237842-	5270	410	320	380	10	185	CAVENDER, NORLIN	1			544255.2	4411735.7
0477389	234443-	255	255	155	255	12	100	PHILLIPS, CYNTHIA M.	1			544983.3	4413269.8
3686537	309959-		580			13	190	BREDVOLD, JEFFREY	1			540525	4408659
10011814	322347-	5315	65				55	FIVE PART DEVELOPMENT - EAST REGIONAL LANDFILL	1			543687	4410437
0499987	245004-	5280	400	320	400	10	120	CAVENDER, NORLIN	1			544615.8	4411500.2
3680636	306322-		520			12	176	SALAZAR, URIEL E.	1			539780	4411348
0517984	254256-	5320	370	300	370	10	140	QUINTANA, EZEQUIEL	1			540271.9	4412106.8
0413820	202686-		280	140	280	10	80	BARLOW, SHANE	1			543908	4409952.5
0518849	254567-	5325	360	260	340	10	140	SHOCKMAN, DANIEL	1			540271.3	4412887.8
0516345	253481-		435	325	435	15	125	LALLAS, ALEXANDER F.	1			542669.9	4411880.8
3653504	287332-		28	12	27		16	FIVE PART DEVELOPMENT	1			543287.9	4410427
3641349	68561-F		1380	1220	1380	40	240	FIVE PART DEVELOPMENT LLC	1			543542.4	4410445.7
0041722	41722-MH		43	33	43		30	US GEOLOGICAL SURVEY	1			541904.8	4408670.3
0506921E	251792-	5275	440	320	440	10	120	TOQUINTO RASCON, PABLO I.	1			542669.2	4412316.3
3654511D	287830-		110	90	110			KERR MCGEE GATHERING LLC	1			539608.9	4409399.5
0444320	217870-		300	110	300	9	85	PHILLIPPI INVESTMENT CO LLC	1			542661.2	4409532.4
10022058	327732-		600	520	600	10	185	MENDOZA, JUAN	1			540649	4409349
0440934	215743-		410	220	410		140	DE LA TORRE, CESAR V.	1			542792.6	4408807.1
0463744	227874-		395	255	395	12.30000019	130	GRAVES ANTOINETTE K TRUSTEE OF THE	1			542665	4409321.2
0543382	265468-		400	180	400	9	120	IBOA, OTONIEL	1			540572.3	4408197.8
3696787B	84318-F		620			10	240	CARRASCO, FRANCISCO	1			540630	4409658
0443902	217349-		530	270	530		155	PHILLIPS, EDWARD M	1			542495.8	4409992.1
3619356	274574-		400	140	400	10	140	HAGAN JON & MERCELINE	1			541111.3	4407534.2
10011815	322348-	5328	75				67	FIVE PART DEVELOPMENT - EAST REGIONAL LANDFILL	1			543688	4410232
3650615D	285924-		110	90	110			ANADARKO PETROLEUM CORPORATION	1			539615.1	4409442
0507056P	249310-		29	19	29		25	US GEOLOGICAL SURVEY	1			543945.8	4408141.2
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0499983	245001-	5280	385	330	385	10	145	CHRISTOPHER JR, GLENN D.	1			545009.2	4411383
3680636	306322-		520			12	176	SALAZAR, URIEL	1			539780	4411348
10024744	87554-F		810	610	810	15	3	HOFFMAN-PHILLIPS, CYNTHIA M.	1			544990	4413263
0216382	120758-		366	306	366	12	160	FRICK, M	1			539641.8	4409540.4
10016358	215418--A		680	480	680	15	150	CHAVEZ, DAVID	1			542856	4408593
0474667	232797-	5280	360	310	360	9	170	GARZA, MICHAEL	1			543561	4412615.5
0499988	245005-	5300	440	350	440	10	115	CAVENDER, NORLIN	1			543876.3	4410981.8
0516345	253481-		435	325	435	15	125	LALLAS, ARYN J.	1			542669.9	4411880.8
0240113	134042-		60	160	360		120	CRONK, G	1			544321.6	4407050.5
0421078	206284-		327	210	327	11	95	SAYLER, RICKS	1			543636.7	4409174.3
0041723	41723-MH		94	83	93		84	US GEOLOGICAL SURVEY	1			541089.7	4413114.2
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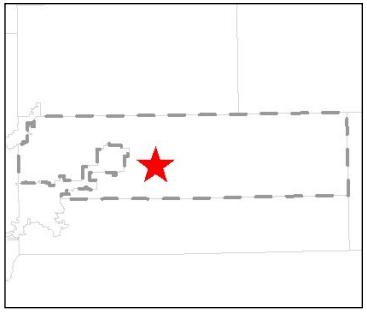
Receipt	Permit	Elev	WellDepth	TopPerfCasing	BotPerfCasing	Yield	StaticWL	ApplicantName	CompleteWell	OGCC_API	OGJobBatch	DispUTMX	DispUTMY
0478166	234635-		400	280	400	10	105	WRIGHT, MARGARET R	1			543423	4409350.8
0506921E	251792-	5275	440	320	440	10	120	TOQUINTO RASCON, PABLO I.	1			542669.2	4412316.3
3654511E	287831-		110	90	110			KERR MCGEE GATHERING LLC	1			539608.7	4409440.7
3680466	306076-		540			13	80	REICH, FRED	1			544650	4409867
0460185	226063-	5260	280	240	280	10	120	BARLOW, SHANE	1			543597	4413398.8
0326183	41002-F	5310	580	420	580	50	150	SPANO, PHIL	1			542860.5	4411574.1
0440934	215743-		410	220	410		140	DE LA TORRE, YOBANK V.	1			542792.6	4408807.1
0441952	217103-		410	200	410	12	150	MENDEZ RAMIREZ, EMILY I.	1			543051.3	4408804.8
0456866A	224462-	5290	300	240	300	10	100	FRONT RANGE DEVELOPMENT CORP	1			541346	4412675
0465988	228711-	5325	250	130	250	13	120	STEVE APPLEHANS & MARYBETH	1			541584	4411272.3
9003346	31096-		60					BULLARD, HERBERT B	1			541898.5	4411492.1
10010423	321435-		600	520	600	10	290	ALDANA, LLARICXE J.	1			541937	4407780
0448990	220628-	5340	395	160	395	15	88	SWEED, JAMES R	1			543593.3	4409530
0463092	227547-		64					CSI, LANDFILL	1			543455.7	4411370.4
0307121B	36889-M							SPANO, PHIL	1			543276.6	4411646.4
0499985	245002-		460	340	460	9	130	ROSK, PAMELA	1			543783.3	4411399.7
3654511B	287828-		110	90	110			KERR MCGEE GATHERING LLC	1			539695.7	4409377.4
3650615A	285921-		110	90	110			ANADARKO PETROLEUM CORPORATION	1			539613.5	4409382.9
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0089860	96618-		315	215	315		92	SPIES, SUZANNE	1			544683.4	4413498.8
0446037B	218746-	5320	405	279	405		180	RAMOS, EUGENIO	1			542757.1	4409204.9
3641887	232988--A		400	340	400	11	125	RITO, LUNA	1			543423	4411720
0507056S	249349-		85	73	83		84	US GEOLOGICAL SURVEY	1			546098.8	4409282.2
3680499	306077-		558				225	KALCEVIC LAND COMPANY (KALCEVIC, JOSEPH H.)	1			540370	4412428
3647013	283833-		60	40	60		37	FIVE PART DEVELOPMENT	1			543231.4	4410467.9
0529095	258953-	5320	550	430	550	15	180	JONES, BARBARA	1			541053.4	4411863
0462756	227402-		320	220	320	10	130	EARLEY, MICHAEL	1			541502.5	4411777
9000561	3839-		208	65	190		50	DAVIS, CHET	1			545099.7	4409873.9
3678726	305204-		480			12	280	BITZ, KRISTEN	1			544880	4410010
0537279	262828-	5370	400	280	400	10	185	CICHOS, REBECCA M	1			541524.7	4408352.2
3622046B	275568-		49	24	49		29	FIVE PART DEVELOPMENT LLC	1			542856.5	4410870.1
0458465	225341-	5340	360	300	360	9	140	RAMIREZ OLLIE & KAREN	1			540514.9	4411356.3
0470988	231364-	5260	225	120	225	15	80	HUNTER TERRY & TERESA & LANDREY	1			542800.7	4413609.6
3650615B	285922-		110	90	110			ANADARKO PETROLEUM CORPORATION	1			539582.9	4409406.6
0507056N	249309-		44	33	43		30	US GEOLOGICAL SURVEY	1			541784.5	4408531.9
0021292P	177775-		73	63	73		64	FIVE PART DEVELOPMENT CO	1			543674.2	4410702
0477389	234443-	255	255	155	255	12	100	PHILLIPS, JOSEPH A.	1			544983.3	4413269.8
0446037B	218746-	5320	405	279	405		180	GUTIERREZ DE RAMOS, MARIA M.	1			542757.1	4409204.9
0443794	217884-		595	515	595	10	105	CASAREZ, NOEMI	1			543620.5	4409651.3
0052537	52537-MH	5394	109	74	109		99	ANADARKO	1			539667.9	4409426.6
3609874	271330-	5365	540	200	540	9	140	YE, CHENG XIONG	1			539866.7	4411036.1
0506921E	251792-	5275	440	320	440	10	120	TOQUINTO BANDERS, PABLO I.	1			542669.2	4412316.3
0477228A	234079-	5250	400	320	380	10	96	LUNA SIGIFREDO & ALICE	1			544215.9	4413232.6
3654511C	287829-		110	90	110			KERR MCGEE GATHERING LLC	1			539645.6	4409354.3
0535022	261833-	5315	520	400	520	10	240	ANDREWS LUCAS C & SHANTEL HOBSON	1			540561.9	4412629.1
0507056T	249351-		94	83	93		85	US GEOLOGICAL SURVEY	1			541271.8	4413304.6
0470087	230998-	5260	280	160	280	15	95	MADERA, CARLOS M	1			542791.6	4413777.2
0464876	228261-	5250	280	220	280	20	140	SNELLING ERIC & CLAUDINE	1			543504.3	4413737.2
3696787B	84318-F		620			10	240	HERNANDEZ, CECILIA	1			540630	4409658
0451771	221883-	5320	545	490	545		110	BLANCHARD, MICHAEL	1			543482.9	4409913.5
0465986	228709-	5300	300	200	300	10	131	MANZO, PATRICK A	1			541456.5	4412021.9
0440934	215743-		410	220	410		140	OROZCO, FLAVIO V.	1			542792.6	4408807.1
0527803	258468-	5325	345	140	340		140	SOTO, JAMIE	1			541767.3	4411237.8
3677708	304167-		520			15	180	RODRIQUEZ JULIO CESAR	1			540014	4411468
0463090	227545-	5300	49					CSI, LANDFILL	1			542959.6	4411634.2
3679061B	237840--A		960			12	175	WHISLER, MONTE	1			543524	4412774
0307121E	36892-M							SPANO, PHIL	1			542660.8	4411652.2
3662758	293168-		540	460	540		400	GREGORY PAUL & TAWNY	1			539745	4411615
3606196	269768-	5295	505	340	505	14	115	MADERA, ARTURO	1			543875.5	4411153.2
3607305	270132-	5240	455	240	455	13	90	CARDENAS LOPEZ, RAFAEL	1			544373.9	4413889.3
0499983	245001-	5280	385	330	385	10	145	CHRISTOPHER, KRISTINA L.	1			545009.2	4411383
10033507	88870-F		560	480	560	11	180	CHAVEZ, VICTOR A.	1			540351	4410593
0507056K	249306-		73	62	72		58	US GEOLOGICAL SURVEY	1			539670	4411780.7
0445406	218206-	5335	350	240	350	10	125	SIMMERING MICHAEL GLEN	1			540521.3	4411615.3

Receipt	Permit	Elev	WellDepth	TopPerfCasing	BotPerfCasing	Yield	StaticWL	ApplicantName	CompleteWell	OGCC_API	OGJobBatch	DispUTMX	DispUTMY
0089859	96619-		315	215	315		90	SIMONS, MONTE	1			545085.8	4413502.4
10011036	321758-		580	480	580	9	180	GONZALEZ, MA G.	1			539768	4410856
3683175	307575-		580			12	189	MUNOZ, MICHAEL	1			540544	4409016
0477228D	234084-	5330	565	460	560		140	MIRAMONTES RAUL LOBATOS	1			543757.3	4409864.3
0532240B	260707-	5305	500	400	500	10	240	CHRISTENSEN SCOTT A & MANDI D	1			540590.5	4413016.9
0506921F	251802-	5275	460	320	460	15	155	PILAND, LOWELL	1			542668.8	4412688.5
10016706	324838-		580	480	580	10	223	NAVA, PEDRO	1			541127	4408008
0031030	97234-VE		280	197	277	11	111	SMALL, VERLA	1			545325.2	4411815.4
10006658	319464-		540			12	120	CRONK, JARED A.	1			544936	4407109
0460506	226234-		300	200	300	10	110	PARFREY, SHAWN A	1			541424.7	4413048.3
0486025	238669-	5330	380	265	380		145	CLADIS, JOHN D	1			540065.3	4412590
3607968	270565-	5275	360	260	360	12.5	125	GROVINE, MICHAEL P	1			544492.9	4413654.2
0465989	228712-	5320	300	120	300	11	100	BARRON-SIERRA, CUTBERTO	1			541950.6	4411203.4
0456866B	224463-	5290	280	180	280	10	120	LUCERO, ROBERT	1			541364.8	4412243.4
3682758	307027-		580			13	135	CMH HOMES INC (AULT, BECKY)	1			540555	4409140
0412772	202135-		367	250	367	10	100	ELDER, JOE	1			544787.2	4408572
0487327A	238882-	5255	275	215	275	11	110	MOLER, COREY	1			545196.6	4413271.7
0482639	236721-	5275	490	370	490	10	280	CAVENDER, NORLIN	1			544981.1	4411822
0358916F	177774-		58	43	58		50	FIVE PART DEVELOPMENT CO	1			543662.2	4411636.7
0049835A	285732-		110	95	110			ANADARKO	1			539663.9	4409423.7
0417614B	204229-		280	197	277	11	111	SMALL, VERLA	1			545328.9	4411811.8
0448770	220478-		390	320	390	9	140	BULINSKI, CINDY L	1			544308.1	4408739.1
9003398	31616-							MUNDELL, CATHERINE M	1			541083.7	4413915.2
0484301	237667-	5280	420	320	420	9	110	BROWN MICHAEL L & BARBARA A	1			543826	4411875.7
0400114	196054-		650	488	650	15	240	SAYLER TIMOTHY MICHAEL	1			543295.6	4409013.4
0437790	214327-		390	280	390	12	90	MILLER, JASON A	1			545102	4409227.7
3696015	228711--A		400				160	APPLEHANS, STEVE	1			541518	4411312
3645165	283010-		355	160	355	7	140	RINKER CLINT & DARLENE	1			540220.7	4413265.8
3628617	277394-	5270	360	300	360	10	160	BEAM, DOUGLAS E	1			544453.4	4411773
0499986	245003-	5280	380	325	380	9	85	COWLISHAW JESSICA M & MARK A	1			544813.5	4411502.7
0478632	234658-		380	300	380	10	110	ODELL TABOT L & ANITA E	1			543855.4	4409573
3617192	273799-	5310	465	405	465	15	150	PFLUGER, DANA R	1			540591.4	4412819.6
3607305	270132-	5240	455	240	455	13	90	BURCIAGA, ARON	1			544373.9	4413889.3
0477228E	234083-	5310	520	420	500	10	80	EASTLAND CAMERON & KATHRYN	1			544278.3	4409973.4
3679805	306045-		480			12	80	RUIS J ISABEL	1			544934	4410010
0531882	260607-	5300	600	380	600		160	RHATIGAN SHAWN & JANET	1			540589.4	4413221.8
0454132	222906-		365	240	360	9	120	PRUETT HERBERT C JR & CAROL A	1			540514.4	4411144.4
9004353	70774-		280	210	280	15	140	WAGNER PHILIP & EADS JACK	1			543605.8	4409377.3
0464604	228203-	5255	240	160	240	10	80	MELTON, BEVERLY J	1			543132.5	4413716.1
0302693	155417-		310	210	310	10	110	CONSERVATION, SERVICES	1			543227	4411615.5
0446037B	218746-	5320	405	279	405		180	GUTIERREZ, ELVIN W.	1			542757.1	4409204.9
0464631	228204-	5255	240	160	240	10	80	GILL GARY & DORINDA	1			543156	4413633.5
0482640	236722-	5270	494	374	474	15	200	MIRACLE RUSSEL & JOANNE	1			545187.7	4411824
0465979	228708-	5265	301	221	301	7	100	ERICKSON PAMELA J & CHARLES C	1			542855.4	4413472.4
3622046C	275602-		69	44	69		52	FIVE PART DEVELOPMENT LLC	1			543236	4410860.8
0457399	224850-	5295	280	180	280	10	110	HENSON, TAMMY	1			541363.9	4412959.7
3650615C	285923-		110	90	110			ANADARKO PETROLEUM CORPORATION	1			539628.6	4409411.2
3670850	299336-		560			12	280	OTT, LAWRENCE P	1			542058	4408033
0474667	232797-	5280	360	310	360	9	170	GARZA, KRISTINA	1			543561	4412615.5
10024744	87554-F		810	610	810	15	3	PHILLIPS, JOSEPH A.	1			544990	4413263
0477228B	234077-	5270	390	310	390	15	160	PILAND, VIRGIL	1			543772	4412783.7
0041688	41688-MH		83	73	83		73	US GEOLOGICAL SURVEY	1			545897.3	4409480.7
0441952	217103-		410	200	410	12	150	MENDEZ RAMIREZ, EMILY I.	1			543051.3	4408804.8
0465987	228710-	5315	380	110	380	15	95	FRONT RANGE DEVELOPMENT CORP	1			541339.3	4411338.5
0467553	229741-	5265	400	280	400	10	60	HOLLINSHEAD JOHN & DEBRA	1			542800.1	4413678.2
0493217	241846-	5280	300	200	300	10	102	MARTINEZ, GILDARDO E	1			541532.1	4412479.7
0482637	236728-		420	320	420	9	110	CAVENDER, NORLIN	1			543559.1	4412184
0484296	237841-	5270	380	310	380	9	90	CAVENDER, NORLIN	1			544592.2	4411817.3
0446351	219321-	5355	420	220	420	10	110	HERNANDEZ MARISOL & J ROSARIO PEREZ	1			543734.7	4408951.7
0480021	235384-	5300	505	375	505	15	115	BROWN LESLIE ANN	1			543081.7	4411739.7
0520490	255285-	5255	400	300	400	10	140	TALAVERA, EVARISTO	1			544556	4413235.6
0307121F	36893-M							SPANO, PHIL	1			542396	4411666.9
0463091	227546-		76					CSI, LANDFILL	1			543615.5	4411460.3
0456973	224487-		360	190	360	9	130	NBQ, CONSTRUCTION	1			541206.8	4411661.5

Appendix G
Adjacent Land Ownership

ERL Property





Legend

- County Boundary
- Adjacent Counties
- Township
- Streets
- Hwy outline
- Road outline
- US, State Hwys
- Tollways
- Streets/Roads
- Residential Buildings
- Parcels

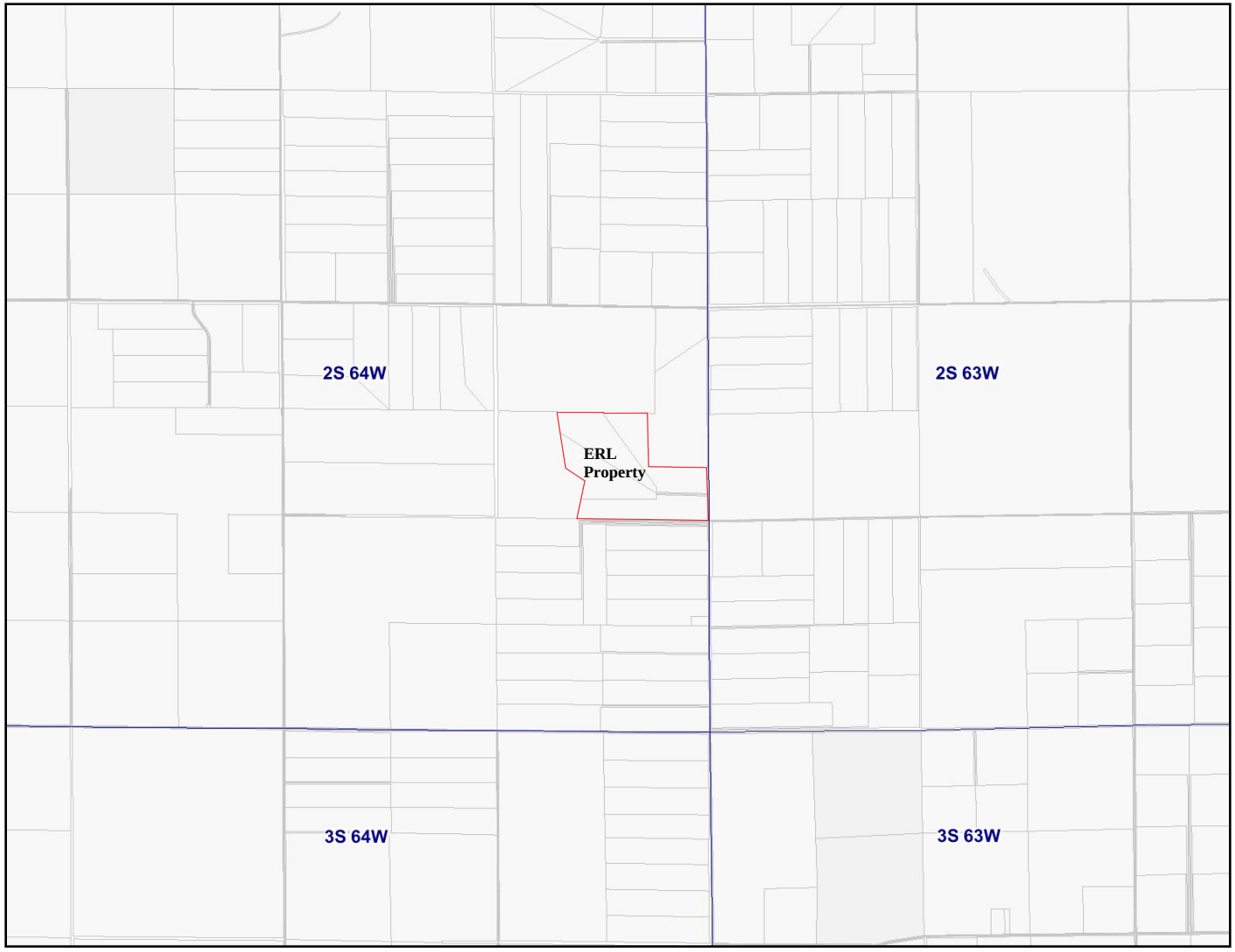
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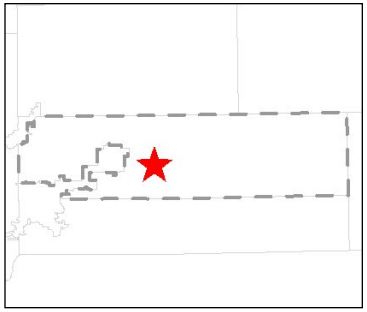
Scale: 1:16,751

Map center: 3283040, 1732759

This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Land Ownership Near ERL





Legend

- County Boundary
- Adjacent Counties
- Township
- Streets
- US/State Hwys
- Tollways
- Streets/Roads
- Parcels

0 5000 10000 15000 ft.

Scale: 1:50,000

Map center: 3281596, 1733361

This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

GCX_OID	Parcel Number	Subdivision	Parcel Address1:	Owner	Ownername1	Ownername2	Owner Address:	Owner City, State, Zip:
0	0172700000090			WARNER LILLIAN M	WARNER LILLIAN M		50700 E 38TH AVE	BENNETT CO 80102-8913
1	0172700000147			PUBLIC SERVICE COMPANY OF COLORADO	PUBLIC SERVICE COMPANY	OF COLORADO	PO BOX 1979	DENVER CO 80201-1979
2	0172700000157			CONSERVATION SERVICES INC C/O WASTE MANAGEMENT	CONSERVATION SERVICES INC	C/O WASTE MANAGEMENT	PO BOX 1450	CHICAGO IL 60690-1450
3	0172700000158			CONSERVATION SERVICES INC C/O WASTE MANAGEMENT	CONSERVATION SERVICES INC	C/O WASTE MANAGEMENT	PO BOX 1450	CHICAGO IL 60690-1450
4	0172723100001		40091 E 88TH AVE	HERMOSILLO JOSE OCTAVIO AND TORRES MAYRA LUJAN	HERMOSILLO JOSE OCTAVIO AND	TORRES MAYRA LUJAN	40091 E 88TH AVE	BENNETT CO 80102-9606
5	0172723100003		40081 E 88TH AVE	PARFREY SHAWN A	PARFREY SHAWN A		40081 E 88TH AVE	BENNETT CO 80102-9606
6	0172723100004		40071 E 88TH AVE	HARRY PATRICIA J AND HARRY TOSHA L	HARRY PATRICIA J AND	HARRY TOSHA L	4255 W 82ND AVE	WESTMINSTER CO 80031-4308
7	0172723100005		40061 E 88TH AVE	THYFAULT KATIE AND THYFAULT CORY SCOTT	THYFAULT KATIE AND	THYFAULT CORY SCOTT	40061 E 88TH AVE	BENNETT CO 80102-9606
8	0172723300002		9010 MANILLA RD	DWYER JOHN F	DWYER JOHN F		9010 MANILLA ROAD	BENNETT CO 80102
9	0172723300004		39655 E 88TH AVE	JONES BARBARA A	JONES BARBARA A		39655 E 88TH AVE	BENNETT CO 80102-9641
10	0172723400001		40051 E 88TH AVE	MARTINEZ GILDARDO E	MARTINEZ GILDARDO E		40051 E 88TH AVE	BENNETT CO 80102-9606
11	0172723400002		40041 E 88TH AVE	LUCERO ROBERT D	LUCERO ROBERT D		40041 E 88TH AVE	BENNETT CO 80102-9606
12	0172723400003		40031 E 88TH AVE	MANZO PATRICK	MANZO PATRICK		40031 E 88TH AVE	BENNETT CO 80102-9606
13	0172723400004		40021 E 88TH AVE	EARLEY MICHAEL D AND EARLEY MACHELLE A	EARLEY MICHAEL D AND	EARLEY MACHELLE A	40021 E 88TH AVE	BENNETT CO 80102-9606
14	0172724100004		9251 SCHUMAKER RD	GARZA MICHAEL PAUL AND GARZA KRISTINA MARIE	GARZA MICHAEL PAUL AND	GARZA KRISTINA MARIE	9251 SCHUMAKER RD	BENNETT CO 80102-9619
15	0172724200001		41321 E 88TH AVE	QU88 LLC	QU88 LLC		6425 S NETHERLAND WAY	CENTENNIAL CO 80016-1329
16	0172724200002		41455 E 88TH AVE	RIGGS LOIDEEN K	RIGGS LOIDEEN K		41455 E 88TH AVE	BENNETT CO 80102-9674
17	0172724200003			ADAMS 88 LLC	ADAMS 88 LLC		6225 S IDER WAY	AURORA CO 80016-4279
18	0172724200004			ADAMS 88 LLC	ADAMS 88 LLC		6225 S IDER WAY	AURORA CO 80016-4279
19	0172724300001		41575 E 88TH AVE	TOQUINTO RASCON PABLO IVAN AND TOQUINTO BANDERAS PABLO IVAN	TOQUINTO RASCON PABLO IVAN AND	TOQUINTO BANDERAS PABLO IVAN	41575 E 88TH AVE	BENNETT CO 80102-9674
20	0172724300002		41697 E 88TH AVE	BRIDGER JENNIFER R AND GALLAGHER JEFFREY D	BRIDGER JENNIFER R AND	GALLAGHER JEFFREY D	41697 E 88TH AVE	BENNETT CO 80102-9674
21	0172724400001		9151 SCHUMAKER RD	THE DENNIS & CHERYL RICHEY FAMILY LIVING TRUST	THE DENNIS & CHERYL RICHEY FAMILY LIVING TRUST		9151 SCHUMAKER RD	BENNETT CO 80102-9603
22	0172724400002		9051 SCHUMAKER RD	ZIMMERMAN JULIE A	ZIMMERMAN JULIE A		9051 SCHUMAKER RD	BENNETT CO 80102-9618
23	0172724400003		41901 E 88TH AVE	GUTIERREZ CESAR OSBALDO	GUTIERREZ CESAR OSBALDO		41901 E 88TH AVE	BENNETT CO 80102-9613
24	0172724400004		41701 E 88TH AVE	LUNA ELDA	LUNA ELDA		4280 W 66TH AVE	ARVADA CO 80003-6418
25	0172725200001		41800 E 88TH AVE	CONSERVATION SERVICES INC C/O WASTE MANAGEMENT	CONSERVATION SERVICES INC	C/O WASTE MANAGEMENT	PO BOX 1450	CHICAGO IL 60690-1450
26	0172725400001		8201 SCHUMAKER RD	FIVE PART DEVELOPMENT CO C/O DUCHARME, MCMILLEN & ASSOCIATES	FIVE PART DEVELOPMENT CO	C/O DUCHARME, MCMILLEN & ASSOCIATES	PO BOX 80615	INDIANAPOLIS IN 46280-0615
27	0172725400002			FIVE PART DEVELOPMENT CO C/O DUCHARME, MCMILLEN & ASSOCIATES	FIVE PART DEVELOPMENT CO	C/O DUCHARME, MCMILLEN & ASSOCIATES	7475 E 84TH AVE	COMMERCE CITY CO 80022-5040
28	0172725400003			FIVE PART DEVELOPMENT CO C/O DUCHARME, MCMILLEN & ASSOCIATES	FIVE PART DEVELOPMENT CO	C/O DUCHARME, MCMILLEN & ASSOCIATES	PO BOX 80615	INDIANAPOLIS IN 46280-0615
29	0172725400004			FIVE PART DEVELOPMENT CO C/O DUCHARME, MCMILLEN & ASSOCIATES	FIVE PART DEVELOPMENT CO	C/O DUCHARME, MCMILLEN & ASSOCIATES	7373 WASHINGTON ST	DENVER CO 80229-6301
30	0172726100001		40080 E 88TH AVE	ANDRADE ABAMILEC CASTANON AND RAMIREZ RAUL BARRIOS	ANDRADE ABAMILEC CASTANON AND	RAMIREZ RAUL BARRIOS	40080 E 88TH AVE	BENNETT CO 80102-9606
31	0172726100002		40160 E 88TH AVE	APPLEHANS STEVE AND APPLEHANS MARYBETH	APPLEHANS STEVE AND	APPLEHANS MARYBETH	40160 E 88TH AVE	BENNETT CO 80102-9610
32	0172726100003		40240 E 88TH AVE	MULLER LORI AND MULLER BERNARD	MULLER LORI AND	MULLER BERNARD	40240 E 88TH AVE	BENNETT CO 80102-9611
33	0172726100004		40280 E 88TH AVE	BARRON SIERRA CUTBERTO AND BARRON CUTBERTO D	BARRON SIERRA CUTBERTO AND	BARRON CUTBERTO D	40280 E 88TH AVE	BENNETT CO 80102-9611
34	0172726200001		8700 MANILLA RD	SIMMERING MICHAEL GLEN	SIMMERING MICHAEL GLEN		8700 N MANILLA ROAD	BENNETT CO 80102
35	0172726200003		8500 MANILLA RD	SMITH BRUCE/SMITH PENNEY AND PRUETT HERBERT	SMITH BRUCE/SMITH PENNEY AND	PRUETT HERBERT	8500 N MANILA RD	BENNETT CO 80102-9507
36	0172726200005		39500 E 88TH AVE	NUNEZ TALAVERA JORGE AND DUARTE RAMIRES GREGORIA	NUNEZ TALAVERA JORGE AND	DUARTE RAMIRES GREGORIA	39500 E 88TH AVE	BENNETT CO 80102-9609
37	0172726200006		8600 MANILA RD	BANUELOS RAUL	BANUELOS RAUL		8600 N MANILA RD	BENNETT CO 80102-9502
38	0172726300001			JOHN D GRANSTROM REVOCABLE TRUST	JOHN D GRANSTROM REVOCABLE TRUST		PO BOX 176	HOLSTEIN NE 68950-0176
39	0172726300002			VENTURE 2011 LLC	VENTURE 2011 LLC		34057 GAP RD	GOLDEN CO 80403-8633
40	0172735100001			MIKE AND JIM KRUSE PARTNERSHIP	MIKE AND JIM KRUSE PARTNERSHIP		72 CASCADE AVE	ALAMOSA CO 81101-2626
41	0172735200001			PEI AND LIU FAMILY TRUST	PEI AND LIU FAMILY TRUST		1043 S HOLLAND ST	LAKEWOOD CO 80226-4166
42	0172735200002			ARVIZO NOEL CORRAL	ARVIZO NOEL CORRAL		5897 QUEBEC ST	COMMERCE CITY CO 80022-4143
43	0172735200003		7750 MANILLA RD	CARRASCO FRANCISCO P AND HERNANDEZ CECILIA	CARRASCO FRANCISCO P AND	HERNANDEZ CECILIA	860 W 132ND AVE LOT 202	WESTMINSTER CO 80234-1409
44	0172735200004			MENDOZA AGUIRRE JUAN GABRIEL	MENDOZA AGUIRRE JUAN GABRIEL		9631 LARK ST	FEDERAL HEIGHTS CO 80260-5740
45	0172735300001		7550 MANILLA RD	INMAN BROCK INMAN ASHLEY	INMAN BROCK	INMAN ASHLEY	7550 MANILLA RD	BENNETT CO 80102
46	0172735300002		7450 MANILLA RD	MUNOZ MICHAEL AND MUNOZ AMY	MUNOZ MICHAEL AND	MUNOZ AMY	7450 N MANILA RD	BENNETT CO 80102-8965
47	0172736100001		7991 SCHUMAKER RD					
48	0172736100002		7971 SCHUMAKER RD	GARNER MICHAEL TROY DEAR JENNIFER	GARNER MICHAEL TROY	DEAR JENNIFER	7971 SCHUMAKER RD	BENNETT CO 80102-9656
49	0172736100003		7751 SCHUMAKER RD	SWEED JAMES ROBERT AND SWEED FLORA MAE	SWEED JAMES ROBERT AND	SWEED FLORA MAE	P O BOX 358	WATKINS CO 80137-0358
50	0172736100005			WOODS KENNETH R	WOODS KENNETH R		7733 SCHUMAKER RD	BENNETT CO 80102-9644
51	0172736100006			EADS SHIRLEE L	EADS SHIRLEE L		7645 SCHUMAKER ROAD	BENNETT CO 80102
52	0172736200001		7995 SCHUMAKER RD	PHILLIPS EDWARD MICHAEL AND PHILLIPS TERREA MAE	PHILLIPS EDWARD MICHAEL AND	PHILLIPS TERREA MAE	7995 SCHUMAKER RD	BENNETT CO 80102
53	0172736200002		7955 SCHUMAKER RD	GERBRACHT R P AND GERBRACHT LESLIE	GERBRACHT R P AND	GERBRACHT LESLIE	7955 SCHUMAKER ROAD	BENNETT CO 80102
54	0172736200003		7925 SCHUMAKER RD	CRANWILL MICHAEL A AND CRANWILL STACEY L	CRANWILL MICHAEL A AND	CRANWILL STACEY L	7925 SCHUMAKER RD	BENNETT CO 80102-9656
55	0172736200004		7905 SCHUMAKER RD	WILLIS EUGENE A AND WILLIS KIMBERLY A	WILLIS EUGENE A AND	WILLIS KIMBERLY A	7905 SCHUMAKER RD	BENNETT CO 80102-9656
56	0172736200005			HUBERD SERVICES COMPANY LLC	HUBERD SERVICES COMPANY LLC		7925 SCHUMAKER RD	BENNETT CO 80102-9656
57	0172736300001		7291 SCHUMAKER RD	CHAVEZ DAVID	CHAVEZ DAVID		7291 SCHUMAKER RD	BENNETT CO 80102-9604
58	0172736300002		7347 SCHUMAKER RD	OROZCO VERA FLAVIO AND VERA DE LA TORRE CESAR AND VERA DE LA TORRE YOBANI	OROZCO VERA FLAVIO AND	VERA DE LA TORRE CESAR AND VERA DE LA TORRE YOBANI	7347 SCHUMAKER RD	BENNETT CO 80102-9604
59	0172736300005			SAYLER PEARL L UND 1/2 INT AND SAYLER BRIAN DEAN UND 1/2 INT	SAYLER PEARL L UND 1/2 INT AND	SAYLER BRIAN DEAN UND 1/2 INT	3685 SOUTH KITTREDGE NO. A	AURORA CO 80013
60	0172736300007		7545 SCHUMAKER RD	GUTIERREZ ELVIN W AND RAMOS EUGENIO AND GUTIERREZ DE RAMOS MARIA M	GUTIERREZ ELVIN W AND RAMOS EUGENIO AND	GUTIERREZ DE RAMOS MARIA M	7545 SCHUMAKER RD	BENNETT CO 80102-9614
61	0172736400002		7451 SCHUMAKER RD	SAYLER TIMOTHY MICHAEL AND SAYLER SUE ANNE	SAYLER TIMOTHY MICHAEL AND	SAYLER SUE ANNE	7451 SCHUMAKER ROAD	BENNETT CO 80102
62	0172736400003		7337 SCHUMAKER RD	MENDEZ RAMIREZ EMILY I	MENDEZ RAMIREZ EMILY I		7337 SCHUMAKER RD	BENNETT CO 80102-9604
63	0172736400004			BENSAM SCHUMAKER LLC	BENSAM SCHUMAKER LLC		6358 W GEDDES DR	LITTLETON CO 80128-4685
64	0172736400005		7551 SCHUMAKER RD	SAYLER CONNIE	SAYLER CONNIE		475 PALMER AVE	BENNETT CO 80102-7837
65	0172900000050			LINNEBUR GRAIN AND BUFFALO LLLP	LINNEBUR GRAIN AND BUFFALO LLLP		PO BOX 298	BYERS CO 80103-0298
66	0172900000051		43705 E 80TH AVE	KRUSE JIM	KRUSE JIM		72 CASCADE	ALAMOSA CO 81101
67	0172900000052			TRUPP REAL ESTATE II LLLP	TRUPP REAL ESTATE II LLLP		404 CONSTITUTION WAY	KYLE TX 78640-2955
68	0172900000055			TRUPP REAL ESTATE I LLLP	TRUPP REAL ESTATE I LLLP		6 OVERLOOK LN	BAILEY CO 80421-2131
69	0172900000056			PILAND LOWELL D AND PILAND SARA A	PILAND LOWELL D AND	PILAND SARA A	43651 E 38TH AVE	BENNETT CO 80102-8846
70	0172900000176		7502 SCHUMAKER RD	SCHULTZ ROBERT J AND SCHULTZ CHERYL A	SCHULTZ ROBERT J AND	SCHULTZ CHERYL A	7502 SCHUMAKER RD	BENNETT CO 80102
71	0172900000177		7380 SCHUMAKER RD	TOWN TIFFENY A AND TOWN MICAH G	TOWN TIFFENY A AND	TOWN MICAH G	7380 SCHUMAKER RD	BENNETT CO 80102-9604
72	0172900000178		7260 SCHUMAKER RD	BLANCHARD HERBERT	BLANCHARD HERBERT		7260 SCHUMAKER RD	BENNETT CO 80102-9604
73	0172900000179		7204 SCHUMAKER RD	DENES ROLAND A	DENES ROLAND A		7204 SCHUMAKER RD	BENNETT CO 80102-9604
74	0172900000180			KILGORE MICHAEL JR	KILGORE MICHAEL JR		38 JESSUP ST	BRIGHTON CO 80601-3039
75	0172900000181		7590 SCHUMAKER RD	MILLER JASON A AND LINDA S	MILLER JASON A AND LINDA S		7590 SCHUMAKER ROAD	BENNETT CO 80102
76	0172900000182		7580 SCHUMAKER RD	BARLOW SHANE	BARLOW SHANE		7580 SCHUMAKER ROAD	BENNETT CO 80102
77	0172900000183		7450 SCHUMAKER RD	MUNOZ MARISOL HERNANDEZ AND PEREZ RAFAEL	MUNOZ MARISOL HERNANDEZ AND	PEREZ RAFAEL	7450 SCHUMAKER RD	BENNETT CO 80102-8968
78	0172919200004		9200 SCHUMAKER RD	BLESSINGER MATTHEW D AND BLESSINGER KAYLA L	BLESSINGER MATTHEW D AND	BLESSINGER KAYLA L	9200 SCHUMAKER RD	BENNETT CO 80102-9619
79	0172919300001		9100 SCHUMAKER RD	BOEHME HOWARD P AND BOEHME NANCY J	BOEHME HOWARD P AND	BOEHME NANCY J	9100 SCHUMAKER RD	BENNETT CO 80102-9618
80	0172919300002			BROWN BARBARA A	BROWN BARBARA A		8900 N SCHUMAKER	BENNETT CO 80102
81	0172919300003		43001 E 88TH AVE	BANUELOS MIGUEL	BANUELOS MIGUEL		43001 E 88TH AVE	BENNETT CO 80102-9630
82	0172919300004		43201 E 88TH AVE	BEAM DOUGLAS E AND BEAM BEVERLY J	BEAM DOUGLAS E AND	BEAM BEVERLY J	PO BOX 249	BENNETT CO 80102
83	0172919400001		43401 E 88TH AVE	ROYCE ALLEN GRAHAM REVOCABLE TRUST	ROYCE ALLEN GRAHAM REVOCABLE TRUST		43401 E 88TH AVE	BENNETT CO 80102-9628
84	0172919400002		43601 E 88TH AVE	TRUONG CUONG	TRUONG CUONG		43601 E 88TH AVE	BENNETT CO 80102-9629
85	0172919400003		43801 E 88TH AVE	SHERMAN CLIFFORD AND SHERMAN GOLDEN	SHERMAN CLIFFORD AND	SHERMAN GOLDEN	43801 E 88TH AVE	BENNETT CO 80102
86	0172930100001		43400 E 88TH AVE	VANAUKEN JOHN AARON	VANAUKEN JOHN AARON		43400 E 88TH AVE	BENNETT CO 80102
87	0172930100002		43600 E 88TH AVE	COWLISHAW MARK AND COWLISHAW JESSICA	COWLISHAW MARK AND	COWLISHAW JESSICA	43600 E 88TH AVE	BENNETT CO 80102-9636
88	0172930100003		43800 E 88TH AVE	CHRISTOPHER GLENN D AND CHRISTOPHER KRISTINA L	CHRISTOPHER GLENN D AND	CHRISTOPHER KRISTINA L	43800 E 88TH AVE	BENNETT CO 80102-9645
89	0172930100004		44000 E 88TH AVE	WOODS COLLIS AND WOODS DONA M	WOODS COLLIS AND	WOODS DONA M	44000 E 88TH AVE	BENNETT CO 80102-9625
90	0172930200001		8770 SCHUMAKER RD	ACEVEDO NOE	ACEVEDO NOE		42700 E 64TH AVE	BENNETT CO 80102-9160
91	0172930200002		8660 SCHUMAKER RD	SOLIS PEDRO	SOLIS PEDRO		8660 SCHUMAKER RD	BENNETT CO 80102-9658
92	0172930200003		8550 SCHUMAKER RD	MADERA ARTURO AND MADERA SONIA	MADERA ARTURO AND	MADERA SONIA	8550 SCHUMAKER RD	BENNETT CO 80102-9658
93	0172930200004		8440 SCHUMAKER RD	FRESON BRUCE M	FRESON BRUCE M		8440 SCHUMAKER ROAD	BENNETT CO 80102
94	0172931100001		43400 E 80TH AVE	REICH FREDRICH C	REICH FREDRICH C		43400 E 80TH AVE	BENNETT CO 80102-8959
95	0172931100002		43620 E 80TH AVE	GARCIA LOYA MIGUEL ANGEL,	GARCIA LOYA MIGUEL ANGEL,		43620 E 80TH AVE	BENNETT CO 80102-8960
96	0172931100003		43800 E 80TH AVE	RUIS RUIS J ISABEL	RUIS RUIS J ISABEL		5222 URSULA WAY	DENVER CO 80239-5853
97	0172931100004			CASTRO JORGE	CASTRO JORGE		8460 ULSTER ST	COMMERCE CITY CO 80022-5013
98	0172931200001		7800 SCHUMAKER RD					
99	0172931200002		42900 E 80TH AVE	EASTLAND CAMERON J AND EASTLAND KATHRYN	EASTLAND CAMERON J AND	EASTLAND KATHRYN	42900 E 80TH AVENUE	BENNETT CO 80102
100	0172931200003		7900 SCHUMAKER RD	ODELL TABOT L AND ODELL ANITA E	ODELL TABOT L AND	ODELL ANITA E	7900 SCHUMAKER RD	BENNETT CO 80102
101	0172931200004		7600 SCHUMAKER RD	COLLINS JUDITH L REVOCABLE TRUST THE UND 1/2 AND TILTON SUSAN M UND 1/2	COLLINS JUDITH L REVOCABLE TRUST THE UND 1/2 AND	TILTON SUSAN M UND 1/2	7600 SCHUMAKER RD	BENNETT CO 80102-9632
102	0181500000342			PILAND LOWELL D AND PILAND SARA A	PILAND LOWELL D AND	PILAND SARA A	43651 E 38TH AVE	BENNETT CO 80102-8846
103	0181701100001			PILAND LOWELL D AND PILAND SARA A	PILAND LOWELL D AND	PILAND SARA A	43651 E 38TH AVE	BENNETT CO 80102-8846
104	0181701200001			MSR LL III	MSR LL III		1280 S PARKER RD APT 100	DENVER CO 80231-2128
105	0181702100001		7190 MANILLA RD	LUNA-BANUELOS APALMON AND LUNA ESTHER	LUNA-BANUELOS APALMON AND	LUNA ESTHER	142 S IRVING ST	DENVER CO 80219-2036

Appendix H
CIG Pipeline Right of Way and Easement Agreement

ALPINE WASTE (GAS PIPELINES) MARCH 25, 2011

#300(E.PIPELINE)	TAG# 251A	NOSIZE	61"COVER	N.7422.0	E.7165.2	ELEV.5306.8
#301	TAG# 52A	16"	47"COVER	N.7424.0	E.7100.9	ELEV.5308.2
#302	TAG#52B	24"	51"COVER	N.7424.8	E.7068.1	ELEV.5308.8
#303(W.PIPELINE)	TAG# 196A	10"	45"COVER	N.7425.7	E.7033.9	ELEV.5309.7
#304(E.PIPELINE)	TAG# 252A	NOSIZE	62"COVER	N.7224.1	E.6868.9	ELEV.5316.0
#305	TAG# 52A	16"	42"COVER	N.7268.1	E.6868.4	ELEV.5316.1
#306	TAG# 52B	24"	34"COVER	N.7290.9	E.6868.8	ELEV.5315.9
#307(W.PIPELINE)	TAG# 196A	10"	47"COVER	N.7314.4	E.6868.9	ELEV.5315.6
#308(E.PIPELINE)	TAG# 252A	NOSIZE	62"COVER	N.6825.7	E.6270.1	ELEV.5322.3
#309	TAG# 52A	16"	36"COVER	N.6863.3	E.6263.7	ELEV.5321.5
#310	TAG# 52B	24"	41"COVER	N.6883.7	E.6260.2	ELEV.5321.2
#311(W.PIPELINE)	TAG# 196A	10"	46"COVER	N.6904.9	E.6256.7	ELEV.5320.9

B1211716 BK 4239 PG 595 - 598 01/14/94 09:45
ROBERT SACK ADAMS CTY CO REC 20.00 DOC 00.00

01211716

AGREEMENT AND PARTIAL RELEASE

BOOK 4239 PG 595

THIS AGREEMENT, made and entered into by and between COLORADO INTERSTATE GAS COMPANY, a Delaware corporation, hereinafter referred to as CIG, and FIVE PART DEVELOPMENT COMPANY, a Colorado general partnership, hereinafter referred to as Five Part;

WITNESSETH:

WHEREAS, CIG is the present owner of a natural gas pipeline right of way agreement executed on December 14, 1966 by Philip Wagner, Jr. and Sophie Jane Wagner in favor of CIG, which right of way agreement is recorded in Book 1337 at Page 320 of the records of Adams County, Colorado, granting a right of way across all of Section 25, Township 2 South, Range 64 West, Adams County, Colorado; and

WHEREAS, upon request made by representatives of Five Part, CIG now desires to define and limit said right of way across said Section 25, Township 2 South, Range 64 West, Adams County, Colorado.

NOW, THEREFORE, KNOW ALL MEN BY THESE PRESENTS:

THAT in consideration of the premises and of the covenants and agreements of Five Part hereinafter set forth, CIG does hereby limit and define its right of way across Section 25, Township 2 South, Range 64 West, to the following tract of land, to-wit:

A tract of land, seventy (70) feet in width across a portion of Section Twenty-five (25), Township Two (2) South, Range Sixty-four (64) West, Adams County, Colorado, more particularly described as follows:

Beginning at a point on the West line of Section 25-2S-64W, Adams County, Colorado, which point bears North 00°19'00" East 972.17 feet with and along said West line from the Southwest corner of Section 25; Thence, with and along the centerline of said right of way and easement, 70 feet in width, North 56°12'58" East 6400.91 feet to the point of exit on the East line of said Section 25, which point bears South 00°20'05" West 628.28 feet with and along said East line from the Northeast corner of said Section 25-2S-64W.

BASIS OF BEARINGS:

THE WEST LINE OF THE SOUTHWEST QUARTER OF SECTION 25-2S-64W, ADAMS COUNTY, COLORADO, BEARS NORTH 00°19'00" EAST FROM THE THE SOUTHWEST CORNER OF SAID SECTION 25 (A 1" CAPPED PIPE) TO THE WEST QUARTER-CORNER OF SAID SECTION 25 (A 3¼" ALUMINUM CAPPED PIPE STAMPED "BAYER L.S. 6973).

CIG hereby releases and conveys to the underlying fee owner(s) all interest of CIG in said Section 25 acquired by virtue of the above described Right of Way Agreement outside of the above described tract of land.

In consideration whereof, Five Part, for itself, its successors and assigns, hereby agrees:

1. Not to build, construct or create, nor to permit others to build, construct or create any buildings or structures of any kind on the above described right of way, 70 feet in width.

2. Not to build, construct, operate or maintain any improved street, road, roadway, alley or thoroughfare over and along the course of said right of way, 70 feet in width.

3. Prior to construction, excavation or installation on, over, across or under said right of way, 70 feet in width, the construction, excavation, installation, operation, maintenance and use of which are not inconsistent with the rights and privileges previously granted to and herein retained by CIG, Five Part shall give notice in writing to CIG of its intention to construct, excavate or install. Further, Five Part agrees not to commence the construction, excavation or installation of any such facilities unless a representative of CIG is present at the site to inspect such construction, excavation or installation and, further, Five Part agrees that all such construction, excavation and installation shall according to proper and workmanlike practices in the industry and with due regard for the rights of CIG and its property.

This agreement shall extend to and binding upon the successors and assigns of the parties hereto.

Executed this 28th day of December, 19 93.

COLORADO INTERSTATE GAS COMPANY

ATTEST: COLORADO INTERSTATE GAS COMPANY CORPORATE SEAL DELAWARE ☆ 1927 ☆

Assistant Secretary

Vice President

FIVE PART DEVELOPMENT COMPANY

Phil Spano, General Partner

CORPORATE ACKNOWLEDGMENT

STATE OF Colorado)
) ss.
COUNTY OF El Paso)

Before me, a Notary Public in and for said County and State, on this 28th day of December, 1993, personally appeared W. H. Zanger to me known to be the identical person who subscribed the name of the maker thereof to the foregoing instrument as its Vice President, and acknowledged to me that he executed the same as His free and voluntary act and deed and as the free and voluntary act and deed of such corporation for the uses and purposes therein set forth.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal the day and year last above written.



Ann Freeman
Notary Public

979 Bayfield Way
Colorado Springs, Colorado 80906
Address

My Commission expires:

7/27/96

CORPORATE ACKNOWLEDGMENT BOOK 4239 PG 598

STATE OF Colorado)
) ss.
COUNTY OF Denver)

Before me, a Notary Public in and for said County and State, on this 17th day of December, 1993, personally appeared Phil Spano to me known to be the identical person who subscribed the name of the maker thereof to the foregoing instrument as its General Partner, and acknowledged to me that he executed the same as his free and voluntary act and deed and as the free and voluntary act and deed of such corporation for the uses and purposes therein set forth.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal the day and year last above written.

Laura Dale
Notary Public

1225 17th Street, 28th Floor

Denver CO 80202
Address

My Commission expires:

8/26/95

LAURA DALE NOTARY PUBLIC STATE OF COLORADO

Appendix I
Climate Information

SUMMARY OF MONTHLY CLIMATIC DATA FOR BYERS 5 ENE COLORADO FOR YEARS 1931-1991 SUBSTATION NO. 51179 DIVISION 4

LATITUDE - 39 45 LONGITUDE - 104 8 ELEVATION - 5100 FEET

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MONTHLY MEAN MAXIMUM TEMP (F)	AVE.	42.2	46.3	52.4	62.6	71.7	83.4	90.1	87.9	79.4	68.0	52.8	44.5	65.2
	MAX.	54.7	59.2	62.4	70.7	78.7	92.4	94.6	93.2	85.9	77.6	64.9	55.8	69.8
	YEAR	1986	1954	1986	1954	1963	1956	1939	1937	1948	1950	1949	1980	1954
	MIN.	28.9	34.2	42.6	53.0	58.3	74.0	84.6	83.9	70.6	52.5	38.5	26.4	61.4
	YEAR	1979	1942	1965	1944	1935	1967	1967	1967+	1965	1969	1972	1983	1983
	YEARS OF RECORD	60.	60.	60.	61.	61.	60.	61.	61.	61.	61.	61.	61.	57.
MONTHLY MEAN MINIMUM TEMP (F)	AVE.	12.8	17.1	22.8	31.8	41.6	50.3	56.3	54.8	46.1	34.7	22.5	15.4	33.9
	MAX.	23.4	26.6	28.7	38.2	48.3	55.5	60.3	58.9	52.7	43.4	29.8	24.3	37.1
	YEAR	1953	1954	1986	1943	1934	1956	1933	1932	1963	1963	1949	1933	1934
	MIN.	-4.4	5.6	13.8	24.6	34.5	45.3	52.5	50.1	39.7	27.1	13.2	1.5	29.5
	YEAR	1937	1936	1965	1975	1975	1975	1972	1974	1974	1969	1979	1983	1975
	YEARS OF RECORD	60.	60.	60.	61.	61.	60.	61.	61.	61.	61.	61.	61.	57.
MONTHLY MEAN AVERAGE TEMP (F)	AVE.	27.6	31.7	37.6	47.2	56.7	66.9	73.2	71.4	62.7	51.4	37.7	30.0	49.5
	MAX.	38.1	42.9	45.6	54.2	61.7	74.0	77.0	75.8	68.7	59.0	47.4	39.0	53.2
	YEAR	1986	1954	1986	1946	1958	1956	1954	1937	1948	1950	1949	1980	1954
	MIN.	12.4	20.1	28.2	40.8	48.4	60.6	69.7	67.3	55.7	39.8	26.4	14.0	46.7
	YEAR	1937	1942	1965	1945	1935	1945	1950	1967	1965	1969	1972	1983	1973
	YEARS OF RECORD	60.	60.	60.	61.	61.	60.	61.	61.	61.	61.	61.	61.	57.
DEGREE DAYS (BASE 65F)	AVE.	1163.1	935.9	844.8	534.8	260.9	59.4	4.9	8.6	132.7	435.4	832.6	1105.0	6318.8
	MAX.	1560	1199	1132	719	400	153	31	30	300	774	1150	1577	7100
	YEAR	1979	1960	1965	1983	1975	1969	1972	1956	1965	1969	1972	1983	1983
	MIN.	824	613	596	341	135	0	0	0	18	214	620	800	5160
	YEAR	1986	1954	1986	1954	1958	1977+	1989+	1988+	1963	1963	1965	1980	1954
	YEARS OF RECORD	40.	41.	40.	41.	41.	40.	41.	41.	41.	41.	41.	41.	38.
NO DAYS MAX TEMP GTR OR EQ 90F	AVE.	0.0	0.0	0.0	0.0	0.8	9.0	17.8	13.5	4.0	0.1	0.0	0.0	45.7
	MAX.	0	0	0	1	6	19	28	22	11	1	0	0	74
	YEAR	1948	1948	1948	1989	1964	1956	1955	1962+	1956	1991+	1949	1948	1954
	MIN.	0	0	0	0	0	0	8	4	0	0	0	0	18
	YEAR	1991+	1991+	1991+	1991+	1991+	1967	1967+	1963	1991+	1990+	1991+	1991+	1967
	YEARS OF RECORD	42.	43.	42.	43.	43.	43.	44.	44.	44.	43.	42.	43.	39.
NO DAYS MAX TEMP LESS OR EQ 32F	AVE.	7.3	3.9	2.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	2.3	4.8	21.0
	MAX.	19	11	7	3	0	0	0	0	1	3	12	16	38
	YEAR	1979	1989	1969+	1983	1948	1948	1948	1948	1985	1991	1985	1983	1983
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	8
	YEAR	1986+	1977+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1990+	1989+	1970+	1981+
	YEARS OF RECORD	42.	43.	43.	43.	43.	42.	43.	43.	43.	43.	43.	44.	38.
NO DAYS MIN TEMP LESS OR EQ 32F	AVE.	30.5	27.1	27.9	16.9	3.4	0.1	0.0	0.0	1.6	12.7	26.4	30.2	177.8
	MAX.	31	29	31	25	12	2	0	0	7	26	30	31	209
	YEAR	1991+	1988+	1980+	1975+	1975	1951	1948	1948	1985+	1969	1979+	1991+	1975
	MIN.	27	22	23	9	0	0	0	0	0	0	19	26	153
	YEAR	1950	1962+	1989+	1986+	1987+	1991+	1991+	1991+	1990+	1948	1953	1955	1963
	YEARS OF RECORD	43.	44.	43.	43.	44.	42.	43.	43.	43.	44.	42.	44.	38.
NO DAYS MIN TEMP LESS OR EQ 0 F	AVE.	5.7	2.5	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8	3.3	13.4
	MAX.	18	9	7	1	0	0	0	0	0	0	4	14	33
	YEAR	1979	1982	1965	1983+	1948	1948	1948	1948	1948	1948	1979+	1983	1979
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	1
	YEAR	1986+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1990+	1980+	1953
	YEARS OF RECORD	42.	43.	43.	43.	43.	42.	43.	43.	43.	43.	43.	44.	38.
HIGHEST TEMPERATURE (F)	TEMP	74	76	85	92	97	106	105	104	99	90	80	76	
	YEAR AND DAY	198630	193520	196328	198921	198928	195423	199001+	193801	195402	199116+	197808+	198027	
	YEARS OF RECORD	61.	60.	60.	61.	61.	60.	61.	61.	60.	60.	60.	61.	
LOWEST TEMPERATURE (F)	TEMP	-32	-36	-16	-9	20	29	38	37	10	1	-19	-33	
	YEAR AND DAY	198418	193608	194302+	197502	197807+	195102	197130	196421+	198530	196914	195516	198922	
	YEARS OF RECORD	60.	60.	60.	61.	61.	61.	61.	61.	59.	59.	60.	61.	

PREPARED BY: COLORADO CLIMATE CENTER, DEPT. OF ATMOSPHERIC SCIENCE, COLORADO STATE UNIV. FT. COLLINS, CO 80523, (303)491-8545

SUMMARY OF MONTHLY CLIMATIC DATA FOR BYERS 5 ENE COLORADO FOR YEARS 1931-1991 SUBSTATION NO. 51179 DIVISION 4

LATITUDE - 39 45 LONGITUDE - 104 8 ELEVATION - 5100 FEET

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MONTHLY PRECIPITATION (IN)	AVE.	0.42	0.41	0.96	1.59	2.65	1.90	2.14	1.63	1.31	0.75	0.63	0.41	14.86
	MAX.	1.39	1.60	3.34	5.24	6.06	8.01	5.93	5.93	5.67	4.22	2.74	1.60	23.76
	YEAR	1942	1934	1981	1938	1975	1965	1991	1951	1938	1969	1972	1973	1969
	MIN.	0.00	0.00	0.13	0.28	0.17	0.10	0.44	0.01	0.00	0.00	0.00	0.00	6.31
	YEAR	1983+	1991+	1982	1956	1974	1956	1939	1960	1978	1988+	1965	1980	1954
	YEARS OF RECORD	61.	61.	61.	61.	61.	61.	61.	61.	61.	61.	61.	60.	60.
GREATEST DAILY PRECIP (IN)	AMOUNT	0.68	0.56	1.30	2.02	3.91	3.02	3.26	4.02	4.01	1.37	1.66	0.67	
	YEAR AND DAY	196208	198411	198104	195702	197306	196516	199123	195103	196602	196614	197201	197324	
	YEARS OF RECORD	41.	43.	40.	44.	42.	44.	44.	44.	43.	43.	43.	40.	
MONTHLY SNOWFALL (IN)	AVE.	6.9	5.8	10.2	6.2	0.6	0.0	0.0	0.0	0.9	2.7	6.4	5.8	46.8
	MAX.	18.0	20.0	32.0	35.2	7.0	0.5	0.0	0.0	18.0	38.0	29.5	20.0	83.0
	YEAR	1965	1934	1981	1935	1950	1937	1931	1931	1936	1969	1946	1982	1959
	MIN.	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0
	YEAR	1983+	1991+	1986	1985+	1991+	1991+	1991+	1991+	1991+	1988+	1988+	1991+	1943
	YEARS OF RECORD	53.	56.	51.	56.	57.	61.	61.	60.	60.	58.	54.	55.	44.
GRTST DEPTH SNOW ON GRND IN MON (IN)		12	13	13	14	4	0	0	0	9	14	15	18	
	YEAR AND DAY	0	0	197923	198422	197301	0	0	0	197117	196912+	198327+	198225	
	YEARS OF RECORD	32.	33.	31.	31.	37.	44.	44.	43.	41.	35.	33.	35.	
NO DAYS PRECIP GTR OR EQ 0.1 IN	AVE.	1.7	1.7	3.4	3.8	5.8	4.7	5.5	4.3	3.1	2.0	2.3	1.5	40.8
	MAX.	7	5	10	9	15	13	11	11	9	7	7	5	78
	YEAR	1951	1952	1952	1957+	1949	1949	1951	1951	1950	1969	1952	1960	1951
	MIN.	0	0	0	1	1	0	2	0	0	0	0	0	24
	YEAR	1991+	1991+	1978+	1982+	1974+	1956	1978+	1960+	1983+	1988+	1981+	1990+	1977+
	YEARS OF RECORD	42.	43.	41.	44.	41.	44.	44.	43.	44.	43.	42.	42.	35.
NO DAYS PRECIP GTR OR EQ 0.5 IN	AVE.	0.1	0.0	0.3	0.8	1.8	1.3	1.3	1.0	0.7	0.5	0.2	0.1	8.6
	MAX.	1	1	4	3	5	6	5	3	5	5	2	2	21
	YEAR	1990+	1984	1949	1984+	1957	1949	1958	1984+	1963	1969	1979	1982	1949
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	1
	YEAR	1991+	1991+	1991+	1991+	1984+	1990+	1988+	1989+	1991+	1991+	1989+	1991+	1954
	YEARS OF RECORD	43.	43.	40.	43.	42.	43.	43.	43.	43.	42.	42.	42.	37.
NO DAYS PRECIP GTR OR EQ 1.0 IN	AVE.	0.0	0.0	0.1	0.2	0.7	0.3	0.5	0.3	0.2	0.1	0.0	0.0	2.4
	MAX.	0	0	1	1	3	3	2	2	2	1	1	0	6
	YEAR	1948	1948	1983+	1984+	1957	1965	1991+	1951	1963	1984+	1991+	1948	1969+
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	0
	YEAR	1991+	1991+	1991+	1991+	1990+	1990+	1990+	1991+	1991+	1991+	1990+	1991+	1990+
	YEARS OF RECORD	43.	43.	40.	43.	43.	43.	44.	43.	43.	42.	43.	42.	38.
NUMBER OF DAYS WITH HAIL	AVE.	0.0	0.0	0.0	0.2	0.9	0.8	0.3	0.2	0.2	0.0	0.0	0.0	2.6
	MAX.	0	0	1	2	3	4	2	2	1	0	0	0	9
	YEAR	1956	1956	1966	1968	1967+	1962	1967+	1969	1966+	1956	1956	1956	1964
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	0
	YEAR	1981+	1981+	1981+	1981+	1981+	1979+	1981+	1981+	1981+	1981+	1981+	1981+	1976+
	YEARS OF RECORD	26.	26.	25.	26.	26.	26.	26.	26.	26.	26.	26.	26.	25.
** NOTE : MANY WEATHER STATIONS DO NOT RECORD ALL HAIL OCCURRENCES. THEREFORE THESE DATA MAY NOT BE REPRESENTATIVE.														
NO. OF DAYS WITH SNOW ON GROUND	AVE.	16.0	11.2	6.5	2.0	0.1	0.0	0.0	0.0	0.1	1.4	6.8	12.7	59.9
(GTR OR EQ 1 INCH ON GROUND)	MAX.	31	29	24	8	2	0	0	0	2	11	30	31	109
	YEAR	1988+	1984+	1984	1984	1979	1963	1963	1963	1985+	1969	1972	1991+	1984
	MIN.	0	0	1	0	0	0	0	0	0	0	0	0	18
	YEAR	1970	1991+	1989+	1990+	1991+	1991+	1991+	1991+	1991+	1988+	1988+	1980	1976
	YEARS OF RECORD	28.	29.	28.	29.	28.	29.	29.	29.	29.	29.	28.	29.	25.

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SUMMARY OF MONTHLY CLIMATIC DATA FOR DENVER WSFO AP COLORADO FOR YEARS 1948-1991 SUBSTATION NO. 52220 DIVISION 4

LATITUDE - 39 46 LONGITUDE - 104 52 ELEVATION - 5280 FEET

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MONTHLY MEAN MAXIMUM TEMP (F)	AVE.	43.1	46.6	51.6	61.4	70.5	81.5	87.8	85.8	77.3	66.5	52.5	45.2	64.2
	MAX.	54.7	59.6	61.2	70.2	79.1	89.0	92.4	89.9	82.3	76.7	64.9	55.0	67.8
	YEAR	1986	1954	1972	1981	1974	1990	1964	1962	1977	1950	1949	1980	1954
	MIN.	28.6	32.7	40.4	51.7	62.5	72.8	81.8	81.2	68.1	49.5	40.4	28.2	60.4
	YEAR	1949	1989	1965	1983	1983	1967	1950	1963	1965	1969	1985	1983	1983
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.
MONTHLY MEAN MINIMUM TEMP (F)	AVE.	16.2	20.3	25.4	34.4	43.9	52.9	58.8	57.3	48.1	36.9	25.4	18.3	36.5
	MAX.	26.3	27.8	33.1	42.5	49.1	58.2	62.9	61.1	54.2	43.1	32.4	27.4	40.7
	YEAR	1953	1954	1986	1981	1958	1956	1980	1983	1981	1950	1949	1980	1981
	MIN.	4.0	12.0	17.5	28.1	39.2	48.3	54.7	53.4	42.4	28.4	19.1	6.7	34.0
	YEAR	1949	1989	1965+	1968	1968+	1951	1972	1974	1971	1969	1985	1983	1968
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.
MONTHLY MEAN AVERAGE TEMP (F)	AVE.	29.7	33.5	38.5	47.9	57.3	67.2	73.3	71.6	62.7	51.7	39.0	31.8	50.3
	MAX.	40.3	43.7	47.1	56.4	61.7	73.4	76.9	74.4	68.2	59.9	48.7	41.2	54.0
	YEAR	1986	1954	1986	1981	1958	1956	1966	1983	1981	1950	1949	1980	1981
	MIN.	16.3	22.4	29.0	41.0	51.4	60.6	68.9	68.1	55.7	39.0	29.8	17.5	48.3
	YEAR	1949	1989	1965	1983	1983	1967	1950	1968	1965	1969	1985	1983	1951
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.
DEGREE DAYS (BASE 65F)	AVE.	1075.9	881.5	808.3	511.3	246.9	55.8	5.4	7.4	126.2	410.7	779.2	1025.6	5934.3
	MAX.	1450	1193	1108	712	419	164	42	35	296	801	1051	1469	6715
	YEAR	1979	1989	1965	1983	1983	1951	1972	1968	1965	1969	1985	1983	1983
	MIN.	758	589	548	260	137	0	0	0	19	229	570	731	4784
	YEAR	1986	1954	1986	1981	1977+	1977+	1989+	1989+	1981	1963	1981	1980	1981
	YEARS OF RECORD	41.	41.	41.	41.	41.	41.	41.	41.	41.	41.	41.	41.	41.
NO DAYS MAX TEMP GTR OR EQ 90F	AVE.	0.0	0.0	0.0	0.0	0.3	6.5	14.4	9.5	2.5	0.0	0.0	0.0	33.8
	MAX.	0	0	0	0	3	15	27	22	7	0	0	0	52
	YEAR	1948	1948	1948	1948	1989	1952	1964	1960	1990+	1948	1948	1948	1978
	MIN.	0	0	0	0	0	0	2	1	0	0	0	0	4
	YEAR	1991+	1991+	1991+	1991+	1991+	1972+	1967	1984+	1991+	1991+	1991+	1991+	1967
	YEARS OF RECORD	43.	43.	43.	43.	43.	44.	44.	44.	44.	43.	43.	43.	43.
NO DAYS MAX TEMP LESS OR EQ 32F	AVE.	6.9	4.5	3.2	0.4	0.0	0.0	0.0	0.0	0.0	0.3	2.5	4.8	22.8
	MAX.	20	12	11	4	0	0	0	0	1	3	10	14	41
	YEAR	1949	1989	1969	1983	1948	1948	1948	1948	1985	1991	1985	1983	1983
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	10
	YEAR	1986+	1970+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1990+	1989+	1976+	1981
	YEARS OF RECORD	44.	44.	44.	43.	43.	43.	43.	43.	43.	43.	44.	44.	43.
NO DAYS MIN TEMP LESS OR EQ 32F	AVE.	29.5	26.0	24.9	11.9	1.6	0.0	0.0	0.0	0.7	8.1	23.7	29.1	155.7
	MAX.	31	29	30	23	7	1	0	0	5	18	30	31	187
	YEAR	1991+	1984+	1970+	1968	1967	1951	1948	1948	1985	1984+	1972	1991+	1984
	MIN.	21	20	15	2	0	0	0	0	0	1	13	22	115
	YEAR	1953	1986	1978	1981	1987+	1991+	1991+	1991+	1991+	1950	1981	1977	1981
	YEARS OF RECORD	44.	44.	44.	44.	44.	43.	43.	43.	43.	44.	44.	44.	43.
NO DAYS MIN TEMP LESS OR EQ 0 F	AVE.	3.6	1.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.3	8.9
	MAX.	13	8	5	1	0	0	0	0	0	0	4	11	20
	YEAR	1962	1989	1948	1975	1948	1948	1948	1948	1948	1948	1952	1983+	1972
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	2
	YEAR	1990+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1991+	1957+
	YEARS OF RECORD	44.	43.	44.	43.	43.	43.	43.	43.	43.	43.	44.	44.	43.
HIGHEST TEMPERATURE (F)	TEMP	73	76	84	89	93	102	103	100	97	89	79	75	
	YEAR AND DAY	198226	196305	197126	198921	198929+	199030+	198908+	198006+	196004	199116	199014+	198027	
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	
LOWEST TEMPERATURE (F)	TEMP	-25	-25	-10	-2	22	30	43	41	17	3	-8	-25	
	YEAR AND DAY	196312	195101	194805	197502	195402	195102	197205+	196423	198529	196913	195010	199022	
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	

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SUMMARY OF MONTHLY CLIMATIC DATA FOR DENVER WSFO AP COLORADO FOR YEARS 1948-1991 SUBSTATION NO. 52220 DIVISION 4

LATITUDE - 39 46 LONGITUDE - 104 52 ELEVATION - 5280 FEET

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MONTHLY PRECIPITATION (IN)	AVE.	0.54	0.62	1.30	1.77	2.56	1.71	1.91	1.50	1.13	0.99	0.87	0.60	15.50
	MAX.	1.44	1.66	4.56	4.13	7.31	4.69	6.41	5.85	4.67	4.17	2.67	2.84	23.31
	YEAR	1948	1960	1983	1957	1957	1967	1965	1979	1961	1969	1991	1973	1967
	MIN.	0.01	0.01	0.18	0.03	0.06	0.09	0.54	0.06	0.01	0.05	0.01	0.03	7.51
	YEAR	1952	1970	1982	1963	1974	1980	1978+	1960	1956	1962	1949	1977	1954
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.
GREATEST DAILY PRECIP (IN)	AMOUNT	0.92	1.01	2.68	3.25	3.27	3.16	2.05	1.93	1.44	1.58	0.95	2.00	
	YEAR AND DAY	196208	195319	198305	196713	197306	197011	196525	195103	197328	196018	197920	198224	
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	
MONTHLY SNOWFALL (IN)	AVE.	8.1	7.7	13.5	9.1	1.8	0.0	0.0	0.0	1.6	4.1	9.1	8.0	63.0
	MAX.	23.7	18.3	30.5	25.5	13.7	0.8	0.0	1.3	17.2	31.2	29.6	30.8	112.0
	YEAR	1948	1960	1983	1957	1950	1951	1948	1951	1971	1969	1991	1973	1959
	MIN.	0.3	0.3	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	27.9
	YEAR	1952	1970	1982	1969	1991+	1991+	1991+	1991+	1991+	1988+	1949	1977	1977
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.
GRTST DEPTH SNOW ON GRND IN MON (IN)		14	10	13	16	7	1	0	1	10	11	17	24	
	YEAR AND DAY	194826	0	0	0	197807+	195305	0	195131	197118	196913	197921	0	
	YEARS OF RECORD	44.	42.	44.	38.	28.	37.	39.	42.	40.	33.	44.	43.	
NO DAYS PRECIP GTR OR EQ 0.1 IN	AVE.	2.1	2.5	4.6	4.9	6.0	4.8	4.9	4.2	3.1	3.0	3.0	2.2	45.2
	MAX.	9	9	12	15	13	17	15	12	8	9	9	8	105
	YEAR	1951+	1952+	1949	1951	1953+	1949	1949	1949	1961+	1969	1952	1953	1951
	MIN.	0	0	1	0	0	0	1	0	0	0	1	0	22
	YEAR	1984+	1991+	1982+	1963	1974	1980+	1989+	1985+	1978+	1988+	1989+	1990+	1954
	YEARS OF RECORD	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.	44.
NO DAYS PRECIP GTR OR EQ 0.5 IN	AVE.	0.2	0.1	0.5	0.9	1.6	0.9	1.1	0.8	0.5	0.6	0.3	0.1	7.7
	MAX.	2	1	4	3	5	5	4	7	4	4	3	2	22
	YEAR	1949	1962+	1949	1973+	1957	1949	1965	1979	1961	1984	1983	1973	1949
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	2
	YEAR	1991+	1991+	1991+	1990+	1984+	1990+	1987+	1990+	1991+	1991+	1990+	1991+	1964+
	YEARS OF RECORD	43.	43.	43.	43.	43.	43.	43.	43.	43.	43.	43.	43.	43.
NO DAYS PRECIP GTR OR EQ 1.0 IN	AVE.	0.0	0.0	0.1	0.2	0.6	0.2	0.4	0.2	0.2	0.1	0.0	0.0	2.1
	MAX.	0	1	1	1	2	1	3	2	2	1	0	1	5
	YEAR	1948	1953	1990+	1980+	1988+	1987+	1956	1951	1961	1984+	1948	1982+	1969
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	0
	YEAR	1991+	1991+	1991+	1991+	1991+	1991+	1987+	1990+	1991+	1991+	1991+	1991+	1986+
	YEARS OF RECORD	43.	43.	43.	44.	44.	44.	43.	43.	43.	43.	43.	43.	43.
NUMBER OF DAYS WITH HAIL	AVE.	0.0	0.0	0.0	0.3	1.3	0.7	0.9	0.7	0.2	0.1	0.0	0.0	4.3
	MAX.	0	0	1	2	3	4	5	3	1	2	1	0	10
	YEAR	1956	1956	1958	1972	1977+	1967	1965	1979+	1976+	1957	1978	1956	1972
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	1
	YEAR	1981+	1981+	1981+	1980+	1975+	1981+	1981+	1978+	1981+	1981+	1981+	1981+	1975+
	YEARS OF RECORD	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
NO. OF DAYS WITH SNOW ON GROUND (GTR OR EQ 1 INCH ON GROUND)	AVE.	12.7	7.6	6.4	2.6	0.3	0.0	0.0	0.0	0.3	1.6	7.3	10.7	49.5
	MAX.	31	24	16	7	3	0	0	0	4	13	19	31	104
	YEAR	1983	1989	1983	1973	1978	1963	1963	1963	1971	1969	1991	1983	1983
	MIN.	2	0	1	0	0	0	0	0	0	0	1	0	16
	YEAR	1981+	1970	1991+	1985+	1991+	1991+	1991+	1991+	1991+	1988+	1988+	1977	1977
	YEARS OF RECORD	29.	29.	29.	29.	29.	29.	29.	29.	29.	29.	29.	29.	29.

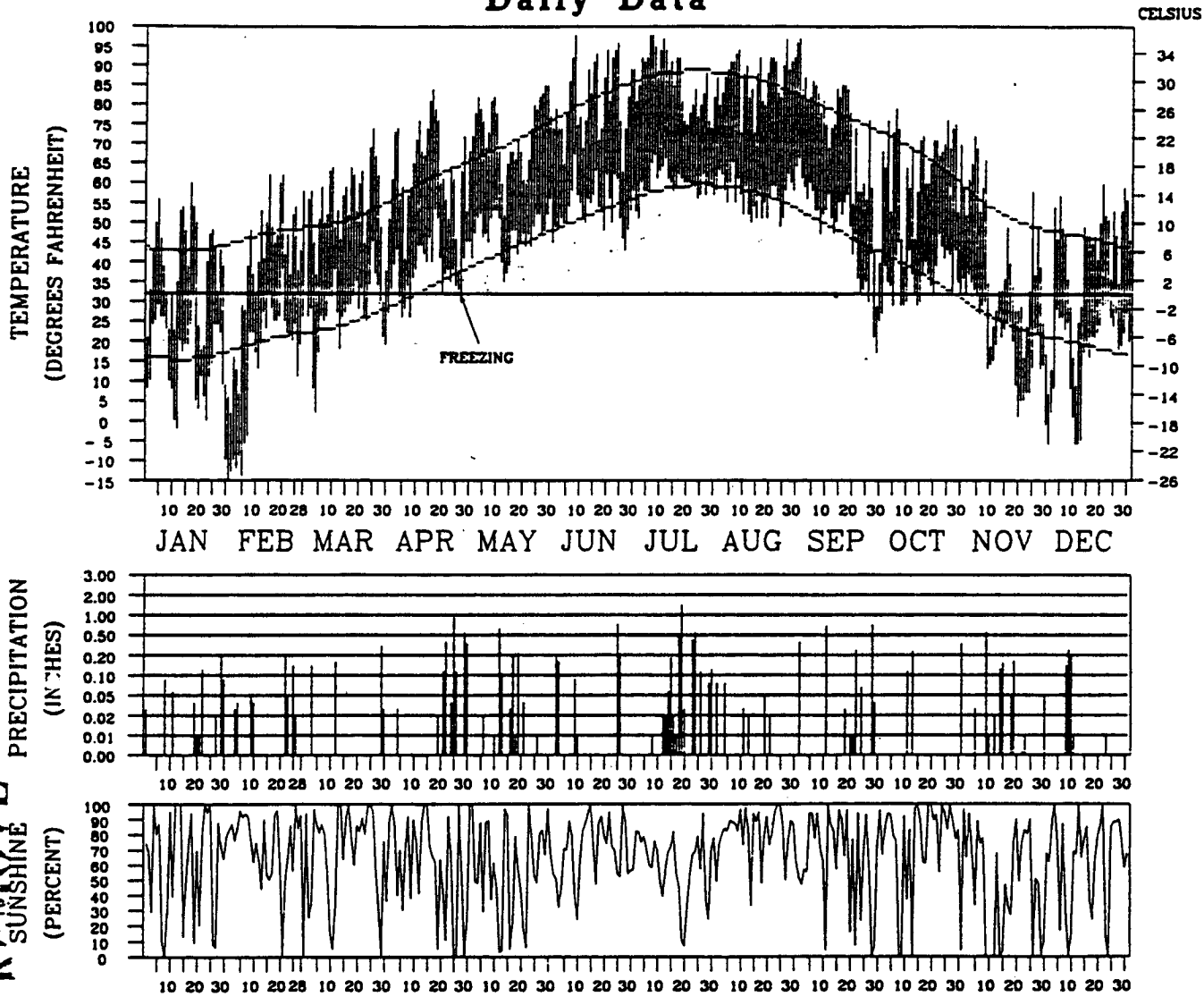
** NOTE : MANY WEATHER STATIONS DO NOT RECORD ALL HAIL OCCURRENCES. THEREFORE THESE DATA MAY NOT BE REPRESENTATIVE.

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1985 LOCAL CLIMATOLOGICAL DATA
ANNUAL SUMMARY WITH COMPARATIVE DATA
DENVER, COLORADO

Daily Data



TEMPERATURE DEPICTS NORMAL MAXIMUM, NORMAL MINIMUM AND ACTUAL DAILY HIGH AND LOW VALUES (FAHRENHEIT)
PRECIPITATION IS MEASURED IN INCHES. SCALE IS NON-LINEAR
SUNSHINE IS PERCENT OF THE POSSIBLE SUNSHINE

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noaa
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER ASHEVILLE NORTH CAROLINA

METEOROLOGICAL DATA FOR 1985

DENVER, COLORADO

LATITUDE: 39°45' N LONGITUDE: 104°52' W ELEVATION: FT. GRND 5282 BARO 5287 TIME ZONE: MOUNTAIN WBAN: 23062

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:													
Averages													
-Daily Maximum	37.5	40.4	54.5	63.8	73.0	82.0	86.3	87.7	71.5	65.1	40.4	41.6	62.0
-Daily Minimum	13.6	14.9	27.1	38.1	46.9	53.9	59.6	57.0	46.1	36.3	19.1	17.2	35.8
-Monthly	25.6	27.7	40.8	51.0	60.0	68.0	73.0	72.4	58.8	50.7	29.8	29.4	48.9
-Monthly Dewpt.	13.3	13.8	19.7	28.4	36.5	40.5	47.2	44.7	38.5	28.1	17.4	12.8	28.4
Extremes													
-Highest	60	62	74	84	85	98	98	97	87	79	72	60	98
-Date	17	20	25	16	29	8	7	31	2	6	4	21	JUL 7
-Lowest	-15	-14	2	26	35	43	51	49	17	27	-1	-6	-15
-Date	31	5	4	8	13	27	2	24	29	1	30	12	JAN 31
DEGREE DAYS BASE 65 °F:													
Heating	1215	1041	742	412	167	42	0	1	241	435	1051	1094	6441
Cooling	0	0	0	1	19	137	256	238	63	0	0	0	714
% OF POSSIBLE SUNSHINE	62	73	68	59	59	69	60	80	63	73	48	63	65
AVG. SKY COVER (tenths)													
Sunrise - Sunset	5.5	5.5	5.1	6.0	5.5	5.3	6.3	4.2	5.4	3.9	7.0	5.5	5.4
Midnight - Midnight	5.3	4.8	4.8	5.7	5.3	5.1	5.8	4.0	5.5	3.8	6.6	4.9	5.1
NUMBER OF DAYS:													
Sunrise to Sunset													
-Clear	11	7	12	8	11	9	3	11	11	16	5	9	113
-Partly Cloudy	9	13	7	8	10	12	19	14	7	8	9	11	127
-Cloudy	11	8	12	14	10	9	9	6	12	7	16	11	125
Precipitation .01 inches or more	10	8	4	9	10	6	15	6	9	3	10	5	95
Snow, Ice pellets 1.0 inches or more	4	3	3	0	0	0	0	0	1	1	5	3	20
Thunderstorms	0	0	0	2	7	8	13	9	4	0	0	0	43
Heavy Fog, visibility /4 mile or less	3	1	0	0	0	0	0	0	0	0	7	0	11
Temperature °F													
-Maximum													
90° and above	0	0	0	0	0	8	12	15	0	0	0	0	35
32° and below	10	7	1	0	0	0	0	0	1	0	10	7	36
-Minimum													
32° and below	31	27	24	6	0	0	0	0	5	10	27	31	161
0° and below	5	7	0	0	0	0	0	0	0	0	1	4	17
AVG. STATION PRESS. (mb)	837.5	834.4	833.1	834.4	835.1	837.5	840.2	838.5	837.5	836.8	832.4	837.8	836.1
RELATIVE HUMIDITY (%)													
Hour 05	73	70	65	64	65	57	62	63	69	63	75	58	65
Hour 11	54	49	38	40	34	31	35	29	42	36	57	46	41
Hour 17 (Local Time)	59	52	33	35	35	29	35	26	40	33	60	51	41
Hour 23	75	71	54	55	56	49	55	52	60	59	70	59	60
PRECIPITATION (inches):													
Water Equivalent													
-Total	0.68	0.59	0.69	2.61	1.33	1.46	3.71	0.28	2.33	0.77	1.20	0.66	16.31
-Greatest (24 hrs)	0.29	0.26	0.34	0.98	0.77	0.93	1.57	0.08	0.80	0.38	0.57	0.40	1.57
-Date	29-30	22-23	29	24-25	12-13	25-26	18-19	4	28-29	31	9	8- 9	JUL 18-19
Snow, Ice pellets													
-Total	12.5	8.7	7.6	0.8	T	0.0	0.0	0.0	8.7	1.9	17.0	10.3	67.5
-Greatest (24 hrs)	5.4	3.3	3.4	0.7	T	0.0	0.0	0.0	8.7	1.9	7.1	6.9	8.7
-Date	29-30	22-23	29	26	13				28-29	13	9	8- 9	SEP 28-29
WIND:													
Resultant													
-Direction (!!!)	136	121	187	295	185	126	176	168	142	151	036	160	160
-Speed (mph)	0.4	0.4	1.8	0.7	1.7	2.0	1.6	3.1	2.0	1.3	0.8	1.3	1.1
Average Speed (mph)	6.6	7.3	10.3	8.9	8.6	8.3	7.9	7.6	7.9	7.5	6.7	7.5	7.9
Fastest Obs. 1 Min.													
-Direction (!!!)	31	04	28	33	30	27	30	35	04	30	06	30	33
-Speed (mph)	29	25	35	41	31	31	31	26	30	32	22	29	41
-Date	17	25	26	3	30	25	4	18	22	22	5	17	APR 3
Peak Gust													
-Direction (!!!)	NW	NE	W	N	N	W	NW	NW	N	NW	N	W	N
-Speed (mph)	41	39	52	53	45	46	44	48	44	41	37	37	53
-Date	15	25	26	4	13	21	4	6	24	22	5	23	APR 4

(!!!) See Reference Notes on Page 68

NORMALS, MEANS, AND EXTREMES

DENVER, COLORADO

LATITUDE: 39°45'N LONGITUDE: 104°52' W ELEVATION: FT. GRND 5282 BARO 5287 TIME ZONE: MOUNTAIN WBAN: 23062

	(a)	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:														
Normals														
-Daily Maximum		43.1	46.9	51.2	61.0	70.7	81.6	88.0	85.8	77.5	66.8	52.4	46.1	64.3
-Daily Minimum		15.9	20.2	24.7	33.7	43.6	52.4	58.7	57.0	47.7	36.9	25.1	18.9	36.2
-Monthly		29.5	33.5	38.0	47.4	57.2	67.0	73.3	71.4	62.6	51.9	38.8	32.5	50.2
Extremes														
-Record Highest	51	73	76	84	85	96	104	104	101	97	88	79	75	104
-Year		1982	1963	1971	1960	1942	1936	1939	1938	1960	1947	1941	1980	JUL 1939
-Record Lowest	51	-25	-30	-11	-2	22	30	43	41	17	3	-8	-21	-30
-Year		1963	1936	1943	1975	1954	1951	1972	1964	1985	1969	1950	1983	FEB 1936
NORMAL DEGREE DAYS:														
Heating (base 65°F)		1101	879	837	528	253	74	0	0	135	414	789	1004	6014
Cooling (base 65°F)		0	0	0	0	11	134	261	203	63	8	0	0	680
% OF POSSIBLE SUNSHINE	36	71	71	70	67	64	71	71	73	74	72	64	67	70
MEAN SKY COVER (tenths)														
Sunrise - Sunset	37	5.6	5.8	6.1	6.0	6.2	5.0	4.9	4.9	4.4	4.5	5.4	5.4	5.4
MEAN NUMBER OF DAYS:														
Sunrise to Sunset														
-Clear	51	10.0	8.1	7.8	6.9	6.1	9.6	9.1	10.0	13.5	13.5	10.3	10.6	115.5
-Partly Cloudy	51	9.2	8.8	10.3	10.7	12.1	12.3	15.9	13.8	8.9	9.0	9.4	9.8	130.2
-Cloudy	51	11.7	11.4	12.8	12.5	12.8	8.1	6.1	7.3	7.6	8.5	10.2	10.6	119.5
Precipitation .01 inches or more	51	5.8	5.7	8.6	8.8	10.6	8.8	9.2	8.6	6.2	5.3	5.3	5.2	88.3
Snow,Ice pellets 1.0 inches or more	51	2.3	2.4	3.7	2.5	0.5	0.0	0.0	0.0	0.3	1.2	2.5	2.3	17.7
Thunderstorms	51	0.0	0.*	0.2	1.5	6.3	9.8	11.1	8.2	3.4	0.9	0.1	0.0	41.4
Heavy Fog Visibility 1/4 mile or less	45	1.2	1.6	1.0	0.8	0.5	0.4	0.4	0.6	0.6	0.7	1.2	1.0	10.1
Temperature °F														
-Maximum														
90° and above	25	0.0	0.0	0.0	0.0	0.3	5.9	15.2	9.3	2.2	0.0	0.0	0.0	32.9
32° and below	25	6.9	4.2	3.0	0.5	0.0	0.0	0.0	0.0	0.*	0.3	2.5	5.1	22.6
-Minimum														
32° and below	25	30.0	26.4	25.4	12.0	1.7	0.0	0.0	0.0	1.0	8.7	24.7	29.1	158.9
0° and below	25	4.3	1.7	0.5	0.*	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.7	9.5
AVG. STATION PRESS.(mb)														
RELATIVE HUMIDITY (%)														
Hour 05	25	64	66	67	67	70	69	68	69	68	64	69	64	67
Hour 11 (Local Time)	25	46	43	42	38	39	37	35	36	38	36	44	45	40
Hour 17	25	49	43	41	35	38	35	34	35	34	35	49	51	40
Hour 23	25	63	64	62	58	61	59	56	58	59	59	65	63	61
PRECIPITATION (inches):														
Water Equivalent														
-Normal		0.51	0.69	1.21	1.81	2.47	1.58	1.93	1.53	1.23	0.98	0.82	0.55	15.31
-Maximum Monthly	51	1.44	1.66	4.56	4.17	7.31	4.69	6.41	5.85	4.67	4.17	2.97	2.84	7.31
-Year		1948	1960	1983	1942	1957	1967	1965	1979	1961	1969	1946	1973	MAY 1957
-Minimum Monthly	51	0.01	0.01	0.13	0.03	0.06	0.09	0.17	0.06	T	0.05	0.01	0.03	T
-Year		1952	1970	1945	1963	1974	1980	1939	1960	1944	1962	1949	1977	SEP 1944
-Maximum in 24 hrs	51	1.02	1.01	2.79	3.25	3.55	3.16	2.42	3.43	2.44	1.71	1.29	2.00	3.55
-Year		1962	1953	1983	1967	1973	1970	1965	1951	1936	1947	1975	1982	MAY 1973
Snow,Ice pellets														
-Maximum Monthly	51	23.7	18.3	30.5	28.3	13.6	0.3			21.3	31.2	39.1	30.8	39.1
-Year		1948	1960	1983	1935	1950	1951			1936	1969	1946	1973	NOV 1946
-Maximum in 24 hrs	51	12.4	9.5	18.0	17.3	10.7	0.3			19.4	12.4	15.9	23.6	23.6
-Year		1962	1953	1983	1957	1950	1951			1936	1969	1983	1982	DEC 1982
WIND:														
Mean Speed (mph)	37	8.7	9.0	9.8	10.2	9.4	8.9	8.4	8.1	8.0	7.9	8.4	8.7	8.8
Prevailing Direction through 1963		S	S	S	S	S	S	S	S	S	S	S	S	S
Fastest Mile														
-Direction (!!!)	31	N	NW	NW	NW	SE	S	SW	N	NW	NW	W	NE	SW
-Speed (MPH)	31	53	49	53	56	54	47	56	42	47	45	48	51	56
-Year		1976	1953	1952	1960	1978	1956	1965	1978	1955	1958	1962	1953	JUL 1965
Peak Gust														
-Direction (!!!)	2	NW	N	W	N	SE	W	NE	NW	W	NW	NW	NW	W
-Speed (mph)	2	41	51	52	53	48	46	45	48	56	41	44	47	56
-Date		1985	1984	1985	1985	1984	1985	1984	1985	1984	1985	1984	1984	SEP 1984

(!!!) See Reference Notes on Page 6B.

HEATING DEGREE DAYS Base 65 deg. F

DENVER, COLORADO

SEASON	JULY	AUG	SEP.	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	TOTAL
1956-57	1	20	66	277	829	901	1206	674	795	701	333	74	5877
1957-58	0	0	141	420	838	782	986	765	990	606	138	36	5702
1958-59	14	4	106	342	724	898	1081	968	841	572	273	25	5848
1959-60	0	6	191	518	815	876	1151	1159	827	434	245	38	6260
#1960-61	7	13	90	396	759	1187	1026	828	804	560	299	65	6034
1961-62	14	0	273	459	902	1150	1411	976	934	437	175	72	6803
1962-63	0	19	112	352	703	961	1417	768	848	442	156	50	5828
1963-64	6	7	29	229	690	1125	1059	1082	982	545	230	72	6056
1964-65	0	16	123	375	743	981	921	1044	1108	411	245	63	6030
1965-66	6	7	296	302	645	924	1122	1017	691	604	204	82	5900
1966-67	0	9	61	391	699	1018	954	832	679	498	388	135	5664
1967-68	4	16	108	389	729	1186	1086	885	751	655	343	38	6190
1968-69	10	35	145	399	871	1114	925	821	1011	378	204	144	6057
1969-70	2	0	56	801	769	998	1061	734	969	632	200	78	6300
1970-71	0	0	198	584	770	977	1018	958	817	508	329	25	6184
1971-72	24	0	273	479	771	1019	1063	832	621	486	246	4	5818
1972-73	42	15	107	397	960	1239	1162	820	771	646	290	56	6505
1973-74	8	0	166	321	758	1029	1277	831	671	507	137	67	5772
1974-75	0	9	199	381	803	1043	1024	957	852	621	332	85	6306
1975-76	0	4	195	363	840	843	1006	740	859	469	254	64	5637
1976-77	0	7	142	509	759	907	1105	749	771	414	137	0	5500
1977-78	2	14	38	358	737	920	1206	936	665	435	335	87	5733
1978-79	0	20	96	366	811	1245	1450	854	751	473	313	81	6460
1979-80	0	20	58	347	941	939	1204	876	828	514	247	9	5983
1980-81	0	4	56	386	683	731	853	801	727	260	243	26	4770
1981-82	0	12	19	375	570	898	1071	918	733	522	306	92	5516
1982-83	3	0	151	487	875	1050	1017	789	885	712	419	129	6517
1983-84	3	0	87	372	833	1469	1163	889	854	673	183	51	6577
1984-85	0	1	183	622	753	990	1215	1041	742	412	167	42	6168
1985-86	0	1	241	435	1051	1094							

See Reference Notes on Page 6B.
Page 5A

COOLING DEGREE DAYS Base 65 deg. F

DENVER, COLORADO

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
1969	0	0	0	0	35	44	312	284	46	0	0	0	721
1970	0	0	0	0	16	93	222	282	40	0	0	0	653
1971	0	0	0	0	0	149	203	248	53	0	0	0	653
1972	0	0	0	0	6	110	210	207	28	1	0	0	562
1973	0	0	0	0	2	138	199	270	21	1	0	0	631
1974	0	0	0	0	36	176	307	157	39	0	0	0	715
1975	0	0	0	0	3	69	246	192	39	5	0	0	554
1976	0	0	0	0	3	112	324	176	52	0	0	0	667
1977	0	0	0	2	11	214	297	182	93	0	0	0	799
1978	0	0	0	0	12	152	308	171	103	2	0	0	748
1979	0	0	0	0	2	112	275	163	102	7	0	0	661
1980	0	0	0	2	10	224	358	263	88	1	0	0	946
1981	0	0	0	7	6	195	346	236	121	1	0	0	912
1982	0	0	0	0	6	42	247	257	59	0	0	0	611
1983	0	0	0	0	7	69	264	301	91	0	0	0	732
1984	0	0	0	0	33	104	315	218	60	0	0	0	730
1985	0	0	0	1	19	137	256	238	63	0	0	0	714

See Reference Notes on Page 6B.
Page 5B

SNOWFALL (inches)

DENVER, COLORADO

SEASON	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	TOTAL
1956-57	0.0	0.0	0.0	0.6	21.3	6.3	5.3	1.6	8.9	25.5	8.8	0.0	78.3
1957-58	0.0	0.0	T	3.9	3.0	0.8	8.9	12.0	14.4	14.1	0.0	0.0	57.1
1958-59	0.0	0.0	T	2.6	9.7	7.7	17.4	17.5	26.8	17.6	T	0.0	99.3
1959-60	0.0	0.0	12.9	11.8	5.3	2.7	10.7	18.3	9.0	9.3	T	0.0	80.0
1960-61	0.0	0.0	0.0	4.6	5.1	17.8	1.0	7.9	29.2	8.6	6.4	0.0	80.6
1961-62	0.0	0.0	5.8	6.2	11.4	3.8	17.2	11.3	6.8	10.0	0.0	0.0	72.5
1962-63	0.0	0.0	0.7	0.0	5.0	1.2	9.1	2.1	18.0	0.2	0.0	0.0	36.3
1963-64	0.0	0.0	0.0	1.1	3.5	5.9	2.6	12.7	18.4	12.1	1.0	0.0	57.3
1964-65	0.0	0.0	0.0	T	6.0	4.4	13.2	17.1	14.9	0.3	T	0.0	55.9
1965-66	0.0	0.0	5.5	0.0	5.5	5.6	3.6	14.6	2.8	6.4	2.9	0.0	46.9
1966-67	0.0	0.0	T	8.3	3.0	1.9	9.9	4.4	6.6	3.6	3.0	0.0	40.7
1967-68	0.0	0.0	0.0	1.7	9.4	13.1	3.0	7.3	9.2	15.1	T	0.0	58.8
1968-69	0.0	0.0	0.0	0.4	5.8	6.9	2.8	4.2	13.2	T	0.0	0.0	33.3
1969-70	0.0	0.0	0.0	31.2	5.1	3.1	0.9	0.3	20.5	4.7	T	0.0	65.8
1970-71	0.0	0.0	4.6	5.9	9.2	0.9	8.6	11.9	9.6	6.0	T	0.0	56.7
1971-72	0.0	0.0	17.2	3.1	1.4	8.4	10.9	9.1	7.1	17.2	0.0	0.0	74.4
1972-73	0.0	0.0	0.0	9.7	19.4	9.8	12.1	3.0	15.1	24.8	1.0	0.0	94.9
1973-74	0.0	0.0	0.0	2.3	9.3	30.8	8.2	10.3	12.8	17.8	0.0	T	91.5
1974-75	0.0	0.0	1.8	1.0	11.9	2.1	3.6	4.0	14.3	10.9	6.1	0.0	55.7
1975-76	0.0	0.0	0.0	2.7	15.2	7.3	3.2	6.4	18.7	1.2	0.0	0.0	54.7
1976-77	0.0	0.0	0.0	7.2	4.5	3.1	2.4	3.1	9.6	4.7	0.0	0.0	34.6
1977-78	0.0	0.0	0.0	3.3	4.1	0.7	5.5	6.2	8.6	4.6	13.5	0.0	46.5
1978-79	0.0	0.0	T	2.7	6.9	14.2	9.1	5.8	18.2	8.1	8.2	0.0	73.2
1979-80	0.0	0.0	0.0	2.7	22.3	16.5	12.3	9.6	12.1	10.0	T	0.0	85.5
1980-81	0.0	0.0	0.0	1.5	7.1	1.2	4.1	4.3	24.0	2.9	T	0.0	45.1
1981-82	0.0	0.0	0.0	2.8	3.3	9.9	4.8	1.8	2.1	2.0	T	0.0	26.7
1982-83	0.0	0.0	0.0	1.2	1.8	27.1	1.3	0.8	30.5	11.3	7.6	0.0	81.6
1983-84	0.0	0.0	T	T	29.3	11.5	3.4	7.9	12.0	16.8	T	0.0	80.9
1984-85	0.0	0.0	5.2	13.1	2.3	5.0	12.5	8.7	7.6	0.8	T	0.0	55.2
1985-86	0.0	0.0	8.7	1.9	17.0	10.3							
Record Mean	0.0	0.0	1.7	3.7	8.3	7.1	7.8	7.4	13.0	9.1	1.8	T	60.0

See Reference Notes on Page 6B.

REFERENCE NOTES

DENVER, COLORADO

GENERAL
T - TRACE AMOUNT.
BLANK ENTRIES DENOTE MISSING/UNREPORTED DATA.
INDICATES A STATION OR INSTRUMENT RELOCATION.
SEE STATION LOCATION TABLE ON PAGE 8.

SPECIFIC
PAGE 2
PM - INCLUDES LAST DAY OF PREVIOUS MONTH

PAGE 3
(a) - LENGTH OF RECORD IN YEARS, ALTHOUGH INDIVIDUAL MONTHS MAY BE MISSING.
* LESS THAN .05
NORMALS - BASED ON THE 1951-1980 RECORD PERIOD.
EXTREMES - DATES ARE THE MOST RECENT OCCURRENCE
WIND DIR.- NUMERALS SHOW TENS OF DEGRESS CLOCKWISE FROM TRUE NORTH. "00" INDICATES CALM.
RESULTANT DIRECTIONS ARE GIVEN TO WHOLE DEGREES.

EXCEPTIONS

PAGE 3
1. FASTEST MILE WINDS ARE THROUGH AUGUST 1981.
PAGES 4A, 4B, 6A
RECORD MEANS ARE THROUGH THE CURRENT YEAR, BEGINNING IN 1872 FOR TEMPERATURE
1872 FOR PRECIPITATION
1935 FOR SNOWFALL

DENVER, COLORADO

Denver enjoys the invigorating climate that prevails over much of the central Rocky Mountain region, without the extremely cold mornings of the high elevations during winter, or the hot afternoons of summer at lower altitudes. Extremely warm or cold weather in Denver is usually of short duration.

Situated a long distance from any moisture source, and separated from the Pacific Ocean by several high mountain barriers, Denver enjoys low relative humidity, light precipitation, and abundant sunshine.

Air masses from four different sources influence Denver weather. These include arctic air from Canada and Alaska, warm, moist air from the Gulf of Mexico, warm, dry air from Mexico and the southwestern deserts, and Pacific air modified by its passage over mountains to the west.

In winter, the high altitude and mountains to the west combine to moderate temperatures in Denver. Invasions of cold air from the north, intensified by the high altitude, can be abrupt and severe. However, many of the cold air masses that spread southward out of Canada never reach the altitude of Denver, but move off over the lower plains to the east. Surges of air from the west are moderated in their descent down the east face of the Rockies, and reach Denver in the form of chinook winds that often raise temperatures into the 60s, even in midwinter.

In spring, polar air often collides with warm, moist air from the Gulf of Mexico and these collisions result in frequent, rapid and drastic weather changes. Spring is the cloudiest, windiest, and wettest season in the city. Much of the precipitation falls as snow, especially in March and early April. Stormy periods are interspersed with stretches of mild, sunny weather that quickly melt previous snow cover.

Summer precipitation falls mainly from scattered thunderstorms during the afternoon and evening. Mornings are usually clear and sunny, with clouds forming during early afternoon to cut off the sunshine at what would otherwise be the hottest part of the day. Severe thunderstorms, with large hail and heavy rain occasionally occur in the city, but these conditions are more common on the plains to the east.

Autumn is the most pleasant season. Few thunderstorms occur and invasions of cold air are infrequent. As a result, there is more sunshine and less severe weather than at any other time of the year.

Based on the 1951–1980 period, the average first occurrence of 32 degrees Fahrenheit in the fall is October 8 and the average last occurrence in the spring is May 3.

STATION LOCATION

DENVER, COLORADO

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude North	Longitude West	Elevation above Sea level: Ground at temperature site	Elevation above Ground: Wind instruments	Extreme thermometers	Psychrometer	Sunshine Switch	Tipping bucket rain gage	Weighing rain gage	8" rain gage	Hygrothermometer	Automatic Observing Equipment *	* Type M = AMOS T = AUTOS Remarks
COOPERATIVE																
One or more locations	11/1859	12/1873	NA													Voluntary observers, broken record.
CITY																
16th (formerly G Street) & Larimer Streets	11/10/71	3/15/73	NA	39° 45'	105° 00'	5177	51	ø20	ø20				48			ø - Estimated.
Woodward Building on Market (formerly Holiday Street) between 15th & 16th Streets	3/15/73	11/30/75	400' WNW	39° 45'	105° 00'	5212	71	37	36				52			
McClintock Block 16th Street	11/30/75	7/1/77	350' ESE	39° 45'	105° 00'	5214	ø70	ø32	ø32				ø50			ø - Estimated.
Broadwell Block on Larimer Street	7/1/77	6/13/81	200' ENE	39° 45'	105° 00'	5214	80	45	44				60			
Tabor Block, 16th & Larimer Streets	6/13/81	12/1/87	200' WSW	39° 45'	105° 00'	5204	109	73	72				86			
Patterson & Thomas Block 17th & Curtis Streets	12/1/87	5/1/91	1100' ESE	39° 45'	105° 00'	5218	103	86	86				79			
Club Building 1700 Block on Arapahoe Street	5/1/91	10/1/95	375' N	39° 45'	105° 00'	5229	121	108	107		97		97			
U. S. Post Office 16th & Arapahoe Streets	10/1/95	12/8/04	600' SW	39° 45'	105° 00'	5214	151	83 a79	83 a79		74		74			a - Effective 6/13/96.
Boston Building 17th & Champa Streets	12/8/04	1/29/16	800' E	39° 45'	105° 00'	5219	136 b172	129	128		119		119			b - Effective 3/1/10.
New Post Office Building 19th & Stout Streets	1/29/16	Present	1000' ENE	39° 45'	105° 00'	5221	113 c	106	108	NA	98 c	NA d98	98 c	NA	NA	c - Removed 4/1/50. d - Installed 4/1/50.
AIRPORT																
Administration Building Stapleton Airfield	9/15/31	6/25/47	NA	39° 46'	104° 53'	5292	59	46	46			5	42			
WB-FAA Building Stapleton Airfield †	6/25/47	5/7/69	0.3 mi.NW	39° 46'	104° 53'	5292 15283	72 g20	6	6	NA e19 f40	4	6	5	NA h5	NA	e - Installed 3/31/50. f - Effective 2/1/57. g - Effective 7/8/60. Fastest mile data from 40' prior to 7/12/60. h - Commissioned 5200' ESE of thermometer site 8/1/60. i - Effective 8/1/60. j - Not moved 5/7/69.
† Stapleton Int'l AP (Effective 10/1/64)																
W. B. Forecast Office †† Stapleton International Airport †† Weather Service Fcst Office (Effective 1970)	5/7/69	1/20/82	1.7 mi.ESE	39° 45'	104° 52'	5283	j20	5	5	22	4	4	4	j5	NA	
Weather Service Fcst Office Stapleton International Airport	1/20/82	Present	1 mi. N	39° 46'	104° 52'	5282	33	5	5	25	4	4	4	5	NA	

SUBSCRIPTION:
Price and ordering information available through: National Climatic Data Center, Federal Building, Asheville, North Carolina 28801

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CLIMATOGRAPHY OF THE UNITED STATES NO. 82 – 5

DECENNIAL CENSUS OF UNITED STATES CLIMATE–

SUMMARY OF HOURLY OBSERVATIONS

105th Meridian Time Zone

DENVER, COLORADO

Stapleton Airfield

1951 - 1960

Washington, D.C.: 1963
Reprinted February 1974

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PREFACE AND EXPLANATION OF TABLES

This summary of surface weather data is one of a series prepared under the Decennial Census of United States Climate, 1960 program. Similar summaries are being published for most Weather Bureau stations. All data are based on monthly data published in Local Climatological Data Supplements for all or part of the period 1951 - 1960. Where the full 10-year period is not covered by the monthly data, summaries are based on the period 1956 - 1960.

This series supersedes the series entitled "Climatography of the United States No. 30-Summary of Hourly Observations", which was published in 1956. It differs from this earlier information in that a longer, more representative period is used for summarization wherever possible. Comparability between stations is improved in the Decennial Census series by the use of identical 10-year and 5-year periods.

The tables in this pamphlet are similar to Tables A through E in the monthly Local Climatological Data Supplements except that Tables B, D, and E give percentage frequencies instead of total occurrences. In these tables all hourly observations are represented unless otherwise specified. The total number of observations used is indicated on each page under the month name. In the percentage tables "+" indicates more than 0 but less than 0.5 in Table E and 0.05 in Tables B and D. Values are not adjusted to make their sums exactly equal to column or row totals.

STATION LOCATION

DENVER, COLORADO
STAPLETON AIRFIELD

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude	Longitude	Elevation above (feet)									Remarks
						Sea level		Ground							
						Ground	Actual barometer elevation (H_a)	Wind instruments	Extreme thermometers	Psychrometer	Telepsychrometer	Tipping bucket rain gage	Weighing rain gage	8" rain gage		
WB-FAA BLDG MODIFICATION CTR STAPLETON AIRFIELD	6/25/47	8/1/60	1/4 MI NW	39°46'N	104°53'W	5292	5298	40	6	6		4	3	3		(a) Mean Hourly Speed and Prevailing Direction from 72' above ground atop the FAA Tower prior to 7/8/60. Fastest Mile from 40' above ground at listed location prior to 7/12/60. Hygrothermometer installed at remote site 5200' ESE of listed location 8/1/60. (b) Temperature and Relative Humidity data shown in this publication are from 6' above ground at listed location prior to 8/1/60.
	8/1/60	PRESENT	NO CHANGE	39°46'N	104°53'W	5292	5298	72 20a	6b	6b	5	4	3	3		

LOCATION AND TOPOGRAPHY:

The airport is located at the northeast edge of Denver on slightly higher ground than most of the city. Denver is on the Great Plains about 40 miles east of the main range of the Rocky Mountains (10,000 to 14,000 feet above sea level) and 18 miles east of the foothills (6000 to 8000 feet elevation). These ranges run almost due north and south. About 40 miles south of Denver is the Palmer Lake Divide, a connecting spur that extends due east of the main range. Its altitude varies frc 8600 feet where it joins the Rockies to about 4000 feet near the Kansas line. The South Platte river flows from the southwest to the northeast about 5 miles west and 2-1/2 miles north of the airport.

SMOKE SOURCES:

Smoke is important only during the colder half of the year. At this time some smoke from the city is carried over the airport on a light west wind (southwest to northwest) but rarely limits visibility to less than three miles.

t and 2-1/2 miles north of the airport.

DEN..R, COLORADO
Stapleton Airfield

JANUARY
7440 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR.	0-4 MPH						5-16 MPH						17-24 MPH						25 MPH AND OVER						TOTAL OBS.
TEMP. °F																									
74/ 70	2						1						2												5
69/ 65	4						11						11												26
64/ 60	18						35						37						4						94
59/ 55	25						104	6					58	4					6						203
54/ 50	35	6					155	41					68	17					11	1					334
49/ 45	43	16	1				180	146	4				91	69	4				16	3					553
44/ 40	29	50	16				142	262	50	2			68	107	7				12	12	2				758
39/ 35	19	76	61	9	1		63	318	209	17	1		37	112	53	9			11	13	2	2			990
34/ 30	6	49	70	33	13	7	24	262	319	81	27	14	13	68	57	7	8	9	1	10	2	2	1		1081
29/ 25		21	100	35	19	16	9	163	358	78	59	30	6	59	57	8	9	10		2		2			1042
24/ 20	1	18	46	32	34	25	12	103	240	99	119	33	2	43	37	19	23	8							892
19/ 15			7	42	33	31	1	4	74	180	86	69	3	16	34	13	15								570
14/ 10			2	19	30	27			10	90	83	68		7	16	9	3				1				365
09/ 05			5	8	22	24	2		3	58	72	41		2	12	10	5								262
04/ 00			1	9	8	5			3	36	33	9			6	5									115
-01/-05				17	11	2			2	44	28	2			1										105
-06/-10			1	9	2				4	16	2														34
-11/-15			1	1					1	3	1														7
-16/-20																									0
-21/-25							1		2																6
TOTAL	182	252	999	209	156	49	741	1334	1601	980	399	80	393	484	284	74	63	27	61	45	4	4	1		7440

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (m.p.h.)										AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47-54	TOTAL	
N	.8	1.5	2.3	1.3	.2	+		+		6.0	9.7
NNE	.5	1.5	1.8	1.2	.2	+				5.1	9.5
NE	.9	1.4	1.5	.7	.1	.1				4.5	8.3
ENE	.3	1.2	1.3	.6	+	.1				3.4	8.9
E	.5	1.3	1.3	.5	.3	.1				3.7	9.1
ESE	.6	1.2	1.0	.5	.1	+				3.3	8.4
SE	.7	1.5	1.4	.7	.1					4.4	8.4
SSE	.8	1.4	1.8	.6	.1					4.8	8.7
S	.9	4.3	7.8	5.5	.5	+				19.0	10.3
SSW	.6	3.0	6.5	6.4	.5	+				16.9	11.1
SW	.7	1.7	2.0	.9	.1					5.4	8.8
WSW	.5	1.0	.9	.5	.2	.1	+			3.2	9.7
W	.5	1.2	1.0	1.0	.3	.2	+			4.1	11.1
WNW	.4	.9	1.2	1.5	.5	.5	.1			5.4	14.0
NW	.7	1.7	1.8	1.4	.5	.4	+			6.6	11.7
NNW	.4	1.0	1.2	.6	.1	+				3.3	8.8
CALM	.5									.5	
TOTAL	9.6	25.8	34.4	24.2	4.6	1.4	.2			100	10.1

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								NO. OF DAYS
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	MIDNT	1	2	3	4	5	6	7	8	9	10	11	MIDNT	
TRACE	23	21	20	19	24	36	31	27	24	20	24	26	21	24	25	23	22	22	24	26	21	21	22	24	38
0+ TO	5	10	14	8	12	7	9	6	6	11	7	5	5	2	1	4	6	4	5	5	6	10	9	9	14
04 TO 09 IN	11	6	5	11	6	3	3	5	4	3	2		1	5	3	3	1	2	3	4	6	4	7	5	27
10 TO 14 IN				1																					11
15 TO 49 IN																									6
50 TO 99 IN																									
1.00 TO 1.99 IN																									
2.00 IN AND OVER																									
TOTAL	39	37	39	39	42	46	43	38	34	34	33	31	27	29	29	30	29	28	34	35	33	35	38	40	96

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING FEET									
	0	100-200	200-400	400-800	800-1500	1500-2500	2500-3500	3500-5000	OVER 5000	TOT
0 TO 1/8	.1	.1	+						+	.2
3/16 TO 3/8	+	.3	+	+						.6
1/2 TO 3/4		.1	.1	.2		+		+	+	.5
1 TO 2 1/2		.1	.2	1.3	1.0	.4	.1	+	.2	3.2
3 TO 6		+	.2	.6	1.5	.3	.6	.2	2.6	6.6
7 TO 15		+	+	.2	1.1	.6	.2	1.3	24.4	29.7
20 TO 30				+	.3	.1	.1	1.0	21.9	23.4
35 OR MORE						+	+	.3	33.4	36.1
TOTAL	.1	.6	.7	2.8	4.0	1.6	1.0	3.2	85.0	100

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS SCALE 0-10			WIND SPEED (M.P.H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25-8 OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	60	14	26	9	61	28	2	6	24	39	14	11	5
01	58	17	25	9	64	27	+	6	25	36	15	14	5
02	59	15	26	9	64	27		6	27	36	14	13	4
03	58	15	26	7	64	29		6	26	35	17	14	2
04	56	17	27	12	57	31	1	5	27	36	15	14	3
05	53	15	33	9	58	32	1	6	28	36	14	14	2
06	49	17	35	10	59	30	1	5	30	36	14	12	4
07	44	16	40	9	59	31	1	5	28	39	14	12	3
08	41	15	44	12	58	30		8	34	34	12	10	2
09	41	20	39	9	59	32	1	11	36	28	12	8	1
10	44	20	36	9	59	30	3	20	38	20	9	5	1
11	42	19	39	9	60	28	3	36	34	20	5	4	1
12	41	17	41	11	57	27	5	45	29	18	6	2	1
13	38	18	45	10	56	29	5	43	30	18	5	1	1
14	37	19	44	10	55	32	3	43	32	18	5	+	1
15	39	18	43	9	54	33	4	42	28	21	7	1	1
16	37	17	46	6	61	31	2	35	32	23	7	3	1
17	37	20	43	10	63	25	3	24	32	30	8	5	1
18	44	19	37	14	64	22	+	19	29	32	10	9	2
19	48	18	34	9	66	24	1	16	25	35	14	8	2
20	51	16	33	10	65	25	2	13	23	37	13	12	2
21	51	18	31	11	59	29	1	11	23	37	15	11	3
22	55	16	28	11	58	30	1	9	23	38	18	10	3
23	58	16	26	8	62	29	+	8	25	37	16	10	5
AVG	47	17	35	10	60	29	2	19	29	31	12	8	2

...C OLORADO
Sta Airfield

FEBRUARY
6792 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR. / TEMP. °F	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
74/ 70	6						10						4												20
69/ 65	10						34						12												56
64/ 60	16	1					60	2					59						16						153
59/ 55	25	2					192	12					69	4					16	1					264
54/ 50	28	9					142	72	2				82	27					16	2					382
49/ 45	21	34	6				149	135	19				58	69	14				16	5					516
44/ 40	15	42	23	1			97	231	65	6			30	109	14				12	1					605
39/ 35	14	49	47	10	1		56	248	209	36	15	6	33	99	46	12	4		16	4	1				938
34/ 30	1	36	74	32	31	13	28	161	245	102	80	61	14	92	40	7	16	11	4	3	1				1057
29/ 25	3	18	58	56	69	14	8	105	216	119	125	55	9	43	32	11	22	6	2	2	1				980
24/ 20	3	11	44	29	49	32	3	42	122	93	141	90		16	22	7	23	6							701
19/ 15		1	29	15	24	9	1	25	83	62	80	9		6	37	4	11								424
14/ 10		1	11	7	22	3		20	69	49	24			4	21	14	10			1	1				238
09/ 05			14	15	9			9	45	52	16		1		11	4	6								179
04/ 00			7	11	4			4	43	24	10				5	3									115
-01/-05			4	3					18	11	2			1	2	1									40
-06/-10			4	3					9	1			1												16
-11/-15																									0
-16/-20							1						1												2
-21/-25								1																	1
TOTAL	142	205	327	178	203	61	729	1067	1346	957	699	179	412	461	237	63	92	43	93	18	4	19			6792

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MILES PER HOUR)								AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	TOTAL	
N	.5	1.6	2.6	1.8	.8	.3	+	7.5	11.7
NNE	.5	1.7	2.2	1.3	.4	.2	.1	6.4	10.7
NE	.8	1.6	1.8	.8	.1	+	+	4.3	8.7
ENE	.6	1.0	1.0	.6	.1			3.3	8.7
E	.4	1.3	2.4	.9	.1			5.1	8.9
ESE	.3	1.3	2.0	.8	.2	+		4.6	8.9
SE	.7	1.8	2.3	.8	.1	+		5.5	7.9
SSE	.4	1.4	1.9	.7	+	+		4.5	7.9
S	1.0	3.3	7.2	5.2	.9	.1		17.6	10.4
SSW	.7	2.9	5.2	5.6	.8	.1		14.7	11.1
SW	.6	1.5	1.6	.8	.2	+		4.7	9.0
WSW	.2	1.0	.9	.4	.1	.1	+	2.7	9.3
W	.3	.8	1.0	1.1	.5	.4	.1	3.9	13.8
WNW	.6	.9	.9	1.6	1.1	.8	.1	5.9	15.0
NW	.7	1.3	1.7	1.7	1.1	.6	+	7.4	12.3
NNW	.4	1.1	1.3	.6	.2	.1	+	3.7	9.7
CALM	.7							.7	
TOTAL	9.2	25.1	33.0	24.1	5.8	2.6	.4	+	100	10.5

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OBS.
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	MIDN.	1	2	3	4	5	6	7	8	9	10	11	MIDN.	
TRACE	29	32	24	25	27	32	32	32	22	25	28	24	25	23	30	21	27	28	31	29	30	28	22	24	493
.01 - .09	4	5	10	6	4	5	10	3	7	4	3	4	5	5	5	8	4	6	7	8	4	8	6	8	97
.10 TO .24	10	7	6	14	17	11	5	8	9	12	11	10	8	8	5	7	8	7	6	9	10	9	14	7	364
.25 TO .49								1												1	1		1	1	132
.50 TO .99																									8
1.00 TO 1.99																									2
2.00 IN AND OVER																									1
TOTAL	43	44	40	45	48	48	47	44	38	41	42	38	36	36	40	36	39	41	44	43	45	45	43	40	1107

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										
	0	100	200	500	1000	1500	2000	3000	4000	OVER 5000	TOT.
0 TO 1/8	.1	.1	+							.1	.2
3/16 TO 1/8	+	.2	.2	.1							.6
1/2 TO 3/4	+	.1	.4	.8	+					.1	1.3
1 TO 2 1/2	+	.4	.8	1.1	1.0	.2	.2	.1	.1	.5	5.2
3 TO 6		.1	.4	1.2	1.1	.6	.5	.2	.2	.7	7.1
7 TO 15				+	.8	.5	.5	1.1	1.6	22.5	27.8
20 TO 30					.1	.2	.5	1.2	19.6	21.9	
35 OR MORE						+	+	.9	34.7	35.6	
TOTAL	.1	.9	1.8	4.9	3.0	1.9	2.5	4.0	80.0	100	

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS (SCALE 0-10)			WIND SPEED (M.P.H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25-OVER	0-29	30-39	40-59	60-79	80-89	90-100
00	57	11	32	7	61	30	2	7	20	35	19	16	4
01	58	11	31	10	56	33	1	6	19	35	18	16	6
02	57	11	32	9	61	29	1	7	22	33	16	16	7
03	55	12	33	10	55	33	2	6	22	32	16	18	7
04	53	14	33	10	59	30	1	5	25	32	15	16	7
05	55	12	33	10	57	29	2	6	24	31	15	17	7
06	47	16	37	9	55	35	1	2	28	29	18	16	7
07	39	17	44	10	50	39	1	5	27	31	15	16	9
08	34	16	51	10	52	36	2	12	31	29	12	13	9
09	35	15	50	10	54	35	2	20	35	25	6	10	4
10	38	17	46	12	55	28	3	29	35	18	5	8	4
11	37	18	45	10	63	25	2	41	29	18	5	6	3
12	35	20	45	11	56	28	3	44	27	19	4	5	2
13	31	24	45	11	52	32	3	45	28	14	5	6	2
14	30	19	51	7	54	31	8	48	24	16	5	6	1
15	29	18	53	7	49	36	8	45	29	14	6	6	1
16	30	17	52	8	52	33	7	41	30	16	6	6	1
17	33	11	56	7	60	30	3	35	27	22	7	6	2
18	38	15	47	9	60	28	4	22	28	25	15	10	5
19	41	18	41	10	65	23	2	16	30	25	13	13	3
20	46	16	38	10	67	22	1	13	26	28	14	14	4
21	51	14	35	7	69	24	+	11	25	29	15	14	4
22	52	13	36	7	64	28	1	9	25	29	17	10	5
23	55	11	34	8	60	31	1	7	23	31	18	17	5
AVG	43	15	42	9	58	30	3	20	28	25	12	12	4

DENVER, COLORADO
Stapleton Airfield

MARCH
7440 Obs.

DENVER, COLORADO
Stapleton Airfield

MARCH
7440 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR. / TEMP. (°F)	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
	00-06	07-12	13-18	19-24	25-30	31-36	00-06	07-12	13-18	19-24	25-30	31-36	00-06	07-12	13-18	19-24	25-30	31-36	00-06	07-12	13-18	19-24	25-30	31-36	
75/ 79							1																		1
70/ 74	8						39						9												56
65/ 69	17						58	1					22						6						104
60/ 64	42	1					180	3					60	3					32						319
55/ 59	32	1					190	26					109	12					24	3					397
50/ 54	26	14					181	90	10				123	37	3				32	12					532
45/ 49	38	39	8				193	191	50	1			88	70	17	1			26	14	3				692
40/ 44	27	50	29	4	1		119	234	148	18	11	6	74	113	46	5			23	15	3				924
35/ 39	11	47	64	19	15	8	50	268	229	68	58	24	24	74	58	8	8		9	25	5				1078
30/ 34	3	34	66	43	29	30	22	161	236	139	93	77	11	62	45	10	19	21	3	10	2				1162
25/ 29		28	46	34	42	12	6	100	162	148	114	48	2	19	52	14	40	2	1	2					937
20/ 24		10	30	20	35	9	1	34	109	86	110	22		5	19	11	42								552
15/ 19		1	22	12	30			6	63	38	103	13		2	14	4	33								361
10/ 14		1	9	9	8			5	33	41	21			1	4		8								142
05/ 09			8	10	9				27	32	15				7		6								116
00/ 04			11	3	2				10	9	10				2		3								60
-01/-05			1	2	1				2		1				2										17
-06/-10			2						2																4
TOTAL	199	226	296	168	160	59	1000	1080	980	600	539	190	520	394	239	76	160	58	166	81	16	10	1	2	1	7440

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MI. PER HOUR)										TOTAL	AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47-54	55 & OVER		
N	.4	1.3	2.7	1.8	.5	.3	.2	.1			8.0	13.8
NNE	.3	1.3	2.5	1.5	.3	.5	.3	.1			7.4	13.6
NE	.5	1.4	1.6	1.0	.3	.1	*				5.1	10.3
ENE	.3	1.3	1.3	1.1	.2	.1					4.2	10.0
E	.5	1.3	1.9	1.0	.2	*					4.9	9.6
ESE	.5	1.0	1.5	.8	.1	*					3.8	9.1
SE	.5	1.6	1.8	1.0	.3	.1					5.3	9.5
SSE	.5	1.1	1.9	.7	.2	.1					4.4	9.6
S	1.0	3.4	6.0	3.2	.6	.1	*				14.0	9.9
SSW	.7	2.9	4.9	3.7	.9	.2	*				13.2	10.4
SW	.6	1.5	1.6	.8	.3	.1	*				4.9	9.7
WSW	.3	.9	.7	.6	.2	*					2.9	10.3
W	.5	.8	1.0	.5	.3	.1	*				3.3	12.3
WNW	.3	.8	1.0	1.6	1.3	.8	.2	.1			6.0	16.3
NW	.7	1.6	2.0	1.7	.9	.6	.1				7.6	12.6
NNW	.3	1.2	1.5	1.2	.5	.1					4.5	10.8
CALM	.7										.7	
TOTAL	8.6	23.2	33.9	22.7	7.0	3.6	1.1	.2			100	11.2

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OBS. WITH PRECIP.
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	MID.	1	2	3	4	5	6	7	8	9	10	11	MID.	
TRACE	39	39	38	37	39	41	30	23	27	25	19	26	19	25	21	27	26	30	32	33	31	35	26	34	49
.01 TO .09 IN.	9	12	13	12	17	7	7	10	7	7	11	5	4	8	4	9	8	7	7	6	14	7	11	8	18
.10 TO .99 IN.	9	8	10	12	8	8	10	11	9	9	7	7	10	6	8	9	9	7	10	14	9	13	14	9	30
1.00 TO 1.99 IN.	2	2	1		1		1		2	1								1	2	1	2	1	1	1	10
2.00 TO 2.99 IN.																									14
3.00 TO 3.99 IN.																									4
4.00 TO 4.99 IN.																									1
5.00 IN. AND OVER																									
TOTAL	59	59	62	61	65	56	48	44	45	42	37	38	33	39	33	39	43	45	51	54	56	56	52	54	56

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										TOT
	0	100	200	300	500	1000	1500	2000	3000	5000	
0 TO 1/8	0	.1			0					0	.1
3/16 TO 3/8	0	.1	.1	0						0	.2
1/2 TO 3/4		.1	.3	.6	0		0				1.3
1 TO 2 1/2		.2	.3	2.1	1.4	.2	.2	.3	.3		7
3 TO 6		.1	.4	1.3	1.6	.6	.6	.5	2.0		7.6
7 TO 15			0	.1	.7	1.7	1.6	2.3	2.0	21.2	29.6
20 TO 30					.1	.3	.6	1.6	18.5	21.5	
35 OR MORE						0	.2	1.2	33.4	34.8	
TOTAL	0	.6	1.7	4.9	5.0	2.7	4.3	9.5	75.5	100	

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUD SCALE 0-10			WIND SPEED (M.P.H.)				RELATIVE HUMIDITY (%)					
	0-2	3-7	8-10	0-3	4-12	13-24	25-& OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	52	8	40	11	58	26	5	11	22	29	19	16	4
01	50	11	39	10	59	27	4	9	23	29	18	17	4
02	50	14	35	12	57	28	3	7	25	28	18	17	5
03	47	15	38	12	62	24	3	7	21	29	20	18	5
04	48	15	36	10	62	27	1	6	21	27	19	20	7
05	51	12	37	12	62	25	2	6	22	29	21	20	3
06	45	13	42	12	62	24	2	5	19	28	18	20	9
07	40	13	47	13	57	27	3	7	25	31	14	16	6
08	38	15	47	13	61	24	2	15	32	24	13	12	4
09	41	15	44	13	57	24	6	28	28	23	10	9	2
10	41	17	42	8	64	20	8	37	26	22	9	6	1
11	39	20	41	7	59	25	10	46	25	18	6	4	1
12	38	16	46	6	56	28	10	49	26	16	6	3	1
13	34	23	43	7	49	35	9	51	29	16	2	2	1
14	32	21	47	5	50	33	12	52	26	14	5	2	1
15	31	19	50	6	41	41	12	53	25	16	3	2	1
16	31	19	50	5	40	46	9	50	26	17	5	2	1
17	30	17	53	3	45	47	5	46	28	18	5	2	1
18	34	17	49	5	53	39	3	34	29	22	10	4	1
19	39	17	44	5	58	34	3	28	31	23	10	5	2
20	43	16	41	5	57	33	5	19	30	23	12	15	3
21	43	15	41	5	65	25	3	16	28	25	15	12	4
22	48	13	39	5	63	27	3	13	29	26	15	15	3
23	48	14	38	5	62	26	3	14	27	27	17	10	4
AVG	41	19	41	9	57	30	5	25	25	22	12	12	4

DE[illegible] COLORADO
Stapleton Airfield

APRIL
7200 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND (MPH)	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
TEMP. (°F)	0-29%	30-49%	50-69%	70-89%	90-100%	0-100%	0-29%	30-49%	50-69%	70-89%	90-100%	0-100%	0-29%	30-49%	50-69%	70-89%	90-100%	0-100%	0-29%	30-49%	50-69%	70-89%	90-100%	0-100%	
85/ 89	1						8						9						1						18
80/ 84	13						55						55						18						139
75/ 79	26						142	1					103						22						294
70/ 74	47	1					208	7					100	6					38	1					406
65/ 69	62	12					199	55					120	21					42	4	2				517
60/ 64	55	42	5				227	114	22	1			96	64	15				26	11	2				682
55/ 59	30	41	17				154	218	84	11	5		94	105	40	5			15	22	3	2			644
50/ 54	13	56	37	10	3	3	79	295	191	32	22	17	38	87	41	10	6	2	27	17	3	2			931
45/ 49	6	45	54	32	21	3	48	202	214	110	67	19	38	59	64	19	16	7	18	5	10	4			1067
40/ 44	1	20	56	28	31	21	17	92	208	101	121	69	8	25	31	26	27	21	4	3	5	2	2		920
35/ 39	8	8	34	19	27	31	6	36	124	77	114	136	2	3	20	9	14	53			2	2	2		735
30/ 34	1	1	20	19	21	12	1	16	60	71	103	48		1	7	12	26	23							452
25/ 29			11	2	8	8			18	16	52	18			2	3	13	13							143
20/ 24				3	1	2			3	3	6	1			3										22
15/ 19					2	1			3	3	8					2	1								18
10/ 14					1					7	5						1								12
05/ 09																									
TOTAL	293	224	236	113	119	83	1140	976	924	440	477	308	659	371	223	86	106	120	213	64	25	10	10	15	7200

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MI. P. H.)								AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32 & OVER	TOTAL	
N	.4	1.5	2.2	2.1	.7	.3		7.1	12.2
NNE	.3	1.3	2.7	1.9	.6	.3	+	7.5	11.7
NE	.7	1.9	1.7	1.5	.3	.1	+	6.1	9.8
ENE	.3	1.5	1.4	1.2	.3	.1		4.8	10.2
E	.6	1.3	1.6	1.2	.4	.1		5.1	10.3
ESE	.4	.8	1.6	.7	.2	.1		3.8	10.0
SE	.6	1.3	1.7	.9	.2	.1	+	4.8	9.7
SSE	.3	1.5	1.6	.9	.3	.1	+	5.6	12.5
S	.6	2.9	5.0	4.6	1.4	.6	.2	15.2	12.4
SSW	.6	2.6	3.9	3.4	.6	.2	.1	11.1	11.1
SW	.3	1.4	1.3	.7	.3	.1	+	4.5	9.5
WSW	.3	.9	.8	.6	.2	.2		3.0	10.9
W	.4	.8	.8	.6	.4	.3	.1	.1	3.7	13.4
WNW	.3	.8	1.2	1.1	.7	.5	.1	.1	+	4.8	14.2
NW	.6	1.7	1.9	1.4	.9	.5	+			7.0	12.0
NNW	.4	1.2	1.7	1.3	.5	.1	+			5.0	10.9
CALM	.8									.8	
TOTAL	8.0	23.5	31.5	24.3	7.9	3.9	.7	.2	+	100	11.3

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OBS.
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	MIDN.	1	2	3	4	5	6	7	8	9	10	11	MIDN.	
TRACE	23	26	20	22	22	26	22	23	20	19	24	28	31	38	36	38	37	35	30	38	30	25	23	25	48
.01 TO .09 IN.	10	6	6	9	6	8	9	6	7	10	5	4	7	7	8	11	8	14	11	11	14	12	5	10	12
.10 TO .24 IN.	11	10	14	19	13	9	10	14	13	9	10	12	4	5	6	8	11	9	15	17	16	15	22	12	40
.25 TO .49 IN.	2	2	2	1		2	2			1	2	2	2			1	1	3	3	2	2	2	1	2	18
.50 TO .99 IN.																						1			12
1.00 TO 1.99 IN.																									9
2.00 IN. AND OVER																									2
TOTAL	46	44	42	47	41	45	43	43	40	39	41	46	44	50	50	58	57	61	59	68	62	55	51	49	241

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										TOTAL
	0	100 OR LESS	101 TO 200	201 TO 500	501 TO 1000	1001 TO 1500	1501 TO 2000	2001 TO 2500	2501 TO 3000	3001 OR MORE	
0 TO 1/8		+		+					+	.1	
3/16 TO 3/8		.2	.3						+	.3	
1/2 TO 3/4		.2	.4	.4	+				+	1.0	
1 TO 2 1/2		.2	.3	2.1	.7	.2		+	.2	3.8	
3 TO 6		+	.4	1.6	1.4	.6	.4	.3	1.3	5.9	
7 TO 15		+	.1	1.3	3.6	1.6	2.0	2.4	17.6	28.7	
20 TO 30				.1	.5	.5	1.8	3.2	17.6	23.7	
35 OR MORE				+	.1	.3	.3	1.6	34.3	36.5	
TOTAL		.3	1.1	5.6	6.0	3.4	4.4	7.5	70.8	100	

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS SCALE 0-10			WIND SPEED (M. P. H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25- & OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	48	15	37	8	62	28	3	12	24	27	12	13	11
01	49	15	36	8	61	28	3	11	25	25	14	15	10
02	51	12	37	8	66	25	2	10	23	24	15	16	11
03	49	15	36	8	66	22	3	9	21	24	16	17	12
04	48	13	39	11	64	24	1	8	22	28	13	14	15
05	40	18	43	10	64	25	1	7	22	28	17	14	11
06	36	15	51	8	63	29	1	9	20	31	15	11	13
07	37	13	50	9	60	28	3	15	26	30	9	11	9
08	34	16	50	11	59	27	3	24	30	22	8	8	7
09	35	16	49	13	53	30	3	36	28	17	7	10	3
10	34	18	48	11	49	34	5	44	23	14	8	5	6
11	32	19	49	6	52	35	7	51	22	13	6	4	4
12	29	19	52	7	51	33	9	56	18	13	5	5	3
13	24	21	54	7	50	34	8	59	18	13	5	4	2
14	20	22	58	7	44	39	10	59	18	15	5	3	1
15	21	21	58	5	45	40	12	58	17	13	4	5	2
16	23	18	59	7	44	41	8	58	17	11	5	8	3
17	21	18	61	5	41	44	10	53	20	9	7	7	3
18	25	16	59	5	46	43	5	45	23	11	6	9	6
19	27	17	56	5	53	34	4	37	27	12	5	10	8
20	35	19	46	5	55	32	4	31	26	16	7	11	10
21	41	16	43	8	56	32	4	25	25	22	7	11	10
22	47	13	40	8	56	33	3	21	24	23	11	9	12
23	48	13	39	7	57	34	2	16	25	25	11	12	11
AVG	36	16	48	8	55	32	5	31	23	20	9	10	7

DENVER COLORADO

MAY

DENVER, COLORADO
Stapleton Airfield

MAY
7440 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
TEMP. °F / RELATIVE HUMIDITY %	Dew Pt.	0-19	20-39	40-59	60-79	80-100	Dew Pt.	0-19	20-39	40-59	60-79	80-100	Dew Pt.	0-19	20-39	40-59	60-79	80-100	Dew Pt.	0-19	20-39	40-59	60-79	80-100	
94/ 95													1												1
89/ 93							19						11						2						32
84/ 88	12						97	2					62						9						181
79/ 75	38	2					223	23					105	19					23	2					426
74/ 70	59	19	1				299	105	8				111	46	4				18	10					665
69/ 65	45	57	13				208	176	40				101	79	17				10	13	4				766
64/ 60	31	85	43	7	3		146	280	139	26	8		63	109	44	9			9	15	8	1			1011
59/ 55	19	69	63	26	14	4	88	220	294	74	28	1	41	80	91	24	11	1	8	9	11	4	1		1179
54/ 50	10	39	100	49	48	8	39	154	306	155	116	24	19	41	69	24	13	3	3	11	14	3	1		1232
49/ 45	6	18	48	51	43	29	24	76	183	149	164	90	9	26	28	17	19	9	1	4	7	4	1		1037
44/ 40	5	11	16	16	37	21	6	27	79	82	88	62		2	27	15	10	2		1	2	1	1		932
39/ 35		5	7	7	14	9		15	23	41	47	65				4	3	2							236
34/ 30			6	1	3	5			5	24	14	24				5	4	2							93
29/ 25					1				2	6	15	1				1	7	1							32
24/ 20											2	4													6
TOTAL	221	297	297	151	163	76	1145	1079	1079	597	470	271	521	406	280	93	75	104	83	36	14	5	3	1	7440

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MILES PER HOUR)								AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	
N	.5	1.8	2.8	2.3	.7	.2	+		8.2 11.4
NNE	.3	1.7	2.2	1.7	.3				6.7 11.4
NE	.5	1.8	2.1	1.3	.2	+			6.0 9.5
ENE	.4	1.2	1.8	1.3	.2	+	+		5.0 10.2
E	.4	1.3	1.8	1.5	.4	.1	+		5.5 10.8
ESE	.3	1.3	1.4	.8	.1	+	+		4.0 9.6
SE	.6	1.4	1.4	1.2	.2	+	+		4.9 9.4
SSE	.4	1.3	1.2	1.2	.4	.2	.1		4.9 11.9
S	.9	2.8	4.7	3.7	1.1	.3	.1		13.5 11.5
SSW	.5	2.2	4.8	3.9	.8	.2	+	+	11.9 11.2
SW	.8	1.8	1.7	1.1	.2	+	+	+	5.7 9.1
WSW	.4	.9	1.0	.6	.2	.1			3.2 9.8
W	.4	1.4	1.1	.6	.2	.1			3.8 9.4
WNW	.4	1.2	1.3	.8	.3	.1	+		4.1 10.2
NW	.9	1.8	2.2	1.6	.6	.1	.1		7.0 10.1
NNW	.3	1.2	2.0	1.0	.3	+			4.8 10.1
CALM	.8								.8
TOTAL	9.1	24.8	33.4	24.2	6.3	1.6	.4	+	100 10.5

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								NO. OF DAYS WITH
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	MIDN.	1	2	3	4	5	6	7	8	9	10	11	MIDN.	
TRACE	22	22	20	19	18	23	24	16	9	14	21	21	28	31	34	43	46	34	40	30	32	33	35	25	18
0.01 TO 0.09 IN.	8	10	13	12	6	10	8	7	7	8	2	4	5	8	5	7	4	9	6	9	8	7	3	11	11
0.10 TO 0.24 IN.	14	14	12	13	15	6	7	8	11	11	10	8	8	11	17	16	15	12	11	15	15	17	18	12	33
0.25 TO 0.49 IN.	3	2		1	4	4	4	2	2		1	4	3	3	3	6	7	4	6	1	3	4	3	2	22
0.50 TO 0.99 IN.			1							1	1					2		1		2				2	13
1.00 TO 1.99 IN.	1	1																							12
2.00 IN. AND OVER																									6
TOTAL	48	49	46	45	43	43	43	33	29	34	35	37	44	53	59	74	72	60	63	57	58	61	57	52	76

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										
	0	100 or less	101-200	201-400	401-900	901-1900	1901-3000	3001-5000	5001-10000	Over 10000	TOT.
0 TO 1/8											
3/16 TO 3/8			+	+							.1
1/2 TO 3/4				.1	+	+				+	.2
1 TO 2 1/2			.1	.3	.4	.2	+		+	.1	1.2
3 TO 6			.1	.6	1.9	1.3	.4	.2	.3	.3	5.2
7 TO 10				.1	1.0	2.1	1.9	2.0	2.1	16.2	26.1
20 TO 30					+	.6	1.3	2.0	2.9	16.4	23.2
35 OR MORE							.1	.5	2.6	40.8	44.0
TOTAL			.2	1.2	3.4	4.6	3.6	4.7	8.1	74.3	100

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS SCALE 0-10			WIND SPEED M.P.H.			RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25- & OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	49	16	35	8	62	28	1	7	20	30	17	18	7
01	50	16	34	10	64	26	1	6	20	28	20	15	12
02	51	15	35	9	64	27	1	5	19	25	21	20	11
03	53	13	34	11	61	27	+	5	19	28	19	21	11
04	44	17	39	9	73	19		4	15	27	17	23	13
05	41	15	44	14	65	21		3	15	27	20	21	13
06	42	14	45	13	66	20	1	5	25	31	17	15	10
07	40	13	47	13	65	21	1	8	31	35	11	10	7
08	39	14	47	19	59	21	2	10	34	28	7	7	5
09	40	14	45	17	61	19	2	32	31	22	7	5	3
10	38	18	44	14	60	24	2	41	29	20	4	3	4
11	34	22	44	9	56	33	2	48	27	16	3	2	4
12	32	21	47	8	56	34	2	54	24	15	3	2	3
13	25	23	52	6	55	35	4	56	25	10	4	5	2
14	18	23	59	3	53	40	4	59	21	11	3	3	2
15	17	21	61	3	47	45	5	57	21	12	4	3	3
16	16	20	63	4	45	46	6	55	21	13	4	5	3
17	17	20	63	4	45	45	6	50	24	14	5	4	4
18	19	24	57	3	51	42	4	43	28	15	7	4	4
19	25	19	56	7	57	30	5	38	35	21	5	8	4
20	30	22	48	11	57	31	1	37	35	24	12	7	5
21	36	25	39	8	59	32	1	35	28	27	15	9	5
22	44	15	41	8	55	37	1	31	23	33	15	12	6
23	47	14	39	8	59	31	1	30	22	29	20	13	7
AVG	35	18	47	9	58	33	2	27	24	22	11	10	6

DENVER, COLORADO
Stapleton Airfield

JUNE
7200 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIRECTION	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
104/100							5																		5
99/ 95	1						10						9												20
94/ 90	22						126						66						7						221
89/ 85	62						310						115	2					13						512
84/ 80	66	20					330	48					167	24					18	3					676
79/ 75	71	42	1				257	218	7				121	78	22				16	15					826
74/ 70	36	92	18				155	521	62	1			70	124	22				7	11	5				924
69/ 65	12	66	60	9			101	369	223	14			33	115	56	4			4	9	2				1070
64/ 60	5	49	110	29	16	1	56	242	358	98	41	1	14	47	63	13	8		4	5	2				1160
59/ 55	9	23	65	51	39	11	18	93	224	171	102	29	9	23	29	21	11	3	1	3	2		2		991
54/ 50	2	5	30	32	68	8	9	35	85	66	94	40	1	10	9	8	8	2		2				1	518
49/ 45	1	3	2	15	10	9	1	13	28	33	34	20	3	3	3	1	5	2						1	210
44/ 40			3	4	5			2	16	11	13	11					1	1						1	70
39/ 35			1	1	5	5			5	4	2	3					1								27
34/ 30					3						5	4													12
TOTAL	289	294	300	133	156	34	1359	1345	1019	398	289	108	604	424	182	97	34	21	69	46	13		2	2	7200

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MI. PER HOUR)										ALL SPEEDS	AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47-54	55 & OVER		
N	.5	1.4	2.1	1.6	.5	.1	+		+		6.1	10.1
NNE	.3	1.4	1.9	1.6	.4	.1	+	+			5.7	10.9
NE	.5	1.5	1.8	1.0	.3	.1	+				5.2	9.7
ENE	.3	1.1	1.8	1.3	.2	.1	+				4.8	10.6
E	.7	1.5	1.8	1.6	.3	.1					5.9	10.1
ESE	.3	1.2	1.8	1.2	.2	+					4.7	10.2
SE	.5	1.3	2.0	1.1	.3	.1	+				5.3	10.1
SSE	.5	1.1	1.7	1.3	.7	.3	.1	+			5.6	12.1
S	1.1	3.4	5.9	4.1	1.4	.5	.1				16.8	11.2
SSW	.7	3.2	5.4	4.0	.8	.1	+				14.2	10.8
SW	.9	2.0	2.1	.9	.2	+					6.1	8.5
WSW	.5	1.3	1.0	.3	.1	+					3.2	8.1
W	.5	1.2	.8	.4	.2	.1	+				3.3	9.1
WNW	.4	.9	1.0	.6	.3	.1		+			3.4	10.4
NW	.6	1.6	1.8	1.1	.2	.1					5.5	9.7
NNW	.4	1.1	1.4	1.0	.2	+					4.1	9.8
CALM	1.0										1.0	
TOTAL	9.0	25.2	34.0	23.0	6.1	1.5	.3	+			100	10.3

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								NO. OF DAYS WITH
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	NOON	1	2	3	4	5	6	7	8	9	10	11	MID	
TRACE	15	16	13	10	8	9	10	11	8	10	12	11	15	27	42	49	30	34	29	32	21	21	13	15	73
[illegible]	7	6	7	1	2	4	2		1	2	1	2	3	2	5	1	8	5	5	3	4	3	6	4	14
[illegible]	3	3	1	3	4	1	3		2	1	3	2	2	5	2	6	8	6	3	9	9	3	4	1	30
[illegible]				2						2			2	5	4	2	2	1	2	1	1		1	1	25
[illegible]					1							2	1									2			5
[illegible]																									2
[illegible]																									
[illegible]																									
TOTAL	29	29	22	16	16	14	15	11	11	15	16	17	27	39	53	58	48	46	41	45	35	33	24	21	353

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										
	0	100-200	300-400	500-900	1000-1400	1500-1900	2000-2400	2500-2900	3000-3400	3500 & OVER	ALL
0 TO 1/8		+								+	
3/16 TO 1/4		+	+							+	
1/2 TO 3/4			+							+	
1 TO 1 1/2		.1	.2	.1	+				.1	.1	.6
2 TO 6		+	.2	.5	.2	.1	.2	.1	.1	.4	1.8
7 TO 15		+	.1	.3	1.3	.3	1.2	1.4	18.9	22.6	
20 TO 30				.1	.5	.6	1.2	2.9	19.1	24.6	
35 OR MORE					+	+	.3	2.3	48.0	50.6	
TOTAL		.1	.3	1.0	1.9	1.0	2.8	6.7	84.3	100	

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS SCALE 0-10			WIND SPEED (M. P. H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25 & OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	58	16	26	7	64	29	+	8	30	34	12	15	6
01	60	16	24	12	65	23	+	9	26	33	14	12	5
02	63	15	23	9	66	24	+	7	25	32	18	12	6
03	63	14	23	13	64	24		5	24	31	20	19	5
04	59	20	21	12	67	21		5	21	32	20	19	5
05	54	19	27	14	67	19		5	22	31	18	20	5
06	58	15	27	16	70	14	+	7	27	37	14	10	4
07	59	15	26	15	68	16	1	13	37	31	11	6	3
08	60	12	28	15	68	17	+	22	45	23	7	4	2
09	61	13	27	22	58	20	+	35	38	20	4	2	2
10	58	14	28	17	61	20	2	50	30	14	2	2	2
11	57	18	25	7	67	24	1	62	24	10	1	2	1
12	46	23	31	6	63	28	2	66	22	7	1	3	1
13	36	25	39	6	53	37	3	67	22	6	2	1	1
14	31	24	46	4	56	36	4	69	19	8	2	1	1
15	28	23	50	4	47	41	8	66	23	7	3	1	1
16	25	23	52	5	48	45	5	62	29	9	3	+	1
17	23	27	50	3	41	50	6	60	26	9	3	1	1
18	31	22	47	5	46	45	3	52	31	10	3	2	+
19	35	23	42	6	51	41	2	42	34	15	6	4	+
20	36	24	40	7	55	36	2	29	35	20	7	5	1
21	41	28	31	10	54	34	2	19	42	25	6	4	2
22	52	20	27	12	59	27	2	15	38	31	8	8	2
23	57	19	24	11	62	26	1	11	36	30	10	10	3
AVG	48	19	33	10	59	29	2	33	29	21	8	7	2

DENVER, COLORADO
Stapleton Airfield

JULY
7400 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR.	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
TEMP.																									
105/100													3												3
99/95	7						26						8												41
94/90	76						298	8					61						2						435
89/85	115	19					479	34					130	18					2						800
84/80	107	98	2				342	102	1				116	66	4				12	3					895
79/75	47	136	15				167	391	42				30	114	10				2	15					981
74/70	10	124	87	6			82	425	241	13			15	121	64	9				9	4	2			1211
69/65	10	89	124	55	9		35	332	398	130	38	9	9	64	89	21	2				2	3			1404
64/60	4	20	101	71	59	20	7	149	312	146	100	60	2	11	39	16	12	3				3	3		1131
59/55	1	6	32	31	36	6	2	13	68	96	82	34	1	3	3	3	2	3							426
54/50			5	9	12	9		2	3	8	19	27						3							99
49/45				2	7					1	2	2						2							16
TOTAL	385	442	366	172	127	35	436	1929	1065	394	249	129	387	397	205	63	16	11	14	33	11	6	3	2	7449

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (NO. MILES PER HOUR)												TOTAL	AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47-54	55-63	64 & OVER			
N	.6	1.7	2.9	1.8	.3	.1	+						7.3	10.2
NNE	.5	1.4	1.9	1.4	.2	+	+						5.3	9.9
NE	.7	1.4	1.6	1.0	.1	.1	+						4.9	9.0
ENE	.5	1.2	1.4	.8	.1	.1							4.0	9.3
E	.4	1.2	1.6	1.0	.1	.1							4.3	9.8
ESE	.3	1.3	1.0	.3	.1	+							3.5	8.9
SE	.5	1.5	1.3	.5	.1	+							4.2	9.0
SSE	.4	1.5	1.3	.7	.2	.1	+						4.3	10.4
S	1.2	3.3	5.6	4.8	.6	.2							15.4	10.5
SSW	.9	3.7	6.7	3.6	.3	.1	+						15.3	10.0
SW	1.2	2.5	2.2	1.0	.1	+							7.1	8.0
WSW	.6	1.4	1.1	.5	.1	+							3.7	8.2
W	.7	1.6	1.2	.6	.1	+							4.0	7.9
WNW	.9	1.4	1.1	.5	.1	+							3.8	8.5
NW	1.0	2.2	2.1	1.0	.2	.1	+	+					6.4	8.4
NNW	.6	1.4	2.4	1.2	.2	+			+				5.8	9.7
CALM	1.0												1.0	
TOTAL	11.6	28.2	35.4	20.9	3.4	.8	.1	+	+				100	9.4

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OCCURRENCES
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	NOON	1	2	3	4	5	6	7	8	9	10	11	MID.	
TRACE	11	16	10	11	13	12	13	7	6	8	9	10	15	29	37	39	40	35	36	37	38	28	17	13	84
.01 TO .09	4	7	3	1	1	2	2	3	1		1		3	4	2	2	0	7	4	9	5	2	5	5	8
.10 TO .49	6		2	2	3		2	2	2	3		1	3	9	7	9	8	6	10	8	9	9	4	7	59
.50 TO .99		1							1				2	3	3	3	2	2	1	2	4	4	2		15
1.00 TO 1.49	1							1						1	1	1		3	1		1			1	11
1.50 TO 1.99															3			4		2					6
2.00 TO 2.99																									7
3.00 TO AND OVER																									
TOTAL	22	24	15	14	17	14	17	13	10	11	9	11	19	43	53	54	50	57	54	56	57	43	28	26	272

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										
	0	100 OR LESS	200 TO 400	500 TO 900	1000 TO 1900	2000 TO 2900	3000 TO 4900	5000 TO 9900	10000 TO 19900	20000 OR MORE	TOTAL
0 TO 1/8				+							+
3/16 TO 3/8	+								+	+	+
1/2 TO 3/4			.1	+					+	+	.1
1 TO 2 1/2			.1	.1	.2					+	.4
3 TO 6			+	.1	.3	.2	.3	.3	+	.3	1.1
7 TO 15					.1	.1	.1	.1	1.1	17.8	21.6
20 TO 30					+	.1	.1	.4	2.1	21.0	24.0
35 OR MORE						+	.1	.2	2.6	49.3	52.7
TOTAL	+	.1	.3	.5	1.6	.5	1.0	6.1	88.6	100	

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS (SCALE 0-10)			WIND SPEED (M.P.H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25 & OVER	0-29	30-39	40-59	60-79	80-89	90-100
00	59	15	26	8	64	28	+	5	36	33	16	9	3
01	60	15	25	11	62	26	+	6	33	35	15	9	4
02	64	15	22	12	66	22	+	5	29	35	19	10	3
03	66	14	20	15	68	18		4	28	38	13	13	3
04	59	21	20	15	68	16		2	25	37	17	13	5
05	58	19	23	17	69	14		2	23	36	20	12	6
06	58	18	23	19	70	11		3	27	40	16	9	5
07	58	18	24	16	71	12		3	33	36	12	9	5
08	61	17	22	20	70	10		13	43	28	8	5	3
09	65	15	20	21	70	9		27	43	21	6	2	1
10	64	17	19	18	72	10		41	38	16	3	2	+
11	61	21	18	15	71	17		54	33	10	3	1	
12	50	29	21	9	72	19		63	27	8	2	+	
13	38	30	32	8	65	26	1	69	22	6	2	1	+
14	29	30	40	7	60	33	2	67	24	6	2	1	1
15	26	29	45	5	55	38	1	67	22	5	3	2	1
16	20	24	56	4	51	43	3	63	25	7	3	2	1
17	22	21	57	5	47	46	2	59	29	10	3	2	2
18	22	25	53	5	57	36	3	51	28	14	3	2	2
19	25	25	51	9	56	35	3	41	34	17	4	2	2
20	29	26	45	12	55	30	3	37	43	17	7	3	2
21	40	25	35	9	63	26	2	31	40	23	9	3	2
22	48	23	30	10	61	29	1	32	43	17	5	2	2
23	57	16	27	10	63	26	1	37	44	10	5	3	1
AVG	47	21	32	12	64	24	1	30	32	22	8	5	2

DENVER, COLORADO
Stapleton Airfield

AUGUST
7440 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR.	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
TEMP. °F / REL. HUM. %																									
99/ 99	3						19																		22
94/ 90	38						195						52						1						286
89/ 85	116	6					444	28					82	7					5	1					697
84/ 80	116	57					379	105	9				65	45	1				5						876
79/ 75	46	157	10				190	353	35				45	99	9				5	11	3				964
74/ 70	16	139	89	4			68	419	195	4			17	112	53	2				3	6				1121
69/ 65	5	77	165	62	19	4	26	338	430	77	34	3	3	61	66	11	1		1	3	5	1	2		1390
64/ 60		34	124	79	65	24	5	191	390	169	138	35	1	30	36	11	7	2			3		1		1328
59/ 55		3	26	96	92	31		35	108	95	119	45		4	8	5	6	2			1				632
54/ 50			8	9	17	3		6	24	13	13	6			1	1						1			98
49/ 45			1		1				9	7															18
TOTAL	340	477	425	202	194	64	1328	1555	1194	359	291	89	295	358	172	30	14	4	16	18	12	2	2	1	7440

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MPH)									AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	
N	.6	1.5	2.2	1.5	.2	.1				6.0	9.9
NNE	.4	1.4	2.0	1.1	.1	+				5.0	9.5
NE	.6	1.4	1.5	.6	.1	+	+			4.2	8.3
ENE	.6	1.0	1.4	.6	+	+				3.6	8.6
E	.6	1.3	1.8	.6	.1	+				4.4	8.8
ESE	.4	.8	1.3	.5	.1	+				3.1	9.0
SE	1.0	1.4	1.5	.5	.1	+				5.1	8.5
SSE	.6	1.4	1.5	.8	.2	+				4.5	8.9
S	1.6	4.2	6.2	4.5	.6	.1				17.3	10.0
SSW	1.3	3.6	7.8	4.4	.3	.1				17.5	9.9
SW	1.1	2.3	2.4	1.0	+	+				6.8	7.8
WSW	.9	1.4	1.3	.5	+	+				4.0	7.1
W	1.0	1.1	1.7	.3	+	+				3.2	6.8
WNW	.6	1.2	1.0	.3	.2	.1	+			3.5	8.6
NW	1.1	1.9	1.6	1.0	.3	.1				6.0	8.6
NNW	.5	1.4	1.5	.7	.1					4.3	8.3
CALM	1.5									1.5	
TOTAL	14.3	27.6	35.6	19.3	2.6	.7	+			100	8.9

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OCCURRENCES
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	NOON	1	2	3	4	5	6	7	8	9	10	11	MID	
TRACE	6	10	10	8	9	7	10	13	11	13	11	13	19	23	26	46	48	36	40	39	43	24	23	17	400
.01 TO .09 IN.	1	1	3			2	1				2	2	3	1	6	9	10	6	6	7	5	3	4		166
.10 TO .24 IN.	3			2	1	1		1			1			2	4	5	7	7	8	8	6	9	2	2	342
.25 TO .49 IN.				1										2	2	3		3	1	4	2	3	3	1	98
.50 TO .99 IN.					1									1		1	1	2	2		1	1	1	1	72
1.00 TO 1.99 IN.															1		1		1						62
2.00 IN. AND OVER			1														1								41
TOTAL	10	12	14	11	10	10	11	14	11	13	14	15	22	29	43	64	68	54	58	58	57	40	33	21	779

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										
	0	100-200	300-400	500-900	1000-1900	2000-2900	3000-4900	5000-9900	10000 OVER	NO
0 TO 1/8	+	+	+							.1
3/16 TO 1/8		+								+
1/2 TO 3/4		+	+	+				+		.1
1 TO 2 1/2		+	+	.2	+	+	+		+	.2
3 TO 6		+	.2	.2	.3	+	.2	.2	.3	1.3
7 TO 15			.1	.2	1.0	.5	.6	1.0	19.3	23.3
20 TO 30					.2	.2	.6	2.5	22.9	26.4
35 OR MORE						+	+	2.1	46.5	48.6
TOTAL	+	.1	.3	.4	1.6	.7	1.3	6.8	88.4	100

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS SCALE 0-10			WIND SPEED (M.P.H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25-8 OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	61	15	23	14	64	22		4	35	33	15	10	3
01	64	18	18	13	65	19		3	31	35	15	12	4
02	64	18	18	15	65	20		2	31	35	16	13	4
03	68	17	15	17	67	16		1	23	38	19	14	6
04	63	21	16	18	65	16	+	+	21	39	17	17	5
05	56	23	21	19	65	16	+	1	19	41	15	19	6
06	57	19	24	21	65	14	+	1	23	43	13	15	5
07	56	17	27	20	66	13	+	2	30	41	7	12	8
08	55	18	27	25	63	12		8	31	27	7	5	1
09	58	16	26	25	68	7		26	40	18	6	1	+
10	58	16	25	23	68	8	1	41	41	14	3	+	+
11	58	21	21	15	70	14	1	54	33	12	1	1	
12	46	26	27	11	69	20	+	62	28	10	1	+	
13	37	32	31	9	66	24	1	65	27	8	1	+	
14	27	31	42	8	63	28	2	67	24	7	2	+	1
15	24	29	47	5	59	34	2	65	24	9	1	1	+
16	22	27	51	5	53	40	2	59	26	9	3	2	1
17	24	24	52	5	54	40	1	53	30	11	3	2	1
18	25	23	52	8	56	34	2	43	33	15	4	4	1
19	28	24	48	13	64	24	1	30	39	20	5	5	1
20	37	21	42	13	59	25	3	22	39	27	4	6	2
21	41	24	35	13	61	23	3	15	38	29	8	6	3
22	49	19	32	13	62	24	3	8	41	28	13	6	3
23	57	18	25	13	60	26	+	7	36	33	13	9	3
AVG	47	21	31	14	63	22	1	27	32	24	8	7	2

DENVER, COLORADO
Stapleton Airfield

SEPTEMBER
7200 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR.	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
TEMP. °F	RH 0-19%	RH 20-39%	RH 40-59%	RH 60-79%	RH 80-89%	RH 90-100%	RH 0-19%	RH 20-39%	RH 40-59%	RH 60-79%	RH 80-89%	RH 90-100%	RH 0-19%	RH 20-39%	RH 40-59%	RH 60-79%	RH 80-89%	RH 90-100%	RH 0-19%	RH 20-39%	RH 40-59%	RH 60-79%	RH 80-89%	RH 90-100%	
99/ 95	1						1																		8
94/ 90	16						59						10												85
89/ 85	87						193						39						3						322
84/ 80	99	5					380	11					69	7					4	1					572
79/ 75	125	19	1				372	56	3				81	29	3				5	2					700
74/ 70	79	60	10				262	145	29				79	35	3				3	3					703
69/ 65	60	99	24	4			176	268	96	8	1		71	52	14	3			2	3					843
64/ 60	24	95	40	7	19	8	129	412	144	25	22	2	39	75	28	2	2		3	4					1078
59/ 55	5	91	75	12	14	13	65	351	276	57	24	10	14	59	32	1		1	1	3				1	1105
54/ 50	2	47	74	37	16	7	28	161	248	83	53	6	4	16	30	8	4	1		2	3		1		631
49/ 45		15	55	33	48	10	2	44	167	102	66	25	1	7	18	6	9	1							616
44/ 40			21	19	18	21		9	35	39	38	12			2	1	1	3						1	212
39/ 35			5	3	4	4			4	13	19	17				1	3	1							74
34/ 30				1	8	10				4	16	12													51
TOTAL	498	431	305	116	127	73	1673	1453	962	327	239	84	399	280	130	22	19	14	25	17	5		1	1	7200

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MI. PER HOUR)								TOTAL	AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39 & OVER		
N	.8	1.8	2.4	1.4	.3	.1	+		6.8	9.6
NNE	.7	1.6	1.7	1.0	.3	.1	+		5.4	9.3
NE	.8	1.7	1.8	.8	.2	+			5.3	8.5
ENE	.5	1.5	1.5	1.0	.1	+			4.7	9.2
E	.6	1.7	1.6	.8	.1				4.8	8.6
ESE	.5	1.3	1.5	.7	.1				3.8	8.6
SE	.9	1.6	1.4	.7	.1				4.8	7.8
SSE	.7	1.7	1.5	.6	.2	.1			4.5	8.8
S	1.5	4.8	6.2	2.8	.6	.1	+		16.0	9.4
SSW	.8	3.8	7.5	5.5	.3	+			18.0	10.3
SW	1.0	2.3	1.7	.8	+				5.8	7.5
WSW	.6	1.2	1.0	.3	+	+			3.0	7.3
W	.7	1.0	.8	.5	.1	+			3.1	8.1
WNW	.5	1.1	.8	.5	.2	.1	+		3.3	9.0
NW	1.1	1.8	1.6	.9	.2	+			5.6	8.4
NNW	.5	1.4	1.4	.6	.1	+			4.1	8.6
CALM	1.2								1.2	
TOTAL	13.1	30.4	34.1	18.9	2.9	.6	.1		100	8.9

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OCCURRENCES
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	NOON	1	2	3	4	5	6	7	8	9	10	11	MID.	
TRACE	9	8	5	6	10	14	12	5	5	8	5	8	12	15	10	15	13	17	21	20	23	14	13	11	48
0- .99 in.	3	3	2	6	2	:	1	2	1	2	1	2	2	1	2	1	1	3	2	2	3	1	4	2	5
1.00 TO 1.99 in.	2	2	6	1	2	:	1	3	5	2	4		1	3	5	2	6	7	6	3	2	4	4	4	22
2.00 TO 2.99 in.	1	2	1	1	3	1	1	1		1				1	2	1	1	1	1	2	1	1	2	3	15
3.00 TO 3.99 in.																1							1		4
4.00 TO 4.99 in.																									4
5.00 TO 5.99 in.																									
6.00 TO 6.99 in.														1											1
7.00 in. AND OVER																									
TOTAL	15	15	14	14	17	19	15	11	9	13	10	10	15	21	19	20	23	28	30	27	29	22	24	20	99

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										
	0	100	200	300	500	1000	2000	3000	OVER 3000	NO
0 TO 1/8	+	+							+	.1
3/16 TO 3/8	+	+	+						+	.1
1/2 TO 3/4			.1	.1					+	.2
1 TO 2 1/2		.1	.3	.1	.1			+	+	.6
3 TO 6		+	.2	.4	.3	.2	+	.1	.3	1.5
7 TO 15			+	.2	.6	1.0	.7	1.0	1.0	22.7	28.3
20 TO 30				+	.3	.4	1.0	1.3	22.9	25.9
35 OR MORE					+	+	.3	.8	42.3	43.5
TOTAL	+	.2	.7	1.4	2.3	1.3	2.3	3.4	88.3	100

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS (SCALE 0-10)			WIND SPEED (M.P.H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25 & OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	75	8	17	32	65	22	+	11	40	28	8	11	3
01	72	11	17	11	68	20	1	10	34	33	11	10	3
02	76	10	14	12	66	22		9	32	33	12	10	4
03	75	8	17	15	63	21		8	31	33	14	10	6
04	73	10	17	11	71	18		5	31	34	13	10	6
05	70	11	18	12	71	17	+	7	29	32	15	10	6
06	66	12	22	15	62	22	+	6	31	33	15	9	6
07	64	14	21	12	68	20		12	40	28	10	7	3
08	65	13	22	18	62	20		21	44	22	6	5	2
09	63	15	22	21	66	14		38	38	15	3	5	1
10	64	14	23	23	64	13	+	54	29	10	3	3	1
11	62	17	22	16	71	13	+	62	25	8	2	2	+
12	59	18	23	12	70	17	+	73	16	8	2	1	1
13	53	20	26	14	62	23	1	75	15	7	1	1	1
14	48	21	31	11	64	25	1	77	13	7	1	1	1
15	47	22	31	7	61	31	2	76	13	7	1	2	+
16	44	24	32	5	59	34	2	74	15	8	2	1	+
17	43	22	34	8	60	31	1	69	18	8	3	1	1
18	49	19	32	17	57	24	2	56	27	11	3	2	2
19	51	20	29	16	58	25	1	41	39	16	3	4	2
20	57	19	25	13	63	23	1	30	42	18	5	4	2
21	60	18	22	10	65	25	+	21	45	21	6	5	2
22	67	12	20	11	67	22		18	42	22	8	8	2
23	70	11	19	10	67	22	1	13	43	24	8	8	3
AVG	61	15	24	13	64	22	1	36	30	19	6	5	2

DENVER, COLORADO
Stapleton Airfield

OCTOBER
7440 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR.	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
	0-20	21-40	41-60	61-80	81-90	91-100	0-20	21-40	41-60	61-80	81-90	91-100	0-20	21-40	41-60	61-80	81-90	91-100	0-20	21-40	41-60	61-80	81-90	91-100	
01/ 05	1						1																		2
06/ 10	20						68						8						1						97
11/ 15	60						231	1					44						3						329
16/ 20	91	5					249	11	1				69	2					3						433
21/ 25	122	16	1				263	60	1				74	14	1				4						556
26/ 30	81	44	4	1			254	139	10	2	1		62	34	2				10	4					648
31/ 35	57	86	26		1		197	249	71		28		64	34	8	1			3	11					810
36/ 50	38	96	67	7	9		157	312	145	46	17	2	57	52	11		1	1	3	1	1				1020
51/ 45	28	83	85	31	44	26	109	284	216	49	91	54	32	56	25	5	4		3	6		2			1230
46/ 40	5	54	90	40	21	22	39	189	223	91	73	39	23	29	25	5	4	6	1				1		984
41/ 35	1	34	65	50	39	13	21	65	140	126	91	37	4	14	9	6	3	3					1	1	723
36/ 30		4	24	24	41	41		22	77	48	62	99		2	11	4	2	5							461
29/ 25			7	10	12	14		1	14	22	26	9				1	4	3						1	124
26/ 20					3	5				4	8	3													23
TOTAL	504	422	369	163	166	121	569	1333	891	384	379	243	437	237	92	22	18	23	41	22	1	2	2	2	6450

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MI. P. H.)								AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	
N	.8	1.7	2.8	1.0	.1	+			6.2	9.0
NNE	.6	1.9	1.7	.9	.2	.1	+		5.7	9.0
NE	.7	2.0	1.7	.7	.1	.1	+		5.5	8.3
ENE	.5	1.4	1.4	.8	.2	+	+		4.5	9.3
E	.9	1.9	1.6	.8	.1				5.5	8.2
ESE	.5	1.6	1.1	.4	.1				3.9	8.1
SE	.3	2.0	1.3	.5	.1				4.8	7.5
SSE	.8	1.8	1.3	.8	.1	+			4.8	7.9
S	1.6	6.0	6.7	3.6	.3	+	+	+	18.2	9.0
SSW	1.1	5.3	6.8	4.2	.6	.1	.1	+	18.2	10.0
SW	.8	1.9	1.4	.8	.1	+			4.9	7.7
WSW	.5	1.8	.8	.2	.1				2.4	7.2
W	.3	.9	.8	.4	.1	.1			2.4	8.5
WNW	.6	.8	.8	.3	.2	.1	+	+	2.8	10.1
NW	1.0	1.9	1.4	.7	.2	.3	.1	+	5.4	9.1
NNW	.7	1.6	1.7	.4	.1	+	+		4.3	8.0
CALM	1.6								1.6	
TOTAL	13.4	33.5	33.0	16.6	2.7	.6	.3	.1	100	8.7

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OCCURRENCES
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	MIDN.	1	2	3	4	5	6	7	8	9	10	11	MIDN.	
TRACE	19	14	12	13	15	21	22	13	17	13	16	13	12	12	16	17	22	23	15	16	21	16	17	13	35
.01 - .10	9	2	5	4	5	4	2	2	2	1	5	6	5	1	4	1	4	3	7	2	2	4	6	6	10
.11 TO .25	6	7	5	7	4	4	5	8	8	10	6	6	3	4	4	6	3	6	5	9	11	9	11	9	10
.26 TO .50					2			1	1	1	2	1	1	1		1	1	1	2	2	1	4			9
.51 TO .75													1			1									5
.76 TO 1.00																				1					5
1.01 TO 1.50																									2
1.51 AND OVER																									
TOTAL	26	23	22	24	26	29	29	24	28	25	27	22	22	18	24	26	32	33	29	30	35	33	34	28	88

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										TOT.
	0	100	200	300	400-500	600-900	1000-1500	1600-2000	2100-3000	OVER 3000	
0 TO 1/8	+	+	+							+	.1
1/16 TO 1/8	+	.1	+							.1	.2
1/2 TO 3/4		.1	.3	.1	+					.1	.5
1 TO 2 1/2		.2	.7	.7	1.2	+				+	1.8
3 TO 6		+	.5	1.4	.8	.2	.3	.1	1.0		4.2
7 TO 15			.1	.9	2.5	1.3	1.6	1.2	22.0	29.5	
20 TO 30					.3	.3	.5	1.5	22.0	25.1	
35 OR MORE						+	.1	.1	37.4	38.5	
TOTAL	.1	.3	1.0	3.1	3.5	1.8	2.5	3.4	83.5	100	

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS SCALE 0-10			WIND SPEED (M. P. H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25-8 OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	70	8	22	13	67	19	1	15	31	24	11	12	7
01	66	11	23	16	62	22	+	14	30	25	16	10	5
02	65	10	24	14	65	21	+	13	28	27	13	12	8
03	66	10	24	10	72	17	1	10	31	24	15	13	7
04	65	12	23	16	70	15	+	10	26	29	13	11	10
05	62	10	28	12	68	19	1	10	26	27	14	13	9
06	54	13	33	15	64	20	1	10	28	27	15	9	11
07	54	12	35	14	66	20	1	16	30	28	7	11	8
08	52	12	36	13	68	19	+	24	34	22	6	9	6
09	50	15	35	17	65	17	1	39	31	14	6	5	5
10	52	14	35	21	65	12	2	50	28	10	5	4	4
11	53	14	33	21	64	15	1	58	27	11	3	4	3
12	53	15	32	15	65	19	1	65	16	9	5	3	2
13	49	18	32	12	65	21	2	67	17	7	4	3	1
14	47	17	36	7	67	23	2	70	14	7	4	3	1
15	49	16	40	11	64	23	2	69	14	7	5	3	1
16	43	19	45	9	60	29	2	66	16	9	3	3	3
17	42	17	41	11	66	22	1	60	21	8	4	5	3
18	40	16	37	16	63	19	2	42	33	11	5	5	3
19	51	15	34	13	70	15	2	35	35	16	5	7	3
20	55	15	31	13	69	16	2	25	36	21	4	8	5
21	56	15	29	10	72	18	+	21	34	25	7	8	6
22	60	14	26	10	71	19	+	19	34	25	7	10	6
23	63	14	24	13	66	21	1	15	34	25	9	10	7
AVG	55	14	32	13	66	19	1	34	27	18	8	8	5

DENVER, COLORADO
Stapleton Airfield

NOVEMBER
7200 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR.	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
AIR TEMP. (°F)																									
75/ 79	1						1																		2
74/ 70	18						26						7												51
69/ 65	31						108						28						6						173
64/ 60	50	1					151	10					42						26						280
59/ 55	79	14					205	38	1				90	6					21	2					462
54/ 50	48	33	5				185	107	13				73	34	2				22	4	2				522
49/ 45	32	72	18				134	233	39	5	5		47	58	10	1	1		5	4	2				665
44/ 40	14	60	32	3	3		97	328	141	32	11		39	101	29	8	3		5	4	3				932
39/ 35	5	49	64	24	19	3	27	262	297	93	69	19	8	50	62	13	11	3	1	4	3	1	1		1009
34/ 30		25	49	38	32	47	2	140	313	155	82	81	1	52	78	34	10	3		1	3	1	2		1148
29/ 25		17	42	39	34	19		72	175	87	84	32		27	45	17	18	2			3	1	4		735
24/ 20		2	39	51	40	7		22	104	78	72	16		16	29	11	11	4			3	1	4		489
19/ 15		1	16	17	27	2		11	71	63	44	5		4	17	9	20				2				307
14/ 10			9	7	19	2		12	44	43	24			2	5	4	2				1				178
09/ 05			2	3	9			4	29	15	10	1		1	4	6	2				1				82
04/ 00			1	4	2			3	11	18	3			1	4	1									46
-01/-05					5			1	6	22	5					2									36
-06/-10											1														1
TOTAL	282	281	291	170	184	84	936	1624	1239	603	410	154	339	360	283	101	79	41	82	24	16	3	6		7200

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MI PER HOUR)										PCT.
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	
N	.5	1.7	1.7	1.5	.6	.1				6.1	16.2
NNE	.5	1.7	1.7	1.2	.5	.1	*			5.6	10.2
NE	.7	1.3	1.1	.8	.1	.1	*			4.2	8.8
ENE	.6	1.6	1.4	1.0	.2	.1				4.9	9.8
E	.5	1.1	1.2	.8	.2	.1				3.8	9.5
ESE	.5	1.3	.9	.7	*	*				3.5	8.2
SE	.6	1.6	1.3	.6	.1					4.1	8.1
SSE	.5	1.8	1.8	.6	.1					4.8	8.1
S	1.1	4.8	8.8	4.8	.2					19.8	9.8
SSW	.7	3.9	6.5	6.0	.4	*				17.5	10.7
SW	.6	1.4	1.6	.9	.2	*	*			4.6	9.1
WSW	.5	.8	.8	.4	.1	*	*			2.8	9.3
W	.4	.8	.6	.3	.4	.2	.1	*		3.4	11.8
WNW	.6	.6	.9	1.2	1.0	.4	.2	*		4.8	15.2
NW	.6	1.4	1.5	1.3	.5	.4	.1			5.7	11.6
NNW	.4	1.3	1.2	.7	.1	*				3.7	9.1
CALM	1.3									1.3	
TOTAL	10.1	26.9	33.6	23.1	4.6	1.4	.4	*		100	10.0

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OBS. WITH PRECIP.
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	MID	1	2	3	4	5	6	7	8	9	10	11	MID	
TRACE	20	20	17	16	22	20	20	20	20	22	24	17	18	18	20	17	19	16	19	20	23	15	16	20	30
0- .99 IN.	6	8	6	12	6	8	5	5	4	8	7	6	6	7	7	7	2	4	3	6	5	9	9	9	4
1.00 TO 1.99 IN.	9	8	12	9	9	4	5	6	7	9	7	7	5	3	1	2	3	6	11	8	10	12	10	9	24
2.00 IN. AND OVER			1		1																1		1		16
TOTAL	33	36	34	33	38	40	30	39	39	39	38	30	29	28	28	26	24	28	33	34	39	36	36	34	88

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										TOT.
	0	100 TO 200	300 TO 500	600 TO 900	1000 TO 1900	2000 TO 2900	3000 TO 3900	4000 TO 4900	5000 TO 9900	10000 OR MORE	
0 TO 1/16	*	*								*	*
1/16 TO 1/8	*	*	*	*						*	.1
1/8 TO 1/4	*	.1	.1	.2	*	*				*	.6
1/4 TO 1/2		.1	.1	1.4	1.1	.3	*	*	.1	.3	3.6
1/2 TO 1		.1	.2	1.0	1.0	.4	.2	.2	1.3	4.4	
1 TO 2				.1	.3	2.0	1.3	1.4	1.6	26.4	34.3
2 TO 3					*	.2	.3	.2	1.2	20.0	23.0
3 OR MORE							.1	.1	.3	33.0	33.9
TOTAL	*	.2	1.1	2.6	2.4	2.9	1.9	1.9	3.4	81.5	100

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS (SCALE 0-10)			WIND SPEED (M.P.H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25-31 OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	57	32	31	7	64	27	1	0	27	35	17	10	6
01	57	34	29	5	62	28	2	2	26	34	17	10	7
02	57	35	28	10	59	31	1	1	24	32	17	15	6
03	56	32	31	9	62	28	1	2	24	30	17	17	8
04	57	32	31	11	58	29	1	1	27	27	16	19	9
05	57	32	31	11	60	28	1	0	25	29	18	14	7
06	48	36	36	8	60	30	1	2	25	32	17	15	7
07	42	38	40	11	58	30	1	0	24	32	18	12	6
08	43	36	41	12	58	29	1	1	29	26	17	10	5
09	45	37	38	13	57	29	1	2	34	19	9	8	2
10	45	37	38	12	57	28	3	3	33	18	9	5	1
11	43	39	38	14	56	29	4	4	27	15	9	6	1
12	44	36	42	8	63	25	4	5	24	15	6	5	1
13	44	35	41	11	59	25	5	5	24	15	6	4	1
14	41	38	41	8	60	28	4	5	25	15	6	5	1
15	39	36	44	10	59	31	4	5	28	14	6	4	1
16	39	37	45	11	59	31	3	4	27	19	5	5	1
17	41	38	41	10	63	26	1	3	30	23	9	6	1
18	46	37	37	11	66	23	1	2	28	29	11	8	2
19	48	37	36	10	66	23	1	1	26	28	29	13	11	3
20	50	37	34	10	62	28	1	1	25	28	31	14	11	4
21	55	35	31	8	65	26	1	1	26	28	32	15	12	5
22	60	34	31	9	62	28	1	1	27	32	16	12	5	7
23	58	32	30	9	65	25	2	2	28	33	16	12	7	4
AVG	49	35	36	10	61	27	2	2	27	25	12	9	4	3

R, COLORADO
pleton Airfield

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
104/100							1						+												1
99/ 95	1						7						2												10
94/ 90	13						68	+					19						1						103
89/ 85	38	2					165	6					38	3					5	+					216
84/ 80	42	14	+				160	45	+				51	14	1				5	1					332
79/ 75	41	38	9				148	104	9				49	34	2				7	5	+				437
74/ 70	36	43	21	1			134	142	54	2			49	44	15	1			9	5	1	+			549
69/ 65	37	40	39	13	3	+	124	155	115	23	7	1	43	39	24	4	1		9	5	1	+	+	+	604
64/ 60	30	34	43	19	16	6	128	148	135	46	31	10	53	33	21	9	2	+	12	5	1	+	+	+	703
59/ 55	33	34	29	18	20	7	139	116	107	49	35	12	61	30	18	9	3	+	12	5	1	+	+	+	731
54/ 50	20	30	36	13	17	4	119	126	92	38	32	11	60	35	16	6	2	+	12	5	1	+	+	+	678
49/ 45	19	37	28	14	16	8	98	151	91	38	39	23	45	48	16	6	2	+	12	5	1	+	+	+	704
44/ 40	12	38	30	12	11	3	66	174	106	40	31	15	35	62	22	5	1	+	9	4	1	+	+	+	692
39/ 35	6	34	43	16	14	3	50	154	157	53	44	25	18	51	32	8	2	+	7	3	1	+	+	+	717
34/ 30	3	22	41	25	25	20	11	102	172	71	56	56	7	38	32	12	4	1	2	1	+	+	+	+	721
29/ 25	1	11	34	24	26	12	4	63	131	64	67	28	2	19	24	11	4	1	1	+	+	+	+	+	553
24/ 20	1	6	23	15	27	9	3	29	79	50	59	18	+	9	14	6	2	+	+	+	+	+	+	+	359
19/ 15		2	15	11	15	3	1	11	56	34	57	9	+	5	12	4	2	+	+	+	+	+	+	+	216
14/ 10		1	6	7	10	1		5	31	27	17	1	+	2	8	3	1	+	+	+	+	+	+	+	119
09/ 05			4	3	5	+		2	19	22	10	+	+	1	5	2	1	+	+	+	+	+	+	+	78
04/ 00			4	4	2			1	11	9	5		+	+	2	1	+	+	+	+	+	+	+	+	36
-01/-05			2	2	1			+	3	8	1		+	+	+	+	+	+	+	+	+	+	+	+	22
-06/-10			2	+				+	3	+	+		+	+	+	+	+	+	+	+	+	+	+	+	6
-11/-15			+					+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	1
-16/-20							+						+						+						+
-21/-25							+	1					+												1
TOTAL	345	382	397	201	197	80	1380	1533	1374	573	460	200	536	467	258	70	23	4	96	56	18	6	1	0	8767

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (in miles per hour)												AVERAGE SPEED	TOTAL OBS.
N	.5	1.6	2.4	1.8	.4	.2	+	+	+				6.7	18.8
NNE	.4	1.6	2.0	1.3	.4	.1	+	+					5.9	10.7
NE	.7	1.5	1.6	.9	.2	.1	+	+					4.9	9.0
ENE	.4	1.2	1.4	.9	.2	.1	+	+					5.2	9.5
E	.5	1.3	1.6	.9	.2	+	+	+					5.0	9.4
ESE	.4	1.2	1.2	.7	.2	+	+	+					4.8	9.0
SE	.7	1.5	1.5	.8	.2	+	+	+					4.8	9.7
SSE	.5	1.5	1.6	.8	.2	.1	+	+					4.8	9.7
S	1.2	4.0	3.5	2.0	.5	.1	+	+					4.8	10.3
SSW	.8	3.4	3.2	1.5	.4	.1	+	+					4.8	10.5
SW	.8	1.8	1.8	.8	.2	+	+	+					3.5	8.5
WSW	.5	1.1	.9	.5	.1	+	+	+					3.1	8.9
W	.5	1.0	1.0	.6	.1	+	+	+					3.4	10.6
WNW	.5	1.0	1.0	.6	.1	+	+	+					4.1	12.9
NW	.8	1.7	1.7	1.3	.3	+	+	+					4.6	10.7
NNW	.6	1.2	1.5	.8	.2	+	+	+					4.2	9.9
CALM	1.0													1.0
TOTAL	10.6	26.7	33.8	21.9	4.9	1.7	.4	.1	+				10.0	100

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OBS.
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.	
TRACE	23	23	20	19	22	27	25	21	19	19	21	21	24	28	32	35	35	33	34	34	33	28	24	24	619
0+ TO	7	8	9	8	6	6	5	5	6	6	5	6	5	5	6	7	8	9	9	11	11	12	12	12	152
TO	9	7	8	10	9	6	6	7	8	8	5	6	5	5	8	7	8	8	8	7	11	11	12	12	155
TO	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	31
TO	+		+					+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	8
TO	+	+											+	+	+	+	+	+	+	+	+	+	+	+	3
TO AND OVER																									2
TOTAL	39	39	37	37	39	39	36	34	32	33	33	32	35	41	52	51	52	51	52	54	53	49	45	41	1151

In Tables A and C, occurrences are for the average year (10-year total divided by 10). Values are rounded to the nearest whole number, but not adjusted to make their sums exactly equal to column or row totals. "+" indicates more than 0 but less than 0.5.

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (miles)	CEILING (feet)										TOTAL
0 TO 1/8	+	+	+	+	+			+	+	+	.1
3/16 TO 3/8	+	+	.1	+	+				+	+	.2
1/2 TO 3/4	+	+	.1	.2	.2	+	+	+	+	+	.5
1 TO 2 1/2	+	+	.1	.4	.5	.6	.2	+	+	.2	2.4
3 TO 6		+	+	.3	1.0	.8	.3	.2	1.2	1.3	4.3
7 TO 15			+	.1	+	1.2	1.1	1.3	1.7	21.3	27.8
20 TO 30				+	+	.3	.4	.4	1.5	20.4	23.9
35 OR MORE					+	+	+	.2	1.4	39.1	40.8
TOTAL	+	+	.4	1.1	3.0	3.5	2.0	2.1	5.3	82.2	100

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS SCALE 0-10			WIND SPEED (mph)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25-& OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	59	13	29	10	63	26	1	8	28	31	14	13	5
01	58	14	27	11	62	26	1	8	29	32	14	13	5
02	59	14	27	11	64	25	1	8	28	32	14	13	5
03	59	13	27	11	64	24	1	8	29	31	14	13	5
04	57	15	28	12	65	23	1	8	29	32	14	13	5
05	56	15	29	13	64	23	1	8	29	31	14	13	5
06	55	15	30	13	63	23	1	8	29	31	14	13	5
07	48	15	36	13	63	23	1	9	31	33	12	11	4
08	47	15	38	15	61	23	1	11	34	34	10	8	3
09	48	15	36	16	61	22	1	12	36	34	9	7	2
10	48	16	36	15	61	23	1	13	40	32	8	5	2
11	47	18	34	11	62	25	2	14	40	32	7	5	2
12	43	20	37	11	62	24	2	14	38	33	8	5	2
13	38	22	40	11	58	29	2	13	36	34	9	6	2
14	34	22	44	11	57	30	2	12	34	35	10	6	2
15	32	21	47	11	53	33	3	12	33	35	10	7	2
16	31	19	50	11	53	33	3	12	33	35	10	7	2
17	31	20	49	11	54	32	3	12	33	35	10	7	2
18	35	19	45	11	57	30	2	12	33	35	10	7	2
19	39	19	42	11	60	28	2	12	33	34	10	7	2
20	43	19	38	11	61	27	2	12	33	34	10	7	2
21	48	18	34	11	62	25	2	12	33	34	10	7	2
22	53	15	32	10	61	26	2	12	33	34	10	7	2
23	56	14	30	10	62	25	2	12	33	34	10	7	2
AVG	47	17	36	11	60	27	2	11	32	34	11	8	3

USCOMM-NOAA-ASHEVILLE-1974-500

DENVER
Stapl

RADO
rfield

MBER
0 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND (MPH)	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH AND OVER						TOTAL OBS.
RH (%)	0-19	20-39	40-59	60-79	80-89	90-100	0-19	20-39	40-59	60-79	80-89	90-100	0-19	20-39	40-59	60-79	80-89	90-100	0-19	20-39	40-59	60-79	80-89	90-100	
74/ 70							5						3						1						9
69/ 65	4						16						10						6						36
64/ 60	18						55						33						9						115
59/ 55	24	1					117	5					53	2					11						213
54/ 50	40	8					142	54	1				87	12	1				17	3					363
49/ 45	27	38	2				151	149	4				85	64	4				18	21					555
44/ 40	15	57	16	1			115	265	86	6			96	99	14				13	18	1				740
39/ 35	11	59	62	17	6	1	61	285	254	34	16	8	41	132	55	4	9		12	14	1				1081
34/ 30	9	63	90	56	43	19	33	240	405	87	69	56	24	99	66	9	12	3	5	11	2	1	2	1	1405
29/ 25	2	24	93	47	64	30	16	177	327	111	148	60	4	43	44	8	15	5	2	3	2	2	1	2	1229
24/ 20	1	15	57	36	55	10	6	82	199	116	104	31		11	31	5	12	6		2		1	3		785
19/ 15		6	23	29	32	2		33	158	66	64	6		24	20	4	9	1							475
14/ 10		2	14	20	18			9	66	51	30			4	10	5									225
09/ 05			7	10	9	1		1	38	37	15			1	9	4									128
04/ 00			4	9	4			1	3	11	1				2	1	1								37
-01/-05			2	3	2			1	2	7	3				1										21
-06/-10				1					2																3
TOTAL	150	269	370	229	229	59	719	1276	1945	528	520	161	396	491	237	40	54	12	94	70	10	4	5	3	7440

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MI. PER HOUR)								TOTAL	AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39 OVER		
N	.6	1.5	1.7	.9	.2	.1	+	+	5.9	10.1
NNE	.4	1.5	1.9	.8	.3	.1	+	+	5.2	10.3
NE	.4	1.1	1.0	.4	.1		+		2.9	8.4
ENE	.6	.9	1.0	.5	.1	+			3.1	8.5
E	.4	1.0	1.3	.4	.1	+			3.2	8.9
ESE	.4	1.0	1.0	.4	+				2.9	8.2
SE	.8	1.4	1.4	.4	+				4.1	7.5
SSE	.5	2.0	1.7	.4	.1	+			4.8	7.9
S	1.3	4.6	8.3	6.0	.6	.1	+		20.9	10.3
SSW	1.2	4.1	8.1	5.9	.7	+	+		19.9	10.5
SW	.7	1.7	1.7	.7	.1	+			4.9	8.1
WSW	.2	1.0	.8	.5	.2	.1	+		2.8	10.2
W	.3	.8	.9	.9	.5	.4	.1	+	4.0	13.5
WNW	.4	1.0	.7	2.0	1.3	.6	.1	.1	6.3	15.5
NW	.6	1.3	1.4	1.3	.7	.3	.1	+	5.7	12.3
NNW	.4	.9	1.1	.5	.1	+	+		3.1	9.3
CALM	1.0								1.0	
TOTAL	10.2	25.0	34.2	22.2	5.2	1.8	.5	.2	100	10.2

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								TOTAL OBS. WITH PRECIP.
	AM HOUR ENDING AT												PM HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	MIDN.	1	2	3	4	5	6	7	8	9	10	11	MIDN.	
TRACE	19	10	8	10	16	22	16	16	16	12	15	19	22	19	18	16	18	19	17	19	16	18	17	18	37
0 TO .01 IN.	8	8	5	8	3	2	5	5	2	5	5	6	3	4	5	4	4	1	3	2	4	2	3	4	5
.02 TO .09 IN.	4	6	10	6	8	7	6	7	9	9	7	3	2	2	2	2	3	4	4	7	8	6	7	7	21
.10 TO .24 IN.					1																				14
.25 TO .49 IN.																									6
.50 TO .99 IN.																									1
1.00 TO 1.99 IN.																									
2.00 IN. AND OVER																									
TOTAL	29	24	23	24	28	31	27	28	27	26	27	28	27	25	25	22	25	24	24	28	28	26	27	29	84

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)										TOTAL
	0	100-200	200-500	500-1000	1000-2000	2000-3000	3000-4000	4000-5000	OVER 5000	NO CEILING	
0 TO 1/8	+		.1		+						.1
3/16 TO 3/8		+		.1					+		.1
1/2 TO 3/4	+		.1	.2	.4	.1					.7
1 TO 2 1/2			.1	.5	1.0	.9	.1	.1	+	.3	3.0
3 TO 4			+	.3	1.0	.6	.2	.2	.1	2.2	4.6
5 TO 15			+	.1	.7	1.1	1.1	1.0	1.0	27.0	32.7
20 TO 30				+	+	.1	.2	.6	1.3	22.2	24.3
35 OR MORE						.1	.1	.1	.5	33.5	34.3
TOTAL	+	.4	1.2	3.2	2.8	1.7	1.9	3.0	85.1	100	

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS (SCALE 0-10)			WIND SPEED (MI. P. H.)				RELATIVE HUMIDITY (%)						
	0-2	3-7	8-10	0-3	4-12	13-24	25-& OVER	0-29	30-49	50-69	70-79	80-89	90-100	
00	58	12	30	11	60	29	4	7	27	36	14	12	3	
01	58	14	29	11	57	30	2	6	28	35	14	14	3	
02	56	16	28	12	60	29	3	6	28	35	12	15	4	
03	55	14	31	10	61	28	1	7	27	32	14	15	4	
04	59	11	30	9	61	28	1	7	27	32	16	13	5	
05	59	16	29	11	60	28	1	8	27	32	14	13	5	
06	50	19	32	12	58	28	2	8	27	31	15	13	5	
07	45	17	38	11	59	28	1	8	26	35	12	13	5	
08	45	15	39	10	58	30	2	11	30	31	13	11	4	
09	47	14	39	7	58	32	3	20	33	27	9	7	4	
10	45	16	39	9	55	32	5	27	32	25	9	3	3	
11	46	19	36	8	60	26	5	37	32	19	5	4	3	
12	45	16	39	9	60	25	5	42	27	21	4	4	2	
13	44	18	37	11	57	27	5	44	28	18	5	5	1	
14	46	15	39	11	55	30	5	44	29	18	4	4	2	
15	44	16	40	10	61	24	3	39	29	22	5	4	1	
16	41	15	44	11	63	24	2	32	32	22	7	6	2	
17	42	19	39	10	65	23	2	23	32	28	8	6	3	
18	48	16	36	11	62	25	2	16	29	31	11	10	3	
19	50	18	32	13	61	25	2	13	26	34	13	11	3	
20	54	15	31	11	62	25	2	11	29	30	14	14	2	
21	56	19	26	11	62	27	1	8	28	35	14	14	2	
22	56	17	27	9	60	30	1	6	26	36	15	14	3	
23	56	15	30	8	62	28	2	7	26	37	14	12	4	
AVG	50	16	34	10	60	27	3	18	29	29	11	10	3	

Appendix J
Excavation and Liner Plan Modification with HELP Modeling

STATE OF COLORADO

John W. Hickenlooper, Governor
Christopher E. Urbina, MD, MPH
Executive Director and Chief Medical Officer

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
Located in Glendale, Colorado

Laboratory Services Division
8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

http://www.cdphe.state.co.us

Colorado Department of Public Health and Environment

Via Certified Mail #7010 1670 0001 6852 1801
Return Receipt Requested

March 31, 2011

Mr. Alek M. Orloff
Five Part Development Company
7475 East 84th Avenue
Commerce City, CO 80022

Re: Final Agency Action: Approval with Modifications
Engineering Design and Operations Plan Amendment
Revised Excavation Plan and Liner Design
East Regional Landfill – Adams County, Colorado

Dear Mr. Orloff:

On January 25, 2011, the Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division ("Division") received a document titled *"East Regional Landfill, Revised Excavation Plan and Liner Design"* prepared by American Environmental Consulting, LLC ("AEC"), dated January 21, 2011 ("EDOP Amendment"). The Division met with representatives of AEC, Five Part Development Company ("Five Part"), Tri-County Health Department ("TCHD"), and Sentinel Consulting Services on January 26, 2011 to discuss the EDOP Amendment. On February 10, 2011, the Division published a notice in the *Your Hub* section of *The Denver Post* requesting public comments on the EDOP Amendment. The public comment period ended March 11, 2011. The Division did not receive any public comments.

Based on discussions from the January 26, 2011 meeting, AEC revised the EDOP Amendment and submitted a revised document dated March 2, 2011("revised EDOP Amendment"). The Division conducted a comprehensive technical review of the revised EDOP Amendment in accordance with procedures outlined in the Solid Waste Act, CRS §30-20-103 *et seq.*, and corresponding Regulations Pertaining to Solid Waste Sites and Facilities, 6 CCR 1007-2, Part 1 ("Solid Waste Regulations"). The Division provided its review comments to Adams County, Tri-County Health Department, AEC, and Five Part via e-mail dated March 8, 2011. In response to Division and TCHD comments, AEC prepared and submitted a response letter dated March 14, 2011 ("Response Letter") and a document titled

"Construction Quality Assurance Plan and Specifications, Liner and Leachate Collection and Removal System, East Regional Landfill, Adams County, Colorado, Revised March 2011" ("Revised CQAP"). The Division has completed its review of the Response Letter and Revised CQAP. It is the determination of the Division that the revised EDOP Amendment as modified by the Response Letter, including the Revised CQAP, can comply with the technical, environmental, and public health standards in the Solid Waste Act and corresponding Solid Waste Regulations if the revised liner design is constructed, operated, and monitored as detailed in the site's approved EDOP, the revised EDOP Amendment, as modified by the Response Letter, the Revised CQAP, and with the modifications described herein. Based on this determination, the Division approves, with the modifications listed herein and in the Response Letter, as final agency action, the revised EDOP Amendment, which includes the Revised CQAP. Please note that the Division's approval with the following modifications does not preclude independent review action by Adams County.

1. **Revised CQAP, Section 5.5.2.3, GCL Sampling and Conformance Testing:** Conformance testing must include the following tests and must be conducted at the rate indicated in Section 5.5.2.3 (i.e., at least one test for every 100,000 square feet to be installed, or at least one sample per lot, whichever results in the greater number of conformance tests):

    - Moisture Content – ASTM D 2216
    - Bentonite Mass per Unit Area – ASTM D 5993
    - Index Flux – ASTM D 5084 or 5887

2. **Response Letter:** Response 6 indicates that the anchor trenches at the perimeter of the fill area will be detailed in each set of construction level drawings for future cell construction. The sixth bullet item in Section 5.5.3 of the Revised CQAP seems to indicate that GCL and geomembrane will be placed in the same anchor trench. The Revised CQAP and construction level design drawings must be updated to clarify, and provide anchoring details, for both the GCL and geomembrane. Section 5.5.5.3 of the Revised CQAP addresses CQA requirements for GCL anchoring. A similar section must be added to Section 5.2 of the Revised CQAP to address CQA requirements for geomembrane anchoring. Please note that Sheet 4 from the construction drawings for Cell 10 shows the geomembrane extending up the outboard wall of the anchor trench. Both the GCL and geomembrane shall extend across the anchor trench floor, but not up the outboard wall of the anchor trench. The Division requires Five Part to submit an updated EDOP Amendment, Revised CQAP, and revised construction drawings that address the anchoring issues identified herein, and that incorporate the revisions outlined in the Response Letter. The revised documents must be submitted to the Division for its review and approval at least sixty (60) calendar days prior to planned commencement of the next phase of liner construction. The revisions can be provided in the form of replacement pages and replacement drawings.

On August 12, 2009, the Division received a document from AEC titled: *"Addendum to Engineering Design and Operations Plan, Five Part Disposal Facility Volumes I and II dated June 1, 2006"* ("EDOP

Addendum"). The EDOP Addendum was prepared by AEC and was submitted to the Division pursuant to requirements of the Certificate of Designation Resolution recorded on July 29, 2009. The Division's review letter dated September 10, 2009 provided fifteen (15) comments on the EDOP Addendum, and requires Five Part to revise and resubmit the EDOP Addendum to the Division for its review and approval. A revised EDOP Addendum has not yet been submitted.

Subsequent to the August 2009 EDOP Addendum, numerous other EDOP Amendments have been reviewed and approved by the Division. Consequently, significant portions of the original EDOP (Doty & Associates; June 1, 2006) have been modified by EDOP Amendments. In recognition of these numerous revisions, Five Part has indicated that it intends to prepare an updated EDOP that addresses the Division's comments from its September 10, 2009 letter and incorporates all of the approved EDOP Amendments into an updated EDOP document. By May 1, 2011, Five Part must prepare a schedule that provides a proposed timetable for completing the EDOP update. The schedule must be submitted to the Division for its review and approval.

The Division is authorized to bill for its review of technical submittals pursuant to the provisions set forth in Section 1.7 of the Solid Waste Regulations. Invoice(s) for the Division's review of the subject documents will be transmitted to Five Part c/o Alpine Disposal, Inc., under separate cover.

Should you have questions, please contact Curt Stovall at (303) 692-2295, curtis.stovall@state.co.us, or Roger Doak at (303) 692-3437, roger.doak@state.co.us.

Sincerely,

Curt Stovall, P.E.
Environmental Protection Specialist
Solid Waste and Materials Management Program
Hazardous Materials and Waste
Management Division

Roger Doak
Permitting Unit Leader
Solid Waste and Materials Management Program
Hazardous Materials and Waste
Management Division

cc: Adams County Board of Commissioners
Jeremy Groves – East Regional Landfill
Deanne Kelly – Tri-County Health Department
Martin Kosec, P.E. – Sentinel Consulting Services, LLC
Christopher La Rue – Adams County Planning and Development Department
Mark McMullen – AEC
Craig Tessmer – Adams County Planning and Development Department

ec: Darrell Dearborn – CDPHE, HMWMD

File: SW/ADM/FIV 2.2

AEC *AMERICAN ENVIRONMENTAL CONSULTING, LLC*

March 1, 2011

Mr. Craig Tessmer
Department of Planning and Development
Adams County
4430 South Adams County Parkway
1st Floor, Suite W2000A
Brighton, Colorado 80601

Ms. Deanne Kelly
Tri-County Health Department
4201 East 72nd Ave. Suite D
Commerce City, Colorado 80022

Mr. Curt Stovall
Colorado Department of Public Health and Environment
HMWMD B-2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Re: Revised Modified Grading Plan and Request to Incorporate GCL Liner
East Regional Landfill; Adams County, Colorado

Dear Mr. Tessmer, Mr. Stovall, and Ms. Kelly:

American Environmental Consulting, LLC (AEC) submitted a request on behalf of Alpine Waste for approval of a revised excavation grading plan and substitute a Geosynthetic Clay Liner (GCL) for the two-foot thick clay liner at the East Regional Landfill (ERL) in a report dated January 21, 2011. During a follow-up meeting with representative of the ERL, AEC, the Colorado Department of Public Health and Environment (CDPHE) and the Tri-County Health Department (TCHD) on January 26th, a few outstanding issues remained. Those issues were:

1. Obtain additional subsurface information in the southeast portion of the site to enable the development of groundwater contours in this area and verify that the top of the liner system is designed with a minimum separation of 10 feet from the underlying groundwater as required.

2. Evaluate the Cation Exchange Capacity (CEC) of the proposed GCL.

3. Review the approved groundwater monitoring system to determine if it is still appropriate for monitoring the sump areas of the landfill considering the redesigned base grades.

We have completed the additional work requested, which required a minor change in the excavation base grades in the eastern end of Module 3, the area that lacked information to develop the groundwater contours. The change in the excavation grades in the east end of Module 3 necessitated minor revisions to all of the drawings except the final cover drawing, and minor revisions to the HELP modeling and travel time calculations for

Module 3. No changes were made in the Module 2 or Module 3 landfill areas, so there are no changes to those grading designs or leachate drainage calculations. Because of the number of documents and pages that required slight revisions to the January 21, 2011 plan, we are resubmitting the entire plan that incorporates responses to the outstanding issues from our January 26th meeting.

The ERL proposes a revision to the original approved excavation grading plan included in the Engineering Design and Operations Plan (EDOP) prepared by Doty & Associates, LLC (June 2006). We are also proposing to substitute a Geosynthetic Clay Liner (GCL) in place of the currently permitted two-foot thick compacted clay liner. As with the current approved design that includes a 60-mil HDPE membrane on top of the clay, the HDPE membrane will remain but be placed on top of the GCL. This revised grading plan is designed to meet the requirement of a minimum separation between the top of the liner and the groundwater of ten feet as approved in the Doty EDOP. Modifications to the approved grading plan included in the EDOP became necessary after changes made to the property borders during the public hearing process and necessitated by conditions encountered during construction of Cell 10. Additionally, supporting documentation was prepared to demonstrate that the plan met the Colorado Department of Public Health and the Environment (CDPHE) regulatory requirements.

As stated above, the facility has a minimum ten-foot separation requirement between the top of the clay liner surface and underlying groundwater. A number of piezometers were installed at the facility in 1991 and 1992 to characterize the subsurface for the original permitting of the facility as a coal ash disposal facility. The water levels in these piezometers were measured at various times between installation and March 1993 to establish static groundwater elevations. Nearly all of those piezometers have been destroyed, so an additional 18 piezometers were installed in November 2010 and February 2011 to verify the original groundwater characterization data and better define the groundwater surface for purposes of the redesign of the grading plan. The piezometers installed in 1991 and 1992 are noted as "pre-existing" and the piezometers installed in 2010 noted as "new" in the attached drawings. In general, the piezometers installed in 2010 and 2011 verify that the 1991/1992 groundwater data was accurate. As can be seen on Sheet 4, many piezometers are nested or placed in very close proximity to each other, but they indicate a difference in groundwater elevations. For purposes of designing the base grades for the landfill that ensure the required separation, the highest groundwater elevations, which are shown on Sheet 4, were used in these cases. A few of the piezometers, particularly those completed in February 2011 (PZ-98, PZ-99, and PZ-100) are dry to the total depth completed. For purposes of developing groundwater contours and establishing a minimum separation between the top of the liner elevations and the underlying groundwater, groundwater was assumed to be present at the total depth of the dry piezometers. The resulting redesigned landfill grades demonstrate a minimum 10-foot of separation between the top of clay (or GCL liner) and the underlying groundwater. Sheet 5 is a drawing showing the groundwater contours and the landfill grades on the top of clay surface (or GCL surface). The groundwater contours were

developed based on the highest recorded groundwater elevation where conflicting elevations are indicated in nested or nearby piezometers, so Sheet 5 includes only the piezometers and groundwater elevations used to develop the groundwater contours.

In addition, we have reviewed the approved groundwater monitoring plan, including the locations of the existing and future groundwater monitoring wells, and they are still appropriate to act as the detection monitoring system at the ERL.

Attached with this submittal are the following:

1. A table showing the separation between the top of the clay or GCL liner and the uppermost groundwater elevation at the relevant piezometers used to develop the groundwater contours. In every case the minimum separation requirement is met.

2. Hydrologic Evaluation of Leaching Potential (HELP) models that evaluate the potential maximum and average depth of leachate on the liner in each of the three fill modules. Results of the modeling indicate that the maximum leachate head on the liner is well below the regulatory maximum of 12-inches.

3. Transit time calculations to estimate the length of time it would take leachate to travel from the farthest point in each module to that module's sump. The transit times were prepared based on the actual grades and longest flow pathways, include leachate travel down the landfill sideslopes, and are well within the maximum 365-day requirement.

4. An equivalency determination to compare the option of using a GCL in place of the currently approved 24 inches of clay beneath the High Density Polyethylene (HDPE) liner. Based on the evaluation, GCL meeting the requirements included in the attached CQA Plan will perform as well as or better than the two-foot of compacted clay liner. Also included in this attachment are the results of the evaluation of the CEC of the GCL liner. Based on our evaluation, the GCL overlain by the HDPE membrane will provide equal or better performance than the currently approved two feet of compacted clay liner.

5. A revised Construction Quality Assurance Plan (CQAP) that includes the specifications and CQA activities associated with installing a GCL instead of constructing the two-foot clay barrier layer. The attached CQAP is identical to the approved CQAP in content with the exception of the additional of the GCL component and adding language regarding the timing of the placement of the protective layer soils as recommended by the CDPHE in their February 9, 2010 approval letter for the CQA Plan. The attached plan has been reformatted slightly to incorporate the new information.

No changes were made to the CQAP that was submitted in the January 21, 2011 submittal, but is included here for completeness.

Also included are a set of revised drawings showing the excavation plan as well as other relevant information. These drawings include:

1. Top of Subgrade (if the liner is to be constructed using 24 inches of recompacted clay)
2. Top of Clay: This is also the drawing that represents the GCL subgrade surface if GCL were used instead of a two-foot thick clay as a barrier layer
3. Final Cover Topography (essentially unchanged from the approved topography)
4. Locations of wells and piezometers used to develop the excavation plan
5. The groundwater surface contours

The information and data provided with this letter shows the excavation will meet the CDPHE requirements for design of a landfill base.

As you know, the East Regional Landfill is quickly reaching capacity on their constructed disposal cell. In order to continue disposal operations, we would appreciate your expeditous review and approval of this plan so we may begin the design and construction on the next cell.

Please feel free to call me if you have any questions during your review, and we would be happy to discuss any issues in person to expedite the review process.

Respectfully Submitted,

American Environment Consulting, LLC

Mark A. McMullen
Principal/Project Manager

Reviewed by:



Michael H. Stewart, P.E.
Principal Engineer

cc: Mr. Alek Orloff, ERLF
Mr. Jeremy Groves, ERLF

attachments

AEC

TAB 1

GROUNDWATER VS.TOP OF LINER SEPARATION

East Regional Landfill

Separation of Groundwater and Top of Clay/GCL Barrier Layer

March 2, 2011

Piezometer	Water Elevation	Subgrade Elevation	Separation at Clay Subgrade	Separation at Top of Clay/GCL
PZ-13	5272.40	5284.45	12.05	14.05
PZ-46	5308.09	5317.78	9.69	11.69
PZ-49	5247.75	5260.59	12.84	14.84
PZ-54	5306.92	5324.00	17.08	19.08
PZ-55	5296.71	5306.34	9.63	11.63
PZ-56	5280.30	5292.81	12.51	14.51
PZ-58	5309.76	5322.10	12.34	14.34
PZ-59S	5310.34	5321.62	11.28	13.28
PZ-64D	5267.41	5299.70	32.29	34.29
PZ-73 *	5250.17	5268.00	17.83	19.83
PZ-74	5266.01	5275.05	9.04	11.04
PZ-80	5285.09	5302.61	17.52	19.52
PZ-81	5306.62	5317.38	10.76	12.76
PZ-82	5309.08	5317.76	8.68	10.68
PZ-83	5290.14	5302.48	12.34	14.34
PZ-85	5285.99	5295.46	9.47	11.47
PZ-86	5285.48	5298.86	13.38	15.38
PZ-87	5281.27	5289.90	8.63	10.63
PZ-89	5273.51	5283.92	10.41	12.41
PZ-90	5287.40	5298.05	10.65	12.65
PZ-91	5292.39	5307.88	15.49	17.49
PZ-93	5288.02	5296.98	8.96	10.96
PZ-94	5269.93	5278.84	8.91	10.91
PZ-95	5251.56	5310.59	59.03	61.03
PZ-97	5271.75	5294.09	22.34	24.34
PZ-98 *	5245.5	5273	27.5	29.5
PZ-99 *	5269.1	5296.6	27.5	29.5
PZ100 *	5276.3	5290	13.7	15.7

* Piezometer dry. Total depth used as a gw elevation. Separation from gw estimated from lowest portion of base near piezometer

TAB 2

HELP MODEL CALCULATIONS AND RESULTS

HELP MODEL RESULTS
HELP Model Input Data

The HELP Model was used to analyze the depth of leachate over the liner during both open and closed scenarios during the life of the East Regional Landfill at each of the three sumps proposed for the landfill. Each sump serves a specific module in the landfill. The maximum allowable depth of leachate on the liner in a module is 12 inches. The open scenario assumes there is ten feet of refuse over the entire module served by one of the three sumps and that 100% of the leachate is recirculated to the refuse (daily cover) surface. The closed scenarios were also modeled for each sump also assuming there was 100% recirculation of leachate as a worst-case scenario. This was also done to determine if the recirculation of leachate to the final cover could be used as an irrigation method, assuming acceptable leachate quality.

General Parameter Data

The general data was input based on the HELP Modeling previously completed by Terracon during the permit process. The climate data was updated to input actual average temperature and precipitation data from a weather station near the Denver International Airport (Attachment 1). To compute solar radiation, default information provided in the program for the city of Denver was used. Tables showing the parameter input data and results of maximum leachate head on the liner are included in Attachment 2.

Runoff curve numbers were generated by the HELP program based on data input representing the landfill module floor lengths, slopes, and soil types.

Two "Maximum Leaf Area Index" (MLAI) values were chosen for this model for two conditions.

1. For the open landfill condition (active, open landfill), a MLAI value of 0 was chosen because it is assumed there is no vegetation on the daily or intermediate cover. This was used for a ten-year simulation under the assumption the landfill is open and uncapped.

2. For the closed landfill condition, a MLAI value of 3.5 was chosen. This value corresponds to conditions of "good" stand of grass. This was used to prepare the 30-year simulation under the assumption the landfill is closed, capped and in its post-closure period.

Two "Evaporative Zone Depth" values were chosen for this model for the same two conditions described above.

1. For conditions of no vegetation, a depth of 14 inches was chosen, as suggested by the program.

2. For conditions of vegetation, a depth of 36 inches was chosen since this was used in the original HELP analysis and the total cap depth is assumed as 48 inches of evapotranspiration type soil material as proposed in the approved design plan.

AEC

Open Condition

The open condition was modeled based on the conservative assumption that the entire module to each sump will be open and covered with ten feet of waste. The additional conservative assumptions used is that model was run using the shallowest slope and longest flow length on the base of each module for the flow length even though the slope varies across the floor of the module.

It is assumed that there is six inches of daily cover on the waste and that 100% of the leachate is recirculated back onto the landfill.

Closed Condition with Final Cover

The closed condition was modeled using the same type of final cover as used in the original permit to calculate the maximum leachate head on the liner at each of the three sumps. The base liner system for the landfill is modeled the same as for the open condition scenarios using the same conservative assumption of slope and flow length. The final cover is assumed to consist of the following:

1. The topsoil thickness is 6 inches. The "Soil Texture" number chosen in the HELP model was number 7 and is based on the type of material available at the site. This value closely compares to saturated hydraulic conductivity values calculated for soil samples collected at relatively shallow depths at the ERLF.

2. The layer under the topsoil is 42 inches of additional soil to provide additional root zone for the vegetative cover and was selected because the original model was run with a total final cover soil thickness of 48 inches and no other barrier material. The default "Soil Texture" number chosen in the HELP model was number 11 as used in the original model runs. This value closely compares to saturated hydraulic conductivity values calculated for soil samples collected at relatively shallow depths at the ERLF.

Additionally, the thickness of waste in the landfill was modeled using the greatest thickness found at any one point in each module served by a sump.

The parameters are shown on the attached tables for the various scenarios.

The HELP model results for the Open Landfill scenarios area included in Attachment 3 and the Closed Landfill scenarios are included as Attachment 4. The results indicate there will never be more than 12 inches of leachate on the liner at one time. In fact, the models show there is 1 inch or less of leachate head on the liner that will be generated during the open case and during post-closure so the proposed excavation plan is acceptable to manage leachate accumulation.

ATTACHMENT 1

ERLF CLIMATE INFORMATION

AEC

HPRCC Product Page

NOTE:
To print data frame (right side), click on right frame before printing.

1971 - 2000

- Daily Temp. & Precip.
- Daily Tabular data (~23 KB)
- Monthly Tabular data (~1 KB)
- NCDC 71-00 Normals (~3 KB)

1961 - 1990

- Daily Temp. & Precip.
- Daily Tabular data (~23 KB)
- Monthly Tabular data (~1 KB)
- NCDC 61-90 Normals (~3 KB)

Period of Record

- Station Metadata
- Station Metadata Graphics

General Climate Summary Tables

- Temperature
- Precipitation
- Heating Degree Days
- Cooling Degree Days
- Growing Degree Days

Temperature

- Daily Extremes and Averages

DENVER WSFO AP, COLORADO

Period of Record General Climate Summary - Temperature

Station:(052220) DENVER WSFO AP

From Year=1948 To Year=2010

	Monthly Averages			Daily Extremes				Monthly Extremes				M Te
	Max.	Min.	Mean	High	Date	Low	Date	Highest Mean	Year	Lowest Mean	Year	>= 90 F
	F	F	F	F	dd/yyyy or yyyymmdd	F	dd/yyyy or yyyymmdd	F	-	F	-	# Days
January	43.8	17.0	30.4	74	02/1997	-25	11/1963	40.3	1986	16.3	1949	0.0
February	46.9	20.4	33.6	76	05/1963	-25	01/1951	43.7	1954	22.3	1989	0.0
March	52.7	26.2	39.4	84	26/1971	-8	03/1960	47.1	1986	29.0	1965	0.0
April	61.3	34.3	47.8	90	30/1992	-2	02/1975	56.3	1981	41.0	1983	0.0
May	70.8	44.0	57.4	96	30/2003	22	02/1954	63.2	1994	50.0	1995	0.5
June	81.6	52.8	67.2	104	26/1994	30	02/1951	73.5	1994	60.6	1967	6.7
July	88.2	59.0	73.6	104	21/2005	43	07/1952	77.9	2003	68.9	1950	15.1
August	85.8	57.3	71.6	102	01/2002	41	23/1964	75.3	1995	67.2	2004	10.0
September	77.4	48.1	62.8	97	04/1960	17	29/1985	68.2	1981	55.6	1965	2.5
October	66.1	36.7	51.4	89	16/1991	3	13/1969	59.9	1950	38.9	1969	0.0
November	52.7	25.5	39.1	81	09/2006	-8	09/1950	48.6	1949	29.7	1985	0.0
December	45.0	18.3	31.6	75	27/1980	-25	22/1990	41.2	1980	17.4	1983	0.0
Annual	64.4	36.6	50.5	104	19940626	-25	19510201	54.0	1981	48.3	1951	34.8

DENVER WSFO AP, COLORADO (052220)

Period of Record Monthly Climate Summary

Period of Record : 8/ 1/1948 to 7/31/2010

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	43.8	46.9	52.7	61.3	70.8	81.6	88.2	85.8	77.4	66.1	52.7	45.0	64.4
Average Min. Temperature (F)	17.0	20.4	26.2	34.3	44.0	52.8	59.0	57.3	48.1	36.7	25.5	18.3	36.6
Average Total Precipitation (in.)	0.50	0.56	1.25	1.79	2.40	1.70	1.96	1.74	1.14	1.01	0.81	0.58	15.43
Average Total SnowFall (in.)	7.3	7.0	12.2	8.3	1.7	0.0	0.0	0.0	1.5	4.1	8.6	7.8	58.6
Average Snow Depth (in.)	1	1	1	0	0	0	0	0	0	0	1	1	0

Percent of possible observations for period of record:

Max. Temp.: 99.7% Min. Temp.: 99.7% Precipitation: 99.7% Snowfall: 99.6% Snow Depth: 99.6%
Check Station Metadata or Metadata graphics for more detail about data completeness.

High Plains Regional Climate Center, contact us.

ATTACHMENT 2

DATA PARAMETER AND RESULTS TABLES

AEC

HELP SUMMARY TABLE
FIVE PART DISPOSAL LANDFILL

HELP Modeling was performed for open and closed scenarios of the ERLF to estimate the maximum amount of head on the bottom liner system. Separate HELP analyses were performed for the Open Condition with 10-feet of waste, 100% recirculation of the leachate, and no runoff; and the Closed Condition using the greatest thickness of waste and shallowest slope of the base, although the base slopes vary, as conservative measures for the analysis. A summary of each of the HELP Model conditions is presented below.

MODEL DESCRIPTION Open Condition: Run 10 Yrs	**Layer 1**	**Layer 2**	**Layer 3**	**Layer 4**	**Layer 5**	**Layer 6**	**Peak Daily Maximum Head on Liner w/ 100% Recirculation**
Sump 1 Area: 63 acres Base slope: 1.4%	6" Daily Cover	10' of Waste	12" Protective Cover	Geocomposite Drainage Layer	60-Mil HDPE	24" Clay	0.062 inches
Sump 2 Area: 37.4 acres Base slope: 1.0 %	6" Daily Cover	10' of Waste	12" Protective Cover	Geocomposite Drainage Layer	60-Mil HDPE	24" Clay	.083 inches
Sump 3 Area: 37.4 acres Base slope: 1.0%	6" Daily Cover	10' of Waste	12" Protective Cover	Geocomposite Drainage Layer	60-Mil HDPE	24" Clay	.056 inches
MODEL DESCRIPTION Closed Condition: Run 30 Yrs	**Layer 1/2** See note	**Layer 3**	**Layer 4**	**Layer 5**	**Layer 6**	**Layer 7**	**Peak Daily Maximum Head on Liner w/ 100% Recirculation**
Sump 1 Area: 63 acres Base slope: 1.4 %	48" Final Cover System	Sump 1: 87' of Waste (Max Ht)	12" Protective Cover	Geocomposite Drainage Layer	60-Mil HDPE	24" Clay	.139 inches
Sump 2 Area: 37.4 acres Base slope: 1.0 %	48" Final Cover System	Sump 2: 74' of Waste (Max Ht)	12" Protective Cover	Geocomposite Drainage Layer	60-Mil HDPE	24" Clay	.157 inches
Sump 3 Area: 37.4 acres Base slope: 1.0%	48" Final Cover System	Sump 3: 96' of Waste (Max Ht)	12" Protective Cover	Geocomposite Drainage Layer	60-Mil HDPE	24" Clay	.138 inches

Note: In the closed condition, Layers 1 and 2 include the 6-inch topsoil material plus the 42-inch remaining soil final cover. The original HELP Modeling included one layer of 48 inches thick.

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

The SCS runoff curve number was computed from each sump area's minimum slope, soil type, and flow length to the drain. In the Open Landfill Cases, bare soil was used while the closed cases used a fair stand of grass to compute the curve number. Each sump area data is outlined in the following tables:

SUMP 1 AREA:	Open Condition 100% Recirculation	Closed Condition 100% Recirculation
SCS RUNOFF CURVE NUMBER	86.9	71.1
FRACTION OF AREA ALLOWING RUNOFF	0 Percent	100 Percent
AREA PROJECTED ON HORIZONTAL PLANE	63 Acres	63 Acres
EVAPORATIVE ZONE DEPTH	14.0 Inches	36.0 Inches
INITIAL WATER IN EVAPORATIVE ZONE	2.13 Inches	6.239 Inches
UPPER LIMIT OF EVAPORATIVE STORAGE	8.206 Inches	16.758 Inches
LOWER LIMIT OF EVAPORATIVE STORAGE	1.240 Inches	6.234 Inches
INITIAL SNOW WATER	0	0
INITIAL WATER IN LAYER MATERIALS	48.804 Inches	328.777 Inches
TOTAL INITIAL WATER	48.8034Inches	328.777 Inches
TOTAL SUBSURFACE INFLOW	0.00 Inches/Year	0.00 Inches/Year

SUMP 2 AREA:	Open Condition 100% Recirculation	Closed Condition 100% Recirculation
SCS RUNOFF CURVE NUMBER	86.9	71.0
FRACTION OF AREA ALLOWING RUNOFF	0 Percent	100 Percent
AREA PROJECTED ON HORIZONTAL PLANE	37.4 Acres	37.4 Acres
EVAPORATIVE ZONE DEPTH	14.0 Inches	36.0 Inches
INITIAL WATER IN EVAPORATIVE ZONE	2.129 Inches	6.240 Inches
UPPER LIMIT OF EVAPORATIVE STORAGE	8.206 Inches	16.758 Inches
LOWER LIMIT OF EVAPORATIVE STORAGE	1.240 Inches	6.234 Inches
INITIAL SNOW WATER	0	0
INITIAL WATER IN LAYER MATERIALS	48.803 Inches	283.226 Inches
TOTAL INITIAL WATER	48.803 Inches	283.226 Inches
TOTAL SUBSURFACE INFLOW	0.00 Inches/Year	0.00 Inches/Year

SUMP 3 AREA:	Open Condition 100% Recirculation	Closed Condition 100% Recirculation
SCS RUNOFF CURVE NUMBER	87.0	71.4
FRACTION OF AREA ALLOWING RUNOFF	0 Percent	100 Percent
AREA PROJECTED ON HORIZONTAL PLANE	37.4 Acres	37.4 Acres
EVAPORATIVE ZONE DEPTH	14.0 Inches	36.0 Inches
INITIAL WATER IN EVAPORATIVE ZONE	2.134 Inches	6.239 Inches
UPPER LIMIT OF EVAPORATIVE STORAGE	8.206 Inches	16.758 Inches
LOWER LIMIT OF EVAPORATIVE STORAGE	1.240 Inches	6.234 Inches
INITIAL SNOW WATER	0	0
INITIAL WATER IN LAYER MATERIALS	48.808 Inches	360.315 Inches
TOTAL INITIAL WATER	48.808 Inches	360.315 Inches
TOTAL SUBSURFACE INFLOW	0.00 Inches/Year	0.00 Inches/Year

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM DENVER, COLORADO

	Open Conditions	Closed Conditions
STATION LATITUDE	39.77 Degrees	39.77 Degrees
MAXIMUM LEAF AREA INDEX	0	3.50
START OF GROWING SEASON (JULIAN DATE)	122	122
END OF GROWING SEASON (JULIAN DATE)	286	286
EVAPORATIVE ZONE DEPTH	14.0 Inches	36.0 Inches
AVERAGE ANNUAL WIND SPEED	8.80 MPH	8.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	54.00%	54.00%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	50.00%	50.00%
AVERAGE 1RD QUARTER RELATIVE HUMIDITY	49.00%	49.00%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	54.00%	54.00%

PRECIPITATION DATA (Attached)
PRECIPITATION DATA WAS INPUT BASED ON DATA TAKEN FROM THE DENVER WSFO AB STATION IN DENVER, COLORADO

TEMPERATURE DATA (Attached)
TEMPERATURE DATA WAS INPUT BASED ON DATA TAKEN FROM THE DENVER WSFO AB STATION IN DENVER, COLORADO

SOLAR DATA
SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER, COLORADO AND STATION LATITUDE OF 39.77 DEGREES

ATTACHMENT 3

HELP RESULTS OPEN LANDFILL SCENARIOS

AEC

HELP MODEL RESULTS

OPEN LANDFILL CASE

SUMP 1 AREA

```
**********************************************************************
**********************************************************************
**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**                    USAE WATERWAYS EXPERIMENT STATION             **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
**********************************************************************
**********************************************************************

PRECIPITATION DATA FILE:     C:\WORK\MODELS\HELP\HELP307\5PTPRE.D4
TEMPERATURE DATA FILE:       C:\WORK\MODELS\HELP\HELP307\5PTTEM.D7
SOLAR RADIATION DATA FILE:   C:\WORK\MODELS\HELP\HELP307\5PTSOL.D13
EVAPOTRANSPIRATION DATA:     C:\WORK\MODELS\HELP\HELP307\5PTEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\WORK\MODELS\HELP\HELP307\5PTSMP1.D10
OUTPUT DATA FILE:            C:\WORK\MODELS\HELP\HELP307\5PTOUT1.OUT

TIME:   8: 8     DATE:   3/ 2/2011

**********************************************************************
     TITLE:  East Regional Landfill- Sump 1 Open LF Case 10 Feet of Waste
**********************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   7
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4730 VOL/VOL
          FIELD CAPACITY                =      0.2220 VOL/VOL
          WILTING POINT                 =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1959 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.520000001000E-03 CM/SEC
        NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 4
                IS RECIRCULATED INTO THIS LAYER.

                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  18
          THICKNESS                     =    120.00   INCHES
          POROSITY                      =      0.6710 VOL/VOL
          FIELD CAPACITY                =      0.2920 VOL/VOL
          WILTING POINT                 =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2805 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4640	VOL/VOL
FIELD CAPACITY	=	0.3100	VOL/VOL
WILTING POINT	=	0.1870	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	1.40	PERCENT
DRAINAGE LENGTH	=	2161.0	FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 2161. FEET.

SCS RUNOFF CURVE NUMBER	=	86.90	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	63.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.130	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.206	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.240	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	48.804	INCHES
TOTAL INITIAL WATER	=	48.804	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Denver Colorado

STATION LATITUDE	=	39.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	122	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	54.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.50	0.56	1.25	1.79	2.40	1.70
1.96	1.74	1.14	1.01	0.81	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
30.40	33.60	39.40	47.80	57.40	67.20
73.60	71.60	62.80	51.40	39.10	31.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO
AND STATION LATITUDE = 39.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.42	0.74	1.15	1.86	1.85	1.85
	1.72	1.80	1.48	0.75	0.73	0.73
STD. DEVIATIONS	0.31	0.37	0.63	1.02	1.02	1.11
	1.26	1.02	0.24	0.59	0.55	0.47
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.398	0.462	1.142	1.901	1.852	1.901
	1.649	1.715	1.252	1.345	0.770	0.627
STD. DEVIATIONS	0.250	0.213	0.546	1.026	1.067	0.955
	1.061	1.316	0.618	0.404	0.381	0.318
LATERAL DRAINAGE RECIRCULATED INTO LAYER 1						
TOTALS	0.0007	0.0013	0.0013	0.0156	0.0119	0.0114
	0.0287	0.0043	0.0066	0.0129	0.0049	0.0036
STD. DEVIATIONS	0.0021	0.0020	0.0016	0.0238	0.0183	0.0247
	0.0606	0.0045	0.0069	0.0209	0.0072	0.0083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE RECIRCULATED FROM LAYER 4						
TOTALS	0.0007	0.0013	0.0013	0.0156	0.0119	0.0114
	0.0287	0.0043	0.0066	0.0129	0.0049	0.0036
STD. DEVIATIONS	0.0021	0.0020	0.0016	0.0238	0.0183	0.0247
	0.0606	0.0045	0.0069	0.0209	0.0072	0.0083

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0001	0.0001	0.0001	0.0014	0.0010	0.0010
	0.0025	0.0004	0.0006	0.0011	0.0004	0.0003
STD. DEVIATIONS	0.0002	0.0002	0.0001	0.0022	0.0016	0.0022
	0.0053	0.0004	0.0006	0.0018	0.0007	0.0007

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	15.08	(2.906)	3447502.2	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	15.014	(2.8630)	3433528.50	99.595
DRAINAGE RECIRCULATED INTO LAYER 1	0.10333	(0.10373)	23629.838	0.68542
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.00000	(0.00000)	0.000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 4	0.10333	(0.10373)	23629.838	0.68542
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.513	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.001	(0.001)		
CHANGE IN WATER STORAGE	0.061	(0.5678)	13972.09	0.405

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	1.24	283575.594
RUNOFF	0.000	0.0000
DRAINAGE RECIRCULATED INTO LAYER 1	0.01159	2649.92603
DRAINAGE COLLECTED FROM LAYER 4	0.00000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 4	0.01159	2649.92603
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00917
AVERAGE HEAD ON TOP OF LAYER 5	0.032	
MAXIMUM HEAD ON TOP OF LAYER 5	0.062	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	25.1 FEET	
SNOW WATER	0.83	190110.1410

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3056
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0906

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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****

FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	0.9323	0.1554
2	34.5131	0.2876
3	3.7200	0.3100
4	0.0020	0.0100
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

****
****

HELP MODEL RESULTS

OPEN LANDFILL CASE

SUMP 2 AREA

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*******************************************************************************
*******************************************************************************
**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                      **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                           **
**                                                                           **
*******************************************************************************
*******************************************************************************

PRECIPITATION DATA FILE:    C:\WORK\MODELS\HELP\HELP307\5PTPRE.D4
TEMPERATURE DATA FILE:      C:\WORK\MODELS\HELP\HELP307\5PTTEM.D7
SOLAR RADIATION DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSOL.D13
EVAPOTRANSPIRATION DATA:    C:\WORK\MODELS\HELP\HELP307\5PTEVAP.D11
SOIL AND DESIGN DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSMP2.D10
OUTPUT DATA FILE:           C:\WORK\MODELS\HELP\HELP307\5PTOUT2.OUT

TIME:  10: 0     DATE:   3/ 2/2011

*******************************************************************************
     TITLE:  East Regional Landfill- Sump 2 Open LF Case 10 Feet of Waste
*******************************************************************************
     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   7
            THICKNESS                     =      6.00   INCHES
            POROSITY                      =      0.4730 VOL/VOL
            FIELD CAPACITY                =      0.2220 VOL/VOL
            WILTING POINT                 =      0.1040 VOL/VOL
            INITIAL SOIL WATER CONTENT    =      0.1959 VOL/VOL
            EFFECTIVE SAT. HYD. COND.     =  0.520000001000E-03 CM/SEC
          NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 4
                   IS RECIRCULATED INTO THIS LAYER.


                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  18
            THICKNESS                     =    120.00   INCHES
            POROSITY                      =      0.6710 VOL/VOL
            FIELD CAPACITY                =      0.2920 VOL/VOL
            WILTING POINT                 =      0.0770 VOL/VOL
            INITIAL SOIL WATER CONTENT    =      0.2805 VOL/VOL
            EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4640	VOL/VOL
FIELD CAPACITY	=	0.3100	VOL/VOL
WILTING POINT	=	0.1870	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	1873.0	FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 1873. FEET.

SCS RUNOFF CURVE NUMBER	=	86.90	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	37.400	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.136	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.206	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.240	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	48.810	INCHES
TOTAL INITIAL WATER	=	48.810	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Denver Colorado

STATION LATITUDE	=	39.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	122	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	54.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.50	0.56	1.25	1.79	2.40	1.70
1.96	1.74	1.14	1.01	0.81	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
30.40	33.60	39.40	47.80	57.40	67.20
73.60	71.60	62.80	51.40	39.10	31.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO
AND STATION LATITUDE = 39.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.42	0.74	1.15	1.86	1.85	1.85
	1.72	1.80	1.48	0.75	0.73	0.73
STD. DEVIATIONS	0.31	0.37	0.63	1.02	1.02	1.11
	1.26	1.02	0.24	0.59	0.55	0.47
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.409	0.462	1.106	1.911	1.902	1.868
	1.623	1.738	1.238	1.357	0.770	0.627
STD. DEVIATIONS	0.272	0.204	0.556	1.019	1.069	0.959
	0.992	1.376	0.636	0.408	0.381	0.318
LATERAL DRAINAGE RECIRCULATED INTO LAYER 1						
TOTALS	0.0003	0.0013	0.0014	0.0188	0.0092	0.0135
	0.0310	0.0055	0.0055	0.0062	0.0057	0.0017
STD. DEVIATIONS	0.0007	0.0019	0.0017	0.0275	0.0119	0.0258
	0.0712	0.0077	0.0065	0.0062	0.0063	0.0018
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE RECIRCULATED FROM LAYER 4						
TOTALS	0.0003	0.0013	0.0014	0.0188	0.0092	0.0135
	0.0310	0.0055	0.0055	0.0062	0.0057	0.0017
STD. DEVIATIONS	0.0007	0.0019	0.0017	0.0275	0.0119	0.0258
	0.0712	0.0077	0.0065	0.0062	0.0063	0.0018

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0000	0.0001	0.0002	0.0021	0.0010	0.0015
	0.0033	0.0006	0.0006	0.0007	0.0006	0.0002
STD. DEVIATIONS	0.0001	0.0002	0.0002	0.0030	0.0013	0.0028
	0.0076	0.0008	0.0007	0.0007	0.0007	0.0002

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	15.08	(2.906)	2046612.6	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	15.011	(2.8200)	2037990.75	99.579
DRAINAGE RECIRCULATED INTO LAYER 1	0.10019	(0.10802)	13601.562	0.66459
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.00000	(0.00000)	0.000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 4	0.10019	(0.10802)	13601.562	0.66459
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.328	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.001	(0.001)		
CHANGE IN WATER STORAGE	0.063	(0.5714)	8620.61	0.421

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	1.24	168344.891
RUNOFF	0.000	0.0000
DRAINAGE RECIRCULATED INTO LAYER 1	0.01239	1682.22278
DRAINAGE COLLECTED FROM LAYER 4	0.00000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 4	0.01239	1682.22278
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00664
AVERAGE HEAD ON TOP OF LAYER 5	0.041	
MAXIMUM HEAD ON TOP OF LAYER 5	0.083	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.83	112859.0390

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3080
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0910

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	0.9373	0.1562
2	34.5381	0.2878
3	3.7200	0.3100
4	0.0020	0.0100
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

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****

HELP MODEL RESULTS

OPEN LANDFILL CASE

SUMP 3 AREA

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**********************************************************************
**********************************************************************
**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**                    USAE WATERWAYS EXPERIMENT STATION             **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
**********************************************************************
**********************************************************************

PRECIPITATION DATA FILE:    C:\WORK\MODELS\HELP\HELP307\5PTPRE.D4
TEMPERATURE DATA FILE:      C:\WORK\MODELS\HELP\HELP307\5PTTEM.D7
SOLAR RADIATION DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSOL.D13
EVAPOTRANSPIRATION DATA:    C:\WORK\MODELS\HELP\HELP307\5PTEVAP.D11
SOIL AND DESIGN DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSMP3.D10
OUTPUT DATA FILE:           C:\WORK\MODELS\HELP\HELP307\5PTOUT3.OUT

TIME:  10: 1     DATE:   3/ 2/2011

**********************************************************************
     TITLE:  East Regional Landfill- Sump 3 Open LF Case 10 Feet of Waste
**********************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   7
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4730 VOL/VOL
          FIELD CAPACITY                =      0.2220 VOL/VOL
          WILTING POINT                 =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1959 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.520000001000E-03 CM/SEC
        NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 4
                IS RECIRCULATED INTO THIS LAYER.

                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  18
          THICKNESS                     =    120.00   INCHES
          POROSITY                      =      0.6710 VOL/VOL
          FIELD CAPACITY                =      0.2920 VOL/VOL
          WILTING POINT                 =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2805 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4640	VOL/VOL
FIELD CAPACITY	=	0.3100	VOL/VOL
WILTING POINT	=	0.1870	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	1472.0	FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 1472. FEET.

SCS RUNOFF CURVE NUMBER	=	87.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	37.400	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.134	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.206	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.240	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	48.808	INCHES
TOTAL INITIAL WATER	=	48.808	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Denver Colorado

STATION LATITUDE	=	39.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	122	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	54.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.50	0.56	1.25	1.79	2.40	1.70
1.96	1.74	1.14	1.01	0.81	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
30.40	33.60	39.40	47.80	57.40	67.20
73.60	71.60	62.80	51.40	39.10	31.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO
AND STATION LATITUDE = 39.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.42	0.74	1.15	1.86	1.85	1.85
	1.72	1.80	1.48	0.75	0.73	0.73
STD. DEVIATIONS	0.31	0.37	0.63	1.02	1.02	1.11
	1.26	1.02	0.24	0.59	0.55	0.47
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.398	0.462	1.142	1.901	1.854	1.901
	1.649	1.715	1.252	1.345	0.769	0.627
STD. DEVIATIONS	0.250	0.213	0.546	1.026	1.069	0.955
	1.061	1.316	0.618	0.404	0.382	0.318
LATERAL DRAINAGE RECIRCULATED INTO LAYER 1						
TOTALS	0.0014	0.0012	0.0016	0.0174	0.0087	0.0117
	0.0306	0.0054	0.0041	0.0125	0.0082	0.0024
STD. DEVIATIONS	0.0035	0.0018	0.0024	0.0243	0.0116	0.0256
	0.0680	0.0079	0.0044	0.0214	0.0104	0.0053
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE RECIRCULATED FROM LAYER 4						
TOTALS	0.0014	0.0012	0.0016	0.0174	0.0087	0.0117
	0.0306	0.0054	0.0041	0.0125	0.0082	0.0024
STD. DEVIATIONS	0.0035	0.0018	0.0024	0.0243	0.0116	0.0256
	0.0680	0.0079	0.0044	0.0214	0.0104	0.0053

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0001	0.0001	0.0001	0.0015	0.0007	0.0010
	0.0026	0.0005	0.0004	0.0011	0.0007	0.0002
STD. DEVIATIONS	0.0003	0.0002	0.0002	0.0021	0.0010	0.0022
	0.0057	0.0007	0.0004	0.0018	0.0009	0.0004

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET		PERCENT
PRECIPITATION	15.08	(2.906)	2046612.6		100.00
RUNOFF	0.000	(0.0000)	0.00		0.000
EVAPOTRANSPIRATION	15.015	(2.8641)	2038458.75		99.602
DRAINAGE RECIRCULATED INTO LAYER 1	0.10541	(0.10863)	14310.876		0.69925
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.00000	(0.00000)	0.000		0.00000
DRAINAGE RECIRCULATED FROM LAYER 4	0.10541	(0.10863)	14310.876		0.69925
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.297		0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.001	(0.001)			
CHANGE IN WATER STORAGE	0.060	(0.5705)	8152.95		0.398

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	1.24	168344.891
RUNOFF	0.000	0.0000
DRAINAGE RECIRCULATED INTO LAYER 1	0.01143	1551.52148
DRAINAGE COLLECTED FROM LAYER 4	0.00000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 4	0.01143	1551.52148
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00520
AVERAGE HEAD ON TOP OF LAYER 5	0.030	
MAXIMUM HEAD ON TOP OF LAYER 5	0.056	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	74.3 FEET	
SNOW WATER	0.83	112859.0390

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3051
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0909

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	0.9334	0.1556
2	34.5055	0.2875
3	3.7200	0.3100
4	0.0020	0.0100
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

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****

ATTACHMENT 4

HELP RESULTS CLOSED LANDFILL SCENARIOS

AEC

HELP MODEL RESULTS

CLOSED LANDFILL CASE

100% RECIRCULATION

SUMP 1 AREA

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**************************************************************************
**************************************************************************
**                                                                      **
**                                                                      **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE            **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)            **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY               **
**                    USAE WATERWAYS EXPERIMENT STATION                 **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY          **
**                                                                      **
**                                                                      **
**************************************************************************
**************************************************************************

PRECIPITATION DATA FILE:    C:\WORK\MODELS\HELP\HELP307\5PTPRE2.D4
TEMPERATURE DATA FILE:      C:\WORK\MODELS\HELP\HELP307\5PTTEM2.D7
SOLAR RADIATION DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSOL2.D13
EVAPOTRANSPIRATION DATA:    C:\WORK\MODELS\HELP\HELP307\5PTEVAP2.D11
SOIL AND DESIGN DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSM1c2.D10
OUTPUT DATA FILE:           C:\WORK\MODELS\HELP\HELP307\5PTOUt4.OUT

TIME:   8:11     DATE:   3/ 2/2011

**************************************************************************
     TITLE:  East Regional Landfill- Sump 1 Closed LF Case, 100% Recirc
**************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   7
            THICKNESS                     =      6.00   INCHES
            POROSITY                      =      0.4730 VOL/VOL
            FIELD CAPACITY                =      0.2220 VOL/VOL
            WILTING POINT                 =      0.1040 VOL/VOL
            INITIAL SOIL WATER CONTENT    =      0.1040 VOL/VOL
            EFFECTIVE SAT. HYD. COND.     =  0.520000001000E-03 CM/SEC
          NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 5
                   IS RECIRCULATED INTO THIS LAYER.
          NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                   FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  11
            THICKNESS                     =     42.00   INCHES
            POROSITY                      =      0.4640 VOL/VOL
            FIELD CAPACITY                =      0.3100 VOL/VOL
            WILTING POINT                 =      0.1870 VOL/VOL
            INITIAL SOIL WATER CONTENT    =      0.2223 VOL/VOL
            EFFECTIVE SAT. HYD. COND.     =  0.639999998000E-04 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1044.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4640	VOL/VOL
FIELD CAPACITY	=	0.3100	VOL/VOL
WILTING POINT	=	0.1870	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04	CM/SEC

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	1.40	PERCENT
DRAINAGE LENGTH	=	2161.0	FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 2161. FEET.

SCS RUNOFF CURVE NUMBER	=	71.10	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	63.000	ACRES
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.239	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	16.758	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.234	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	328.777	INCHES
TOTAL INITIAL WATER	=	328.777	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Denver Colorado

STATION LATITUDE	=	39.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	122	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	54.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.50	0.56	1.25	1.79	2.40	1.70
1.96	1.74	1.14	1.01	0.81	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
30.40	33.60	39.40	47.80	57.40	67.20
73.60	71.60	62.80	51.40	39.10	31.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO
AND STATION LATITUDE = 39.77 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.38	0.63	1.14	1.72	2.00	1.77
	2.09	1.74	1.38	0.75	0.75	0.65
STD. DEVIATIONS	0.30	0.33	0.76	1.01	1.09	1.07
	1.15	1.07	0.59	0.53	0.55	0.39
RUNOFF						
TOTALS	0.001	0.012	0.009	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.001
STD. DEVIATIONS	0.002	0.034	0.033	0.000	0.001	0.000
	0.000	0.000	0.000	0.000	0.000	0.007
EVAPOTRANSPIRATION						
TOTALS	0.318	0.501	1.171	1.703	2.196	2.606
	2.087	1.718	1.097	0.731	0.416	0.365
STD. DEVIATIONS	0.199	0.196	0.221	0.421	0.855	1.647
	1.065	1.050	0.601	0.250	0.189	0.215
LATERAL DRAINAGE RECIRCULATED INTO LAYER 1						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0087
	0.0186	0.0087	0.0004	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0003	0.0441
	0.0922	0.0461	0.0015	0.0001	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE RECIRCULATED FROM LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0087
	0.0186	0.0087	0.0004	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0003	0.0441
	0.0922	0.0461	0.0015	0.0001	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008
	0.0016	0.0008	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0040
	0.0081	0.0041	0.0001	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.00 (2.862)	3429664.5	100.00
RUNOFF	0.022 (0.0450)	5135.74	0.150
EVAPOTRANSPIRATION	14.908 (2.9218)	3409376.50	99.408
DRAINAGE RECIRCULATED INTO LAYER 1	0.03650 (0.18368)	8346.967	0.24338
LATERAL DRAINAGE COLLECTED FROM LAYER 5	0.00000 (0.00000)	0.000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 5	0.03650 (0.18368)	8346.967	0.24338
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000 (0.00000)	0.159	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000 (0.001)		
CHANGE IN WATER STORAGE	0.066 (0.6852)	15151.32	0.442

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	2.42	553429.812
RUNOFF	0.152	34687.5859
DRAINAGE RECIRCULATED INTO LAYER 1	0.02494	5702.39209
DRAINAGE COLLECTED FROM LAYER 5	0.00000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 5	0.02494	5702.39209
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.01694
AVERAGE HEAD ON TOP OF LAYER 6	0.068	
MAXIMUM HEAD ON TOP OF LAYER 6	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.19	272213.1250

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3365
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1732

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.3299	0.2216
2	10.6171	0.2528
3	304.8480	0.2920
4	3.7200	0.3100
5	0.0020	0.0100
6	0.0000	0.0000
7	10.2480	0.4270
SNOW WATER	0.000	

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HELP MODEL RESULTS

CLOSED LANDFILL CASE

100% RECIRCULATION

SUMP 2 AREA

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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY             **
**                USAE WATERWAYS EXPERIMENT STATION                 **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\WORK\MODELS\HELP\HELP307\5PTPRE2.D4
TEMPERATURE DATA FILE:      C:\WORK\MODELS\HELP\HELP307\5PTTEM2.D7
SOLAR RADIATION DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSOL2.D13
EVAPOTRANSPIRATION DATA:    C:\WORK\MODELS\HELP\HELP307\5PTEVAP2.D11
SOIL AND DESIGN DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSM2C2.D10
OUTPUT DATA FILE:           C:\WORK\MODELS\HELP\HELP307\5PTOUT5.OUT

TIME:  10: 5     DATE:   3/ 2/2011

**********************************************************************
     TITLE:  East Regional Landfill- Sump 2 Closed LF Case-100% Recirc
**********************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   7
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4730 VOL/VOL
          FIELD CAPACITY                =      0.2220 VOL/VOL
          WILTING POINT                 =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1040 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.520000001000E-03 CM/SEC
        NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 5
                 IS RECIRCULATED INTO THIS LAYER.
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                                LAYER  2
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  11
          THICKNESS                     =     42.00   INCHES
          POROSITY                      =      0.4640 VOL/VOL
          FIELD CAPACITY                =      0.3100 VOL/VOL
          WILTING POINT                 =      0.1870 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2223 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.639999998000E-04 CM/SEC
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LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	888.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4640	VOL/VOL
FIELD CAPACITY	=	0.3100	VOL/VOL
WILTING POINT	=	0.1870	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04	CM/SEC

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	1873.0	FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 1873. FEET.

SCS RUNOFF CURVE NUMBER	=	71.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	37.400	ACRES
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.241	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	16.758	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.234	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	283.226	INCHES
TOTAL INITIAL WATER	=	283.226	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Denver Colorado

STATION LATITUDE	=	39.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	122	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	54.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.50	0.56	1.25	1.79	2.40	1.70
1.96	1.74	1.14	1.01	0.81	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
30.40	33.60	39.40	47.80	57.40	67.20
73.60	71.60	62.80	51.40	39.10	31.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO
AND STATION LATITUDE = 39.77 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.38	0.63	1.14	1.72	2.00	1.77
	2.09	1.74	1.38	0.75	0.75	0.65
STD. DEVIATIONS	0.30	0.33	0.76	1.01	1.09	1.07
	1.15	1.07	0.59	0.53	0.55	0.39
RUNOFF						
TOTALS	0.001	0.012	0.009	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.001
STD. DEVIATIONS	0.002	0.034	0.033	0.000	0.001	0.000
	0.000	0.000	0.000	0.000	0.000	0.007
EVAPOTRANSPIRATION						
TOTALS	0.318	0.501	1.172	1.703	2.196	2.607
	2.086	1.718	1.097	0.731	0.416	0.365
STD. DEVIATIONS	0.200	0.196	0.221	0.422	0.855	1.648
	1.065	1.051	0.601	0.250	0.189	0.215
LATERAL DRAINAGE RECIRCULATED INTO LAYER 1						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0084
	0.0180	0.0084	0.0004	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0002	0.0418
	0.0892	0.0442	0.0011	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE RECIRCULATED FROM LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0084
	0.0180	0.0084	0.0004	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0002	0.0418
	0.0892	0.0442	0.0011	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009
	0.0019	0.0009	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0046
	0.0095	0.0047	0.0001	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	15.00	(2.862)	2036023.1	100.00
RUNOFF	0.022	(0.0450)	3046.43	0.150
EVAPOTRANSPIRATION	14.908	(2.9216)	2023987.37	99.409
DRAINAGE RECIRCULATED INTO LAYER 1	0.03524	(0.17613)	4783.769	0.23496
LATERAL DRAINAGE COLLECTED FROM LAYER 5	0.00000	(0.00000)	0.000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 5	0.03524	(0.17613)	4783.769	0.23496
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000	(0.00000)	0.102	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000	(0.002)		
CHANGE IN WATER STORAGE	0.066	(0.6849)	8988.79	0.441

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	2.42	328544.062
RUNOFF	0.152	20592.3145
DRAINAGE RECIRCULATED INTO LAYER 1	0.02375	3223.92456
DRAINAGE COLLECTED FROM LAYER 5	0.00000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 5	0.02375	3223.92456
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.01147
AVERAGE HEAD ON TOP OF LAYER 6	0.078	
MAXIMUM HEAD ON TOP OF LAYER 6	0.157	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	4.2 FEET	
SNOW WATER	1.19	161599.5620

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3365
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1732

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.3299	0.2216
2	10.6169	0.2528
3	259.2960	0.2920
4	3.7200	0.3100
5	0.0020	0.0100
6	0.0000	0.0000
7	10.2480	0.4270
SNOW WATER	0.000	

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HELP MODEL RESULTS

CLOSED LANDFILL CASE

100% RECIRCULATION

SUMP 3 AREA

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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**                    USAE WATERWAYS EXPERIMENT STATION             **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY       **
**                                                                  **
**                                                                  **
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**********************************************************************

PRECIPITATION DATA FILE:    C:\WORK\MODELS\HELP\HELP307\5PTPRE2.D4
TEMPERATURE DATA FILE:      C:\WORK\MODELS\HELP\HELP307\5PTTEM2.D7
SOLAR RADIATION DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSOL2.D13
EVAPOTRANSPIRATION DATA:    C:\WORK\MODELS\HELP\HELP307\5PTEVAP2.D11
SOIL AND DESIGN DATA FILE:  C:\WORK\MODELS\HELP\HELP307\5PTSM3C2.D10
OUTPUT DATA FILE:           C:\WORK\MODELS\HELP\HELP307\5PTOUT6.OUT

TIME:  10: 6     DATE:   3/ 2/2011

**********************************************************************
     TITLE:  East Regional Landfill- Sump 3 Closed LF Case-100% Recirc
**********************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   7
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4730 VOL/VOL
          FIELD CAPACITY                =      0.2220 VOL/VOL
          WILTING POINT                 =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1040 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.520000001000E-03 CM/SEC
        NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 5
                 IS RECIRCULATED INTO THIS LAYER.
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  11
          THICKNESS                     =     42.00   INCHES
          POROSITY                      =      0.4640 VOL/VOL
          FIELD CAPACITY                =      0.3100 VOL/VOL
          WILTING POINT                 =      0.1870 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2223 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.639999998000E-04 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1152.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4640	VOL/VOL
FIELD CAPACITY	=	0.3100	VOL/VOL
WILTING POINT	=	0.1870	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04	CM/SEC

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	1472.0	FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 1472. FEET.

SCS RUNOFF CURVE NUMBER	=	71.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	37.400	ACRES
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.241	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	16.758	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.234	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	360.315	INCHES
TOTAL INITIAL WATER	=	360.315	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Denver Colorado

STATION LATITUDE	=	39.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	122	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	54.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.50	0.56	1.25	1.79	2.40	1.70
1.96	1.74	1.14	1.01	0.81	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
30.40	33.60	39.40	47.80	57.40	67.20
73.60	71.60	62.80	51.40	39.10	31.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO
AND STATION LATITUDE = 39.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.38	0.63	1.14	1.72	2.00	1.77
	2.09	1.74	1.38	0.75	0.75	0.65
STD. DEVIATIONS	0.30	0.33	0.76	1.01	1.09	1.07
	1.15	1.07	0.59	0.53	0.55	0.39
RUNOFF						
TOTALS	0.001	0.012	0.009	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.001
STD. DEVIATIONS	0.002	0.034	0.033	0.000	0.001	0.000
	0.000	0.000	0.000	0.000	0.000	0.007
EVAPOTRANSPIRATION						
TOTALS	0.318	0.501	1.171	1.703	2.196	2.606
	2.086	1.719	1.097	0.731	0.416	0.365
STD. DEVIATIONS	0.200	0.196	0.221	0.421	0.855	1.645
	1.066	1.051	0.601	0.250	0.188	0.215
LATERAL DRAINAGE RECIRCULATED INTO LAYER 1						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0094
	0.0183	0.0088	0.0005	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0003	0.0462
	0.0961	0.0471	0.0020	0.0001	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE RECIRCULATED FROM LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0094
	0.0183	0.0088	0.0005	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0003	0.0462
	0.0961	0.0471	0.0020	0.0001	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008
	0.0015	0.0007	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0040
	0.0080	0.0039	0.0002	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.00 (2.862)	2036023.1	100.00
RUNOFF	0.023 (0.0450)	3056.03	0.150
EVAPOTRANSPIRATION	14.908 (2.9216)	2023977.50	99.408
DRAINAGE RECIRCULATED INTO LAYER 1	0.03715 (0.19144)	5043.807	0.24773
LATERAL DRAINAGE COLLECTED FROM LAYER 5	0.00000 (0.00000)	0.000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 5	0.03715 (0.19144)	5043.807	0.24773
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000 (0.00000)	0.087	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000 (0.001)		
CHANGE IN WATER STORAGE	0.066 (0.6854)	8989.34	0.442

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	2.42	328544.062
RUNOFF	0.152	20592.3145
DRAINAGE RECIRCULATED INTO LAYER 1	0.02686	3646.33813
DRAINAGE COLLECTED FROM LAYER 5	0.00000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 5	0.02686	3646.33813
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.01030
AVERAGE HEAD ON TOP OF LAYER 6	0.070	
MAXIMUM HEAD ON TOP OF LAYER 6	0.138	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	10.4 FEET	
SNOW WATER	1.19	161599.5620

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3365
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1732

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.3299	0.2216
2	10.6171	0.2528
3	336.3840	0.2920
4	3.7200	0.3100
5	0.0020	0.0100
6	0.0000	0.0000
7	10.2480	0.4270
SNOW WATER	0.000	

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****

TAB 3

LEACHATE TRANSIT TIME CALCULATIONS

East Regional Landfill
March, 2011
Leachate Transit Time

The grading plan for the East Regional Landfill includes three modules, each with a leachate collection and removal sump as indicated in the attached figure. The grades to the sump in each module vary. The transit time to the sump is calculated for the longest flow path in each sump to determine if the time is less than the regulatory requirement of one year.

The leachate drainage media is a geocomposite drainage net. The permeability used for the calculations are based on the previously approved, site-specific specifications for the material.

The resulting transit times from the furthest point in each module to the module sump are all less than 1 year, meeting the minimum regulatory requirement. The calculations are attached.

East Regional Landfill

Leachate Transit Time Calculations - Sump 1 Longest Run

Q = Flow Rate
K = Permeability
A = Cross-Sectional Area
i = Slope = (h2/h1)/L
L = Drainage Length
n = Effective Porosity
Q = VA = KiA = KA(h2-h1)/L
V = (K)(i)(n) = (K)[(h2-h1)/L]/n

Segment 1:		Segment 2:	
Distance Traveled (ft)	19	Distance Traveled (ft)	1302
Slope =	33.00%	Slope =	2.20%

Segment 3:	
Distance Traveled (ft)	840
Slope =	2.10%

Drainage Media Geocomposite	Design K (cm/sec)	Design K (ft/day)	Travel Slope i (ft/ft)	Effective Porosity n (unitless)	V (ft/day)	Distance 1 Year (ft)	Regulatory Critical Length (ft)	Transit time to Sump days	Transit time to Sump years
Segment 1	1.97E+00	5.58E+03	0.3300	1	1843	672,707	19	0.01	0.000
Segment 2	1.97E+00	5.58E+03	0.0220	1	123	44,847	1302	10.60	0.029
Segment 3	1.97E+00	5.58E+03	0.0210	1	117	42,809	840	7.16	0.020
						Total Transit Time to Sump 1 (days) =		17.8	0.05 Years

Conversions:

1 year =	31,536,000	seconds
1 foot =	30.48	cm
1 inch =	0.0254	meters
1meter =	3.28	ft
1 cm =	0.01	meters
1 gal/min =	2.08E-04	m3/sec-m
1 cm/sec =	2835	ft/day
days per year =	365	days

Note: Distances and elevations from design plate.

East Regional Landfill

Leachate Transit Time Calculations - Sump 2 Longest Run

Q = Flow Rate
K = Permeability
A = Cross-Sectional Area
i = Slope = (h2/h1)/L
L = Drainage Length
n = Effective Porosity
Q = VA = KiA = KA(h2-h1)/L
V = (K)(i)(n) = (K)[(h2-h1)/L]/n

Segment 1:		Segment 2:	
Distance Traveled (ft)	775	Distance Traveled (ft)	134
Slope =	1.00%	Slope =	1.50%
Segment 3:		Segment 4:	
Distance Traveled (ft)	378	Distance Traveled (ft)	350
Slope =	3.70%	Slope =	2.90%
Segment 5:			
Distance Traveled (ft)	236		
Slope =	1.70%		

Drainage Media Geocomposite	Design K (cm/sec)	Design K (ft/day)	Travel Slope i (ft/ft)	Effective Porosity n (unitless)	V (ft/day)	Distance 1 Year (ft)	Regulatory Critical Length (ft)	Transit time to Sump days	Transit time to Sump years
Segment 1	1.97E+00	5.58E+03	0.0100	1	56	20,385	775	13.88	0.04
Segment 2	1.97E+00	5.58E+03	0.0150	1	84	30,578	134	1.60	0.00
Segment 3	1.97E+00	5.58E+03	0.0370	1	207	75,425	378	1.83	0.01
Segment 4	1.97E+00	5.58E+03	0.0290	1	162	59,117	350	2.16	0.01
Segment 5	1.97E+00	5.58E+03	0.0170	1	95	34,655	236	2.49	0.01
						Total Transit Time to Sump 2 (days) =		22.0	0.06 Years

Conversions:

1 year =	31,536,000	seconds
1 foot =	30.48	cm
1 inch =	0.0254	meters
1meter =	3.28	ft
1 cm =	0.01	meters
1 gal/min =	2.08E-04	m3/sec-m
1 cm/sec =	2835	ft/day
days per year =	365	days

Note: Distances and elevations from design plate.

East Regional Landfill

Leachate Transit Time Calculations - Sump 3 Longest Run

Q = Flow Rate
K = Permeability
A = Cross-Sectional Area
i = Slope = (h2/h1)/L
L = Drainage Length
n = Effective Porosity
Q = VA = KiA = KA(h2-h1)/L
V = (K)(i)(n) = (K)[(h2-h1)/L]/n

Segment 1:		Segment 2:	
Distance Traveled (ft)	40	Distance Traveled (ft)	211
Slope =	25.00%	Slope =	1.90%
Segment 3:		Segment 4:	
Distance Traveled (ft)	519	Distance Traveled (ft)	296
Slope =	4.20%	Slope =	3.40%
Segment 5:			
Distance Traveled (ft)	406		
Slope =	1.50%		

Drainage Media Geocomposite	Design K (cm/sec)	Design K (ft/day)	Travel Slope i (ft/ft)	Effective Porosity n (unitless)	V (ft/day)	Distance 1 Year (ft)	Regulatory Critical Length (ft)	Transit time to sump days	Transit time to sump years
Segment 1	1.97E+00	5.58E+03	0.2500	1	1396	509,627	40	0.03	0.00
Segment 2	1.97E+00	5.58E+03	0.0190	1	106	38,732	211	1.99	0.01
Segment 3	1.97E+00	5.58E+03	0.0420	1	235	85,617	519	2.21	0.01
Segment 4	1.97E+00	5.58E+03	0.0340	1	190	69,309	296	1.56	0.00
Segment 5	1.97E+00	5.58E+03	0.0150	1	84	30,578	406	4.85	0.01
						Total Transit Time to Sump 3 (days) =		10.6	0.03 Years

Conversions:

1 year =	31,536,000	seconds
1 foot =	30.48	cm
1 inch =	0.0254	meters
1meter =	3.28	ft
1 cm =	0.01	meters
1 gal/min =	2.08E-04	m3/sec-m
1 cm/sec =	2835	ft/day
days per year =	365	days

Note: Distances and elevations from design plate.

Transmissivity to Permeability

Transmissivity =	0.48	gal/min/ft	from Tech Specs
Transmissivity =	0.0001	m2/sec	from GSE Spec sheet for 0.48 gal/min/ft material
Thickness =	5.08	mm =	0.00508 m = 200 mil
Horiz Hyd Cond =	0.020	m/sec	
Horiz Hyd Cond =	1.97	cm/sec	

Conversions

1	ft =	30.48	cm
60	sec per	1	minute
7.48	gal per	1	cubic foot
1	mm =	0.00328	ft
1	ft/day =	3.5E-06	m/sec



LEGEND

- 5315 — EXISTING CONTOURS (2 FT. INTERVAL)
- EXISITNG CELL 10 LIMITS
- 5315 — PROPOSED LANDFILL SUBGRADE CONTOURS (2 FT. INTERVAL)
- PROPERTY LIMIT (BY R.W. BAYER & ASSOCIATES, 2007)
- 5007 — PROPERTY CORNER SURVEY POINT (BY R.W. BAYER & ASSOCIATES, 2007, REBAR, CAP FOUND OR SET)
- ADJOINING PROPERTY BOUNDARY
- GAS PIPELINE RIGHT OF WAY
- GAS PIPELINE ACCESS ROAD
- SECTION MARKER
- MW-3 — EXISTING GROUND WATER MONITORING LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION)
- GP2 — EXISTING GAS MONITORING WELL LOCATION
- LANDSCAPED SCREENING BERM
- SCREENING TREE LOCATION
- SCREENING BUSH LOCATION

N

SCALE
200' 0 200'
CONTOUR INTERVAL 1 TO 2FT.

NOTE: ORIGINAL LDD CAD WORK, COORDINATES AND TOPOGRAPHIC DATA FROM R.W. BAYER & ASSOCIATES, INC. MAY 09, 2007

TRAVEL TIME CALCULATIONS
SUBGRADE TRAVEL PATHS, SLOPES, AND LENGTHS
EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

CLIENT: FIVE PART DEVELOPMENT, LCC		
PROJECT: REVISED LDF DESIGN 2010		
PROJECT NO: FIVE PART_2010	DATE COMPLETED: 01/11	
DESIGNED BY: AEC	APPROVED BY: MAM	
DRAWN BY: JGN	DWG NAME: HELP_TRAVEL TIME DRAWING rev 03/2011	
REVISION:	REVISED BY: MAM	DATE: 03/11
0 ISSUED FOR REVIEW		

AEC AMERICAN ENVIRONMENTAL CONSULTING, LLC.

TAB 4

GCL VS CLAY EQUIVALENCY
CEC EVALUATION

East Regional Landfill
Geosynthetic Clay Liner versus Compacted Clay Liner Equivalency

The current liner system at the East Regional Landfill (ERLF) is approved as a 24-inch compacted clay liner (CCL) overlain by a High Density Polyethylene (HDPE). ERLF is requesting the option to use a Geosynthetic Clay Liner (GCL) in place of the CCL. If used, the GCL will be installed at the grades and elevations that represent the top of the CCL

The GCL material is generally regarded as equivalent or superior to CCL, assuming it is correctly installed (Koerner and Daniel, 1994). The installation of the GCL material is a key to ensuring the material performs as designed. Therefore, the installation of the GCL will be completed as per the Construction Quality Assurance Plan (revised January 2011) to ensure proper installation procedures are followed.

The equivalency demonstration was completed using the Koerner, Daniel guidance and was also completed using the HELP Model as a comparison tool.

Koerner, Daniel Calculations

The equivalency calculations are included below. The calculations are based on the assumption that there will be a maximum of 12-inches of leachate on the liner. These calculations also do not include the High Density Polyethylene (HDPE) liner that will cover the GCL. The HDPE will ultimately be the controlling material but this assessment was done to compare only the GCL to the CCL.

GCL/CCL Equivalency Calculations

$$v = k * \frac{(H + T)}{T}$$ from Technical Equivalency Assessment of GCLs to CCLs; Koerner and Daniel

where:

v = downward water flux
k = material hydraulic conductivity
H = height of water on material (assume 12 inches of leachate)
T = thickness of material

Compacted Clay Liner (CCL)

k =	1.00E-07	cm/sec
H =	30.48	cm
T =	60.96	cm

Geosynthetic Clay Liner (GCL)

k =	3.00E-09	cm/sec
H =	30.48	cm
T =	0.635	cm

v_{CCL} = 1.50E-07
v_{GCL} = 1.47E-07

The assessment shows the GCL to have a lower downward flux of water than the CCL.

HELP Model Comparison

The equivalency was also assessed based on comparing the results of the HELP Modeling effort for the excavation plan. The HELP modeling was completed assuming a 24-inch CCL to determine how much head will be on the liner during various times of the landfill development and under various scenarios. In order to determine equivalency, the scenarios with the greatest average annual percolation through the liner were selected for the open landfill case and for the closed landfill case and the CCL was changed to a GCL.

Average Annual Percolation
Scenario 1: Open Landfill, Sump Area 1: 63 acres:
CCL: 0.00000 inches (0.518 cubic feet)
GCL: 0.00000 inches (0.446 cubic feet)

Scenario 2: Closed Landfill, Sump Area 1: 63 acres:
CCL: 0.00000 inches (0.157 cubic feet)
GCL: 0.00000 inches (0.137 cubic feet)

In both cases, the average annual percolation is less for the GCL then for the CCL. Therefore, the GCL will be equivalent or superior to the CCL.

Summary

Many states now allow GCL as an alternative to CCL without conducting an equivalency demonstration. This includes Nebraska as outlined in the NDEQ guidance document 06-224. The state of New Mexico uses a HELP Model comparison to assess equivalency. Other states use the flux calculations to assess equivalency. The East Regional Landfill is requesting the use of GCL as an alternative to CCL and has used both the assessment calculations outlined. Both show the GCL to be superior to the CCL.

References

1. Koerner, R. M. and Daniel, D. E. (1994), "Technical Equivalency Assessment of GCLs to CCLs," Proc. GRI-7 Conference on Geosynthetic Liner Systems, IFAI, St. Paul, MN, pp. 255-275 and Proc. LGA/GRI Symposium on Geosynthetic Clay Liners, Nuremberg, Germany, pp. 59-84.

2. Nebraska Department of Environmental Quality; Environmental Guidance Document; Geosynthetic Clay Liners, No. 06-224; July 2007

3. New Mexico Environment Department; Solid Waste Bureau; Permit Section; Performance Demonstration for an Alternate Liner Design under Section 306.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling; April 1, 1998

HELP MODEL RESULTS

1. Open Case with 100% Recirculation of Leachate
2. Closed Case with No Recirculation of Leachate

1. Open Case with 100% Recirculation of Leachate

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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:     C:\WORK\MODELS\HELP\HELP307\5PTPRE.D4
TEMPERATURE DATA FILE:       C:\WORK\MODELS\HELP\HELP307\5PTTEM.D7
SOLAR RADIATION DATA FILE:   C:\WORK\MODELS\HELP\HELP307\5PTSOL.D13
EVAPOTRANSPIRATION DATA:     C:\WORK\MODELS\HELP\HELP307\5PTEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\WORK\MODELS\HELP\HELP307\5PS1OGCL.D10
OUTPUT DATA FILE:            C:\WORK\MODELS\HELP\HELP307\5PTOUT7.OUT

TIME:  13:28     DATE:   1/19/2011

**********************************************************************
       TITLE:  East Regional Landfill- Sump 1 Open LF Case 10 Feet of Waste
          With GCL instead of 24 inches of Clay with 100% Recirculation
**********************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   7
            THICKNESS                     =      6.00   INCHES
            POROSITY                      =      0.4730 VOL/VOL
            FIELD CAPACITY                =      0.2220 VOL/VOL
            WILTING POINT                 =      0.1040 VOL/VOL
            INITIAL SOIL WATER CONTENT    =      0.1959 VOL/VOL
            EFFECTIVE SAT. HYD. COND.     =  0.520000001000E-03 CM/SEC
          NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 4
                   IS RECIRCULATED INTO THIS LAYER.

                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  18
            THICKNESS                     =    120.00   INCHES
            POROSITY                      =      0.6710 VOL/VOL
            FIELD CAPACITY                =      0.2920 VOL/VOL
            WILTING POINT                 =      0.0770 VOL/VOL
            INITIAL SOIL WATER CONTENT    =      0.2805 VOL/VOL
            EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4640	VOL/VOL
FIELD CAPACITY	=	0.3100	VOL/VOL
WILTING POINT	=	0.1870	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	1.40	PERCENT
DRAINAGE LENGTH	=	2285.0	FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 2285. FEET.

SCS RUNOFF CURVE NUMBER	=	86.80	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	63.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.132	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.206	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.240	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	39.008	INCHES
TOTAL INITIAL WATER	=	39.008	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Denver Colorado

STATION LATITUDE	=	39.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	122	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	54.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.50	0.56	1.25	1.79	2.40	1.70
1.96	1.74	1.14	1.01	0.81	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
30.40	33.60	39.40	47.80	57.40	67.20
73.60	71.60	62.80	51.40	39.10	31.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING

COEFFICIENTS FOR DENVER COLORADO
AND STATION LATITUDE = 39.77 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.42	0.74	1.15	1.86	1.85	1.85
	1.72	1.80	1.48	0.75	0.73	0.73
STD. DEVIATIONS	0.31	0.37	0.63	1.02	1.02	1.11
	1.26	1.02	0.24	0.59	0.55	0.47
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.399	0.462	1.142	1.878	1.875	1.908
	1.619	1.737	1.252	1.345	0.770	0.627
STD. DEVIATIONS	0.250	0.213	0.546	1.048	1.048	0.957
	1.085	1.294	0.618	0.405	0.381	0.318
LATERAL DRAINAGE RECIRCULATED INTO LAYER 1						
TOTALS	0.0025	0.0010	0.0014	0.0176	0.0101	0.0112
	0.0275	0.0043	0.0047	0.0085	0.0036	0.0019
STD. DEVIATIONS	0.0074	0.0014	0.0019	0.0252	0.0162	0.0248
	0.0618	0.0049	0.0051	0.0136	0.0051	0.0035
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE RECIRCULATED FROM LAYER 4						
TOTALS	0.0025	0.0010	0.0014	0.0176	0.0101	0.0112
	0.0275	0.0043	0.0047	0.0085	0.0036	0.0019
STD. DEVIATIONS	0.0074	0.0014	0.0019	0.0252	0.0162	0.0248
	0.0618	0.0049	0.0051	0.0136	0.0051	0.0035

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0002	0.0001	0.0001	0.0017	0.0009	0.0011
	0.0026	0.0004	0.0005	0.0008	0.0003	0.0002
STD. DEVIATIONS	0.0007	0.0001	0.0002	0.0024	0.0015	0.0024
	0.0057	0.0005	0.0005	0.0013	0.0005	0.0003

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.08 (2.906)	3447502.2	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	15.014 (2.8742)	3433513.75	99.594
DRAINAGE RECIRCULATED INTO LAYER 1	0.09426 (0.09781)	21557.252	0.62530
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.00000 (0.00000)	0.000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 4	0.09426 (0.09781)	21557.252	0.62530
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.446	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.001 (0.001)		
CHANGE IN WATER STORAGE	0.061 (0.5614)	13986.83	0.406

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	1.24	283575.594
RUNOFF	0.000	0.0000
DRAINAGE RECIRCULATED INTO LAYER 1	0.01158	2648.11621
DRAINAGE COLLECTED FROM LAYER 4	0.00000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 4	0.01158	2648.11621
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00216
AVERAGE HEAD ON TOP OF LAYER 5	0.033	
MAXIMUM HEAD ON TOP OF LAYER 5	0.065	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	44.0 FEET	
SNOW WATER	0.83	190110.1410

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3058
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0907

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	0.9325	0.1554
2	34.5148	0.2876
3	3.7200	0.3100
4	0.0020	0.0100
5	0.0000	0.0000
6	0.4500	0.7500
SNOW WATER	0.000	

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2. Closed Case with No Recirculation of Leachate

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:     C:\WORK\MODELS\HELP\HELP307\5PTPRE2.D4
TEMPERATURE DATA FILE:       C:\WORK\MODELS\HELP\HELP307\5PTTEM2.D7
SOLAR RADIATION DATA FILE:   C:\WORK\MODELS\HELP\HELP307\5PTSOL2.D13
EVAPOTRANSPIRATION DATA:     C:\WORK\MODELS\HELP\HELP307\5PTEVAP2.D11
SOIL AND DESIGN DATA FILE:   C:\WORK\MODELS\HELP\HELP307\5PTS1GCL.D10
OUTPUT DATA FILE:            C:\WORK\MODELS\HELP\HELP307\5PTOUT8.OUT

TIME:  13:42     DATE:   1/19/2011

**********************************************************************
               TITLE:  East Regional Landfill- Sump 1 Closed LF Case
   With GCL instead of 24 inches of Clay and 100% Recirculation to Topsoil Layer
**********************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   7
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4730 VOL/VOL
          FIELD CAPACITY                =      0.2220 VOL/VOL
          WILTING POINT                 =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1040 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.520000001000E-03 CM/SEC
        NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 5
                 IS RECIRCULATED INTO THIS LAYER.
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  11
          THICKNESS                     =     42.00   INCHES
          POROSITY                      =      0.4640 VOL/VOL
          FIELD CAPACITY                =      0.3100 VOL/VOL
          WILTING POINT                 =      0.1870 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2223 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.639999998000E-04 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1044.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4640	VOL/VOL
FIELD CAPACITY	=	0.3100	VOL/VOL
WILTING POINT	=	0.1870	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04	CM/SEC

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	1.40	PERCENT
DRAINAGE LENGTH	=	2285.0	FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 2285. FEET.

SCS RUNOFF CURVE NUMBER	=	71.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	63.000	ACRES
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.240	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	16.758	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.234	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	318.980	INCHES
TOTAL INITIAL WATER	=	318.980	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Denver Colorado

STATION LATITUDE	=	39.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	122	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	54.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.50	0.56	1.25	1.79	2.40	1.70
1.96	1.74	1.14	1.01	0.81	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
30.40	33.60	39.40	47.80	57.40	67.20
73.60	71.60	62.80	51.40	39.10	31.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DENVER COLORADO
AND STATION LATITUDE = 39.77 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.38	0.63	1.14	1.72	2.00	1.77
	2.09	1.74	1.38	0.75	0.75	0.65
STD. DEVIATIONS	0.30	0.33	0.76	1.01	1.09	1.07
	1.15	1.07	0.59	0.53	0.55	0.39
RUNOFF						
TOTALS	0.001	0.012	0.009	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.001
STD. DEVIATIONS	0.002	0.034	0.033	0.000	0.001	0.000
	0.000	0.000	0.000	0.000	0.000	0.007
EVAPOTRANSPIRATION						
TOTALS	0.318	0.501	1.171	1.703	2.196	2.603
	2.089	1.719	1.097	0.731	0.416	0.365
STD. DEVIATIONS	0.200	0.196	0.221	0.422	0.855	1.641
	1.063	1.051	0.601	0.250	0.189	0.215
LATERAL DRAINAGE RECIRCULATED INTO LAYER 1						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0084
	0.0209	0.0090	0.0005	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0003	0.0435
	0.0938	0.0463	0.0016	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE RECIRCULATED FROM LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0084
	0.0209	0.0090	0.0005	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0003	0.0435
	0.0938	0.0463	0.0016	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008
	0.0019	0.0008	0.0001	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042
	0.0087	0.0043	0.0002	0.0000	0.0000	0.0000

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	15.00	(2.862)	3429664.5	100.00
RUNOFF	0.022	(0.0450)	5131.88	0.150
EVAPOTRANSPIRATION	14.908	(2.9217)	3409383.75	99.409
DRAINAGE RECIRCULATED INTO LAYER 1	0.03891	(0.18435)	8899.004	0.25947
LATERAL DRAINAGE COLLECTED FROM LAYER 5	0.00000	(0.00000)	0.000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 5	0.03891	(0.18435)	8899.004	0.25947
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000	(0.00000)	0.137	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000	(0.001)		
CHANGE IN WATER STORAGE	0.066	(0.6850)	15148.06	0.442

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	2.42	553429.812
RUNOFF	0.152	34687.5859
DRAINAGE RECIRCULATED INTO LAYER 1	0.02482	5675.98975
DRAINAGE COLLECTED FROM LAYER 5	0.00000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 5	0.02482	5675.98975
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00306
AVERAGE HEAD ON TOP OF LAYER 6	0.071	
MAXIMUM HEAD ON TOP OF LAYER 6	0.148	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.19	272213.1250

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3365
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1732

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.3299	0.2216
2	10.6170	0.2528
3	304.8480	0.2920
4	3.7200	0.3100
5	0.0020	0.0100
6	0.0000	0.0000
7	0.4500	0.7500
SNOW WATER	0.000	

****
****

Geosynthetic Clay Liner
Cation Exchange Capacity and Liner Performance
February 10, 2011

The purpose of this memo is to discuss the ability of a composite liner system with a geomembrane/ Geosynthetic Clay Liner (GCL) to perform as well as a geomembrane/Compacted Clay Liner (CCL) on the base of the East Regional Landfill (ERLF) landfill as a result of ion exchange. GCLs used as a barrier layer to liquid migration such as that proposed for the ERLF are manufactured using a high-grade sodium bentonite encased between woven or nonwoven fabric. Sodium bentonite is selected as the primary material in a GCL because of its high swelling capacity. However, sodium bentonite is a monovalent cation (Na^{+}) and is susceptible to ion exchange with polyvalent cations in certain circumstances. The monovalent to polyvalent cation exchange process reduces the swelling potential of the bentonite thereby making the GCL more permeable (although the ion exchange process in some situations can also decrease permeability). It should also be noted from the outset that compacted clay can also be subject to cation exchange processes but that topic is beyond the scope of this discussion.

The design of the liner system at the ERLF includes a prepared subgrade, followed by placement of a GCL and, above the GCL, a 60-mil High Density Polyethylene (HDPE) cover providing separation between the GCL and any leachate. While many studies have been conducted regarding the performance of GCLs subject to cation exchange processes, most have been conducted using a single GCL with no geomembrane cover that is permeated with varying concentrations of solutions of polyvalent cations (typically Calcium Ca^{++}), some with very high concentrations. Calcium is used because it is prevalent in many soils and tends to be the predominant ion found to exchange with sodium in a GCL. The research has also focused more on final cover applications because they are the most easily exhumed and studied.

Cation exchange most typically is found to occur in GCLs as a result of water (leachate in the case of a landfill liner as at the ERLF) percolating down to the GCL through a soil or waste containing significant amounts of leachable calcium, magnesium, or other polyvalent cations. Studies completed by Dobras and Elzea, (1993), James, et al (1997), and Melchior (1997) document increases to hydraulic conductivity in the range of one to two orders of magnitude in GCLs as a result of cation exchange processes. However, in these studies, none of the GCLs were covered with a geomembrane which allowed the increases in hydraulic conductivity to occur over the entire GCL resulting in greater leakage. Additionally, the permeants in these studies were a calcium rich material which is a worst-case situation. Recommendations were made to use a geomembrane cover to minimize the effects of the cation exchange (Egloffstein, 1997 and Daniel, 2000).

It was also hypothesized that cation exchange can also occur from the upward diffusion of cations from the subgrade (Meer and Benson, 2007) in final covers (GCL only covers and one geomembrane/GCL cover). Scalia and Benson (January, 2011) followed up on that study and conducted a study of hydraulic conductivity of GCLs used in composite barriers exhumed from landfill final covers. The geomembrane component was placed on the topside of the system so

the GCL was subject to upward diffusion of cations. The results indicated that while GCLs in composite barriers are altered by their environment, this type of composite liner system nonetheless functions very well in a broad variety of climates with near zero percolation being reported in arid and semi-arid climates.

Egloffstein (2000) studied the effects of ion exchange and desiccation of natural sodium bentonites in GCLs using data from previous research. These studies were completed on uncovered (no overlying geomembrane) GCLs using varying types of permeants as a head source directly on the GCL. They were also subjected to wetting and drying cycles to determine the effects of desiccation. While he noted there was a slight increase in the hydraulic conductivity (one-half to one order of magnitude), he also noted it was "not alarming, as long as design engineers take this effect into consideration". His review also concluded that at least one study used unrealistically high concentrations of electrolytic solutions when testing the GCL which are "much more extreme than worst case". He summarized "The ion concentrations usually existing in the leachate of natural soils do not give much reason for concern regarding the influence of the electrolyte content on the permeability". This statement applies to percolation of water through typical natural soils versus some of the studies done using high concentration calcium permanents. Egloffstein also found that desiccation played a large part in the increased permeability of the GCLs but that desiccation can be avoided by covering the GCL with a geomembrane, as is the case at the ERLF, and/or placing a load (a vegetation layer of 0.75 to 1 meter of soil) on the GCL, as the case with a base liner versus a final cover.

The leakage rates of a GCL/geomembrane composite liner were compared to a similar composite liner using CCL instead of GCL. This study was done on double liner systems with leak detection layers between the composite liners in 91 landfills monitored for up to 10 years (Bonaparte, et al, 1999). The study also compared leakage rates during various life cycle stages of the landfill liner system including the initial life, active life, and post-closure stages. The results show that GCL/geomembrane composite liners outperformed the standard CCL/geomembrane composite liner systems in all cases and at each life cycle stage. This conclusion suggests that even with the cation exchange processes typical in landfill applications, the GCL/geomembrane composite liner will outperform the CCL/geomembrane composite liner.

A study was performed to compare the effects of confining stress on the permeability of GCLs permeated with both water and a concentrated calcium chloride solution (Daniel, 2000). CETCO reported additional details of the Daniel study in a technical document (CETCO, TR-321, revised May 2002). Hydraulic conductivity testing was conducted using a flexible wall permeameter. The concentrated calcium chloride (5,000 mg/L Ca^{++}) was allowed to achieve full ion exchange with the sodium in the GCL and reach equilibrium conditions. The results indicate an acceptable permeability of $\leq 5 \times 10^{-9}$ cm/sec is maintained and a decrease in permeability occurs as an increase in the confining stress is achieved. Daniel concluded that "chemical attack is of much less concern for a landfill liner than for a landfill cover".

A study is being conducted to evaluate changes in permeability as a result of cation exchange in GCLs during its hydration after being placed on a subgrade (Bradshaw, Benson, 2009). The analysis is based on using a variety of soil types for the subgrade and hydrating the GCLs for varying lengths of time with various permeants including real and synthetic leachates. The results to date indicate that cation exchange can take place during GCL hydration on a subgrade but "an increase in hydraulic conductivity due to exchange during subgrade hydration has only been observed in one case". Additionally, the GCL was directly permeated with leachate after subgrade hydration. This scenario would not occur at the ERLF because of the installation of a 60-mil HDPE. Following permeation of the GCL with leachate, only modest increases (less than a factor of 2.5) were found to occur. It was the author's conclusion that, "these changes in hydraulic conductivity are not particularly important".

In summary, the geomembrane/GCL composite is expected to outperform geomembrane/CCL composite in the base of the ERLF. Studies have shown that while there is the potential for a cation exchange as a result of hydration of the GCL in the subgrade, it is not substantial. The more substantial effects of cation exchange occur when the GCL is the sole barrier component and is not covered with a geomembrane and therefore subject to direct permeation from leachate. The ERLF design incorporates a 60-mil HDPE geomembrane so this will not occur. Additionally, the wet-dry cycling that can occur on a GCL, and may be the greater cause of higher GCL permeabilities, will not occur because of the HDPE geomembrane over the GCL and the landfill material precludes exposure to the wetting and drying process. Lastly, it has been shown that placing a load on the GCL helps maintain the low material permeability. The GCL will be under a significant load at the base of the landfill.

References:

1. Bonaparte, R., Daniel, D.E., and Koerner, R.M., December, 2002, Assessment and Recommendations for Optimal Performance of Waste Containment Systems, EPA 600/R-02/099, , U. S. EPA, ORD, Cincinnati, OH.

2. Bradshaw, S. and Benson, C., October, 2009, Progress Report for Q1-Q3 2009 for the Study "Effect of Stress, Hydration, and Ion Exchange on the Hydraulic Conductivity of GCLs.

3. Daniel, D.E., 2000, Hydraulic Durability of Geosynthetic Clay Liners. Proceedings of the GRI-14 Conference on Hot Topics in Geosynthetics – I, R.M Koerner, Y.G. Hsuan, and M.V. Ashley (Eds.), Gil Publications, Folsom, P.A., , pp 116-135.

4. Dobras, T. N., and Elzea, J. M. 1993. In-Situ Soda Ash Treatment for Contaminated Geosynthetic Clay Liners. Proc., Geosynthetics '93, Industrial Fabrics Association, St. Paul, MN, U.S.A., 3, pp. 1145-1160.

5. Egloffstein, T., December, 2000, Natural Bentonites - Influence of the Ion Exchange and Partial Desiccation on Permeability and Self-Healing Capacity of Bentonites Used In GCLs.

6. James, A.N., Fullerton, D., and Drake, R., 1997, "Field Performance of a GCL Under Ion Exchange Conditions", Journal of Geotechnical and Geoenvironmental Engineering, Vol. 123, No. 10, pp. 897-902.

7. Meer, S. R., and Benson, C. H. 2007, "Hydraulic conductivity of geosynthetic clay liners exhumed from landfill final covers." *J. Geotech. Geoenviron. Eng.*, 133_5_, 550–563.

8. Mechior, S, 1997, "In-Situ Studies on the Performance of Landfill Caps" (Compacted Soil Liners, Geomembranes, Geosynthetic Clay Liners, Capillary Barriers)", in International Containment Technology Conference, Proceedings, St. Petersburg, Florida, February 9-12, 1997 , pp. 365-373.

9. Scalia, J. and Benson, C.H, January, 2011, Hydraulic Conductivity of Geosynthetic Clay Liners Exhumed from Landfill Final Covers with Composite Barriers, Journal of Geotechnical and Geoenvironmental Engineering, ASCE,.

TAB 6

DRAWINGS

WASTE MANAGEMENT / CSI PROPERTY

WASTE MANAGEMENT / CSI PROPERTY

XCEL ENERGY PROPERTY

WASTE MANAGEMENT / CSI PROPERTY

CELL 10

MODULE 1

MODULE 2

MODULE 3

5005 5006 5007 5003 5002 5001 5004 5008 5009 5010

GP-2 MW-2 MW-3 GP-3 GP-4 MW-4 MW-1

LEGEND

- 5315 — EXISTING CONTOURS (2 FT. INTERVAL)
- EXISITNG CELL 10 LIMITS
- 5315 — PROPOSED LANDFILL SUBGRADE CONTOURS (2 FT. INTERVAL)
- PROPERTY LIMIT (BY R.W. BAYER & ASSOCIATES, 2007)
- 5007 — PROPERTY CORNER SURVEY POINT (BY R.W. BAYER & ASSOCIATES, 2007, REBAR, CAP FOUND OR SET)
- ADJOINING PROPERTY BOUNDARY
- GAS PIPELINE RIGHT OF WAY
- GAS PIPELINE ACCESS ROAD
- SECTION MARKER
- MW-3 — EXISTING GROUND WATER MONITORING LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION)
- GP-2 — EXISTING GAS MONITORING WELL LOCATION
- LANDSCAPED SCREENING BERM
- SCREENING TREE LOCATION
- SCREENING BUSH LOCATION

N

SCALE
200' 0 200'
CONTOUR INTERVAL 1 TO 2FT.

NOTE: ORIGINAL LDD CAD WORK, COORDINATES AND TOPOGRAPHIC DATA FROM R.W. BAYER & ASSOCIATES, INC. MAY 09, 2007

SHEET 1
SUBGRADE EXCAVATION FOR 2-FOOT CLAY LINER OPTION
EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

CLIENT: FIVE PART DEVELOPMENT, LCC	
PROJECT: REVISED LDF DESIGN 2010	
PROJECT NO: FIVE PART_2010	DATE COMPLETED: 01/11
DESIGNED BY: AEC	APPROVED BY: MAM
DRAWN BY: JGN	DWG NAME: ERL REV_PERMIT_0001.dwg
REVISION:	REVISED BY: MAM DATE: 02/11
0 ISSUED FOR REVIEW	
1 REVISE FLOOR TOPO MODULE 3	

AEC AMERICAN ENVIRONMENTAL CONSULTING, LLC.



LEGEND

- 5315 — EXISTING CONTOURS (2 FT. INTERVAL)
- EXISITNG CELL 10 LIMITS
- 5315 — PROPOSED LANDFILL SUBGRADE CONTOURS (2 FT. INTERVAL)
- 5315 — PROPOSED LANDFILL TOP OF CLAY/GCL OPTION CONTOURS (2 FT. INTERVAL)
- PROPERTY LIMIT (BY R.W. BAYER & ASSOCIATES, 2007)
- 5007 — PROPERTY CORNER SURVEY POINT (BY R.W. BAYER & ASSOCIATES, 2007, REBAR, CAP FOUND OR SET)
- ADJOINING PROPERTY BOUNDARY
- GAS PIPELINE RIGHT OF WAY
- GAS PIPELINE ACCESS ROAD
- SECTION MARKER
- MW-3 — EXISTING GROUND WATER MONITORING LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION)
- GP-2 — EXISTING GAS MONITORING WELL LOCATION
- LANDSCAPED SCREENING BERM
- SCREENING TREE LOCATION
- SCREENING BUSH LOCATION

NOTE: SURFACE SHOWN REPRESENTS EITHER TOP OF 2 FT. CLAY LINER, OR SUBGRADE FOR GLC LINER

N

SCALE
200' 0 200'
CONTOUR INTERVAL 1 TO 2FT.

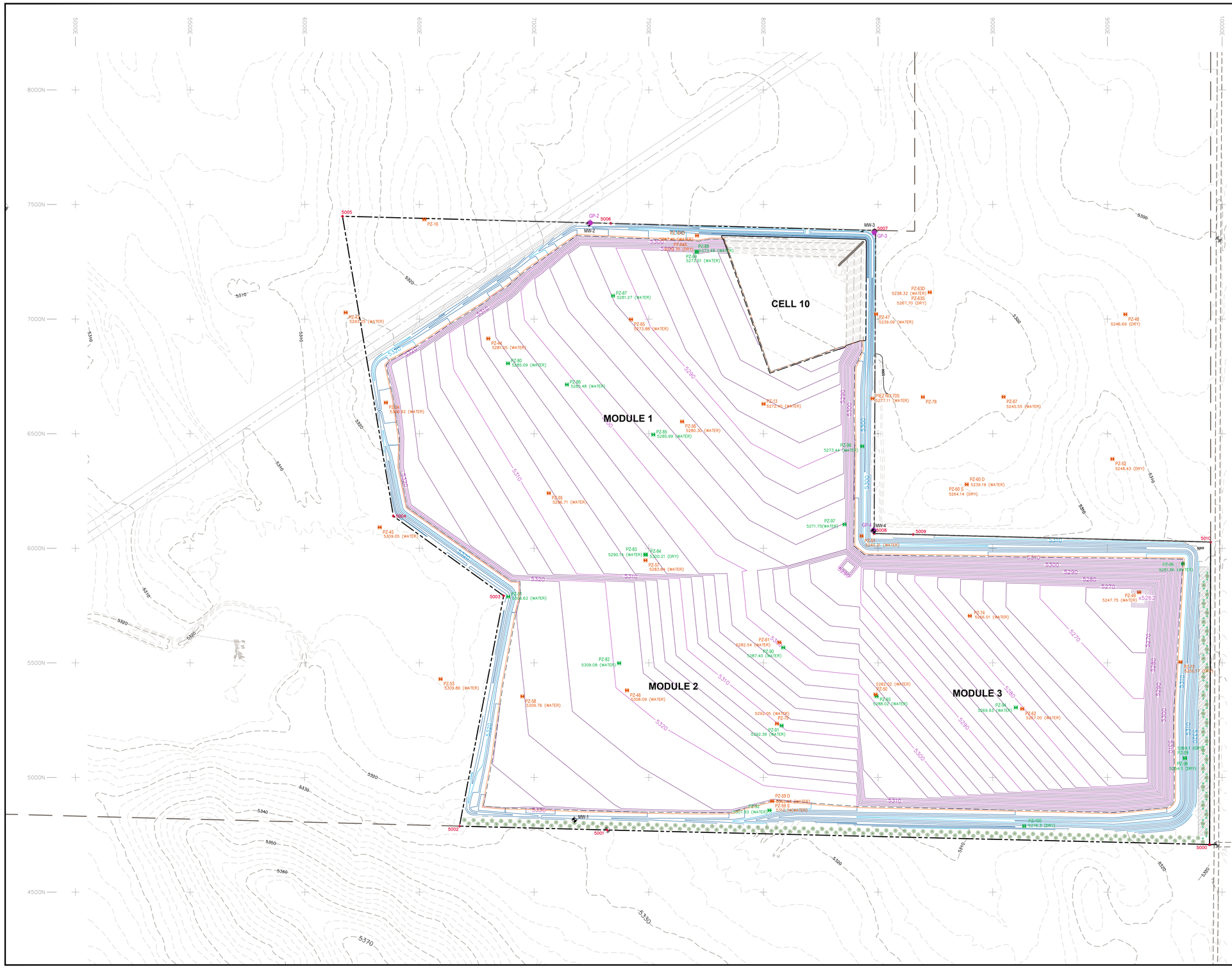
NOTE: ORIGINAL LDD CAD WORK, COORDINATES AND TOPOGRAPHIC DATA FROM R.W. BAYER & ASSOCIATES, INC. MAY 09, 2007

SHEET 2
TOP OF CLAY/GCL LINER OPTION
EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

CLIENT: FIVE PART DEVELOPMENT, LCC	
PROJECT: REVISED LDF DESIGN 2010	
PROJECT NO: FIVE PART_2010	DATE COMPLETED: 01/11
DESIGNED BY: AEC	APPROVED BY: MAM
DRAWN BY: JGN	DWG NAME: ERL REV_PERMIT_0002.dwg
REVISION:	REVISED BY: MAM DATE: 02/11

0	ISSUED FOR REVIEW
1	REVISED FLOOR TOPO MODULE 3

AEC AMERICAN ENVIRONMENTAL CONSULTING, LLC.



LEGEND

- 5315 — EXISTING CONTOURS (2 FT. INTERVAL)
- EXISITNG CELL 10 LIMITS
- 5315 — PROPOSED LANDFILL SUBGRADE CONTOURS (2 FT. INTERVAL)
- 5315 — PROPOSED LANDFILL TOP OF CLAY/GCL OPTION CONTOURS (2 FT. INTERVAL)
- PROPERTY LIMIT (BY R.W. BAYER & ASSOCIATES, 2007)
- 5007 — PROPERTY CORNER SURVEY POINT (BY R.W. BAYER & ASSOCIATES, 2007, REBAR, CAP FOUND OR SET)
- ADJOINING PROPERTY BOUNDARY
- GAS PIPELINE RIGHT OF WAY
- GAS PIPELINE ACCESS ROAD
- SECTION MARKER
- MW-3 — EXISTING GROUND WATER MONITORING LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION)
- PZ-1 — PRE-EXISTING GROUND WATER PIEZOMETER LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION "WATER" OR TOTAL DEPTH IF "DRY")
- PZ-80 — NEW GROUND WATER PIEZOMETER LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION "WATER" OR TOTAL DEPTH IF "DRY")
- GP-2 — EXISTING GAS MONITORING WELL LOCATION
- LANDSCAPED SCREENING BERM
- SCREENING TREE LOCATION
- SCREENING BUSH LOCATION

N

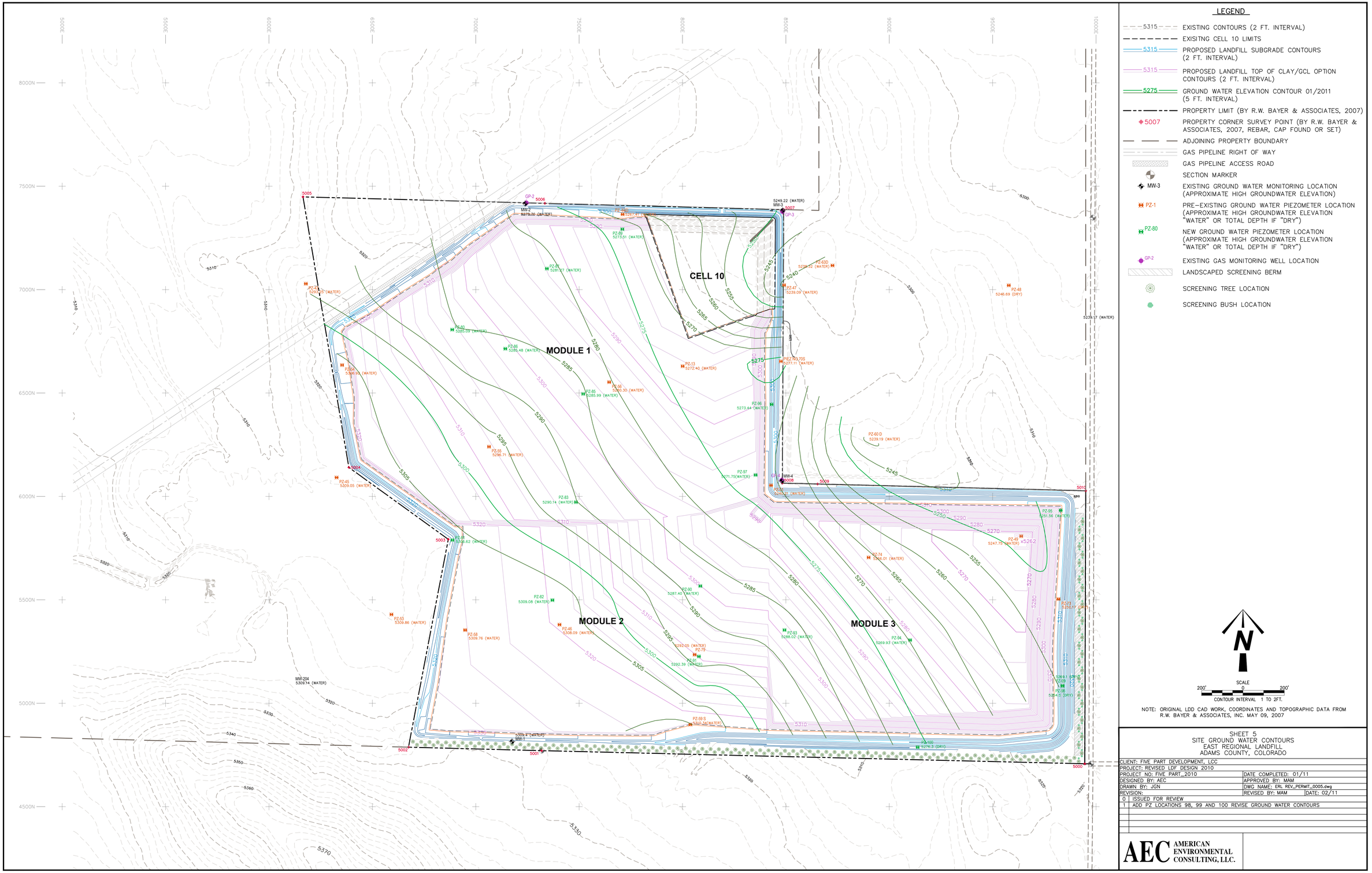
SCALE
200' 0 200'
CONTOUR INTERVAL 1 TO 2FT.

NOTE: ORIGINAL LDD CAD WORK, COORDINATES AND TOPOGRAPHIC DATA FROM R.W. BAYER & ASSOCIATES, INC. MAY 09, 2007

SHEET 4
SITE PIEZOMETER AND GROUND WATER ELEVATIONS
EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

CLIENT: FIVE PART DEVELOPMENT, LCC	
PROJECT: REVISED LDF DESIGN 2010	
PROJECT NO: FIVE PART_2010	DATE COMPLETED: 01/11
DESIGNED BY: AEC	APPROVED BY: MAM
DRAWN BY: JGN	DWG NAME: ERL REV_PERMIT_0004.dwg
REVISION:	REVISED BY: MAM DATE: 02/11
0 ISSUED FOR REVIEW	
1 ADD PZ LOCATIONS 98, 99 AND 100	

AEC AMERICAN ENVIRONMENTAL CONSULTING, LLC.



LEGEND

- 5315 — EXISTING CONTOURS (2 FT. INTERVAL)
- EXISITNG CELL 10 LIMITS
- 5315 — PROPOSED LANDFILL SUBGRADE CONTOURS (2 FT. INTERVAL)
- 5315 — PROPOSED LANDFILL TOP OF CLAY/GCL OPTION CONTOURS (2 FT. INTERVAL)
- 5275 — GROUND WATER ELEVATION CONTOUR 01/2011 (5 FT. INTERVAL)
- PROPERTY LIMIT (BY R.W. BAYER & ASSOCIATES, 2007)
- 5007 — PROPERTY CORNER SURVEY POINT (BY R.W. BAYER & ASSOCIATES, 2007, REBAR, CAP FOUND OR SET)
- ADJOINING PROPERTY BOUNDARY
- GAS PIPELINE RIGHT OF WAY
- GAS PIPELINE ACCESS ROAD
- SECTION MARKER
- MW-3 — EXISTING GROUND WATER MONITORING LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION)
- PZ-1 — PRE-EXISTING GROUND WATER PIEZOMETER LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION "WATER" OR TOTAL DEPTH IF "DRY")
- PZ-80 — NEW GROUND WATER PIEZOMETER LOCATION (APPROXIMATE HIGH GROUNDWATER ELEVATION "WATER" OR TOTAL DEPTH IF "DRY")
- GP-2 — EXISTING GAS MONITORING WELL LOCATION
- LANDSCAPED SCREENING BERM
- SCREENING TREE LOCATION
- SCREENING BUSH LOCATION

N

SCALE
200' 0 200'
CONTOUR INTERVAL 1 TO 2FT.

NOTE: ORIGINAL LDD CAD WORK, COORDINATES AND TOPOGRAPHIC DATA FROM R.W. BAYER & ASSOCIATES, INC. MAY 09, 2007

SHEET 5
SITE GROUND WATER CONTOURS
EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO

CLIENT: FIVE PART DEVELOPMENT, LCC	
PROJECT: REVISED LDF DESIGN 2010	
PROJECT NO: FIVE PART_2010	DATE COMPLETED: 01/11
DESIGNED BY: AEC	APPROVED BY: MAM
DRAWN BY: JGN	DWG NAME: ERL REV_PERMIT_0005.dwg
REVISION:	REVISED BY: MAM DATE: 02/11
0 ISSUED FOR REVIEW	
1 ADD PZ LOCATIONS 98, 99 AND 100 REVISE GROUND WATER CONTOURS	

AEC AMERICAN ENVIRONMENTAL CONSULTING, LLC.

Appendix K
Leachate Drainage Material Modification Approval

STATE OF COLORADO

Bill Ritter, Jr., Governor
James B. Martin, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

http://www.cdphe.state.co.us

Laboratory Services Division
8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

Colorado Department
of Public Health
and Environment

March 4, 2008

Kevin J. Taylor, P.G., Senior Project Geologist
Terracon
10625 W. I-70 Frontage Road, North
Suite 3
Wheat Ridge, CO 80033

RE: Geocomposite Drainage Layer Calculations and Hydrologic Evaluation of Landfill Performance (HELP) Model Calculations Five Part Disposal Facility, Bennett, Colorado
Terracon Project No.: 25087002

Dear Mr. Taylor,

The Hazardous Materials and Waste Management Division of the Department of Public Health and Environment (the Division) received on January 30, 2008, one copy of a document entitled "Geocomposite Drainage Layer Calculations and Hydrologic Evaluation of Landfill Performance (HELP) Model Calculations" for Five Part Disposal Facility, Bennett, Colorado. The document responds to two comments that Tri-County Health Department submitted in a letter dated November 1, 2007, which were:

- Comment No. 1.c. - No modeling or calculations are provided demonstrating how the revised leachate collection system design will maintain less than a 12-inch depth of leachate over the HDPE geomembrane as required by 6 CCR 1007-2, Section 3.25.D.

- Comment No. 1.d - No modeling or calculations are provided demonstrating how the revised leachate collection system design will transport leachate from the most distant part of the cell to the sump in less than 12 months as required by 6 CCR 1007-2, Section 3.25.D.

The response submitted from Terracon including travel time calculations and HELP Modeling indicate that the Geocomposite proposed to be used for construction of the leachate collection system will satisfy the requirements of the Solid Waste Regulations. Additional minor comments discussed in a letter dated February 26, 2008 from Tri-County Health Department will provide additional insight into the calculation methods provided and the Division is anticipating a copy of the response. Please provide two copies to the Division to expedite review time.

Sincerely,

Darrell R. Dearborn
Geologist, Solid Waste Unit
Compliance Program

Cc: Mark Molen, Molen and Associates, LLC
Mark McMullen, AEC
Craig Tessmer, Adams County Planning
Ken Manzo, Five Part Disposal, 13848 Harrison St., Thornton, CO 80602
Brad Coleman, Sentinel Consulting, Inc. File SW/ADM/FIO – 2.1

Appendix L
Updated HELP Modeling

HELP MODEL EVALUATION FOR THE EAST REGIONAL LANDFILL

1.0 INTRODUCTION

OBJECTIVE: To evaluate the performance of the proposed landfill design configuration using the U.S. Environmental Protection Agency's (EPA's) Hydrologic Evaluation of Landfill Performance (HELP) model (version 4.01). Specifically, the model was used to determine if the calculated leachate head on the primary liner in the proposed configuration would exceed 12 inches.

METHODOLOGY: Input data used in the HELP model consists of local meteorological data and details of the proposed landfill design configuration. The model then uses this data to perform calculations related to leachate generation and produces a model output that specifies the calculated average leachate head, peak leachate head, annual leachate drainage volume, and peak leachate drainage volume.

2.0 MODEL INPUTS

These site-specific parameters are independent of landfill design and are used for all modelling scenarios.

Precipitation Data

Precipitation was simulated based on HELP v4 weather simulation for the following coordinates: 39.77°N 104.50°W. The average annual precipitation is 14.19 inches, and the average monthly precipitation quantities are:

MEAN PRECIPITATION (INCHES) - LEADVILLE, COLORADO					
January	February	March	April	May	June
0.38	0.42	0.84	1.79	2.21	1.76
July	August	September	October	November	December
2.31	1.52	1.20	0.84	0.53	0.40

Temperature Data

Temperature was simulated based on HELP v4 weather simulation for the following coordinates: 39.77°N 104.50°W. The average monthly temperatures are:

MEAN NORMAL TEMPERATURES (F) - LEADVILLE, COLORADO					
January	February	March	April	May	June
26.53	29.14	41.82	51.46	64.23	76.36
July	August	September	October	November	December
79.65	77.41	71.55	53.73	38.13	26.61

Solar Radiation Data

Solar radiation was simulated based on HELP v4 weather simulation for the following coordinates: 39.77°N 104.50°W.

Wind Speed and Relative Humidity

Wind Speed and Relative Humidity were imported into the HELP v4 model from the National Solar Radiation Database 1991-2005, using the Denver International Airport dataset (USAF Site ID 725650TYA). The values used are:

Average wind speed	9 mph
Average first quarter relative humidity	47%
Average second quarter relative humidity	52%
Average third quarter relative humidity	45%
Average fourth quarter relative humidity	54%

Growing Season Dates

Starting and ending dates for the growing season were unchanged from the program defaults for Denver, CO and input as Julian day 122 starting and ending Julian day 286.

3.0 SIMULATION SCENARIOS

The HELP Model was used to generate results for three different conditions:

Scenario 1. Newly Constructed Cell
Scenario 2. Early Open Conditions
Scenario 3. Intermediate Open Conditions
Scenario 4. Closed Conditions

The conditions also varied based on using the option of a 2-foot compacted clay beneath the High-Density Polyethylene (HDPE) Liner or using a Geosynthetic Clay Liner (GCL) beneath the HDPE. The closed landfill conditions were modeled using both a water balanced alternative final cover and an LLDPE barrier final cover.

3.1 Scenario 1. Newly Constructed Cell

The newly constructed cell is an 18-acre open portion of the landfill with no waste placed. The layers used in the Model for this scenario are:

Layer #	Type	Porosity (vol/vol)	Field Cap (vol/vol)	Wilt Point (vol/vol)	Hyd Cond. (cm/sec)	Thickness (inches)
1	Daily Cover	0.453	0.19	0.085	7.2×10^{-4}	**6**
2	MSW	0.671	0.292	0.077	1.0×10^{-3}	**60**
3	Protective Cover	0.398	0.244	0.136	1.2×10^{-4}	**12**
4[1]	Geocomposite	0.85	0.01	0.005	1.0×10^{1}	**0.2**
5	60-mil HDPE | 2 pinholes/acre | 2 defects/acre | Good Placement				2.0×10^{-13}	**0.06**
6	[2]24-Inch Compacted Soil Liner	0.45	0.4	0.3	1.0×10^{-7}	**24**
	[3]Geosynthetic Clay Liner	0.75	0.747	0.4	5.0×10^{-9}	**0.25**

1. Leachate drainage layer with 1300 feet drainage length @ 3% grade and 0% leachate recirculation.
2. 24-inch Compacted Soil Liner used in Scenario 1.A.
3. Geosynthetic clay liner used in Scenarios 1.B.

Evapotranspiration Data

The following data was input to simulate the newly constructed cell condition where the operations layer is bare soil:

Maximum Leaf Index: A maximum leaf index of zero was used to represent bare ground conditions.

Evaporative Zone Depth: An evaporative zone depth of 12 inches was used to represent the 12-inch operations layer thickness.

SCS Runoff Curve Number

For this condition, it is assumed that 0% of the fill area allows runoff. Therefore, the model assumes zero runoff volume, ignores the SCS curve number, and all precipitation within the fill footprint is added to the cover infiltration volume.

3.2 Scenario 2. Early Open Conditions

The early open condition assumes there is roughly 6 feet of waste in place over the 18-acre open portion of the landfill. This waste is covered with 6 inches of daily cover soil. The layers used in the Model for this scenario are:

Layer #	Type	Porosity (vol/vol)	Field Cap (vol/vol)	Wilt Point (vol/vol)	Hyd Cond. (cm/sec)	Thickness (inches)
1	Daily Cover	0.453	0.19	0.085	7.2×10^{-4}	**6**
2	MSW	0.671	0.292	0.077	1.0×10^{-3}	**72**
3	Protective Cover	0.398	0.244	0.136	1.2×10^{-4}	**12**
4[1]	Geocomposite	0.85	0.01	0.005	1.0×10^{1}	**0.2**
5	60-mil HDPE | 2 pinholes/acre | 2 defects/acre | Good Placement				2.0×10^{-13}	**0.06**
6	[2]24-Inch Compacted Soil Liner	0.45	0.4	0.3	1.0×10^{-7}	**24**
	[3]Geosynthetic Clay Liner	0.75	0.747	0.4	5.0×10^{-9}	**0.25**

1. Leachate drainage layer with 1300 feet drainage length @ 3% grade and 0% leachate recirculation.
2. 24-inch Compacted Soil Liner used in Scenario 2.A.
3. Geosynthetic clay liner used in Scenarios 2.B.

Evapotranspiration Data

The following data was input to simulate the early open conditions, where cover soils are generally bare (i.e. no vegetation):

Maximum Leaf Index: A maximum leaf index of zero was used to represent bare ground conditions.

Evaporative Zone Depth: An evaporative zone depth of 6 inches was used to represent open fill, bare ground conditions, where daily cover depth is 6 inches.

SCS Runoff Curve Number

For Early Open Conditions, it is assumed that 0% of the fill area allows runoff. Therefore, the model assumes zero runoff volume, ignores the SCS curve number, and all precipitation within the fill footprint is added to the cover infiltration volume.

3.3 Scenario 3. Intermediate Open Conditions (50' waste in place)

Proposed Landfill Layer Data

The following data was input to simulate the intermediate open landfill waste condition, with 50' of waste in place over the 35-acre Module 3 area covered with 12" of intermediate cover soils:

Layer #	Type	Porosity (vol/vol)	Field Cap (vol/vol)	Wilt Point (vol/vol)	Hyd Cond. (cm/sec)	Thickness (inches)
1	Intermediate Cover	0.453	0.19	0.085	7.2×10^{-4}	**12**
2	MSW	0.671	0.292	0.077	1.0×10^{-3}	**600**
3	Protective Cover	0.398	0.244	0.136	1.2×10^{-4}	**12**
4[1]	Geocomposite	0.85	0.01	0.005	1.0×10^{1}	**0.2**
5	60-mil HDPE | 2 pinholes/acre | 2 defects/acre | Good Placement				2.0×10^{-13}	**0.06**
6	[2]24-Inch Compacted Soil Liner	0.45	0.4	0.3	1.0×10^{-7}	**24**
	[3]Geosynthetic Clay Liner	0.75	0.747	0.4	5.0×10^{-9}	**0.25**

1. Leachate drainage layer with 1450 feet drainage length @ 3.24% grade and 100% leachate recirculation.
2. 24-inch Compacted Soil Liner used in Scenario 3.A.
3. Geosynthetic clay liner used in Scenario 3.B.

Evapotranspiration Data

The following data was input to simulate the open waste condition, where cover soils are generally bare (i.e. no vegetation):

Maximum Leaf Index: A maximum leaf index of 1 was used to represent sparse ground cover conditions.

Evaporative Zone Depth: An evaporative zone depth of 12 inches was used to represent open fill, bare ground conditions, where intermediate cover depth is 12 inches.

SCS Runoff Curve Number

For Intermediate Open Conditions, it is assumed that 100% of the 35-acre fill area allows runoff. Runoff from the area was calculated using an SCS runoff curve number of 83.2, which was generated within the HELP Model based on intermediate cover soils of Sandy Loam, a poor stand of grass, a surface slope of 10%, and a slope length of 500 feet.

3.4 Scenario 4. Closed Conditions (100' waste in place)

Scenarios 1, 2, and 3 were each run two times with different liner barrier layers. Sub-scenario A is a 24-inch compacted clay liner, and it was the most conservative scenario in that it was the most permeable liner system resulting in the most leakage of leachate through the liner system. To simplify Scenario 4, it was run with only a 24-inch sand leachate drainage layer and 12-inch compacted clay liner.

Proposed Landfill Layer Data

The following data was input to simulate the closed waste condition, with 100' of waste in place (average fill depth across expansion area) over 35.1-acre area (the entire Module 3).

Two sub-scenarios were considered, one for each of the two final cover systems, and they are discussed further in Sections 3.4.1 and 3.4.2.

SCS Runoff Curve Number

For Closed Conditions, it is assumed that 100% of the fill area allows runoff. Runoff from the area was calculated using an SCS runoff curve number of 86.2, which was generated within the HELP Model based on vegetative cover soils of Sandy Clay Loam, a fair stand of grass, a surface slope of 25%, and a slope length of 550 feet

3.4.1 Scenario 4.A Water Balanced Final Cover

This scenario was designed with a 3.5-foot-thick water-balanced final cover system on top of the intermediate soil layer. The layers used in the Model for Scenario 4.A are:

Layer #	Type	Porosity (vol/vol)	Field Cap (vol/vol)	Wilt Point (vol/vol)	Hyd Cond. (cm/sec)	Thickness (inches)
1	Alternative Final Cover	0.398	0.244	0.136	1.2×10^{-4}	**42**
2	Intermediate Cover/Base Layer	0.453	0.19	0.085	7.2×10^{-4}	**12**
3	MSW	0.671	0.292	0.077	1.0×10^{-3}	**1200**
4	Protective Cover	0.398	0.244	0.136	1.2×10^{-4}	**12**
5[1]	Geocomposite	0.85	0.01	0.005	1.0×10^{1}	**0.2**
6	60-mil HDPE | 2 pinholes/acre | 2 defects/acre | Good Placement				2.0×10^{-13}	**0.06**
7	24-Inch Compacted Soil Liner	0.45	0.4	0.3	1.0×10^{-7}	**24**

1. Leachate drainage layer with 1450 feet drainage length @ 3.24% grade and 0% leachate recirculation.

Evapotranspiration Data

The following data was input to simulate the open waste condition, where cover soils are generally bare (i.e. no vegetation):

Maximum Leaf Index: A maximum leaf index of 2 was used to represent fair stand of grass cover conditions.

Evaporative Zone Depth: An evaporative zone depth of 42 inches was used to represent the final thickness of the water balanced final cover system.

3.4.2 Scenario 4.B Geomembrane Barrier Final Cover

This scenario's final cover system is designed with a 40-mil LLDPE geomembrane barrier covered with an 18-inch protective cover and vegetative soil layer. The layers used in the Model for Scenario 4.B are:

Layer #	Type	Porosity (vol/vol)	Field Cap (vol/vol)	Wilt Point (vol/vol)	Hyd Cond. (cm/sec)	Thickness (inches)
1	Protective Cover/Veg. Layer	0.398	0.244	0.136	1.2×10^{-4}	**18**
2	40-mil LLDPE | 2 pinholes/acre | 2 defects/acre | Good Placement				4.0×10^{-13}	**0.04**
3	Intermediate Cover/Base Layer	0.453	0.19	0.085	7.2×10^{-4}	**12**
4	MSW	0.671	0.292	0.077	1.0×10^{-3}	**1200**
5	Protective Cover	0.398	0.244	0.136	1.2×10^{-4}	**12**
6[1]	Geocomposite	0.85	0.01	0.005	1.0×10^{1}	**0.2**
7	60-mil HDPE | 2 pinholes/acre | 2 defects/acre | Good Placement				2.0×10^{-13}	**0.06**
8	24-Inch Compacted Soil Liner	0.45	0.4	0.3	1.0×10^{-7}	**24**

1. Leachate drainage layer with 1450 feet drainage length @ 3.24% grade and 0% leachate recirculation.

Evapotranspiration Data

The following data was input to simulate the closed landfill condition, where cover soils are generally vegetated, and vegetative cover is monitored and repaired as needed.

Maximum Leaf Index: A maximum leaf index of 2 was used to represent fair stand of grass cover conditions.

Evaporative Zone Depth: An evaporative zone depth of 18 inches was used to represent the protective and vegetative soil cover over the LLDPE geomembrane.

4.0 SIMULATION RESULTS

4.1 Scenario 1 – Newly Constructed Cell Case Results

	A) 24-Inch Clay Liner	B) Geosynthetic Clay Liner
Average Head on liner	0.0004 in.	0.0004 in.
Max head on liner	0.1402 in.	0.1402 in.
Ave. Annual leachate collected	12,715.1 ft^3	12,715.2 ft^3
Ave. Annual leakage through liner	0.0514 ft^3	0.0284 ft^3

4.2 Scenario 2 – Early Open Conditions Case Results

	A) 24-Inch Clay Liner	B) Geosynthetic Clay Liner
Average Head on liner	0.0040 in.	0.0040 in.
Max head on liner	0.3710 in.	0.3710 in.
Ave. Annual leachate collected	125,417.9 ft^3	125,418.2 ft^3
Ave. Annual leakage through liner	0.3624 ft^3	0.1261 ft^3

4.3 Scenario 3 – Intermediate Open Conditions Case Results

	A) 24-Inch Clay Liner	B) Geosynthetic Clay Liner
Average Head on liner	0.0006 in.	0.0006 in.
Max head on liner	0.2482 in.	0.2499 in.
Ave. Annual leachate collected	36,629.2 ft^3	33,109.8 ft^3
Ave. Annual leakage through liner	0.1558 ft^3	0.0777 ft^3

4.4 Scenario 4 – Closed Conditions Case Results

Scenario 4.A	Water Balanced Final Cover
Precipitation	1,808,525.2 ft^3
Runoff	31,551.4 ft^3
Evapotranspiration	1,779,115.2 ft^3
Average Head on liner	0 in.
Max head on liner	0 in.
Ave. Annual leachate collected	0 ft^3
Ave. Annual leakage through liner	0 ft^3

Scenario 4.B	Geomembrane Final Cover
Ave. head on final cover membrane	0.0493 in.
Ave. peak daily head on final cover membrane	4.2292 in.
Ave. Annual leakage through final cover	653.7 ft^3
Average Head on liner	0 in.
Max head on liner	0 in.
Ave. Annual leachate collected	0 ft^3
Ave. Annual leakage through liner	0 ft^3

4.4 Summary

The modeling shows that regardless of the liner or leachate drainage system selected, there will not be more than 12 inches of leachate on the liner. The maximum head on the liner is 0.37 inches in the early open landfill conditions.

ATTACHMENT 1

SCENARIO 1 – NEWLY CONSTRUCTED CELL
HELP MODEL RESULTS

ATTACHMENT 1.A

SCENARIO 1.A HELP MODEL RESULTS
24" CLAY LINER

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: ERL HELP Scenario 1.A **Simulated On:** 12/6/2024 10:24

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam (Moderate)
Material Texture Number 24

Thickness	=	12	inches
Porosity	=	0.365	vol/vol
Field Capacity	=	0.305	vol/vol
Wilting Point	=	0.202	vol/vol
Initial Soil Water Content	=	0.226	vol/vol
Effective Sat. Hyd. Conductivity	=	2.70E-06	cm/sec

Layer 2

Type 2 - Lateral Drainage Layer
Geocomposite (200 mil)
Material Texture Number 44

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	3	%

Drainage Length	=	1300	ft

Layer 3

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 4

Type 3 - Barrier Soil Liner

24-Inch Soil Compacted Soil Barrier

Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.45	vol/vol
Field Capacity	=	0.4	vol/vol
Wilting Point	=	0.3	vol/vol
Initial Soil Water Content	=	0.45	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	96.6	
Fraction of Area Allowing Runoff	=	0	%

Area projected on a horizontal plane	=	18	acres
Evaporative Zone Depth	=	12	inches
Initial Water in Evaporative Zone	=	2.712	inches
Upper Limit of Evaporative Storage	=	4.38	inches
Lower Limit of Evaporative Storage	=	2.424	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	13.514	inches
Total Initial Water	=	13.514	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.77	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	122	days
End of Growing Season (Julian Date)	=	286	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	47	%
Average 2nd Quarter Relative Humidity	=	52	%
Average 3rd Quarter Relative Humidity	=	45	%
Average 4th Quarter Relative Humidity	=	54	%

Note: Evapotranspiration data was obtained for DENVER, COLORADO

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
0.377976	0.42303	0.835809	1.785262	2.213768	1.758551

2.309971 1.517605 1.200053 0.837816 0.531606 0.402749

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
26.5	29.1	41.8	51.5	64.2	76.4
79.7	77.4	71.5	53.7	38.1	26.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Average Annual Totals Summary

Title: ERL HELP Scenario 1.A
Simulated on: 12/6/2024 10:26

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	14.19	[2.3]	927,448.8	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	14.005	[2.791]	915,083.7	98.67
Subprofile1				
Lateral drainage collected from Layer 2	0.1946	[0.5017]	12,715.1	1.37
Percolation/leakage through Layer 4	0.000001	[0.000001]	0.0514	0.00
Average Head on Top of Layer 3	0.0004	[0.001]	---	---
Water storage				
Change in water storage	-0.0054	[0.939]	-350.0	-0.04

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: ERL HELP Scenario 1.A
Simulated on: 12/6/2024 10:26

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	1.99		130,335.3
Runoff	0.000		0.0000
Subprofile1			
Drainage collected from Layer 2	0.0918		6,000.2
Percolation/leakage through Layer 4	0.000000		0.0116
Average head on Layer 3	0.0703		---
Maximum head on Layer 3	0.1402		---
Location of maximum head in Layer 2	1.61	(feet from drain)	
Other Parameters			
Snow water	5.6138		366,808.2
Maximum vegetation soil water	0.3610	(vol/vol)	
Minimum vegetation soil water	0.2020	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: ERL HELP Scenario 1.A
Simulated on: 12/6/2024 10:26
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.5512	0.2126
2	0.0020	0.0100
3	0.0000	0.0000
4	10.8000	0.4500
Snow water	0.0000	---

ATTACHMENT 1.B

SCENARIO 1.B HELP MODEL RESULTS
GEOSYNTHETIC CLAY LINER

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: ERL HELP Scenario 1.B **Simulated On:** 12/6/2024 10:28

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam (Moderate)
Material Texture Number 24

Thickness	=	12	inches
Porosity	=	0.365	vol/vol
Field Capacity	=	0.305	vol/vol
Wilting Point	=	0.202	vol/vol
Initial Soil Water Content	=	0.226	vol/vol
Effective Sat. Hyd. Conductivity	=	2.70E-06	cm/sec

Layer 2

Type 2 - Lateral Drainage Layer
Geocomposite (200 mil)
Material Texture Number 44

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	3	%

Drainage Length	=	1300	ft

Layer 3

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 4

Type 3 - Barrier Soil Liner

GCL

Material Texture Number 45

Thickness	=	0.25	inches
Porosity	=	0.75	vol/vol
Field Capacity	=	0.747	vol/vol
Wilting Point	=	0.4	vol/vol
Initial Soil Water Content	=	0.75	vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E-09	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	96.6	
Fraction of Area Allowing Runoff	=	0	%

Area projected on a horizontal plane	=	18	acres
Evaporative Zone Depth	=	12	inches
Initial Water in Evaporative Zone	=	2.712	inches
Upper Limit of Evaporative Storage	=	4.38	inches
Lower Limit of Evaporative Storage	=	2.424	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	2.901	inches
Total Initial Water	=	2.901	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.77	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	122	days
End of Growing Season (Julian Date)	=	286	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	47	%
Average 2nd Quarter Relative Humidity	=	52	%
Average 3rd Quarter Relative Humidity	=	45	%
Average 4th Quarter Relative Humidity	=	54	%

Note: Evapotranspiration data was obtained for DENVER, COLORADO

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
0.377976	0.42303	0.835809	1.785262	2.213768	1.758551

2.309971 1.517605 1.200053 0.837816 0.531606 0.402749

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
26.5	29.1	41.8	51.5	64.2	76.4
79.7	77.4	71.5	53.7	38.1	26.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Average Annual Totals Summary

Title: ERL HELP Scenario 1.B
Simulated on: 12/6/2024 10:30

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	14.19	[2.3]	927,448.8	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	14.005	[2.791]	915,083.7	98.67
Subprofile1				
Lateral drainage collected from Layer 2	0.1946	[0.5017]	12,715.2	1.37
Percolation/leakage through Layer 4	0.000000	[0]	0.0284	0.00
Average Head on Top of Layer 3	0.0004	[0.001]	---	---
Water storage				
Change in water storage	-0.0054	[0.939]	-350.0	-0.04

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: ERL HELP Scenario 1.B
Simulated on: 12/6/2024 10:30

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	1.99		130,335.3
Runoff	0.000		0.0000
Subprofile1			
Drainage collected from Layer 2	0.0918		6,000.2
Percolation/leakage through Layer 4	0.000000		0.0018
Average head on Layer 3	0.0703		---
Maximum head on Layer 3	0.1402		---
Location of maximum head in Layer 2	1.61	(feet from drain)	
Other Parameters			
Snow water	5.6138		366,808.2
Maximum vegetation soil water	0.3610	(vol/vol)	
Minimum vegetation soil water	0.2020	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: ERL HELP Scenario 1.B
Simulated on: 12/6/2024 10:30
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.5512	0.2126
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1875	0.7500
Snow water	0.0000	---

ATTACHMENT 2

SCENARIO 2 – EARLY OPEN CONDITIONS
HELP MODEL RESULTS

ATTACHMENT 2.A

SCENARIO 2.A HELP MODEL RESULTS
24" CLAY LINER

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: ERL HELP Scenario 2.A **Simulated On:** 12/6/2024 10:55

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
FSL - Fine Sandy Loam
Material Texture Number 7

Thickness	=	6	inches
Porosity	=	0.473	vol/vol
Field Capacity	=	0.222	vol/vol
Wilting Point	=	0.104	vol/vol
Initial Soil Water Content	=	0.2159	vol/vol
Effective Sat. Hyd. Conductivity	=	5.20E-04	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	72	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 3

Type 1 - Vertical Percolation Layer

SCL - Sandy Clay Loam

Material Texture Number 10

Thickness	=	12	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 4

Type 2 - Lateral Drainage Layer

Geocomposite (200 mil)

Material Texture Number 44

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	3	%
Drainage Length	=	1300	ft

Layer 5

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec

FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

Type 3 - Barrier Soil Liner

24-Inch Soil Compacted Soil Barrier

Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.45	vol/vol
Field Capacity	=	0.4	vol/vol
Wilting Point	=	0.3	vol/vol
Initial Soil Water Content	=	0.45	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	87.5	
Fraction of Area Allowing Runoff	=	0	%
Area projected on a horizontal plane	=	18	acres
Evaporative Zone Depth	=	6	inches
Initial Water in Evaporative Zone	=	1.295	inches
Upper Limit of Evaporative Storage	=	2.838	inches
Lower Limit of Evaporative Storage	=	0.624	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	36.049	inches
Total Initial Water	=	36.049	inches

Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.77	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	122	days
End of Growing Season (Julian Date)	=	286	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	47	%
Average 2nd Quarter Relative Humidity	=	52	%
Average 3rd Quarter Relative Humidity	=	45	%
Average 4th Quarter Relative Humidity	=	54	%

Note: Evapotranspiration data was obtained for DENVER, COLORADO

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
0.377976	0.42303	0.835809	1.785262	2.213768	1.758551
2.309971	1.517605	1.200053	0.837816	0.531606	0.402749

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec

26.5	29.1	41.8	51.5	64.2	76.4
79.7	77.4	71.5	53.7	38.1	26.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Average Annual Totals Summary

Title: ERL HELP Scenario 2.A
Simulated on: 12/6/2024 10:56

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	14.19	[2.3]	927,448.8	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	12.296	[2.075]	803,424.2	86.63
Subprofile1				
Lateral drainage collected from Layer 4	1.9195	[0.8894]	125,417.9	13.52
Percolation/leakage through Layer 6	0.000006	[0.000002]	0.3624	0.00
Average Head on Top of Layer 5	0.0040	[0.0019]	---	---
Water storage				
Change in water storage	-0.0213	[0.4392]	-1,393.6	-0.15

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: ERL HELP Scenario 2.A
Simulated on: 12/6/2024 10:56

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	1.99		130,335.3
Runoff	0.000		0.0000
Subprofile1			
Drainage collected from Layer 4	0.2436		15,918.9
Percolation/leakage through Layer 6	0.000000		0.0280
Average head on Layer 5	0.1864		---
Maximum head on Layer 5	0.3710		---
Location of maximum head in Layer 4	5.19	(feet from drain)	
Other Parameters			
Snow water	2.3667		154,641.3
Maximum vegetation soil water	0.4730	(vol/vol)	
Minimum vegetation soil water	0.1040	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: ERL HELP Scenario 2.A
Simulated on: 12/6/2024 10:56
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	0.6554	0.1092
2	21.0239	0.2920
3	2.9280	0.2440
4	0.0020	0.0100
5	0.0000	0.0000
6	10.8000	0.4500
Snow water	0.0000	---

ATTACHMENT 2.B

SCENARIO 2.B HELP MODEL RESULTS
GEOSYNTHETIC CLAY LINER

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: ERL HELP Scenario 2.B **Simulated On:** 12/6/2024 10:43

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
FSL - Fine Sandy Loam
Material Texture Number 7

Thickness	=	6	inches
Porosity	=	0.473	vol/vol
Field Capacity	=	0.222	vol/vol
Wilting Point	=	0.104	vol/vol
Initial Soil Water Content	=	0.2159	vol/vol
Effective Sat. Hyd. Conductivity	=	5.20E-04	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	72	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 3

Type 1 - Vertical Percolation Layer

SCL - Sandy Clay Loam

Material Texture Number 10

Thickness	=	12	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 4

Type 2 - Lateral Drainage Layer

Geocomposite (200 mil)

Material Texture Number 44

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	3	%
Drainage Length	=	1300	ft

Layer 5

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec

FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

Type 3 - Barrier Soil Liner

GCL

Material Texture Number 45

Thickness	=	0.25	inches
Porosity	=	0.75	vol/vol
Field Capacity	=	0.747	vol/vol
Wilting Point	=	0.4	vol/vol
Initial Soil Water Content	=	0.75	vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E-09	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	87.5	
Fraction of Area Allowing Runoff	=	0	%
Area projected on a horizontal plane	=	18	acres
Evaporative Zone Depth	=	6	inches
Initial Water in Evaporative Zone	=	1.295	inches
Upper Limit of Evaporative Storage	=	2.838	inches
Lower Limit of Evaporative Storage	=	0.624	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	25.437	inches
Total Initial Water	=	25.437	inches

Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.77	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	122	days
End of Growing Season (Julian Date)	=	286	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	47	%
Average 2nd Quarter Relative Humidity	=	52	%
Average 3rd Quarter Relative Humidity	=	45	%
Average 4th Quarter Relative Humidity	=	54	%

Note: Evapotranspiration data was obtained for DENVER, COLORADO

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
0.377976	0.42303	0.835809	1.785262	2.213768	1.758551
2.309971	1.517605	1.200053	0.837816	0.531606	0.402749

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec

26.5	29.1	41.8	51.5	64.2	76.4
79.7	77.4	71.5	53.7	38.1	26.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Average Annual Totals Summary

Title: ERL HELP Scenario 2.B
Simulated on: 12/6/2024 10:45

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	14.19	[2.3]	927,448.8	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	12.296	[2.075]	803,424.2	86.63
Subprofile1				
Lateral drainage collected from Layer 4	1.9195	[0.8894]	125,418.2	13.52
Percolation/leakage through Layer 6	0.000002	[0]	0.1261	0.00
Average Head on Top of Layer 5	0.0040	[0.0019]	---	---
Water storage				
Change in water storage	-0.0213	[0.4392]	-1,393.6	-0.15

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: ERL HELP Scenario 2.B
Simulated on: 12/6/2024 10:45

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	1.99		130,335.3
Runoff	0.000		0.0000
Subprofile1			
Drainage collected from Layer 4	0.2436		15,918.9
Percolation/leakage through Layer 6	0.000000		0.0045
Average head on Layer 5	0.1864		---
Maximum head on Layer 5	0.3710		---
Location of maximum head in Layer 4	5.19	(feet from drain)	
Other Parameters			
Snow water	2.3667		154,641.3
Maximum vegetation soil water	0.4730	(vol/vol)	
Minimum vegetation soil water	0.1040	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: ERL HELP Scenario 2.B
Simulated on: 12/6/2024 10:45
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	0.6554	0.1092
2	21.0239	0.2920
3	2.9280	0.2440
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1875	0.7500
Snow water	0.0000	---

ATTACHMENT 3

SCENARIO 3 – INTERMEDIATE CONDITIONS
HELP MODEL RESULTS

ATTACHMENT 3.A

SCENARIO 3.A HELP MODEL RESULTS
24" CLAY LINER

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: ERL HELP Scenario 3.A **Simulated On:** 12/6/2024 11:05

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
FSL - Fine Sandy Loam
Material Texture Number 7

Thickness	=	12	inches
Porosity	=	0.473	vol/vol
Field Capacity	=	0.222	vol/vol
Wilting Point	=	0.104	vol/vol
Initial Soil Water Content	=	0.1327	vol/vol
Effective Sat. Hyd. Conductivity	=	5.20E-04	cm/sec

Note: 100% of drainage collected from Layer 4 is recirculated into this layer.

Layer 2

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	600	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 3

Type 1 - Vertical Percolation Layer

SCL - Sandy Clay Loam

Material Texture Number 10

Thickness	=	12	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 4

Type 2 - Lateral Drainage Layer

Geocomposite (200 mil)

Material Texture Number 44

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	3.24	%
Drainage Length	=	1450	ft

Note: 100% of drainage collected from this layer is recirculated into Layer 1.

Layer 5

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

Type 3 - Barrier Soil Liner

24-Inch Soil Compacted Soil Barrier

Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.45	vol/vol
Field Capacity	=	0.4	vol/vol
Wilting Point	=	0.3	vol/vol
Initial Soil Water Content	=	0.45	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	83.2	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	35.1	acres
Evaporative Zone Depth	=	12	inches
Initial Water in Evaporative Zone	=	1.592	inches
Upper Limit of Evaporative Storage	=	5.676	inches
Lower Limit of Evaporative Storage	=	1.248	inches
Initial Snow Water	=	0	inches

Initial Water in Layer Materials	=	190.522	inches
Total Initial Water	=	190.522	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.77	Degrees
Maximum Leaf Area Index	=	1	
Start of Growing Season (Julian Date)	=	122	days
End of Growing Season (Julian Date)	=	286	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	47	%
Average 2nd Quarter Relative Humidity	=	52	%
Average 3rd Quarter Relative Humidity	=	45	%
Average 4th Quarter Relative Humidity	=	54	%

Note: Evapotranspiration data was obtained for DENVER, COLORADO

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
0.377976	0.42303	0.835809	1.785262	2.213768	1.758551
2.309971	1.517605	1.200053	0.837816	0.531606	0.402749

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
26.5	29.1	41.8	51.5	64.2	76.4
79.7	77.4	71.5	53.7	38.1	26.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Average Annual Totals Summary

Title: ERL HELP Scenario 3.A
Simulated on: 12/6/2024 11:05

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	14.19	[2.3]	1,808,525.2	100.00
Runoff	0.274	[0.536]	34,898.3	1.93
Evapotranspiration	13.929	[2.282]	1,774,680.8	98.13
Subprofile1				
Recirculation into Layer 1	0.2875	[0.423]	36,629.2	2.03
Lateral drainage collected from Layer 4	0.0000	[0]	0.0000	0.00
Drainage recirculated from Layer 4	0.2875	[0.423]	36,629.2	2.03
Percolation/leakage through Layer 6	0.000001	[0.000001]	0.1558	0.00
Average Head on Top of Layer 5	0.0006	[0.0009]	---	---
Water storage				
Change in water storage	-0.0083	[0.4505]	-1,054.0	-0.06

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: ERL HELP Scenario 3.A
Simulated on: 12/6/2024 11:05

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	1.99		254,153.9
Runoff	1.292		164,647.3
Subprofile1			
Drainage Recirculated into Layer 1	0.1575		20,070.9
Drainage collected from Layer 4	0.0000		0.0000
Drainage recirculated from Layer 4	0.1575		20,070.9
Percolation/leakage through Layer 6	0.000000		0.0379
Average head on Layer 5	0.1245		---
Maximum head on Layer 5	0.2482		---
Location of maximum head in Layer 4	2.79	(feet from drain)	
Other Parameters			
Snow water	2.3667		301,550.5
Maximum vegetation soil water	0.3173	(vol/vol)	
Minimum vegetation soil water	0.1040	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: ERL HELP Scenario 3.A
Simulated on: 12/6/2024 11:05
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.3439	0.1120
2	175.1999	0.2920
3	2.9280	0.2440
4	0.0020	0.0100
5	0.0000	0.0000
6	10.8000	0.4500
Snow water	0.0000	---

ATTACHMENT 3.B

SCENARIO 3.B HELP MODEL RESULTS
GEOSYNTHETIC CLAY LINER

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: ERL HELP Scenario 3.B **Simulated On:** 12/6/2024 11:03

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
FSL - Fine Sandy Loam
Material Texture Number 7

Thickness	=	12	inches
Porosity	=	0.473	vol/vol
Field Capacity	=	0.222	vol/vol
Wilting Point	=	0.104	vol/vol
Initial Soil Water Content	=	0.1327	vol/vol
Effective Sat. Hyd. Conductivity	=	5.20E-04	cm/sec

Note: 100% of drainage collected from Layer 4 is recirculated into this layer.

Layer 2

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	600	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 3

Type 1 - Vertical Percolation Layer

SCL - Sandy Clay Loam

Material Texture Number 10

Thickness	=	12	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 4

Type 2 - Lateral Drainage Layer

Geocomposite (200 mil)

Material Texture Number 44

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	3.24	%
Drainage Length	=	1450	ft

Note: 100% of drainage collected from this layer is recirculated into Layer 1.

Layer 5

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

Type 3 - Barrier Soil Liner

GCL

Material Texture Number 45

Thickness	=	0.25	inches
Porosity	=	0.75	vol/vol
Field Capacity	=	0.747	vol/vol
Wilting Point	=	0.4	vol/vol
Initial Soil Water Content	=	0.75	vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E-09	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	83.2	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	35.1	acres
Evaporative Zone Depth	=	12	inches
Initial Water in Evaporative Zone	=	1.592	inches
Upper Limit of Evaporative Storage	=	5.676	inches
Lower Limit of Evaporative Storage	=	1.248	inches
Initial Snow Water	=	0	inches

Initial Water in Layer Materials	=	179.91	inches
Total Initial Water	=	179.91	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.77	Degrees
Maximum Leaf Area Index	=	1	
Start of Growing Season (Julian Date)	=	122	days
End of Growing Season (Julian Date)	=	286	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	47	%
Average 2nd Quarter Relative Humidity	=	52	%
Average 3rd Quarter Relative Humidity	=	45	%
Average 4th Quarter Relative Humidity	=	54	%

Note: Evapotranspiration data was obtained for DENVER, COLORADO

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
0.377976	0.42303	0.835809	1.785262	2.213768	1.758551
2.309971	1.517605	1.200053	0.837816	0.531606	0.402749

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
26.5	29.1	41.8	51.5	64.2	76.4
79.7	77.4	71.5	53.7	38.1	26.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Average Annual Totals Summary

Title: ERL HELP Scenario 3.B
Simulated on: 12/6/2024 11:03

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	14.19	[2.3]	1,808,525.2	100.00
Runoff	0.272	[0.527]	34,651.0	1.92
Evapotranspiration	13.930	[2.297]	1,774,921.6	98.14
Subprofile1				
Recirculation into Layer 1	0.2599	[0.4037]	33,109.8	1.83
Lateral drainage collected from Layer 4	0.0000	[0]	0.0000	0.00
Drainage recirculated from Layer 4	0.2599	[0.4037]	33,109.8	1.83
Percolation/leakage through Layer 6	0.000001	[0]	0.0777	0.00
Average Head on Top of Layer 5	0.0006	[0.0009]	---	---
Water storage				
Change in water storage	-0.0082	[0.4634]	-1,047.5	-0.06

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: ERL HELP Scenario 3.B
Simulated on: 12/6/2024 11:03

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	1.99		254,153.9
Runoff	1.275		162,469.8
Subprofile1			
Drainage Recirculated into Layer 1	0.1586		20,209.9
Drainage collected from Layer 4	0.0000		0.0000
Drainage recirculated from Layer 4	0.1586		20,209.9
Percolation/leakage through Layer 6	0.000000		0.0060
Average head on Layer 5	0.1253		---
Maximum head on Layer 5	0.2499		---
Location of maximum head in Layer 4	2.81	(feet from drain)	
Other Parameters			
Snow water	2.3667		301,550.5
Maximum vegetation soil water	0.3081	(vol/vol)	
Minimum vegetation soil water	0.1040	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: ERL HELP Scenario 3.B
Simulated on: 12/6/2024 11:03
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.3455	0.1121
2	175.1999	0.2920
3	2.9280	0.2440
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1875	0.7500
Snow water	0.0000	---

ATTACHMENT 4

SCENARIO 4 – CLOSED CONDITIONS
HELP MODEL RESULTS

ATTACHMENT 4.A

SCENARIO 4.A HELP MODEL RESULTS
WATER BALANCED FINAL COVER

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: ERL HELP Scenario 4.A **Simulated On:** 12/6/2024 11:50

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	42	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.15	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
FSL - Fine Sandy Loam
Material Texture Number 7

Thickness	=	12	inches
Porosity	=	0.473	vol/vol
Field Capacity	=	0.222	vol/vol
Wilting Point	=	0.104	vol/vol
Initial Soil Water Content	=	0.112	vol/vol
Effective Sat. Hyd. Conductivity	=	5.20E-04	cm/sec

Layer 3

Type 1 - Vertical Percolation Layer (Waste)

Municipal Solid Waste (MSW) (900 pcy)

Material Texture Number 18

Thickness	=	1200	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 4

Type 1 - Vertical Percolation Layer

SCL - Sandy Clay Loam

Material Texture Number 10

Thickness	=	12	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 5

Type 2 - Lateral Drainage Layer

Geocomposite (200 mil)

Material Texture Number 44

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol

Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	3.24	%
Drainage Length	=	1450	ft

Layer 6

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 7

Type 3 - Barrier Soil Liner

24-Inch Soil Compacted Soil Barrier

Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.45	vol/vol
Field Capacity	=	0.4	vol/vol
Wilting Point	=	0.3	vol/vol
Initial Soil Water Content	=	0.45	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were specified by the user.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	86.2	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	35.1	acres
Evaporative Zone Depth	=	42	inches
Initial Water in Evaporative Zone	=	6.3	inches
Upper Limit of Evaporative Storage	=	16.716	inches
Lower Limit of Evaporative Storage	=	5.712	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	371.774	inches
Total Initial Water	=	371.774	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.77	Degrees
Maximum Leaf Area Index	=	2	
Start of Growing Season (Julian Date)	=	122	days
End of Growing Season (Julian Date)	=	286	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	47	%
Average 2nd Quarter Relative Humidity	=	52	%
Average 3rd Quarter Relative Humidity	=	45	%
Average 4th Quarter Relative Humidity	=	54	%

Note: Evapotranspiration data was obtained for DENVER, COLORADO

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
0.377976	0.42303	0.835809	1.785262	2.213768	1.758551
2.309971	1.517605	1.200053	0.837816	0.531606	0.402749

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
26.5	29.1	41.8	51.5	64.2	76.4
79.7	77.4	71.5	53.7	38.1	26.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Average Annual Totals Summary

Title: ERL HELP Scenario 4.A
Simulated on: 12/6/2024 11:50

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	14.19	[2.3]	1,808,525.2	100.00
Runoff	0.248	[0.462]	31,551.4	1.74
Evapotranspiration	13.963	[2.153]	1,779,115.2	98.37
Subprofile1				
Lateral drainage collected from Layer 5	0.0000	[0]	0.0000	0.00
Percolation/leakage through Layer 7	0.000000	[0]	0.0000	0.00
Average Head on Top of Layer 6	0.0000	[0]	---	---
Water storage				
Change in water storage	-0.0168	[0.5079]	-2,141.5	-0.12

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: ERL HELP Scenario 4.A
Simulated on: 12/6/2024 11:50

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	1.99		254,153.9
Runoff	1.157		147,392.5
Subprofile1			
Drainage collected from Layer 5	0.0000		0.0000
Percolation/leakage through Layer 7	0.000000		0.0000
Average head on Layer 6	0.0000		---
Maximum head on Layer 6	0.0000		---
Location of maximum head in Layer 5	0.00	(feet from drain)	
Other Parameters			
Snow water	2.3667		301,550.5
Maximum vegetation soil water	0.2132	(vol/vol)	
Minimum vegetation soil water	0.1360	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: ERL HELP Scenario 4.A
Simulated on: 12/6/2024 11:50
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	5.7672	0.1373
2	1.3725	0.1144
3	350.4000	0.2920
4	2.9280	0.2440
5	0.0020	0.0100
6	0.0000	0.0000
7	10.8000	0.4500
Snow water	0.0000	---

ATTACHMENT 4.B

SCENARIO 4.B HELP MODEL RESULTS
LLDPE GEOMEMBRANE FINAL COVER

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: ERL HELP Scenario 4.B **Simulated On:** 12/6/2024 12:03

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	18	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.15	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 3

Type 1 - Vertical Percolation Layer
FSL - Fine Sandy Loam
Material Texture Number 7

Thickness	=	12	inches
Porosity	=	0.473	vol/vol
Field Capacity	=	0.222	vol/vol
Wilting Point	=	0.104	vol/vol
Initial Soil Water Content	=	0.112	vol/vol
Effective Sat. Hyd. Conductivity	=	5.20E-04	cm/sec

Layer 4

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	1200	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	12	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol

Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 6

Type 2 - Lateral Drainage Layer

Geocomposite (200 mil)

Material Texture Number 44

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	3.24	%
Drainage Length	=	1450	ft

Layer 7

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	2	Holes/Acre
FML Installation Defects	=	2	Holes/Acre
FML Placement Quality	=	3	Good

Layer 8

Type 3 - Barrier Soil Liner

24-Inch Soil Compacted Soil Barrier

Material Texture Number 43

Thickness	=	24	inches

Porosity	=	0.45	vol/vol
Field Capacity	=	0.4	vol/vol
Wilting Point	=	0.3	vol/vol
Initial Soil Water Content	=	0.45	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were specified by the user.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	86.2	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	35.1	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	2.7	inches
Upper Limit of Evaporative Storage	=	7.164	inches
Lower Limit of Evaporative Storage	=	2.448	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	368.174	inches
Total Initial Water	=	368.174	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.77	Degrees
Maximum Leaf Area Index	=	2	
Start of Growing Season (Julian Date)	=	122	days

End of Growing Season (Julian Date)	=	286	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	47	%
Average 2nd Quarter Relative Humidity	=	52	%
Average 3rd Quarter Relative Humidity	=	45	%
Average 4th Quarter Relative Humidity	=	54	%

Note: Evapotranspiration data was obtained for DENVER, COLORADO

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
0.377976	0.42303	0.835809	1.785262	2.213768	1.758551
2.309971	1.517605	1.200053	0.837816	0.531606	0.402749

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
26.5	29.1	41.8	51.5	64.2	76.4
79.7	77.4	71.5	53.7	38.1	26.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.77/-104.5

Average Annual Totals Summary

Title: ERL HELP Scenario 4.B
Simulated on: 12/6/2024 12:03

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	14.19	[2.3]	1,808,525.2	100.00
Runoff	0.293	[0.521]	37,269.4	2.06
Evapotranspiration	13.904	[2.23]	1,771,570.5	97.96
Subprofile1				
Percolation/leakage through Layer 2	0.005130	[0.011394]	653.7	0.04
Average Head on Top of Layer 2	0.0493	[0.112]	---	---
Subprofile2				
Lateral drainage collected from Layer 6	0.0000	[0]	0.0000	0.00
Percolation/leakage through Layer 8	0.000000	[0]	0.0000	0.00
Average Head on Top of Layer 7	0.0000	[0]	---	---
Water storage				
Change in water storage	-0.0025	[0.4102]	-314.7	-0.02

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: ERL HELP Scenario 4.B
Simulated on: 12/6/2024 12:03

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	1.99		254,153.9
Runoff	1.269		161,720.9
Subprofile1			
Percolation/leakage through Layer 2	0.001087		138.5
Average head on Layer 2	4.2292		
Subprofile2			
Drainage collected from Layer 6	0.0000		0.0000
Percolation/leakage through Layer 8	0.000000		0.0000
Average head on Layer 7	0.0000		---
Maximum head on Layer 7	0.0000		---
Location of maximum head in Layer 6	0.00	(feet from drain)	
Other Parameters			
Snow water	2.3667		301,550.5
Maximum vegetation soil water	0.2992	(vol/vol)	
Minimum vegetation soil water	0.1360	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: ERL HELP Scenario 4.B
Simulated on: 12/6/2024 12:03
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.4720	0.1373
2	0.0000	0.0000
3	1.4979	0.1248
4	350.4000	0.2920
5	2.9280	0.2440
6	0.0020	0.0100
7	0.0000	0.0000
8	10.8000	0.4500
Snow water	0.0000	---

Appendix M
Construction Quality Assurance Plan

CONSTRUCTION QUALITY ASSURANCE PLAN AND SPECIFICATIONS

LINER AND LEACHATE COLLECTION AND REMOVAL SYSTEM AND FINAL COVER SYSTEM

EAST REGIONAL LANDFILL
ADAMS COUNTY, COLORADO



Prepared for:
Five Part Development, LLC

Prepared by:
American Environmental Consulting, LLC
8191 Southpark Lane
Unit #107
Littleton, Colorado 80120



Original April 2011
(Revised February 2025)

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1.0 INTRODUCTION

These are the construction quality assurance (CQA) procedures for site development of the East Regional Landfill located in Adams County, Colorado. The goals of these procedures are to provide mechanisms for:

1. assuring that proper construction techniques and procedures are used,

2. assuring that the intent of the design is met, and

3. resolving problems that may arise during construction

2.0 DEFINITIONS

2.1 Construction Quality Assurance and Construction Quality Control

The CQAP is a site-specific document which addresses the following: (i) CQA personnel responsibilities, authorities, and qualifications; (ii) inspection, monitoring, and testing activities necessary to ensure that the facility is constructed to meet or exceed design criteria, plans, and specifications; and (iii) CQA documentation requirements.

Construction Quality Assurance (CQA) - A planned and systematic pattern of means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service.

In the context of this document, Quality Assurance Plan (QAP) refers to means and actions employed by the CQA Engineer to assure conformity of liner system preparation, production, and installation with this CQA Plan, the Specifications, and the Construction Drawings. CQA is provided by a party independent from the product Manufacturer and Contractor.

Construction Quality Control (CQC) -Those actions provide a means to measure and control the characteristics of an item or service to meet contractual and regulatory requirements.

CQC refers to those actions taken by Manufacturers, Suppliers, Contractors, or Owners, including their designated representatives, to ensure that the materials and the workmanship meet the requirements of the Specifications, and the Construction Drawings. In the case of soils, and within this CQA Plan, CQC is typically made a part of the CQA requirements and is provided by the CQA Engineer. In the case of geosynthetic and other non-soil components, the Manufacturers and installers of the various geosynthetics provide CQC.

Earthwork - An activity involving the use of soil or rock materials for construction purposes.

Earthwork Contractor - The person or firm responsible for earthwork related activities.

CQA Engineer – The individual or firm responsible for oversight of all CQA activities required by the design drawings, specifications, and this CQA Plan and may or may not be the same as the Design Engineer. The duties and responsibilities of the CQA Engineer are separate and distinct from those of the Design Engineer and include certification of the construction as described in this CQA Plan. The CQA Engineer shall be a Professional Engineer (P.E.) registered in the State of Colorado and may be represented by other personnel variously referred to as the CQA Monitor, CQA Resident Engineer, or Project Manager, etc., who shall work under the direction and supervision of the CQA Engineer. The CQA Engineer may not approve any substantive changes to the approved design or specifications.

CQA Monitor – Typically the field representative of the CQA Engineer. The CQA Monitor conducts oversight, field testing, and documentation of the construction to verify that it is conducted in accordance with the approved design, CQA Plan, and specifications. The CQA Monitor works under the supervision and authority of the CQA Engineer, but may not make any independent changes to the requirements of the approved CQA Plan, Design, or specifications.

Design Engineer – The individual or firm responsible for the development of the design and specifications for the construction project and may or may not be the same as the CQA Engineer. The duties and responsibilities of the Design Engineer are separate and distinct from those of the CQA Engineer. Any substantive changes to the design and specifications must be approved by the Design Engineer.

General Fill – Compacted soil fill used for purposes of providing a firm base surface for construction components, backfill of trenches used to anchor synthetic materials outside of the lined cell area, surface water control structures, or other fills not specified elsewhere. In general, General fill characteristics are specific to the intended use and are installed under specific compaction and often moisture requirements.

Geomembrane - The synthetic lining material, also referred to as geomembrane, High Density Polyethylene (HDPE) membrane or liner, used in construction as a barrier to fluid migration.

Geotextile - A synthetic fabric used in construction, generally for filtration, protection, or limiting transmission of fluids.

Geocomposite - A synthetic drainage material composed of a three-dimensional "net" of rigid synthetic strands that allow lateral flow of fluids. Has a geotextile on one or both sides for the purposes of minimizing fine soil materials into the net portion of the composite.

Geosynthetics Contractor - The person or firm responsible for geosynthetic related construction activities. May apply to the provider, installer, or both in the context of usage.

Geosynthetic Clay Liner – GCL, a fabricated liner material consisting of sodium bentonite chips sandwiched between two geotextile fabrics or other synthetic materials to provide a barrier to migration of liquids. The GCL shall be reinforced (needle-punched).

Minimum Average Roll Value – MARV, The minimum average value of a particular physical property of a material, for 95 percent of all of the material in the lot.

Overlap – Where two adjacent geosynthetic panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

Panel - a two-dimensional unit area of the geosynthetic material that will be constructed in the field or in the fabricators plant and generally joined by some fashion to an adjacent panel. Unless cut smaller, the panel width generally corresponds to the width of a roll when geosynthetic products are supplied by the roll.

Project Construction Drawings & Specifications - These are all project related drawings and specification including design modifications and record drawings.

Project Documents - These include construction drawings, record drawings, specifications, shop drawings, construction quality control and quality assurance plans, quality assurance documentation, safety plans, and project schedules.

Project Manager - The official representative of the Owner responsible for construction of the project.

Record Drawings - Drawings recording the dimensions, details and coordinates of the facility after construction is completed (as-built drawings).

3.0 MEETINGS

In order to facilitate construction and to clearly define construction goals and activities, close coordination between the Engineer, Owner, CQA Monitor and the various Contractors is essential. To meet this objective the following meetings will be held.

3.1 Pre-Construction Meetings

A pre-construction meeting will be held at the site within two weeks prior to the start of construction. The CQA Engineer, Project Manager, CQA Monitor, Earthwork Contractor, Geosynthetics Contractor and others designated by the Owner will attend this meeting. The purposes of this meeting are as follows:

- Provide all parties with relevant documents
- Review the project construction drawings, specifications, and CQA plan
- Review and assign responsibilities for each party
- Identify key personnel
- Define lines of communications
- Establish reporting and documenting procedures
- Establish work area security and safety protocols
- Establish testing protocols and procedures for correcting and documenting construction deficiencies
- Conduct a site inspection to discuss work areas, work plans, stockpiling, laydown areas, access roads, haul roads, and related items
- Review the project schedule
- Develop any required addends to the project documents

This meeting will be documented by the Project Manager or his designee and copies of the minutes will be distributed to all parties.

3.2 Progress Meetings

Progress meetings will be held weekly during the period of the work. At a minimum, the CQA Monitor, Project Manager, and the Contractors will attend these meetings and the following topics will be discussed:

- Scheduled work activities
- Problems encountered or expected
- Recent CQA test results
- Other appropriate matters

Minutes of the meetings will be kept by the CQA Monitor and distributed to all parties.

3.3 Problem Resolution Meetings

As required, special meetings will be held to discuss problems or deficiencies. At a minimum, the CQA Monitor and appropriate Contractor will be in attendance. If the problem requires a design modification, the Project Manager, CQA Engineer, and Design Engineer will also be present. Minutes of the meeting will be kept by the CQA Monitor and, if appropriate, the Design Engineer.

4.0 EARTHWORK

4.1 General

Construction must be conducted in accordance with the project construction drawings and specifications. To monitor compliance, a two part quality assurance testing program will be implemented that includes material evaluation and construction testing. Material evaluation includes borrow, geosynthetics, and other pre-construction investigations. Construction testing includes those activities that occur during material placement. All quality assurance testing shall be conducted in accordance with this CQA plan and the project construction drawings and specifications. Where there is a discrepancy, the document that requires the most frequent number of tests or the more stringent test requirement will govern unless otherwise specified by the CQA Engineer. All in -situ testing and sampling will be observed by the CQA Monitor. Documentation shall meet the requirements of this CQA plan.

4.2 Surveying

Site survey requirements include performing periodic and record surveys to confirm that the disposal cells are constructed in accordance with approved design plans. Periodic surveys are conducted as necessary during construction to guide excavation and liner installation activities. Record surveys are considered final surveys of a specific constructed element demonstrating compliance with approved plans. Record surveys require Professional Land Surveyor certification and will be included in the CQA certification report.

Surveys will be required both within the portion of the landfill liner being constructed, and outside of the liner construction (generally for surface water drainage structures). Elevations and x,y coordinates shall be determined and recorded on a minimum 50-foot centers as well as at major grade breaks and drainage flow lines with 50 foot spacing at each of the following surfaces and at locations shown on the drawings:

- Top of excavated subgrade
- Top of protective layer
- Top of waste final grade
- Top of Final Cover
- Permanent Stormwater Control Features

All piping installed within the area constructed to receive refuse shall be surveyed at the end points, all changes in direction or orientation, and alignment at sufficient points to allow location of the pipes once they are buried.

All applicable constructed features shall comply with the tolerances shown on Table 1 unless otherwise approved by the Design Engineer.

TABLE 1
SURVEY TOLERANCES

Horizontal, All Points	plus or minus 0.50 feet of design coordinates (± 0.50 feet)
Vertical, Excavation Subgrade and Top of Waste Final Grade	plus 0.00 to minus 0.20 feet of design (+ 0.00 to – 0.20 feet)
Vertical, Top of Final Cover	plus 0.20 to minus 0.00 feet of design (+0.20 to -0.00 feet)
Vertical, Stormwater Controls	plus 0.20 to minus 0.20 feet of design (+0.20 to -0.20 feet)

All constructed layers for which a minimum thickness is specified shall be constructed to that minimum thickness. Nothing in Table 1 shall be construed to allow a layer to be constructed at less than the minimum required thickness.

4.3 Soil Material Evaluation and Construction Quality Assurance

The soils used in the landfill construction include materials for general fill components both within and outside of the lined area, compacted clay liner, sump drainage material, and protective soils. Definitions of these materials are provided herein and material uses are shown either on the drawings or will be identified by the Owner or CQA Engineer. Prior to the start of construction, sources for each material shall be identified and samples tested to determine that they meet project specifications. Additional sources may be identified during the course of construction and must be tested and approved by the CQA Engineer prior to their use.

4.3.1 Sampling

Samples shall be obtained in a manner to best ensure the sample is representative of the materials to be used in construction.

4.3.2 Testing

Tests to confirm required properties shall be performed on each material from each borrow source. All test results shall be thoroughly documented. Testing frequency for each material is presented in Tables 2 through 5.

TABLE 2
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF GENERAL FILL

Test	Standard Test Method	Construction Frequency	Preconstruction Frequency
Standard Proctor	ASTM D 698	As needed for material [(1)]	1 per 5,000 cy
Grain Size	ASTM D 422	As needed for material [(1)]	1 per 5,000 cy
Compacted Density-nuclear methods	ASTM D 2922	1 per 100 linear feet per 12-inch thickness (anchor trench) 1 per 10,000 ft^2 per 12-inch thickness (area fills)	
Compacted Moisture Content – nuclear methods	ASTM D 3017	1 per 100 linear feet per 12-inch lift (anchor trench) 1 per 10,000 ft^2 per 12-inch lift (area fills)	

[(1)] The CQA Monitor will determine if additional testing of materials is required due to a change in material characteristics based on visual observation or comparing field moisture density testing with existing Proctor information

TABLE 2A
CQA REQUIRED PROPERTIES FOR CONSTRUCTION OF GENERAL FILLS

Property	Requirement
Grain Size	Specific to use and must be approved by CQA Monitor. For most uses, must exhibit some cohesion sufficient for stability
Compacted Density	Equal or greater than 95% of Maximum Standard Proctor Density within lined area out to perimeter ditch. For some general fills over synthetic materials, the Design Engineer may specify alternative density to avoid damage to synthetics
Compacted Moisture Content	$\pm$ 5% of Optimum Moisture defined by Standard Proctor Test for synthetic anchor trenches and fills within the lined area intended for waste disposal. Outside of lined area intended for waste, moisture content necessary to achieve compaction specification

TABLE 3
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF SOIL LINER

Test	Standard Test Method	Construction Frequency (minimum)	Preconstruction Frequency
Standard Proctor	ASTM D698	1 per 5,000 cy	1 per 4,000 cy
Grain Size	ASTM D422	1 per 1,000 cy	1 per 4,000 cy
Atterberg Limits	ASTM D4318	1 per 1,000 cy	1 per 4,000 cy
Permeability	ASTM D5084	1 per 5,000 cy	1 per 4,000 cy
Compacted Density-nuclear methods	ASTM D2922	1 per 10,000 ft^2 per lift (min 5 per acre per lift)	
Compacted Moisture-nuclear methods	ASTM D3017	1 per 10,000 ft^2 per lift (min 5 per acre per lift)	
One-Point Proctor	ASTM D 698	1 per 5,000 cy and for each change in material type	

TABLE 3A
CQA REQUIRED PROPERTIES FOR CONSTRUCTION OF SOIL LINER

Property	Requirement
USCS Class.	CL, CH, SC
Plastic Index	> 10
Grain Size	< 20% greater than U.S. No. 4 Sieve > 30% passing the #200 Sieve No particles greater than 1 inch after compaction
Hydraulic Conductivity	$\leq 1 \times 10^{-7}$ cm/sec after compaction
Compacted Density	$\geq$ to 95% of maximum Standard Proctor Density
Compacted Moisture Content	0 to +4 percent of Optimum Moisture defined by Standard Proctor Test

TABLE 4
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF PROTECTIVE SOIL LAYER

Test	Standard Test Method	Construction Frequency	Preconstruction Frequency
Grain Size	ASTM D422	1 per 5,000 cy	1 per 10,000 cy
Atterberg Limits	ASTM D 4318	1 per 5,000 cy	1 per 10,000 cy
Double Hydrometer Ratio	ASTM D422 and ASTM D 4221	All soils with a PI of less than 8.5	All soils with a PI of less than 8.5

TABLE 4A
CQA REQUIRED PROPERTIES FOR
CONSTRUCTION OF PROTECTIVE SOIL LAYER

Property	Requirement
Grain Size	Max nominal size 3-inches. Occasional up to 2 inches with CQA approval Not angular based on visual inspection
Atterberg Limits	PI $\geq$ 8.5
Dispersivity	DHR less than 0.50 or 50% for soils less than PI of 8.5

TABLE 5
MINIMUM TEST FREQUENCY FOR CQA
EVALUATION OF SUMP DRAINAGE MATERIAL

Test	Standard Test Method	Construction Frequency	Preconstruction Frequency
Grain Size	ASTM D422	1 per sump; min 1 per source	1 per sump; min 1 per source
Calcium Carbonate	USDS60 6 or ASTM D3042		1 per sump; min 1 per source
Permeability	ASTM D 2434	1 per sump; min 1 per source	1 per sump; min 1 per source
USCS Class.	ASTM D 2487		1 per sump; min 1 per source

TABLE 5A
CQA REQUIRED PROPERTIES FOR
CONSTRUCTION OF SUMP DRAINAGE MATERIAL

Property	Requirement
Grain Size	$\geq$ 95% greater than sump pipe perforations < 5% passing #200 U.S. Sieve Maximum particle size 3 inches
Calcium Carbonate	$\leq$ 15%
Permeability	$\geq 1 \times 10^{-2}$ cm/sec
USCS Class.	GW or GP

Note: Calcium Carbonate conducted at the discretion of the CQA Engineer based on the source of the gravel or rock. The Design Engineer may waive minor deviations from the Grain Size specification if the permeability is met.

4.3.3 Inspection

Inspection of soil placement shall at a minimum include:

- The surface on which soils are to be placed
- Determining that the construction activities are not adversely impacting other items such as piping and geosynthetics
- monitoring lift thickness

- Observing the effect of compaction equipment on the material placed (e.g., penetration, pumping, and cracking)
- Observing placement for material segregation and uniformity of the moisture content
- Observing the compacted base for desiccation cracking on low permeability barrier layers
- Observing that the materials are placed to the lines and grades shown on the drawings

4.3.3.1 General Fill

General Fill soils are used in a variety of applications inside of the lined construction area, including backfilling of over-excavated materials to design subgrade prior to constructing liner systems, backfilling of geosynthetic anchor trenches, and non-structural components such as surface-water control berms. General Fill soils are also used for construction of features outside of the lined area such as access roads, berms, surface water drainage structures, etc. The requirements for construction of General Fills are specific to the intended uses and described herein for components within the lined construction area.

General Fill shall be tested and meet the requirements as specified in Tables 2 and 2A above and approved by the CQA Monitor based on the specific use.

Areas within the lined portion of the construction that are backfilled with General Fill shall be proof rolled if to be overlain by soil or geosynthetic liner materials. All surfaces within the lined area, geosynthetic anchor trenches, and temporary surface water control structures where General Fill are to be used shall be approved by the CQA Monitor prior to placing the General Fill.

Compaction of General Fill may be conducted with heavy construction equipment as directed by the CQA Monitor, and shall be uniformly conducted to provide consistency throughout the component. Compaction over geosynthetics shall not be conducted using heavy construction equipment, but may be compacted by lighter equipment or other means approved by the CQA Monitor. General Fill used for backfilling over-excavated materials within the lined area to form a subgrade for overlying liner components shall be placed and compacted in individual loose lifts no more than nine inches thick. General Fill used for backfilling geosynthetic anchor trenches and internal temporary surface control berms on top of the liner system shall be placed and compacted in individual lifts of approximately 12 inches thick to prevent damage to underlying geosynthetics. Compaction of General Fill soils in geosynthetic anchor trenches shall be done by mechanical methods or otherwise approved by the CQA Monitor so as not to damage the synthetic materials. General Fills used in temporary surface water berms constructed on top of liner and leachate collection drainage layers shall not be compacted with heavy equipment and only to the extent to form a firm stable structure.

4.3.3.2 Compacted Soil Liner

No frozen or partially frozen clay materials may be placed, spread, or compacted for construction

of the soil liner. Soil liner may not be constructed over frozen or partially frozen materials. Frozen soil is defined as soil with visible ice (frozen crystals). If the material has visible ice crystals, it can be used if it is processed or otherwise warmed until no visible crystals remain. No clay soil containing any roots, rock, refuse, plant material or other deleterious material shall be used.

Materials used for compacted soil liner shall be tested as shown in Tables 3 and 3A. Where field density or moisture contents fail to meet specified values, the failing area will be determined by the CQA Monitor based on the locations of passing test data, and the failing area will be reworked ½ of the distance to the nearest passing data or the material removed at the discretion of the Earthwork Contractor. If the Earthwork Contractor chooses to rework areas that do not meet moisture content, requirements, the area will be scarified, moisture conditioned, and recompacted.

Prior to placing the first lift of soil liner, the subgrade shall be proof-rolled under the direction and observation of the CQA Monitor using heavy equipment to determine if it will provide a firm base for the lining system. Of particular concern are areas that are excessively soft. To evaluate the subgrade, the CQA Monitor will, at a minimum, provide continuous visual observation during proof-rolling. If materials are excavated below the design subgrade and backfilled in accordance with this plan using approved general fill, the CQA Monitor shall verify that the backfill materials have been tested and approved prior to placing clay liner.

Soil liner materials shall be moisture conditioned to near optimum moisture content prior to placing in the construction area. They shall be spread and compacted in lifts of loose thickness required to result in compacted lifts of no more than approximately six inches thick, and in no cases shall the resulting compacted lift be thicker than the length of the pads or feet on the compactor. The soil liner shall be compacted with a sheepsfoot, tamper-foot, or similar penetrating foot compactor approved by the CQA Engineer to properly knead the clay materials and break up clods. No clods with dry centers, stones, or other deleterious materials greater than one inch in the longest direction shall be allowed following compaction of the soil.

The surface of each lift shall be scarified or roughed up with the sheepsfoot compactor to the satisfaction of the CQA Monitor prior to placing the next lift of soil liner in order to provide continuous bonding between lifts.

The required testing frequencies shown in Table 3 can be increased at the direction of the CQA Monitor when visual or other observations indicate a potential problem. Examples of conditions that may warrant additional tests include the following:

- Compactors slip during operations
- Excessive pumping or cracking of the fill
- Lift thickness is greater than specified
- Dirt clogged rollers are used to compact the fill

- The compactor is improperly ballasted
- Adverse weather
- Equipment breakdown
- Work conducted in difficult areas
- A high frequency of failed tests

All perforations of the constructed low hydraulic conductivity soil elements including nuclear density device probe holes, sand cone holes, permeability sampling locations, and grab sample locations shall be repaired. Perforations shall be repaired by backfilling the holes with bentonite and hydrating until the water reaches the soil surface. Granular bentonite shall be used to backfill smaller diameter penetrations such as those from the nuclear density tests, and either granular, pelletized, or chips may be used to fill larger penetrations such as those created by verification permeability sampling.

The final surface of the soil liner shall be graded and smoothed with a smooth-drum roller to the lines and grades specified in the plans. The geomembrane shall not be placed prior to verification and approval of the grades and elevations and approval of the soil liner and surface by the CQA Monitor and the geomembrane installer.

4.3.3.3 Protective Soil Layer

A minimum 12-inch thick protective layer of soils meeting specific criteria shall be placed above the leachate collection system on the floor and directly on the HDPE membrane on the sideslopes to protect the underlying liner and leachate collection system components. The protective layer must be placed within a reasonable amount of time following construction of the underlying liner system to help protect the liner from the potential effects of freeze/thaw cycles.

Protective layer soils must be tested and meet the requirements shown on Tables 4 and 4A. The protective layer soils shall be placed and spread using only low ground-pressure track equipment approved by the CQA Engineer and the equipment shall not travel over the geosynthetic materials unless a minimum of 12-inches of protective soils separates the equipment from the geosynthetic materials.

Protective layer soils shall not be placed from the top of slopes downward, but shall be placed from the bottom of slopes working upward. To be able to maintain the appropriate thickness of soils on slopes of 4H:1V or greater, the soils may be placed and verified ahead of refuse filling operations rather than in one single construction episode prior to refuse filling.

Compaction of the protective layer soils shall be avoided to prevent damage to the geosynthetic components. Incidental compaction from the equipment used to place and spread the soils is sufficient to firm and stabilize the soils until they can be covered with refuse.

4.3.3.4 Sump Drainage Materials

The sump is filled with specified aggregate material meeting the test requirements of Tables 5 and 5A. Sump drainage materials shall be carefully placed into the sump to the limits shown on the drawings without causing damage to the underlying HDPE membrane. In no cases shall sump drainage material be allowed to fall into place from a height of more than two feet.

The CQA Monitor shall constantly observe and monitor the placement of the sump drainage material, and shall immediately halt placement of the sump drainage material if damage is suspected.

The CQA Monitor shall inspect the sump drainage material prior to, and during its placement to ensure is remains clean and continues to meet the requirements for fine material shown in Table 5A. No equipment shall be allowed directly on the sump drainage material once placed in the sump. Any grading or adjusting of the sump drainage material shall be done by hand or by bucket or hoe stationed outside of the sump limits.

4.4 Deficiencies

When deficiencies (items that do not meet specified values) are discovered, the CQA Monitor shall immediately determine the nature and extent of the problem and notify the Earthwork Contractor. In all cases, the CQA Monitor will attempt to notify the Earthwork Contractor within 1/2 hour of discovering the deficiency. If the deficiency will cause construction delays of more than one hour or will necessitate substantial rework, the CQA Monitor shall notify both the Earthwork Contractor and the Project Manager. The Earthwork Contractor shall correct the deficiency to the satisfaction of the CQA Monitor. If the Earthwork Contractor is unable to correct the problem, the CQA Engineer will develop and present to the Project Manager suggested solutions for approval. If the solution involves a design revision, the Design Engineer shall also be contacted. The corrected deficiency shall be retested before additional work is performed by the Earthwork Contractor. All retests and steps taken to correct the problem shall be documented by the CQA Monitor.

4.5 Alternative Final Cover Soil Placement

4.5.1 Introduction

The ERL currently needs approval for construction of a 3.5-foot-thick monolithic Alternative Final Cover (AFC) that relies on the water balance principals of evaporation, transpiration, and moisture storage capacity to minimize infiltration of precipitation into the waste mass as required in the "Final Guidance for Water Balance Covers in Colorado" (Guidance, CDPHE, March 2013). This CQAP will be become effective upon CDPHE approval of the AFC design.

4.5.2 Construction Quality Assurance for Earthwork

This section describes the material specifications, standards, monitoring and testing that will be performed to assure that the earthwork construction meets the specified requirements and the design intent of the project. The items discussed below are not necessarily ordered in the sequence of actual construction.

The scope of earthwork construction for this project includes the following:

- Selective soil stockpiling;
- Subgrade Suitability and Repair;
- Alternative Final Cover (AFC)/Revegetation Construction Quality Assurance; and

4.5.3 Material Evaluation

4.5.3.1 Testing

Material evaluation testing is required for materials used in earthworks construction both before construction begins to evaluate the suitability of the materials and during construction to verify continued compliance and that the design intent is achieved.

Potential sources will be identified for each material and samples will be collected and tested to assess whether they meet project specifications. Samples will be obtained in accordance with this plan and applicable and accepted standards. Sample records and test results will be maintained and stored at the project site. Table 6 includes the minimum frequency of testing required while Table 6A provides the required properties for each soil type. Unless otherwise specified, the CQA Engineer will determine how many and what type of tests should be conducted prior to construction depending on such criteria as the source(s) of the materials and their consistency.

TABLE 6
AFC CONSTRUCTION SOILS TESTING METHODS AND FREQUENCIES PER MATERIAL TYPE

Test[1]	ASTM Test Method	AFC[2] (min. test per cy)
Preconstruction		
Water content	D 2216	1 per 6,500 CY
Standard Proctor	D 698	1 per 6,500 CY
Particle Size	D 422 (with full hydrometer)	1 per 6,500 CY
pH	EPA Method 846 SW 9045C[7]	1 per 6,500 CY
CaCO3	USDA Handbook Number 60[7]	1 per 6,500 CY
Concurrent with Construction		
Standard Proctor	D 698	1 per 3,000 CY
Particle Size	D 422 (with full hydrometer)	1 per 1,500 CY
Compacted Thickness	Per Design	Per CQAP[2]
In-Place Nuclear (Dry) Density	D 6938	3/ac/lift
In-Place Nuclear Moisture Content	D 6938	3/ac/lift
pH	EPA Method 846 SW 9045C[3]	1 per 5 acres
CaCO3	USDA Handbook Number 60[3]	1 per 5 acres

(Sources are Final Guidance for Water Balance Covers in Colorado Unless Otherwise Noted)

Notes:

1) Frequency same as suggested in Guidance. Frequency may be decreased at CQA based on homogeneity of source and approved by CDPHE.
2) Thickness will be verified by survey in accordance with survey requirements in this plan.
3) Alternative test methods may be acceptable after consultation with NRCS or other vegetation specialist.

TABLE 6A
AFC SOIL MATERIAL SPECIFICATIONS AND STANDARDS

Property	Specification
Particle Size	Less than 15% retained on the #10 sieve Max 2" size Fit inside USDA Triangle Ecozone 3, (Figure 2.2.1-3
Compacted Moisture	< Optimum
Compacted Density	≥80% to ≤90% D_{max}
pH	6.0-8.4
CaCO3	< 15 %, by weight
Other	<4" clod size following placement. Free from deleterious substances(2)

Notes:
(1) The upper 6-inches of the final cover will be tested and seeded per recommendations from the NRCS.
(2) Frozen soils, large rock, refuse, brush, roots, vegetation

4.5.3.2 Test Frequencies

Table 6A establishes the types of tests, test methods, and test frequencies for earthwork construction quality assurance. The test frequencies listed establish a minimum number of required tests for the properties that must be evaluated for a particular function. Extra testing must be conducted whenever work or materials are suspect, marginal, or of poor quality. Extra testing may also be performed to provide additional data for engineering evaluation. Failing tests do not contribute to the total number of tests performed to satisfy the minimum test frequency.

Examples of conditions that may warrant additional tests include the following:

- Elapsed time between construction activities;
- Variation in equipment
- Visual indications of a substantial variation in materials;
- Excessive pumping or cracking of fill;
- Dirt-clogged rollers used to compact the fill;
- Improperly ballasted compactor;
- Adverse weather;
- Equipment breakdown;
- Work conducted in difficult areas;
- Appearance of lignite or gypsum;
- High frequency of failed tests; and
- Lift thickness greater than specified.

4.5.4 Material and Monitoring Requirements

Earthwork components of the construction are summarized in Section 6.3.1. Each component has specific construction requirements that must be monitored. The following sections list the monitoring requirements for each type of earthwork.

4.5.4.1 Selective Soil Stockpiling

The CQA Monitor shall periodically observe and direct earthmoving activities to the extent required to identify suitable materials for use in construction and to assist the contractor in the proper segregation of material types and placement in the appropriately designated stockpiles.

The CQA Monitor shall:

- Visually monitor excavation to identify soil types;
- Confirm soil types by sampling and visual classification; and
- Direct the Contractor to the appropriate stockpile location for its intended use.

4.5.5 Subgrade Suitability and Repair

Construction quality assurance for subgrade acceptability involves verifying grade control as required in preparation for the installation of the final cover, and observations of the condition of the surface. Prior to initiating the final cover construction, the subgrade area (surface of the layer on which the final cover is constructed) will be inspected for unsuitable areas that may adversely affect the proper construction of final cover. This inspection program will continue as construction of the final cover progresses. Unsuitable areas will be identified by the CQA Monitor and the area will be repaired or replaced to the satisfaction of the CQA Monitor prior to installing final cover over it. The CQA Monitor will:

- Verify that stripping and removal of vegetation, if needed, is complete and excavated materials are place in the proper stockpiles as designated by owner;
- Verify that construction surveying and staking, if necessary, is performed before work starts and thereafter as necessary during the work;
- Verify survey data complies with approved design;
- Inspect the subgrade and identify areas of weak, soft, or otherwise unsuitable soils that would inhibit the ability of the final cover to be constructed in accordance with the approved design to the approved thicknesses and grades;
- Require as necessary, and observe, proof rolling of the subgrade questionable areas of the slopes for excessive rutting, heaving, or soft soils;
- Inspect the subgrade for the presence of refuse and incontinuity of grade that would adversely affect construction of the final cover to the minimum required thickness and/or grades; and
- Ensure that all noncompliant areas are properly repaired according the requirements in this document.

Proof rolling will be conducted using appropriately-heavy equipment (front-end loader, motor-grader, etc.) as directed by the CQA Monitor to identify any soft areas that require repair in the

opinion of the CQA Monitor. Any soft areas requiring repair will initially be compacted using appropriate equipment in an attempt to reduce the deflection. If compaction is unsuccessful, the area of unsuitable material will be delineated and removed to a depth dictated by the CQA Monitor. There are two options for replacing the removed material;

1. It may be replaced with suitable fill material that alleviates the condition; or
2. With approval of the CQA Monitor, it may be replaced with AFC material in compliance with Section 6.3.3.3 per the specifications in Table 6 and Table 6A.

Due to the nature of municipal solid waste, deflection of the subgrade over the final lift of refuse at the base of the cover may be noted. The CQA Monitor will evaluate the conformance of the subgrade with this plan and must approve of the subgrade conditions in the cover area before it is placed. The Contractor shall not place any materials over the subgrade without approval of the CQA Monitor.

4.5.6 AFC

Samples of potential AFC soils will be collected and tested in the laboratory both prior to construction to verify suitable material properties, and during construction to verify continuity of material properties and compliance with moisture storage layer construction in compliance with the requirements shown on the Tables 6 and 6A.

Soil samples from borrow sources proposed for the AFC must be collected to demonstrate that sufficient quantities of the appropriate soils are available to achieve the design cover thickness. Standard index property testing as summarized in Table 6 will be performed. The testing described will be performed at the recommended frequency listed in Table 6 for the borrow source(s).

Prior to the placement of AFC, the CQA Personnel will ensure and document that:

- The design thickness of the final cover is appropriate for the soils to be used in the AFC construction;
- All or an approved portion of the final lift of refuse is complete, and that a survey has been conducted to verify that the subgrade elevations conform to the Construction Drawings;
- The subgrade should have a minimum of 6-inches of cover soil (foundation layer) over the refuse;
- The foundation layer is separate from, and in addition to, the 3.5-foot-thick AFC cover resulting in a minimum 4-foot soil mass above the refuse.
- Slopes over an approximate 5 percent grade are roughed up to promote bonding and stability between the AFC and foundation layer;
- The surface of the subgrade is free of debris, wet and soft areas, ponded water, vegetation, mud, ice or frozen material; and,
- If frozen subgrade material is encountered prior to final cover placement, it is removed and replaced with unfrozen material.

During placement of the AFC materials, the CQA Personnel will ensure and document that:

- CQA tests are conducted at the frequency listed in Table 6.
- AFC soil materials shall be placed at less than optimum moisture content and compacted to 80 to 90 percent (inclusive) of maximum Standard Proctor Density and verified through field moisture and density testing.
- Each lift is placed and spread using equipment and methods to result in minimal compaction. Relatively low-ground pressure (LGP) equipment is preferable during soil placement and grading to avoid over-compaction; however, alternative equipment may be used if it is capable of uniform compaction to the required specification. All equipment traveling on the AFC materials must be approved by the CQA Engineer.
- If necessary to meet these requirements, a 24-inch (minimum) diameter disc may be used to break up clods, expose stones and oversize material to allow for removal, and to assist in reducing compaction. Using a motor grader with ripping teeth to loosen material to meet the compaction specifications, particularly for areas that have been over-compacted due to traffic is also permissible.
- Individual fill lifts during placement should be a minimum of 18-inches thick to avoid compaction of the material. The surface of individual lifts shall be left in a slightly roughened condition to establish bonding and stability between the lifts.
- The Contractor shall not place cover materials on waste or subgrade that contains debris, branches, vegetation, mud, ice, or frozen material. If frozen material is encountered, it shall be removed and replaced in accordance with this Plan. Prior to moisture storage layer placement, any wet or soft areas of the subgrade identified by the CQA Monitor as unsuitable shall be replaced or repaired.
- The finished surface of the AFC shall be relatively smooth and free of any protruding rocks and wheel ruts which could result in ponding water.
- Test pits or other large excavations required for CQA purposes shall be backfilled by the contractor in accordance with this Plan.

Samples of AFC material will be collected during construction and submitted for laboratory analyses at the frequencies in Table 6 to verify the property requirements included in Table 6A. Nuclear density gauge methods will be used for testing the in-situ materials at the frequencies in Table 6 for their compacted dry unit weight and moisture content for conformance with the requirements set forth in Table 6A. This quality assurance testing during AFC placement shall be completed to control the constructed density and moisture and verify the continued acceptability of the AFC materials.

The testing frequency during construction of the AFC may be increased at the discretion of the CQA Personnel when visual observations of construction performance indicate potential problems such as inconsistent or non-uniform conditions. Additionally, the CQA Personnel may increase the frequency of testing during adverse weather conditions, if areas of over-compaction are identified, if equipment breaks down, at the start and finish of grading, after extensive construction breaks or if the material fails to meet the requirements of this Plan.

If an area in the AFC layer is discovered that fails to meet requirements, the CQA Personnel will delineate the extent of the area and the reason for the failure. The CQA Personnel will define the extent of the defective area by additional tests, observations, a review of records, or other means that are deemed appropriate. If additional tests are used to define a defective area a minimum of three tests, triangulating the defective area will be conducted. After the extent of the area is

delineated, the area one-half the distance between the failing test location and the nearest passing test locations will be reworked as necessary. Retests will be performed following the reworking activities. The CQA Personnel will observe and document that the deficiency is corrected by retesting repaired areas before the Contractor performs any additional work in the area of the deficiency. Any over-compacted zones will be appropriately reworked by ripping or removal and replacement of the material to assure that materials meet the density requirements.

The CQA Monitor will ensure the AFC placement and construction methods are conducted in a manner to protect all prior work. In the event of damage, the damaged area will be immediately repaired as necessary to meet the project requirements. The CQA Personnel will observe and document that all damages are repaired.

All field density and moisture tests will be reported on field moisture/density forms. Test locations will be identified in relationship to the pre-established survey grid coordinate or stake number locations.

4.5.7 AFC Revegetation

Prior to commencing revegetation operations, the NRCS will be contacted for recommendations on revegetation procedures. Revegetation of the AFC will be done in accordance with these recommendations.

For a period of three years following revegetation activities and on an as needed basis following that, ERL personnel will use the NRCS to assess the success of the revegetation activities. The NRCS will visually examine the revegetated areas and make recommendations as needed to ensure the revegetation plan at the landfill is successful.

4.6 LLDPE Lined Final Cover Soil Placement

As an option, the final cover may be a LLDPE lined cover consisting of a LLDPE liner, overlain by a geocomposite drainage system, overlain by 1.5 feet of protective soils. This section outlines the CQA for final cover soil placement if this option is chosen. The CQA Engineer will verify and document that the final cover is installed to the extents, elevations, grades, and thicknesses shown on the Drawings. There are no soil material specifications required for this final cover option.

Prior to the placement of the initial 12-inch soil component of the final cover under the LLDPE liner, the CQA Monitor will ensure that:

- All or an approved portion of the last refuse lift is complete, and a survey has been conducted at each 50-foot grid point within the construction area. The survey shall be conducted at either: 1) the top of the last refuse lift, or 2) the top of the intermediate cover soil, or 3) the top of the existing intermediate cover soil with an accompanying test pit to determine the depth of the existing cover soils.
- The subgrade meets the requirements of Section 5.0 of this CQA Plan;
- Slopes shall not be steeper than a 4 to 1 slope ratio. It is recommended that cover soils be tested by a lab for friction angle interface before use. If there is any deviation in this

practice, the project engineer must approve the deviation in writing.

- The surface of the subgrade is free of excessively wet or soft areas, ponded water, vegetation, mud, ice or frozen material; and,
- If frozen subgrade material is encountered, it is removed and replaced with unfrozen soil fill material.
- Final LLDPE liner and overlying cover soil placement shall not begin until the Contractor has verified that subgrade elevations and grades conform to the Construction Drawings and the CQA Engineer has accepted the existing subgrade condition.
- The Contractor shall not place final cover soil material on a surface or subgrade that contains debris, branches, vegetation, mud, ice, or frozen material. If frozen material is encountered, it shall be removed and replaced in accordance with this Specification. The initial lift of final cover soil placement may take place over debris (the last refuse lift), but the debris shall be compacted and graded such that it leaves a relatively uniform surface to ensure a minimum 12 inches of final cover soils can be placed between the refuse and the LLDPE liner.

Prior to the placement of the 12-inch protective soil component of the final cover over the LLDPE membrane, the CQA Monitor will ensure that:

- The LLDPE liner has been installed according to the project specifications.
- Boots and seams of boots around gas collection and control system penetrations are installed according to the project specifications.
- Compaction of protective soil layer material shall be kept to a minimum and limited to incidental construction traffic.
- The overlying 12-inch soil component can be placed in a single 12-inch lift. The final 6-inch topsoil layer shall also be placed in a single lift. Each lift shall be placed using low ground pressure equipment or as otherwise approved by the CQA Engineer. The equipment will be used on the soil above the LLDPE in a manner as to protect the underlying material. No sharp turns, fast driving, quick stops, etc. will occur.

Prior to the placement of the 6-inch topsoil component of the final cover, the CQA Monitor will ensure that:

- The topsoil stockpile shall be cleared and grubbed so the soil being placed is weed free.
- The topsoil lift shall be placed and graded for seedbed placement as per the NRCS revegetation plan.
- The finished surface of the final cover shall be relatively smooth and free of any protruding materials or depressions which could result in ponding water.

The CQA Monitor will document the properties of the final cover soil as determined by this CQA Plan and will report any nonconformance (if not corrected) with the requirements to the CQA Engineer.

4.6.1 LLDPE Lined Cover Revegetation

Prior to commencing revegetation operations, the NRCS will be contacted for recommendations on revegetation procedures. Revegetation of the AFC will be done in accordance with these recommendations.

For a period of three years following revegetation activities and on an as needed basis following that, ERL personnel will use the NRCS to assess the success of the revegetation activities. The NRCS will visually examine the revegetated areas and make recommendations as needed to ensure the revegetation plan at the landfill is successful.

5.0 GEOSYNTHETICS

5.1 General

Placement of geosynthetics must be completed in accordance with the project construction drawings and specifications. To monitor compliance, a quality assurance program will be implemented that includes: (1) a review of the Geosynthetics Contractor's quality control submittals, (2) material conformance testing, (3) construction testing, and (4) construction observation. Conformance testing refers to activities that take place prior to material installation. Construction testing includes those activities that occur during geosynthetics installation. All quality assurance testing shall be conducted in accordance with this CQA plan and with the project construction drawings and specifications. All field testing will be observed by the CQA Monitor. Documentation shall meet the requirements of the CQA plan.

5.2 Geosynthetic Clay Liner

The following sections describe the material specifications and observation activities necessary to ensure the geosynthetic clay liner (GCL) is installed appropriately.

5.2.1 Submittals to Owner

- The Geosynthetics Contractor shall furnish the conceptual layout of the proposed plan for placement of the GCL panels over the area of installation.

- A representative sample of the GCLs.

- Prior to shipment, the Geosynthetics Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.

- As installation proceeds, the Geosynthetics Contractor shall submit certificates of subgrade acceptance, signed by the Contractor and Engineer for each area that is covered by the GCL.

5.2.2 Material

5.2.2.1 Properties

The reinforced GCL shall consist of a layer of granular sodium bentonite clay needlepunched between two geotextiles and shall comply with all of the criteria listed in Table 7 in this Section. Prior to ordering the material and delivery to the site, the Geosynthetics Contractor shall provide the CQA Engineer with manufacturer’s documentation that the GCL meets the requirements and specifications shown in Table 7.

TABLE 7
MINIMUM REINFORCED GCL PROPERTIES

MATERIAL PROPERTY	TEST METHOD	MANUFACURERS QC TEST FREQUENCY	REQUIRED VALUES[1]
BENTONITE PROPERTIES			
Bentonite Swell Index	ASTM D 5890	1/100,000 lb	24 mL/2g min.
Bentonite Fluid Loss[1]	ASTM D 5891	1/100,000 lb	18 ml max.
FINISHED GCL PROPERTIES			
Bentonite Mass/Area[2]	ASTM D 5993	1/45,000 ft^2	0.75 lbs/ft^2 (3.6 kg/m^2)
GCL Tensile Strength[2]	ASTM D 6768	1/225,000 ft^2	23 lbs/in (40 N/cm)
GCL Peel Strength	ASTM D 6496	1/45,000 ft^2	2.1 lbs/in (360 N/m)
GCL Index Flux[1]	ASTM D 5887	270,000 ft^2	1 x 10^{-8} m^3/m^2/sec MAX
GCL Hydraulic Conductivity[1]	ASTM D 5887	270,000 ft^2	5 x 10^{-9} cm/sec MAX

(1) These values are maximum (all others are minimum).
(2) Mass of the GCL and bentonite is measured after oven drying per the stated test method.

5.2.2.2 Product Quality Documentation

The GCL manufacturer shall provide the Geosynthetics Contractor or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

- Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the swell index and fluid loss values shown in Table 7.

- Manufacturer's test data for the finished GCL product, including the parameters of bentonite mass/area, tensile strength, and representative hydraulic conductivity data demonstrating compliance with the performance parameters shown in Table 7.

- GCL lot and roll numbers supplied for the project with corresponding shipping information.

5.2.2.3 GCL Sampling and Conformance Testing

Conformance testing is necessary in order to verify that the materials installed meet the requirements set forth in the specification. This section lists bentonite mass per unit area and swell index and fluid loss tests, which will be utilized to verify the quality of the delivered materials. All tests can be done prior to the rolls being delivered as long as the tested roll numbers are those delivered for each lot and verified by the CQA Monitor.

Conformance testing of samples collected from the rolls to be used at the facility shall be conducted at the rate of one test for every 100,000 square feet to be installed, or one sample per lot, whichever results in the greater number of conformance tests. The sample may be collected prior to shipment to the site, and in this case, the roll number from which the samples will be

collected shall be included with all test reports and compared with the roll numbers delivered to the site. The sample shall be forwarded to the Third Party Laboratory for the following tests:

- Moisture content – ASTM D 2216
- Bentonite Mass per Unit Area – ASTM D 5993
- Index Flux – ASTM D 5887

Samples shall be taken across the entire roll width and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor or sampler shall mark the machine direction, the manufacturer's roll identification number, and the date the sample was obtained on the sample.

The CQA Monitor will review all test results and shall report any nonconformance with the requirements in Table 7 to the Project Manager and to the Geosynthetics Contractor.

Moisture Content

During conformance testing, the moisture content of the manufactured bentonite shall be tested per ASTM D 2216. Samples shall be cut in accordance with the above requirements that are representative of the rolls or lots delivered to the facility. The CQA Monitor shall review the results of the conformance tests and shall reject rolls with unacceptable moisture content or approve of the test results prior to use.

Bentonite Mass Per Unit Area

A test to verify that the specified amount of bentonite has been encapsulated in the GCL will be conducted to measure the bentonite mass per unit area of representative samples cut from delivered rolls. ASTM D 5993 provides procedures for performing the mass per unit area test. If for any reason the resulting mass per unit area values do not meet the required MARVs, the corresponding rolls will not be accepted.

Index Flux

The Index Flux of the GCL is related to the permeability and is one of the most important indicators of its ability to function as a barrier material. ASTM D 5084 or ASTM D 5887 provide procedures for testing Index Flux. As with the mass per unit area test, if these values are not achieved in conformance testing, the corresponding rolls will not be accepted.

5.2.2.4 Product Labeling

Prior to shipment, the GCL manufacturer shall label each roll, identifying:

- Product identification information (Manufacturer's name and address, brand name, product code).
- Lot number and roll number.
- Roll length, width and weight.

5.2.2.5 Packaging

- The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.
- All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

5.2.2.6 Shipping and Handling

- The manufacturer assumes responsibility for initial loading of the GCL. Shipping will be the responsibility of the party paying the freight or designee. Unloading, on-site handling and storage of the GCL are the responsibility of the Geosynthetics Contractor, Installer or other designated party.
- A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.
- The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

5.2.2.7 Storage

- Storage of the GCL rolls shall be the responsibility of the Geosynthetics Contractor and approved by the CQA Monitor. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry and well drained.

- Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

- All stored GCL materials and the accessory bentonite must be covered with a plastic covering or tarpaulin until their installation.

- The integrity and legibility of the labels shall be preserved during storage.

5.2.3 Subgrade Preparation

- Any earthen surface upon which the GCL is installed shall be prepared in accordance with the project specifications and drawings. Any fill required to achieve design subgrade shall be placed, compacted, and tested to the General Fill specifications shown in Tables 2 and 2A this CQAP.

- The finished, compacted surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation.
2. Construction Debris.
3. Sticks.
4. Sharp rocks.
5. Void spaces.
6. Ice.
7. Abrupt elevation changes.
8. Standing water.
9. Cracks larger than one-quarter inch (6 mm) in width.
10. Any other foreign matter that could contact the GCL.

- Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall be removed, crushed or pushed into the surface with a smooth-drum compactor.

- On a continuing basis, the project CQA Monitor shall verify and certify acceptance of the subgrade immediately before GCL placement.

- It shall be the Geosynthetic Contractor's responsibility thereafter to indicate to the CQA Monitor any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

- At the top of sloped areas of the job site, an anchor trench for the GCL and overlying geomembrane shall be excavated in accordance with the project plans and specifications and as approved by the CQA Monitor. When utilizing an anchor trench design, the trench shall be excavated and approved by the CQA Monitor prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench. Observations and measurements will be made of the anchor trenches to confirm that they are constructed as specified. Additional observations will be made to ensure the following:

  * The anchor trench is made with slightly rounded corners as to avoid sharp bends in the GCL and geomembrane
  * The anchor trench is adequately drained to prevent ponding of water or softening of the adjacent soils while the trench is open

  * The General Fill soil used to backfill the anchor trench shall be compacted as outlined in the CQAP Tables 2 and 2A. Testing will be done on two lifts in the trench and at each 100 feet of linear trench.

5.2.4 GCL Placement

5.2.4.1 Placement

- The areas to be lined with GCL shall be agreed upon by the Installer and the Engineer or CQA Monitor prior to installation.

- GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL.

- Equipment which could damage the GCL shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

- Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet will be used to reduce friction damage during placement if required by the CQA Monitor.

- The GCL panels shall be placed parallel to the direction of the slope on slopes greater than 4H:1V.

- All GCL panels should lie flat on the underlying surface, with no wrinkles or folds, especially at the exposed edges of the panels.

- Only as much GCL shall be deployed as can be covered at the end of the working day with the HDPE geomembrane or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. The CQA Engineer, CQA Monitor, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

5.2.4.2 GCL Seaming

- The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

- The minimum dimension of the longitudinal overlap should be 6 inches (150 mm). If the GCL is manufactured with a grooved cut in the nonwoven geotextile that allows bentonite to freely extrude into the longitudinal overlap, then no supplemental bentonite is required for this overlap. If the GCL does not have a grooved cut in the nonwoven geotextile longitudinal overlap, then bentonite-enhanced seams are required as described below.

- End-of-roll overlapped seams should be constructed with a minimum overlap of 24 inches (600 mm). Seams at the ends of the panels should be constructed such that they

are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. End-of-roll overlapped seams require bentonite-enhanced seams as described below.

- Bentonite-enhanced seams are constructed between the overlapping adjacent panels as follows. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150-mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap.

- To avoid seam separation, the GCL should not be put in excessive tension by the weight or expansion of textured geomembrane on steep slopes.

5.2.4.3 Detail Work

- The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the design drawings and the GCL Manufacturer.

- Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

5.2.4.4 Damage Repair

- If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be shall be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Granular bentonite should be applied around the damaged area prior to placement of the patch.

5.2.4.5 HDPE and Cover Placement

- The GCL shall be covered at the end of the working day with the HDPE geomembrane, or a temporary waterproof tarpaulin.

- Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain or rubber-track vehicles) may be used to facilitate the installation of any geosynthetic material placed over the GCL. The GCL supplier or CQA Engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

- When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet may be required at the direction of the CQA Monitor to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

5.2.5 GCL CQA Activities

5.2.5.1 CQA During Placement

CQA activities that will be documented during GCL placement include the following:

- Observation to ensure the GCL placement plan was followed.

- Qualitative observation of the weather conditions (i.e. temperature, humidity, precipitation, and wind) to ensure that they are acceptable for GCL placement and joining. At the beginning of each working day, the CQA Monitor should confirm that there are no ambient site conditions which could affect the quality of the installation. Specifically, the presence at the job site of excessively high winds, rain, standing water, or snow may be construed as unsuitable weather for GCL installation. There are no temperature restrictions for installing the GCL, however.

- Prior to each day's installation activities, the site engineer and/or CQA Monitor should inspect the work area to ensure that it has been prepared in accordance with the specification and design drawings. Specifically, the design grades have been verified, the slope length and steepness have been verified, the anchor trench dimensions should be measured, and the subgrade should be inspected and approved. Any deviations from the specifications or design drawings should be noted and rectified before the GCL is installed.

- The anchor trench must meet or exceed the design dimensions but must also be free of any sharp corners or protrusions which could put excessive stress on the GCL. The CQA Monitor must ensure that the anchor trench is carefully prepared and meets the requirements in the CQAP.

- The unrolling and placement of the GCL should be performed in such a way that the GCL is not damaged or unduly stretched, folded, or creased. It is necessary that the GCL be deployed in a fully relaxed (but not wrinkled) state.

- Observe that equipment used to deploy the GCL does not cause rutting in the soil foundation. Also, observe that the ends of the GCL rolls are not damaged while being unrolled.

- Observe that fugitive clay, stones, sand, trash, etc. is not entrapped in or beneath the GCL which could cause damage to the overlying GCL or HDPE membrane.

- Observe that the panels are positioned such that their long dimension is parallel to the direction of the slope. Panels may only be placed across the slope when the slope is less steep than 4H:1V or when the slope length is very short (less than or equal to 3 m).

- Additionally, observe that the panels are “shingled” on shallow slopes (less than 4H:1V) meaning the upgradient panel overlaps the downgradient panel.

- Observations to confirm that required overlaps of adjacent GCL rolls are achieved, that proper temporary anchorage is used (i.e. sand bags or tires), and that the panel is placed in a relaxed (nonstressed) state.

- Observe that saturated GCL is replaced prior to placement of the overlying HDPE membrane.

- As each GCL panel is placed, it will be observed for tears, punctures, and thin spots. To accomplish this, the panels will be traversed by CQA personnel in such a way that the entire surface is inspected. Any defects shall be marked on the GCL for repair.

5.2.5.2 CQA for GCL Seaming

CQA observation activities that will be documented during seaming operations include:

- The area to be seamed is free from fugitive clay, stones, sand, trash, etc.

- Weather conditions are acceptable for seaming (ie: no precipitation, wind).

- The GCL is not damaged by equipment or personnel during the seaming process.

- The GCL's are overlapped in accordance with this plan. Most GCL now comes with self-seaming materials on the long edges of the GCL. For these products, supplemental bentonite is required only for the end-of-panel overlapped seams and the CQA Monitor shall observe that the end seams have the proper supplemental bentonite. Granular bentonite will be used as per the manufacturer's recommendation for the ends of rolls/ or when materials do not have the self-seaming properties. The CQA inspector should observe the accessory bentonite as it is being placed within the overlap zone and should give verbal approval of the seam before the overlap is flipped back into place.

- No horizontal seams are made on slopes of 4H:1V or greater (unless slope is 3 meters or less in length), or within five (5) feet of the toe of slopes greater than 4H:1V.

5.2.5.3 CQA for GCL Anchoring

CQA observations during anchoring will include the following:

- It is important to ensure that, at the top of a slope, the GCL is properly placed in the anchor trench. After confirming that the trench has been constructed according to the specifications, the GCL should be placed in the trench such that it extends across the trench floor but not up the rear wall of the trench. Excess material if any, should be cut off, *not* folded over on top of the existing material.

- On interior slopes of 4H:1V or greater, the GCL will extend past the crest of the slope to the shallower slope a minimum of 10 feet as a runout anchor. No seams will be allowed on interior slopes of 4H:1V or greater or within 5 feet of the slope toe.

- Good housekeeping practices are used in the trenching operation, minimizing any loose soil material in the trench or on the downhill side of the trench

- The GCL panels are overlapped, including the length in the trench.

- Prior to placement of protective soils, any temporary support for the GCL has been removed

- Placement of protective soils is not performed until approved by the CQA Monitor

- Placement of protective soils is performed with the materials and conditions as provided in the CQAP.

5.2.5.4 Post-Construction Observation

Following GCL installation, and immediately before placement of the HDPE membrane, the CQA Monitor will make final observations to determine that the GCL:

- Has been installed in the proper locations and according to the project plans and drawings.

- Does not show damage or distress.

- Does not show wrinkles that could prevent intimate contact with the overlying FML.

- No potentially harmful objects are present, i.e. stones, cutting blades, needles, small tools, sandbags, etc.

5.2.6 GCL Documentation

Thorough documentation of all CQA activities associated with installing the GCL are necessary in order to provide a written record that the GCL has been properly installed. The CQA documentation package for a GCL installation should include the following items:

- Bills of lading and corresponding packing list confirming receipt of all GCL installed at the site.
- A panel layout drawing in which the GCL roll numbers are keyed to their location in the field.
- Locations where damage was encountered and repaired should also be marked.
- A daily report or diary of the activities undertaken at the site during construction.
- Certification that the requirements for the subgrade and for the cover material were achieved.
- The MQC certification and accompanying test data.
- A description of deviations, if any, made to the original CQA plan during the installation.
- Photographs of the GCL during installation.

5.3 Geomembranes

5.3.1 Requirements of The HDPE and LLDPE Geomembranes Manufacturer and Installer

The Geomembrane Manufacturer of the roll goods must have successfully produced a minimum of 2,000,000 square meters (20,000,000 square feet) that meets the Geomembrane manufacturer's specifications.

The geomembrane Installer shall have installed a minimum of 100,000 square meters (1,000,000 square feet) of specified geomembrane and be an International Association of Geosynthetics Installer certified installer. Evidence of experience shall include a list of completed facilities totaling at least the above number of square feet per category. The list should include the name and the purpose of the facility, location, geomembrane thickness, total square footage of the installation, date of installation, owner or project manager and engineer or designer. This list should include the contact name and telephone number of the appropriate person who can discuss this project.

5.3.2 Material

5.3.2.1 HDPE Membrane

A double-sided textured 60-mil thick membrane of High Density Polyethylene will be placed directly over the GCL on the base and sidewalls of refuse disposal areas. Prior to ordering the material and delivery to the site, the Contractor shall provide the CQA Engineer with manufacturer's documentation that the resin and membrane meet the requirements and specifications shown in Tables 8 and 9.

TABLE 8
HDPE GEOMEMBRANE RESIN AND EXTRUDATE REQUIREMENTS

Property	Test Method	Requirement
Resin		
Density (gm/cm3)	ASTM D 1505	$\geq$ 0.932
Melt Flow Index (g/10 min)	ASTM D 1238 (190/2.16)	<1.0
OIT (minutes)	ASTM D 3895 (1 ATM @ 200˚ C)	$\geq$ 100
Extrudate		
Carbon Black Content (%)	ASTM D 1603, modified	$\geq$ 2%

TABLE 9
HDPE GEOMEMBRANE MATERIAL SPECIFICATIONS

Property	Units	Test	Test Method	60-mil HDPE
Thickness	Mils	Every Roll	ASTM D 5994	54 min;57 min ave.
Geomembrane Density	g/cm^3	200,000 lb	ASTM D 1505 / D 792	0.940 min
Carbon Black Content	%	20,000 lb	ASTM D 1603/D 4218 (1)	2.0 – 3.0
Tensile Strength at Yield	ppi	20,000 lb	ASTM D 6693, GRI-GM13	126 min
Tensile Strength at Break	ppi	20,000 lb	Same as above	90 min
Elongation at Yield	%	20,000 lb	Same as above	12
Elongation at Break	%	20,000 lb	Same as above	100
Tear Resistance	Lbs	45,000 lb	ASTM D 1004	42
Asperity Height	Mils	Every 2nd roll	ASTM D 7466/GRI GM13	10 mil Average
Oxidative Induction Time (2)	Minutes	200,000 lb(1)	ASTM D 3895, 200°C;O_2, 1 atm	>100
Puncture Resistance	Lbs	45,000 lb	ASTM D 4833	90
Carbon Black Dispersion	Category	45,000 lb	ASTM D 5596	9 of 10 in Cat 1, 2 Max 1 in Cat 3

(1) Method D 4218 may be used if acceptable correlation to D 1603 can be certified by Manufacture or testing.
(2) OIT not standard MQC test, so may be approved as a reference property on Data Sheet

5.3.2.2 LLDPE Membrane

As an option, the ERL may use a double sided textured 40 mil LLDPE lined final cover and 1.5 feet of protective and vegetative cover soils instead of the Alternative Final Cover.

The LLDPE sheet material produced must be uniform in color, thickness, and surface texture. The sheet must be free of pinholes, blisters, and undistributed raw materials. LLDPE material must have uniform edges. The LLDPE sheet material shall have the minimum property values in accordance with ASTM standards shown on Table 10. The following are the tests conducted on the finished lining materials. Testing is done at standard temperature and humidity conditions. These tests are conducted after the material has been allowed to age for 24 to 48 hours. This allows the samples to obtain at least 95 percent of the full physical properties.

TABLE 10
40 MIL LLDPE GEOMEMBRANE MINIMUM PROPERTY VALUES (GRI GM17 TABLE 2(A)-TEXTURED)

Properties	Test Method	Test Value	Min Testing Frequency
Thickness mils (min. ave) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.)	D 7466	16	Every 2nd roll(1)
Density g/ml (max.)	D 1505/D 792	0.939	200,000 lb
Tensile Properties(2) (min. ave.) •break strength – lb/in. •break elongation - %	D 6693 Type IV	60 250	20,000 lb
2% Modulus – lb/in. (max.)	D 5323	60,000	per formulation
Tear Resistance – lb (min. ave.)	D 1004	22	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	44	45,000 lb
Axi-Symmetric Break Resistance Strain - % (min.)	D 5617	30	per formulation
Carbon Black Content - %	D 4218(3)	2.0-3.0	45,000 lb
Carbon Black Dispersion	D 5596	note(4)	45,000 lb
Oxidative Induction Time (OIT)(5) (a) Standard OIT (min. ave.), **OR** (b) High Pressure OIT (min. ave.)	D 3895 D 5885	100 400	200,000 lb
Oven Aging at 85°C(6) (a) Standard OIT (min. ave.) - % retained after 90 days **OR** (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	35 60	per formulation
UV Resistance(7) (a) Standard OIT (min. ave.) **OR** (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs(9)	D 7238 D 3895 D 5885	N.R.(8) 35	per formulation
Brittleness Temperature	D 1790	Max -60° C 50% failure	Per formulation

NOTES

(1) Alternate the measurement side for double sided textured sheet.

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(7) The condition of the test should be 20 hr. UV cycle at 75□C followed by 4 hr. condensation at 60□C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

From Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes: Geosynthetic Institute, GRI Test Method GM17 (http://www.geosynthetic-institute.org/grispecs/gm17.pdf)

5.3.3 Delivery

The CQA Monitor shall verify the following on delivery of the material.

- Equipment used to unload the rolls will not damage the membrane.

- Care is used to unload the rolls.
- All documentation required by the specifications has been received.
- The roll numbers delivered to the site match the roll numbers that were tested in the manufacturer's quality control test data submitted to confirm compliance with Tables 8 and 9 or 10, where applicable. CQA Monitor will record the roll numbers delivered to the site for future reference.

At the discretion of the CQA Monitor, damaged rolls may be rejected and shall be removed from the site or stored at a location designated by the Owner that is separate from the accepted rolls. All rolls that do not have proper manufacturer's documentation will be rejected.

5.3.4 Conformance Testing

Conformance testing of samples collected from the rolls to be used at the facility shall be conducted at the rate of one test for every 100,000 square feet to be installed, or one sample per lot, whichever results in the greater number of conformance tests. The sample may be collected prior to shipment to the site, and in this case, the roll number from which the samples will be collected shall be included with all test reports and compared with the roll numbers delivered to the site. The sample shall be forwarded to the Third Party Laboratory for the following tests:

- Density (ASTM D 792 Method A or ASTM D 1505)
- Carbon black content (ASTM D 1603 or D 4218 if acceptable correlation shown)
- Thickness (ASTM D 1593)
- Tensile characteristics (ASTM D 638 or D 6693/GRI GM13)

The CQA Monitor will review all test results and shall report any nonconformance with the requirements in Tables 8 and 9 or 10, where applicable, to the Project Manager and to the Geosynthetics Contractor.

Samples shall be taken across the entire roll width and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor or sampler shall mark the machine direction, the manufacturer's roll identification number, and the date the sample was obtained on the sample.

5.3.5 Geomembrane Installation

5.3.5.1 Surface Preparation

Prior to liner installation, the CQA Monitor shall verify that the following conditions exist:

- All lines and grades have been verified by a qualified surveyor.
- The subgrade has been prepared in accordance with the specifications.
- The surface has been proof-rolled and compacted to be free of surface irregularities, loose soil, and protrusions.

- There is no desiccation cracking of the soil liner surface.
- The supporting surface does not contain stones or other material that could damage the liner.
- There are no excessively soft areas that could result in liner damage.
- The soil liner testing is complete and meets specified values.
- All construction stakes and hubs have been removed.
- The Geosynthetics Contractor has certified in writing that the surface on which the geomembrane will be installed is acceptable.

5.3.5.2 Panel Placement

The Geosynthetics Contractor shall give each panel an identification number which shall be agreed to and used by the CQA Monitor, Project Manager, and the Geosynthetics Contractor. The CQA Monitor shall establish a chart showing correspondence between roll numbers, certification reports, and panel numbers. The CQA monitor shall record the panel number on the Panel Placement Log and Geomembrane Placement Record.

During panel placement, the CQA Monitor shall:

- Observe the sheet surface as it is deployed and record all panel defects and disposition of the defects (e.g., panel rejected or patch installed). All repairs are to be made in accordance with the specifications.
- Verify that equipment used does not damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or by other means.
- Verify that the surface beneath the geomembrane has not deteriorated since previous acceptance.
- Verify there are no stones, construction debris, or other items beneath the geomembrane that could cause damage.
- Observe that the geomembrane is not dragged across an unprotected surface. If the geomembrane is dragged across an unprotected surface, the geomembrane shall be inspected for scratches and repaired or rejected, if necessary.
- Record weather conditions including temperature, wind, and humidity. The membrane shall not deployed in the presence of excess moisture (e.g., rain, fog, dew, or mist).
- Verify that people working on the membrane do not smoke, wear shoes that could damage the membrane, or engage in activities that could damage the membrane.

- Verify that the method used to deploy the sheet minimizes wrinkles and that the sheets are anchored to prevent movement by wind. The CQA monitor will not specify anchorage methods (the Geosynthetics Contractor is responsible for any damage resulting to or from windblown membranes).

The CQA monitor shall inform both the Geosynthetics Contractor and the Project Manager if the above conditions are not met.

5.3.5.3 Trial Seams

Prior to seaming, each welder and seaming apparatus shall be tested in accordance with these requirements to determine if the equipment is functioning properly and conditions are amenable to seaming. Trial seams shall be conducted for each piece of equipment to be employed shall be conducted at the beginning of each seaming period, at least once every five hours, and if the ambient temperature changes more than 20 degrees F within any seaming period.

Samples for trial seams shall be at least five feet long and 12 inches wide with the seam centered lengthwise. Overlaps shall be at least four inches for fusion seams and three inches for extrusion seams. A minimum of two one-inch-wide coupons at locations selected by the CQA Monitor shall be removed from each sample and tested in the peel mode with a field tensiometer. For a seaming apparatus and seamer to be considered acceptable, the weld must meet the same requirements for peel as the field seams and shown on Tables 11A and 11B, where applicable. If a sample fails the trial weld, the reason for the failure must be determined, corrected, and another trial weld conducted. No seaming apparatus that does not have a passing trial weld shall be allowed to conduct seaming operations. It is very important that the weld be completed under conditions similar to those under which the panels will be seamed. If at any time during seaming the CQA Monitor believes that an operator or seaming apparatus is not functioning properly, additional trial welds shall be performed. If there are large changes in temperature (20 degrees F within a seaming period), humidity, or wind speed, the weld test should be repeated.

5.3.5.4 Field Seaming

The Geosynthetics Contractor shall provide the Project Manager and CQA Monitor with a seam and panel layout drawing and is responsible for updating this drawing daily as the job proceeds. No panels shall be seamed until the panel layout drawing has been approved by the CQA Engineer. A seam numbering system shall be agreed to by the CQA Monitor, Project Manager, and Geosynthetics Contractor prior to the start of seaming operations. One procedure is to identify the seam by adjacent panels. For example, the seam located between Panel 120 and 302 would be Seam No. 120/302.

Acceptable seaming methods include double-fusion and extrusion. Double-fusion methods shall be the primary method and extrusion welding methods will only be used in cross-seams, patches, small repairs, or other awkward areas where an extrusion weld would result in a better weld than an extrusion weld.

During seaming operations, the CQA Monitor shall verify the following:

- That the seaming apparatus to be used has successfully completed the trial weld procedures.

- The Geosynthetics Contractor has the number of seamers and spare parts agreed to in the pre-construction meeting.

- Equipment used for seaming does not damage the membrane.

- The extruder is purged prior to beginning a seam until all heat-degraded material is removed (extrusion welding only).

- Seam grinding has been completed less than one hour before seam welding (extrusion welding only).

- Seam edges are beveled, and grind marks are perpendicular to the seam (extrusion welding only).

- Grind marks do not extend more than 1/4 inch from edge of weld.

- The ambient temperature measured within six inches of the membrane surface is between 32 and 100 degrees Fahrenheit, unless otherwise approved in writing by the CQA Engineer. Seaming conducted below 32 degrees Fahrenheit shall be conducted in accordance with GRI Test Method GM 9, "Cold Weather Seaming of Geomembrane".

- The end of old welds, more than 5 minutes old, are ground to expose new material before restarting a weld (extrusion welding only).

- The weld is free of dust, dirt, moisture, or other contaminants.

- For cross seams, the seam is ground to a smooth incline prior to welding (fusion welding only).

- The seams are overlapped a minimum of 3 inches for extrusion welding and 4 inches for fusion welding.

- No solvents or adhesives are present in the seam area unless written approval has been received from the CQA Engineer.

- The procedure used to temporarily hold the panels together does not damage the panels and does not preclude CQA testing.

- The panels are being seamed in accordance with the plans and specifications.

- After welding, grind marks are completely covered with extrudate (extrusion welding only)

- The geomembrane is seamed to the boots of LFGCCS penetrations according to the project specifications. (LLDPE only)

The CQA Monitor shall prepare a Seaming Record and Seaming/Panel Placement Log to document seaming CQA activities.

5.3.6 Construction Testing

5.3.6.1 Non-Destructive Seam Testing

One hundred percent of accessible seams shall be non-destructively tested for continuity by air pressure (air lance) of double fusion welds and vacuum box testing of extrusion welds. Occasionally seams must be constructed that cannot be tested by air pressure or vacuum box methods, and in these cases the CQA Monitor shall very closely inspect the quality and continuity of the seam. Air pressure and vacuum box testing shall be conducted using the following procedures:

5.3.6.1.1 Air Pressure Testing

1. Air pressure testing is applicable to double fusion welding which produces a double seam with an enclosed space.

    a. The equipment for air pressure testing shall consist of the following:

        i. An air pump (manual or motor driven), equipped with pressure gauge and capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.

        ii. A rubber hose with fittings and connections.

        iii. A sharp hollow needle or other pressure feed device, approved by CQA Engineer.

    b. The following procedures shall be followed:

        i. Seal both ends of the seam to be tested.

        ii. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.

        iii. Insert a protective cushion between the air pump and the geomembrane.

iv. Pressurize the air channel to a pressure of approximately 30 psi. Close valve, allow two minutes for pressure to stabilize, and sustain pressure for at least five minutes.

v. If loss of pressure of 3 psi or more in the 5 minute test period is measured or does not stabilize, locate faulty area and repair in accordance with Section 3.06 C.

vi. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seam the cut end of the air channel.

vii. Remove needle or other approved pressure feed device and seal the hole in the geomembrane.

5.3.6.1.2 Vacuum Testing

1. Vacuum testing is applicable to extrusion welding and to non-seam areas of the liner.

   a. The equipment shall consist of the following:

      i. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.

      ii. A pump assembly equipped with a pressure controller and pipe connections.

      iii. A rubber pressure/vacuum hose with fittings and connections.

      iv. A soapy solution. (CQA Monitor shall ensure solution makes bubbles when air is passed through. Windshield washer fluid shall be used as anti-freeze in cold weather.)

      v. A bucket and wide paintbrush, or other means of applying the soapy solution.

   b. The following procedures shall be followed:

      i. Wet a strip of geomembrane approximately 12 inches by 48 inches with the soapy solution.

      ii. Place the box over the wetted area.

iii. Close the bleed valve and open the vacuum valve.

iv. Ensure that a leak-tight seal is created.

v. Energize the vacuum/venturi pump and reduce the applied pressure to approximately five psi (10 in of Hg) gauge.

vi. For a minimum of ten seconds, apply vacuum with the box placed and maintaining a seal, examine the geomembrane through the viewing window for the presence of soap bubbles.

vii. If no bubble appears after ten seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum three inches overlap, and repeat the process.

viii. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 5.2.5.

During non-destructive testing operations, the CQA Monitor shall:

- Record and observe all continuity testing.
- Record the location, date, test number, technician name, and results of all testing. These results shall be recorded on the Panel Placement/Seaming Log.
- Mark the location of any defects requiring repairs.
- Mark the failed areas with a waterproof marker compatible with the liner (spray paint should not be used), and inform the Geosynthetics Contractor and the Project Manager of any required repairs.
- Verify that all testing is completed in accordance with the project specifications.
- Verify that all repairs are completed and tested in accordance with the project specifications.

5.3.6.2 Destructive Seam Testing

Destructive seam tests will be performed at selected intervals, at least one test per 500 feet and at least one test per seam. Test locations shall be determined by identifying each 500 feet of seam. At least one test location within each 500 foot section will be selected at the discretion of the CQA Monitor considering such factors as:

- Wrinkling in seam area
- Suspect seaming equipment
- Adverse weather conditions (wind, temperature, moisture)
- Possibility of dirt in the seam
- Failing tests

However additional tests shall be performed, if the CQA Monitor suspects the seam may not meet specification requirements or additional questionable areas are identified.

Destructive tests are performed to evaluate seam strength and to estimate long-term performance. Destructive testing shall be performed concurrently (within 2 working days of the time the seam is completed) with seaming operations, not at the completion of the installation.

Destructive testing consists of testing the strength of the seam in both the peel and shear modes. The CQA Monitor shall select locations where seam samples will be cut for laboratory testing. These locations shall be established as follows:

- Beginning in one end of the membrane seaming operation and progressing in an organized manner across the entire constructed area, identify the beginning and end of each consecutive 500 linear feet of seam.
- A test location shall be determined within each 500 linear foot section of seam at the discretion of the CQA Monitor. Test locations shall not be identified prior to welding. Locations selected may be prompted by liner distortion due to overheating, weld contamination, or any potential cause of poor welds as listed above. The Geosynthetics Contractor shall not be informed in advance of the destructive sample locations.
- Additional destructive tests may be conducted at the discretion of the CQA Monitor based on the questionable quality of the seam or localized areas.
- Unless extenuating circumstances dictate, removing samples for destructive testing from the sump area shall be avoided.

Samples shall be removed by the Geosynthetics Contractor at locations identified by the CQA Monitor. The CQA Monitor shall:

- Observe sample cutting.
- Ensure each sample is marked sample with an identifying number that contains the seam number and sample number.
- Ensure each sample location is recorded on the panel layout drawing and Seaming/Panel

Layout Log.

Two types of samples shall be taken at each location. First, two seam samples (coupons), 1 inch wide by 12 inches long with the seam centered across the length, shall be taken 40-42 inches apart. These samples shall be tested in the field by the contractor using a tensiometer capable of quantitatively measuring shear and peel strengths. If one or both of the samples fails, the Geosynthetics Contractor can, at his discretion,

1. reconstruct the seam between passed test locations, or

2. take another test sample 10 feet from the point of the field test in each direction and repeat this procedure. If the second test passes, the Geosynthetics Contractor can either reconstruct or cap strip the seam between the two passed test locations. If subsequent tests fail, the procedure is repeated until the length of the poor quality seam is established. Repeated failures indicate a problem with the seaming equipment or operator error (or both) and appropriate action should be taken.

Once the field tests have passed, a sample shall be recovered from between passing field sample locations for Third party Laboratory testing. The sample shall be a minimum of 38 inches long by 12 inches wide, with the seam centered along the length. The recovered sample shall be divided into three parts: one 12 by 12-inch section shall be given to the Geosynthetics Contractor, one 12 inch by 12 inch sample shall be sent to the Third party Laboratory for testing, and one 12 inch by 12 inch sample shall be given to the Owner for archiving. The results of the laboratory testing shall be recorded.

If the laboratory test fails in either peel or shear, the Geosynthetics Contractor may either reconstruct all of the seams constructed with that particular seaming apparatus or additional samples may be recovered. If additional samples are to be recovered, samples must be taken on either side of the failed sample from seam constructed with the same seaming apparatus for third party testing. These samples must be taken at least 10 feet from the location of the failed sample and may require a sample from a different seam if necessary to bound the failing sample location by two passing samples constructed with the same seaming apparatus. Sample size and disposition shall be as described in the preceding paragraph. This process shall be repeated until passed tests bracket the failed seam section. All seams shall be bounded by locations from which passing Third Party Laboratory tests have been taken. In cases involving more than 50 feet of reconstructed or cap stripped seam, the reconstructed or cap stripped seam must also be tested. Third party Laboratory testing governs seam acceptance. In no case shall field testing of installed seams be used for final acceptance.

5.3.6.3 Third Party Laboratory Testing

Destructive samples shall be shipped by the CQA Monitor to the Third Party Laboratory on the same day the sample is obtained. Testing shall include seam strength and peel (ASTM. D. 4437). At least five (5) specimens shall be tested in peel and 5 specimens in shear. At least 4 of the 5 specimens tested by each method must meet the minimum test values presented below. The Third-Party Laboratory shall provide test results within 24 hours in writing or via telephone conversation with the CQA Monitor. Final written test results are to be provided within 5 days.

The CQA Monitor shall immediately notify the Geosynthetics Contractor in the event of a failed test. No areas, except as necessary to provide wind protection or to prevent the penetration of water beneath the geomembrane, are to be covered prior to receiving Third party Laboratory test results and approval from the CQA Monitor.

5.3.6.4 Passing Criteria for Welds

Passing criteria for trial weld and destructive seam tests are shown in Tables 11A and 11B below. Boot seams to LLDPE penetrations will meet the criteria in Table 10B. Failure to meet the criteria for trial welds in Tables 11A or 11B, as applicable, shall render the equipment that was used in the failed trial weld unacceptable until the reason for the failure has been identified and rectified and until approval for its use is given by the CQA Monitor. Failure to meet the criteria in Tables 11A and 11B for constructed seams shall trigger an investigation of the cause of the failure. The problem shall be rectified to the satisfaction of the CQA Monitor and additional confirmatory destructive tests shall be conducted.

TABLE 11A
HDPE GEOMEMBRANE MINIMUM SEAM STRENGTHS
Per ASTM D 4437 or equivalent

Type of Weld	Shear Strength At Yield	Peel Strength At Yield	Maximum Seam Separation in Peel	Minimum Strain at Break in Shear
Fusion Weld	120 ppi	91 ppi	25% of seam	50%
Extrusion Weld	120 ppi	78 ppi	25% of seam	50%

Note: Only peel and shear strength tests are required in field. Seam separation and strain are laboratory only tests.

TABLE 11B
LLDPE GEOMEMBRANE MINIMUM SEAM STRENGTHS
Per ASTM D 4437 or equivalent

Type of Weld	Shear Strength At Yield	Peel Strength At Yield	Maximum Seam Separation in Peel	Minimum Strain at Break in Shear
Fusion Weld	60 ppi	50 ppi	25% of seam	50%
Extrusion Weld	60 ppi	44 ppi	25% of seam	50%

Note: Only peel and shear strength tests are required in field. Seam separation and strain are laboratory only tests.

5.3.7 Repairs

Any portion of the geomembrane with a flaw or that fails a non-destructive or destructive test shall be repaired in accordance with these requirements. The CQA Monitor shall locate and describe all repairs on the appropriate CQA form, as follows:

- Patching - used to repair large holes, tears, large panel defects, and destructive sample locations.

- Extrusion - used to repair small defects in the panels and seams. In general, this

procedure should be used for defects less than 3/8 inch in the largest dimension.

- Capping - used to repair failed welds or to cover longer lengths of seams.

- Removal - used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles) from the installed geomembrane.

5.3.8 Wrinkles, Bridging & Folding

Placing soil cover or drain materials over the geomembrane, temperature changes, or creep may cause wrinkles to develop in the geomembrane. Any wrinkles that can fold over shall be repaired either by cutting out excess material, or, if possible, allowing the liner to relax and contract due to temperature changes. Wrinkles more than 12 inches in height that cannot be reduced or mitigated by other means shall be cut out, removed, and repaired. The CQA Monitor shall closely monitor equipment travel over the geomembrane and placement of overlying components to prevent any wrinkle from folding over. In no case shall material be placed over the geomembrane that could result in geomembrane folding.

Unless approved by the CQA Engineer, bridging must be removed.

All folded HDPE geomembrane shall be removed and repaired in accordance with the requirements for installation of the original membrane.

5.3.8.1 Sealing Around Penetrations in LLDPE Liner

The LLDPE membrane shall be sealed to all concrete structures and other openings through the lining in accordance with details shown on the engineer-approved shop drawings. Factory and/or field fabricated pipe boots shall be used to seal all pipes penetrating the liner. All joints shall be tightly bonded.

5.3.9 Geomembrane Acceptance

The Geosynthetics Contractor shall retain all ownership and responsibility for the geomembrane until acceptance by the Owner. In the event the Geosynthetics Contractor is responsible for placing materials over the geomembrane, the Geosynthetics Contractor shall retain ownership and responsibility for the geomembrane until the cover is placed. The geomembrane shall be accepted by the CQA Engineer when:

- The installation is finished.

- All seams have been inspected, field tested and approved.

- All required laboratory tests have been completed and approved.

- All required Geosynthetics Contractor supplied documentation has been received and approved.

- All record drawings have been completed and approved.

5.4 Geotextiles

5.4.1 Material

A minimum 8-ounce per square yard geotextile is used to encapsulate the rock in the sump to protect the underlying geomembrane, and to restrict the entry of fine soil materials into the sump. The material shall be a continuous-filament polyester or polypropylene, non-woven, needle-punched fabric meeting the requirements shown in Table 12 below. Prior to ordering the material and delivery to the site, the Contractor shall provide the CQA Engineer with manufacturer's documentation that the Geotextile meets the requirements and specifications shown in Table 12.

TABLE 12
MINIMUM GEOTEXTILE MATERIAL REQUIREMENTS

Property	Unit	Test Method	Manufacturers Min. Test Frequency	Min. Ave. Roll Value(1)
Weight	oz/sq yd	ASTM D 5261	100,000 sf	8
Grab Strength	lbs	ASTM D 4632	100,000 sf	180
Grab Elongation	%	ASTM D 4632	100,000 sf	113
Trapezoidal Tear Strength	lbs	ASTM D 4533	100,000 sf	68
CBR Puncture Strength	lbs	ASTM D 6241	100,000 sf	230
Permittivity	sec^{-1}	ASTM D 4491	600,000 sf	0.02
AOS	US Sieve	ASTM D 4751	600,000 sf	80 (2)
UV Stability	%/hrs	ASTM D 4355	Per formulation	60/500
(1) values shown are in the weakest principal direction (2) AOS is the Maximum AOS value (largest opening size) average roll value				

The CQA Monitor shall verify the following:

- Equipment used to unload the rolls will not damage the geotextile
- Care is used to unload the rolls
- All documentation required by the specification has been received

Any damaged rolls shall be rejected and removed from the site. All rolls that do not have proper manufacturer's documentation shall be stored at a separate location until all documentation has been received and approved.

5.4.2 Conformance Testing

Conformance testing of the rolls of geotextile designated for the site shall be conducted at the

rate of one sample per 100,000 square feet, or one sample per lot, whichever results in the greater number of conformance tests. The sample shall be forwarded to the Third Party Laboratory for the following tests:

- Mass per unit area
- Thickness
- Puncture resistance
- Wide strip tensile or grab tensile tests (see specification)
- Permeability (if material used as a filter layer)
- Apparent Opening Size (if material used as a filter layer)

The CQA Monitor will review all test results and shall report any nonconformance to the Project manager and to the Geosynthetics Contractor. All test results shall reference the roll number or lot number as appropriate. If samples are collected for testing prior to delivery to the site, the CQA Monitor shall confirm that the rolls sampled for conformance testing correspond to the rolls delivered to the site.

Samples shall be taken across the entire roll width and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The sampler shall mark the manufacturer's roll identification number, machine direction, and date on the sample.

5.4.3 Geotextile Installation

5.4.3.1 Surface Preparation

Prior to geotextile installation, the CQA Monitor shall verify that:

- All lines and grades have been verified by a qualified surveyor.
- The subgrade has been prepared in accordance with the specifications and the earthwork portion of the CQA Manual, and, if placed over a geosynthetic, the portion of the geosynthetic installation to be covered by the geotextile, including all required documentation and testing has been completed and approved by the CQA Engineer.
- The supporting surface does not contain stones or other material that could damage the geotextile or, where applicable, an overlying geosynthetic.
- There are no excessively soft areas that could result in damage to an overlying component.
- All construction stakes and hubs have been removed

5.4.3.1.1 Panel Placement

During panel placement, the CQA Monitor shall:

- Observe the geotextile as it is deployed and record all defects and disposition of the defects (e.g., panel rejected, or patch installed). All repairs are to be made in accordance with the specifications.

- Verify that equipment used does not damage the geotextile by handling, trafficking, leakage of hydrocarbons, or by other means.

- Verify that people working on the geotextile do not smoke, wear shoes that could damage the geotextile or engage in activities that could damage the geotextile.

- Verify that the geotextile is anchored to prevent movement by the wind (the Geosynthetics Contractor is responsible for any damage resulting to or resulting from windblown geotextiles).

- Verify that all geotextile is covered prior to 500 hours of exposure to ultraviolet radiation (sunlight).

The CQA Monitor shall inform both the Geosynthetics Contractor and the Project Manager if the above conditions are not met.

5.4.3.1.2 Field Seaming

Seaming shall be by sewing, fusion, overlap, or other approved bonds. The overlap is dependent upon the method of seaming.

During geotextile placement, the CQA Monitor shall verify:

- The seams are overlapped a minimum of 6 inches if sewn, 12 inches if fusion (heat) bonded, or 24 inches if simply overlapped.

- Overlaps are oriented in the direction of earth filling-i.e.; the direction of earth filling should be in the direction of the seams, not perpendicular to the seams.

- No horizontal seaming shall be allowed on slopes steeper than 10H:1V.

- Thread used to sew the panels together shall be polymeric thread.

- The panels are being joined in accordance with the plans and specifications.

5.4.3.2 Repairs

Allowable repair procedures include:

- Patching - used to repair holes, tears, and defects.

- Removal - used to replace areas with large defects where the preceding method is not appropriate.

- On slopes steeper than 10H:1V, a fabric patch shall be sewn into place using a double sewn lock stitch no closer than one inch to the edge of the patch with the patch extending a minimum 6 inches beyond the perimeter of the tear or damaged section. On slopes flatter than 10H:1V, the patch may be spot seamed using fusion methods with a minimum of 36 inches overlap past the perimeter of the tear or damaged section.

5.4.4 Deficiencies

When deficiencies are discovered, the CQA Monitor shall immediately determine the nature and extent of the problem, notify the Geosynthetics Contractor, and complete required documentation. In all cases, the CQA Monitor will notify the Geosynthetics Contractor within 1/2 hour of discovering the deficiency. If the deficiency will cause construction delays of more than 4 hours or will necessitate substantial rework, the CQA Monitor shall also notify the Project Manager.

The Geosynthetics Contractor shall correct the deficiency to the satisfaction of the CQA Engineer. If the Geosynthetics, Contractor is unable to correct the problem, the CQA Engineer will develop and present to the Project Manager suggested solutions for approval. If the solution requires a design revision, the Design Engineer shall also be contacted. The corrected deficiency shall be retested before additional work is performed if necessary to ensure compliance with these requirements. All retests and the steps taken to correct the problem shall be documented by the CQA Monitor.

5.5 Geocomposite

A synthetic geocomposite drainage material is designed on the base of the disposal cells to transmit leachate to the sump for removal. The geocomposite consists of a polyethylene geonet with a minimum eight-ounce per square yard non-woven geotextile bonded to each side.

5.5.1 Material

The geocomposite must meet or exceed the properties shown in Table 13. Prior to ordering the material and delivery to the site, the Contractor shall provide the CQA Engineer with manufacturer's documentation that the Geocomposite meets the requirements and specifications shown in Table 13.

TABLE 13
MINIMUM GEOCOMPOSITE
MATERIAL REQUIREMENTS

Property	Test Method	Manufacturer's QC Test Frequency	Specified Value [a]
Geocomposite			
Transmissivity [b]	ASTM D 4716	1/540,000 ft^2	0.5 gal/min/ft
Ply Adhesion	GRI GC-7, ASTM D 7005	1/50,000 ft^2	1.0 lb/in
Geonet Core (before lamination)			
Thickness	ASTM D 5199	1/50,000 ft^2	200 mil
Density	ASTM D 1505	1/50,000 ft^2	0.95 g/cm^3
Carbon Black Content [c]	ASTM D 1603/D 4218	1/50,000 ft^2	1.5% to 3.0 %
Tensile Strength	ASTM D 7179	1/50,000 ft^2	45 lb/in
Compressive Strength	ASTM 6364	1/100,000 ft^2	120 lb/in^2
Geotextile (before lamination)			
Mass per unit area	ASTM D 5261	1/90,000 ft^2	8.0 oz/yd^2
Grab Strength	ASTM D 4632	1/90,000 ft^2	200 lb
Tear Strength	ASTM D 4533	1/90,000 ft^2	80 lb
Puncture strength	ASTM D 4833/D 4261	1/90,000 ft^2	430 lb
AOS [d]	ASTM D 4751	1/540,000 ft^2	80 US sieve
Permittivity	ASTM D 4491	1/540,000 ft^2	0.2 sec^{-1}
UV Stability	ASTM D 4355 (500 hrs)	Once per formulation	50 % retained
(a) These are MARV values that are based on the cumulative results of specimens tested and determined by GSE. AOS is maximum average roll value.			
(b) Gradient 0.1, normal load of 10,000 psf, water at 70 deg F between steel plates for 15 minutes			
(c) ASTM D 4218 may be used if acceptable correlation is certified by Manufacturer or testing			
(d) Maximum AOS value (largest opening size)			

The contractor must submit documentation of the proposed material to the CQA Engineer for review for compliance with the above specifications prior to delivery of the material to the site and the CQA Engineer must confirm that the material characteristics meets or exceeds the minimum requirements in Table 13.

Upon delivery to the site the CQA Monitor shall verify the following:

- Equipment used to unload the rolls will not damage the geotextile

- Care is used to unload the rolls

- All documentation required by this plan have been received

- Each roll has the name of the manufacturer, product identification, lot number, roll number, and roll dimensions.

- The geocomposite is stored off the ground and shall be protected from puncture, cutting, excessive heat and cold, moisture, mud, dirt, or other deleterious conditions. The CQA Monitor can reject any rolls that he feels have been damaged and will not meet the requirements of this plan.

Any damaged rolls shall be rejected and removed from the site. All rolls that do not have proper manufacturer's documentation shall be stored at a separate location until all documentation has been received and approved.

5.5.2 Installation

5.5.2.1 Surface Preparation

The CQA Monitor shall ensure that all installation, inspections, and testing of the underlying geosynthetic membrane has been completed and approval to begin placement of the geocomposite has been given by the CQA Engineer.

The CQA Monitor shall inspect the underlying geomembrane immediately prior to placement of the geocomposite to ensure that conditions are suitable for the geocomposite installation. Excessive soil, dirt, rock, trash, or other deleterious materials shall be removed from the membrane. In addition, the CQA Monitor shall verify that the geomembrane complies with Section 5.2.7 of this plan regarding potential folding of wrinkles.

5.5.2.2 Installation

The geocomposite shall be installed to the lines and grades shown on the drawings. Only small four-wheeler ATV type equipment may be used directly over the geomembrane to install the geocomposite and must be approved by the CQA Monitor. There shall be no vehicle travel directly on the geocomposite. The CQA Monitor shall closely monitor equipment travel over the geomembrane and ensure any damage is repaired prior to covering with the geocomposite.

The CQA Monitor shall ensure that:

- Panel placement shall be planned such that no horizontal seams on slopes steeper than 5H:1V except in the sump, and this shall be avoided as much as possible, and only constructed with approval by the CQA Engineer.

- The geonet component of each panel shall be overlapped a minimum of 4 inches.

- The upper geotextile of adjoining panels are continuously heat lysterred to prevent entry

of fines into the geocomposite drainage net.

- All exposed edges of the geonet component are protected from intrusion of fine soil materials by continuous heat lystering a strip of geotextile to both the upper and lower geotextile components of the geocomposite.

- Cutting tools do not damage the underlying geomembrane
- Nylon strings, plastic fasteners (zip ties) or polymer braid are used to join adjacent panels. No metallic fasteners shall be allowed. Fasteners shall be a different color than the geotextile to allow for easy identification of the seams.

- On slopes of 5H:1V or less, seams and cross-seams shall be joined using the methods allowed above at minimum 10-foot intervals. For slopes steeper than 5H:1V such as the sump slopes, panels shall be joined using the methods allowed above at minimum 5-foot intervals for seams running up and down the slope and at 2-foot intervals for cross seams perpendicular to the maximum slope angle. Panel layout shall be planned such that seams running perpendicular to the direction of maximum slope on slopes greater than 5H:1V (i.e., along the slope rather than up and down the slope) shall be avoided.

- All geotextile is covered prior to 500 hours of exposure to ultraviolet radiation (sunlight).

- The geonet core is installed such that it directly contacts the sump drainage aggregate.

- The geotextile covering the sump drainage aggregate is appropriately seemed to the top geotextile layer of the geocomposite.

5.5.2.3 Repairs

The CQA Monitor shall inspect the geocomposite during installation and note any holes or defects requiring repair. Repairs shall be accomplished by placing a geocomposite patch that extends a minimum of one foot beyond the damaged area and secured to the underlying geocomposite every 6 inches by one of the methods provided for in Section 6.2.2.

If any damaged area extends more than 50% of the width of a panel, the entire section shall be cut out and the two remaining portions of geocomposite joined with a new section of geocomposite as described in Section 6.2.2.

5.5.2.4 Placement of overlying materials

Only low-ground pressure track equipment approved by the Design Engineer is allowed to travel over the geocomposite to place protective soils, and then only if a minimum one-foot of protective soil exists between the equipment and the geocomposite. If absolutely necessary to conduct repairs, etc., any vehicle travel directly on the geocomposite shall obtain prior approval by the CQA Engineer, and any such vehicle travel will be closely inspected by the CQA Monitor.

Sharp turns of the track equipment are prohibited, and the placement sequence should minimize

any turns over the geocomposite.

The geocomposite in a working area shall not be covered with protective soils or other materials until the CQA Monitor has completed all testing and inspections in the area and has provided approval to cover the geocomposite.

6.0 POLYETHYLENE PIPE AND FITTINGS

An SDR-17 High Density Polyethylene pipe is designed to run along a portion of the base of the leachate collection sump and up the cell sidewall to the ground surface outside of the cell. The purpose of the pipe is to allow entry of leachate collected in the sump and provide access at the ground surface to a pump for removing leachate from the sump.

6.1 Material

The leachate removal pipe, also called an inclined riser pipe, shall be manufactured of HDPE and have a Standard Diameter Ratio of 17 (SDR-17). All fitting, caps, joints, couplings, etc. shall also be manufactured of HDPE and made specifically for the specified pipe and size.

The portion of the pipe laid on the base of the sump is perforated to allow entry of leachate. The perforations shall be sized to provide adequate water entry capacity but prohibit entry of sump drainage rock or gravel. The portion of the pipe above the level of the sump and running up the cell sidewall is solid (non-perforated).

The CQA Monitor shall inspect all pipe upon delivery to the facility and record all labeling to verify that the pipe meets these requirements.

6.2 Installation

6.2.1 Joining of Pipe Segments

Segments of the inclined riser pipe shall be joined using one of the following heat methods:

- Butt-Fusion
- Electro-Fusion

The heat method used shall follow manufacturers recommendations and be conducted in accordance with acceptable standards and practice. Upon removal of the heat source from the joint, the pipe segments shall remain pressed together under pressure until the joint has cooled to near ambient temperature before moving the pipe. The CQA Monitor shall confirm that adequate time has evolved before the pipe is moved in preparation for placement in the cell.

The CQA Monitor shall pay particular attention to the joints forming the angle between the horizontal perforated section on the base of the sump and the non-perforated section rising on the sidewall to the ground surface.

6.2.2 Installation

The completed pipe section shall be placed to the lines shown on the drawings. The CQA Monitor shall observe and inspect the placement of the pipe, paying particular attention to the integrity of the pipe joints and the contact of the pipe with the underlying layer, particularly at the change in angle of the pipe between the horizontal section in the sump and the portion laying on the cell sideslope.

The CQA Monitor shall note any bridging of the pipe that would cause stress on the pipe after backfilling and refuse placement. The CQA Monitor will bring any unacceptable bridging to the attention of the contractor, who shall rectify the situation by placing bedding materials beneath the bridged sections or another remedy acceptable to the CQA Monitor.

The entire constructed in place pipe shall be surveyed for location and elevation at each end point, change in angle or direction, and at approximately 25-foot intervals.

6.2.3 Acceptance

No materials shall be placed over the installed pipe until the CQA Monitor has verified that it has been placed to the lines shown on the drawings, inspected the integrity of the joints, verified that the pipe has been surveyed in conformance with Section 7.2.2, and approval is provided to do so by the CQA Monitor.

7.0 DOCUMENTATION

The quality assurance plan depends on thorough monitoring and documentation of all construction activities. Therefore, the CQA Monitor shall document that all quality assurance requirements have been addressed and satisfied. Documentation shall consist of daily record keeping, construction problem resolutions, photographic records, design and specification revisions, weekly progress reports, and a certification and summary report.

7.1 Daily Record Keeping

At a minimum, daily records shall consist of field notes, summary of the daily meeting with the Contractor, observation and data sheets, and construction problem and resolution reports. At least one photograph of each work area shall be taken on each day of construction. If possible, this information shall be submitted daily to the Project Manager for review and approval.

7.2 Observation and Test Data Sheets

Observation and data sheets shall include the following information:

- Date, project name, and location
- Weather data, including periodic temperature readings
- A description of the location of the work area including sample and test locations
- A description of ongoing construction
- A summary of test results identified as passing, failing, or in the event of a failed test, retest results
- Test equipment calibrations, if applicable
- Off-site materials received including the source and any required certificates
- A summary of decisions regarding acceptance of the work and/or corrective actions taken
- The signature of the CQA Monitor

7.3 Construction Problem and Resolution Documentation

This report identifies and documents construction problems and resolutions. This report is intended to document problems involving significant rework and is not intended to document items that are easily corrected unless the problems are reoccurring. At a minimum this report shall include:

- A detailed description of the problem

- The location and cause of the problem
- How the problem was identified
- How the problem was resolved
- Personnel involved
- Signature of the CQA Monitor and Project Manager

7.4 Photographs

All construction activities will be recorded, including significant problems and remedial actions. The photographs will be identified by location, time, date, and person taking the photograph. Digital copies of the photographs will be given to the Project Manger weekly or more frequently.

7.5 Design and Specifications Changes

Design and specification changes may be required during construction. In such cases, the CQA Monitor shall notify the Project Manager and the CQA Engineer. Design and specification changes shall only be made with written agreement of the Design Engineer.

7.6 Weekly Progress Reports

If requested by the Client, CQA Engineer or Project Manager, the CQA Monitor shall prepare weekly progress reports summarizing construction and quality control activities. This report which is submitted to the Project manager shall contain, at a minimum, the following information:

- The date, project name, and location
- A summary of work activities
- A summary of deficiencies and resolutions
- The signature of the CQA Monitor

7.7 Certification Report

At the completion of the project, the CQA Engineer shall prepare a certification report. This report shall certify that the work has been performed in compliance with the construction drawings and specifications. At a minimum, this report shall contain:

* A summary of all construction activities

* Survey data will be included with a certification sheet signed by a PLS in Colorado.

* Observation and test data sheets required for documentation of compliance with this plan

* Sampling and testing location plans

* A description of significant construction problems and the resolution of these problems

* A list of changes and deviations from the approved construction drawings and specifications and the justification for these changes

- Documentation of inspections by the CQA Engineer
- Representative photographs of the construction
- Record Drawing
- As-built drawings of the completed cell including the top of subgrade, top of clay liner (if used), and the top of the protective layer
- All panel layout drawings from the installation of the GCL, geomembrane, geocomposite and geotextile
- A certification sealed by an engineer registered in the State of Colorado

The record drawings shall accurately locate all construction items including the piping, the extent and thickness of lining, leachate collection system components, and other appropriate details. All surveying required for the development of the record drawings shall be conducted under the supervision of a licensed surveyor.

8.0 MODIFICATION/AMENDMENT RECORD

Date of Modification/ Amendment	Description of Modification/Amendment Original CQAP Dated April 2011
1. October 24, 2015	Eliminate requirement for scarification, re-compaction, and density testing For subgrade below GCL liner per October 7, 2015 approval letters from CDPHE and TCHD
2. October 24, 2015	Revise/update/correct acceptable test methods for HDPE, Geotextile, Geocomposite, and GCL materials. Updated for new test methods, commonly used methods by manufacturers, or correct typographical errors
3. July 18, 2016	Revised Table 8(now Table 11)- specification for strain of HDPE for destructive tests. Eliminated previous minimum strain at yield for shear test of 10% and replaced with minimum strain at break for shear test of 50%.
4. February 26, 2025	Revised GCL, HDPE Membrane, Geotextile, and Geocomposite Specs to current Geosynthetics Research Institute Guidelines. CQA for final cover installation added.