KAW VALLEY ENGINEERING, INC.

STORM WATER DRAINAGE STUDY

Clean Energy
LNG Fueling Station
Tidewater Drive
West Branch, Cedar County, Iowa

Prepared for:

Fiedler Group
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Prepared by:

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Consulting Engineers

Junction City, Kansas • Kansas City, Missouri • Lenexa, Kansas • Salina, Kansas

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I. INTRODUCTION

A. Purpose of Study

Kaw Valley Engineering on behalf of Clean Energy has prepared this storm drainage study to evaluate peak runoff and to size a proposed detention basin and control structure on a tract of land in West Branch, Iowa.

B. Project Description

The Clean Energy LNG Fueling Station project is located at 126 Tidewater Drive in a light industrial area, and will be located on 1.50 acres of a 4.14 acre tract of land. The project will disturb approximately 1.5 acres of land with improvements comprising 1.26 acres of the site. The site is currently comprised of green space and trees with light underbrush. To the north of the site is Tidewater Drive and light industrial facilities. To the west of the site is the existing President Motel. There is open green space to the east for several hundred feet before encountering a light industrial facility. To the south is several hundred feet of row crops before encountering another light industrial facility. (See Vicinity Map on page 2)

C. Topography

The existing topography of the property slopes down to the east 1.5 to 5 percent. Elevations range from approximately 777 feet near the middle of the west property line to 769 near the middle of the east property line. The site is very near the top of the local watershed and has very little off-site stormwater entering the property. The storm water sheet flows east across the property and continues to a shallow swale 250 feet east of the east property line.

D. Flow Patterns

Pre-developed project site runoff flows to an offsite swale and to an unnamed tributary of the West Branch Wapsinonic Creek to the West Branch Wapsinonic Creek to Wapsinonic Creek to the Cedar River. Post-developed project site runoff will sheet flow to an onsite storm drainage BMP system and detention basin which discharges to the 5% slope leading to the existing swale to the unnamed tributary of West Branch Wapsinonic Creek.

E. Soils

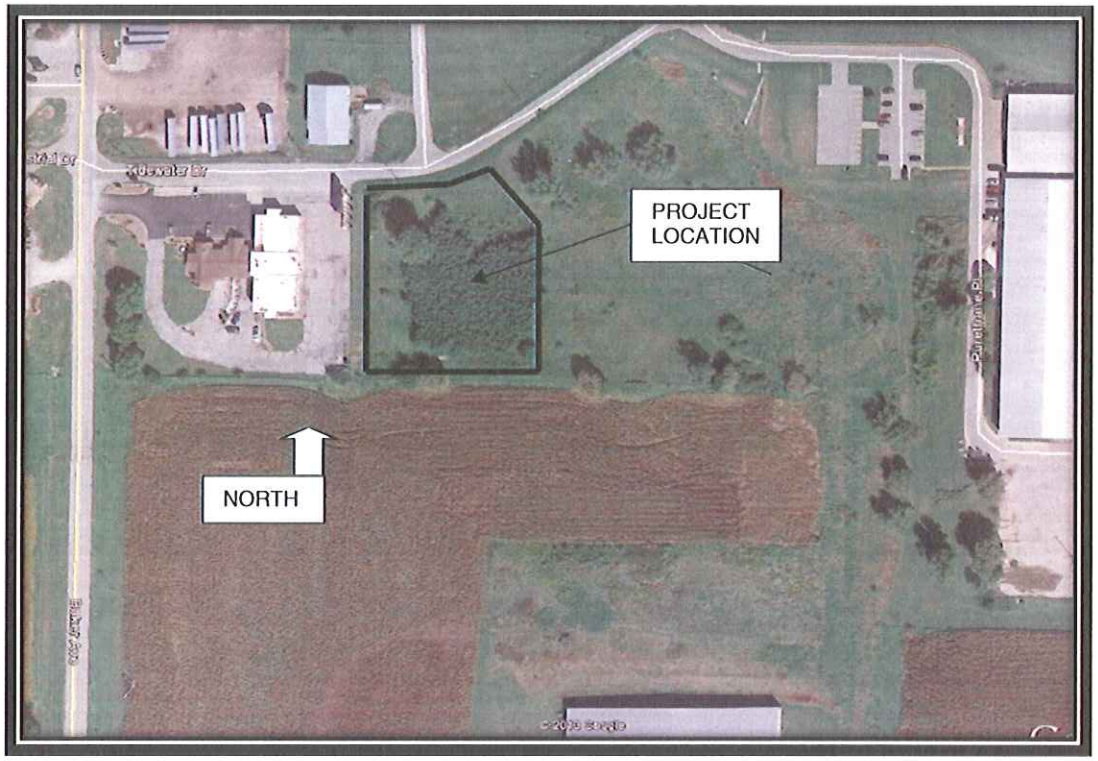
The soils on the project site were identified according to the Soil Survey of Cedar County, Iowa on the United States Department of Agriculture website. The following soil is found on the Project Site. (See APPENDIX A)

- 120B Tama silty clay loam, 2 to 5 percent slopes, well drained loess
- 120C Tama silty clay loam, 5 to 9 percent slopes, well drained loess

The soils are identified by the soil survey as Hydrologic Group B and located in Section 6 per ISMM 2C-2. Infiltration rates were determined for the site with percolation tests and provided in the Geotechnical Engineering Services Report, dated August 16, 2013 prepared by PSI. (See APPENDIX J)

F. Flood Statement

The site is outside of the 100-Year floodplain per the Flood Insurance Rate Map Panel 211 of 400 for Cedar County, Iowa and Incorporate Areas. (See APPENDIX B)



VICINITY MAP

II. METHOD OF ANALYSIS

A. Design Standard

The analysis was performed in accordance with the requirements of the City of West Branch, Iowa, and the Iowa Stormwater Management Manual (ISMM).

B. Time of Concentration

The Time of Concentration was calculated using TR-55 formulas for sheet flow, shallow concentrated flow per ISMM 2C-2.

C. Precipitation Model

Rainfall data was developed from Tables in ISMM 2C-3. The site analysis was performed for the 1.26 acre developed site only. The Peak flow for the 5-Year existing condition was calculated by the Rational Method as outlined in ISMM 2C-4 and the modeling program, Bentley Pond Pack V8i using the SCS Unit Hydrograph model with Type II, 24-hour storms. The post development analysis was performed using the modeling program, Bentley PondPack V8i and the SCS Unit Hydrograph model with Type II, 24-hour storms **using rainfall amounts from Section 2C-2 Rainfall Runoff Analysis, Table 2.** The analysis was performed for the 5, 10, 25, 50 and 100-year events.

D. Curve Numbers

CN values were obtained from Table 2 ISMM 2C-5 for Hydrologic Soil Group B. A CN of 61 was used for green open space and a CN of 98 was used for impervious areas.

E. Target Release Rate

The detention basin analysis is based on the City requirement to detain the difference in volume of the 5-year undeveloped storm and the 100-year developed storm event and to have a maximum 100-year developed peak runoff less than or equal to the 5-year peak runoff rate.

III. EXISTING CONDITION ANALYSIS

A. Summary of Existing Condition Analysis

The 1.26 acre site is currently comprised of green space and trees with light underbrush. (See APPENDIX C) Using the Rational Method a peak discharge was determined for the 5-year storm event and will be used as the target release rate for the 100-year storm event in the proposed condition. From Worksheet 1 the Time of Concentration (Tc) was determined to be 0.46 hrs. Using this Tc and a CN value of 61 the peak runoff and volume were determined for the 5, 10, 25, 50 and 100 year storm events using Pond Pack. Results of the analysis are shown in Table 1 below and presented in APPENDIX D.

TABLE 1
PEAK FLOW AND VOLUME

DA	Area (ac)	CN	Tc (Hrs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
DA1	1.26	61	0.46	0.61	0.97	1.66	2.31	3.01
Volume (ac-ft)				0.074	0.106	0.168	0.227	0.289

IV. PROPOSED CONDITION ANALYSIS`

A. Summary

The project proposes to construct a Clean Energy LNG Fueling Station on the 1.50 acre site. When completed, 1.26 acres of the site (DA-1), including 0.91 acres of parking lot or impervious area will be directed to an extended dry detention pond located along the eastern property line of the site.

B. Post Developed Flows

Runoff from the parking lot will sheet flow to the east side of the parking lot and released to riprapped channels via two curb cuts. The channels will flow directly to the basin and flow via a

concrete channel to the primary discharge pipe. The remaining 0.22 acres of the site (DA-2) will remain open green space and will flow from the site un-detained, as in the existing condition. Offsite drainage to the site will be captured in a swale on the west side of the parking lot and directed away from the developed site and not passed through the basin (See APPENDIX E).

C. Post Developed CN Values

Using the CN values for impervious and green space areas, a weighted value, CN_W was determined for the 1.44 acre developed site and is presented below. A CN of 61 was used for the un-detained area.

DA-1

CN 98 = 0.91 Ac.
CN 61 = 0.34 Ac.

CN_W – DA 1
Total Area = 1.44 Ac.

$$CN_W = \frac{(0.91*98)+(0.34*61)}{1.26}$$

CN_W = 87.2 (Use 87)

D. Post Developed Runoff Summary

From Worksheet 1 for the 1.26 acre developed condition the Time of Concentration (Tc) was determined to be 5 minutes. A Tc of 5 minutes was also used for the 0.22 acre un-detained area. The proposed watersheds were then modeled using Pond Pack. Results of the analysis are shown in Table 2 and presented in APPENDIX F.

TABLE 2
PEAK FLOW AND VOLUME

DA	Area (ac)	CN	Tc (Hrs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
DA1	1.26	87	5	4.67	5.69	7.41	8.86	10.31
Peak Volume (ac-ft)				0.257	0.315	0.414	0.499	0.585
DA-2	0.22	61	5	0.17	0.26	0.43	0.58	0.75
Peak Volume (ac-ft)				0.011	0.015	0.024	0.033	0.042
Total Peak Flow (cfs)				4.84	5.95	7.84	9.44	11.06
Total Volume (ac-ft)				0.269	0.330	0.438	0.533	0.627

E. Detention Basin Summary

As a result of the improvements there will be an increase in the peak runoff from this site. To mitigate the impacts and to meet City standards an extended dry detention basin is proposed to be constructed along the eastern property line of the site. As stated previously the basin is designed

to detain the difference in volume of the 5-year undeveloped storm and the 100-year developed storm event and to meet the target release rate from the site of 0.61 cfs. The proposed pond volume is presented Table 3 below.

F. Detention Basin Sizing

To meet the volume requirement, a detention basin having a top of basin elevation of 772.80' and the dimensions shown in Table 3 is proposed.

TABLE 3
ESTIMATE OF PROPOSED
DETENTION POND VOLUME

Elevation	Area (s.f.)	Volume (c.f.)	Accumulative Volume (c.f.)
769.50	2624		
770	5729	2088	2088
771	10647	8188	10276
772	12153	11400	21676

G. Detention Basin Routing

Discharge from the basin will be via five (5) 2.5" openings at an invert elevation of 769.8 feet, into the 42" Riser Pipe. From the riser flow will be via a 15" pipe that will daylight on site south of the basin. Using the modeling program Pond Pack the 1.28 acre site was routed through the proposed basin. Results of the pond routing analysis are shown in Table 4 and presented in APPENDIX G.

TABLE 4
POND ROUTING ANALSIS

	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
Peak Flow In	4.67	5.69	7.41	8.86	10.31
Peak Flow Out	**0.32**	**0.38**	**0.48**	**0.54**	**0.59**
Peak Volume Out (ac-ft)	**0.106**	**0.148**	**0.223**	**0.287**	**0.352**

H. Primary Discharge Summary

The 42" riser is proposed in the basin to pass the 100-Year storm event. Discharge from the riser will be via an 15" pipe. Flow calculations for the riser and discharge pipe are presented in APPENDIX H.

I. Peak Flow Summary

The detention basin is able to reduce the peak runoff for all storm events and limit the developed peak runoff for the 100 year storm event to the 5 year existing peak runoff. A comparison of the peak flow for the existing and developed area is presented Table 5.

TABLE 5
TOTAL PEAK FLOW
EXISTING AND DEVELOPED

	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
Existing Condition	0.61	0.97	1.66	2.31	3.01
Developed Condition	**0.32**	**0.38**	**0.48**	**0.54**	**0.59**
Change	**-0.29**	**-0.59**	**-1.18**	**-1.77**	**-2.42**

J. Embankment and Channel Protection

Runoff from the parking lot will flow to the detention basin via two riprapped lined channels. To mitigate erosion and sediment transport, filter fabric will be used between the excavated channel and the rip rap. To further mitigate the potential for erosion within the basin, the sides will be vegetated and a **2 foot wide riprap flume with filter fabric** will be constructed along the bottom of the channel. **In addition, a 2 inch perforated pipe will be installed below the riprap flume to provide an under drain for the detention pond.** Downstream of the basin a receiving channel will be constructed and lined with a filter fabric overlain by rip rap. Silt fencing and other erosion control measures will remain in place until permanent vegetation is established on the site.

K. Permits

At this time no permits have been obtained by the developer. A NPDES permit will be submitted along with other permits required by the governing authorities.

If you have questions or comments about this study please contact me at (816) 468-5858.

Respectfully Submitted,
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PROFESSIONAL ENGINEER
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Leon Osbourn, P.E.
President

APPENDIX

APPENDIX A
SOIL SURVEY OF CEDAR COUNTY, IOWA

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

Iowa Department of Agriculture and Land Stewardship

IOWA STATE UNIVERSITY
Iowa Agriculture and Home Economics Experiment Station

IOWA STATE UNIVERSITY
University Extension

In cooperation with Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service, Iowa State University, and Division of Soil Conservation, Iowa Department of Agriculture and Land Stewardship

Soil Survey of Cedar County, Iowa

Part I

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

Iowa Department of Agriculture and Land Stewardship

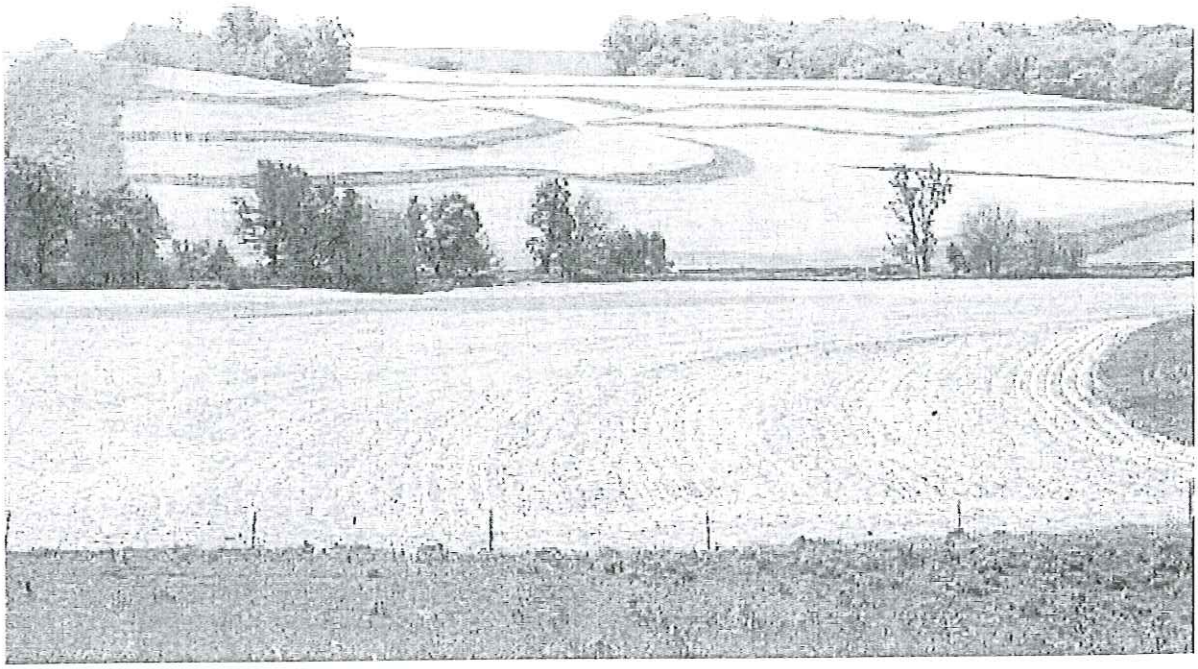
IOWA STATE UNIVERSITY
Iowa Agriculture and Home Economics Experiment Station

IOWA STATE UNIVERSITY
University Extension

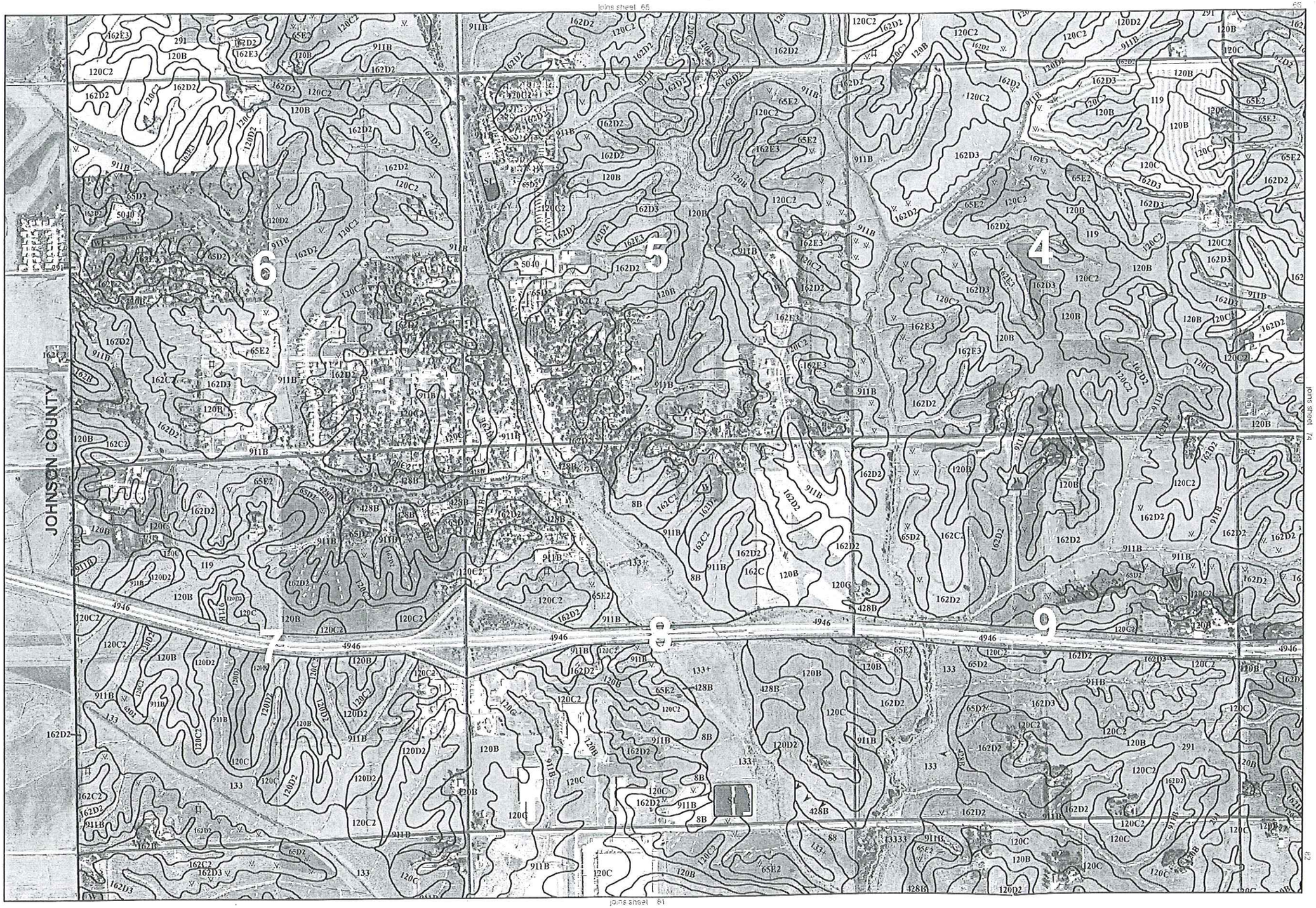
In cooperation with Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service, Iowa State University, and Division of Soil Conservation, Iowa Department of Agriculture and Land Stewardship

Soil Survey of Cedar County, Iowa

Part II



Township 79N Range 04W



0 1/4 1/2 3/4 1 Miles

0 1,000 2,000 3,000 4,000 5,000 Feet

Soil Survey of Cedar County, Iowa

This map was prepared by the U.S. Department of Agriculture, Natural Resources Conservation Service using the 2008 Cedar County, Iowa SSURGO certified database. The soils and hydrography were compiled to the summer 2006 imagery of the National Agricultural Inventory Project (NAIP).

North American Datum of 1983 (NAD83). GRS-80 Spheroid. Universal Transverse Mercator, zone 15.

Visit the online Web Soil Survey at http://websoilsurvey.nrcs.usda.gov for official and current USDA soil information as viewable maps and tables. Visit the Soil Data Mart at http://soildatamart.usda.gov to download SSURGO certified soil tabular and spatial data.

United States Department of Agriculture
NRCS Natural Resources Conservation Service

Flooding: None
Depth to wet zone: More than 6.7 feet all year
Ponding: None
Available water capacity to a depth of 60 inches: 12.1 inches
Content of organic matter in the upper 10 inches: 3.5 percent

120B—Tama silty clay loam, 2 to 5 percent slopes

Component Description

Tama and similar soils
Extent: 85 to 95 percent of the unit
Position on the landscape: Summits and ridgetops (fig. 8)
Slope range: 2 to 5 percent
Texture of the surface layer: Silty clay loam
Depth to restrictive feature: Very deep (more than 60 inches)
Drainage class: Well drained
Parent material: Loess
Flooding: None
Depth to wet zone: More than 6.7 feet all year
Ponding: None
Available water capacity to a depth of 60 inches: 12.1 inches
Content of organic matter in the upper 10 inches: 3.5 percent

Figure 8.—Contour buffer strips and grassed waterways help to control erosion in an area of Tama and Downs soils.

Minor Dissimilar Components

Osco and similar soils
Extent: 5 to 15 percent of the unit

120C—Tama silty clay loam, 5 to 9 percent slopes

Component Description

Tama and similar soils
Extent: 75 to 85 percent of the unit
Position on the landscape: Shoulders, summits, and side slopes
Slope range: 5 to 9 percent
Texture of the surface layer: Silty clay loam
Depth to restrictive feature: Very deep (more than 60 inches)
Drainage class: Well drained
Parent material: Loess
Flooding: None
Depth to wet zone: More than 6.7 feet all year
Ponding: None
Available water capacity to a depth of 60 inches: 12.1 inches
Content of organic matter in the upper 10 inches: 3.5 percent

Minor Dissimilar Components

Osco and similar soils
Extent: 5 to 15 percent of the unit

Tama, moderately eroded, and similar soils
Extent: 5 to 15 percent of the unit

120C2—Tama silty clay loam, 5 to 9 percent slopes, moderately eroded

Component Description

Tama, moderately eroded, and similar soils
Extent: 85 to 95 percent of the unit
Position on the landscape: Shoulders, summits, and side slopes
Slope range: 5 to 9 percent
Texture of the surface layer: Silty clay loam
Depth to restrictive feature: Very deep (more than 60 inches)
Drainage class: Well drained
Parent material: Loess
Flooding: None
Depth to wet zone: More than 6.7 feet all year
Ponding: None
Available water capacity to a depth of 60 inches: 11.7 inches
Content of organic matter in the upper 10 inches: 2.3 percent

Minor Dissimilar Components

Osco, moderately eroded, and similar soils
Extent: 5 to 15 percent of the unit

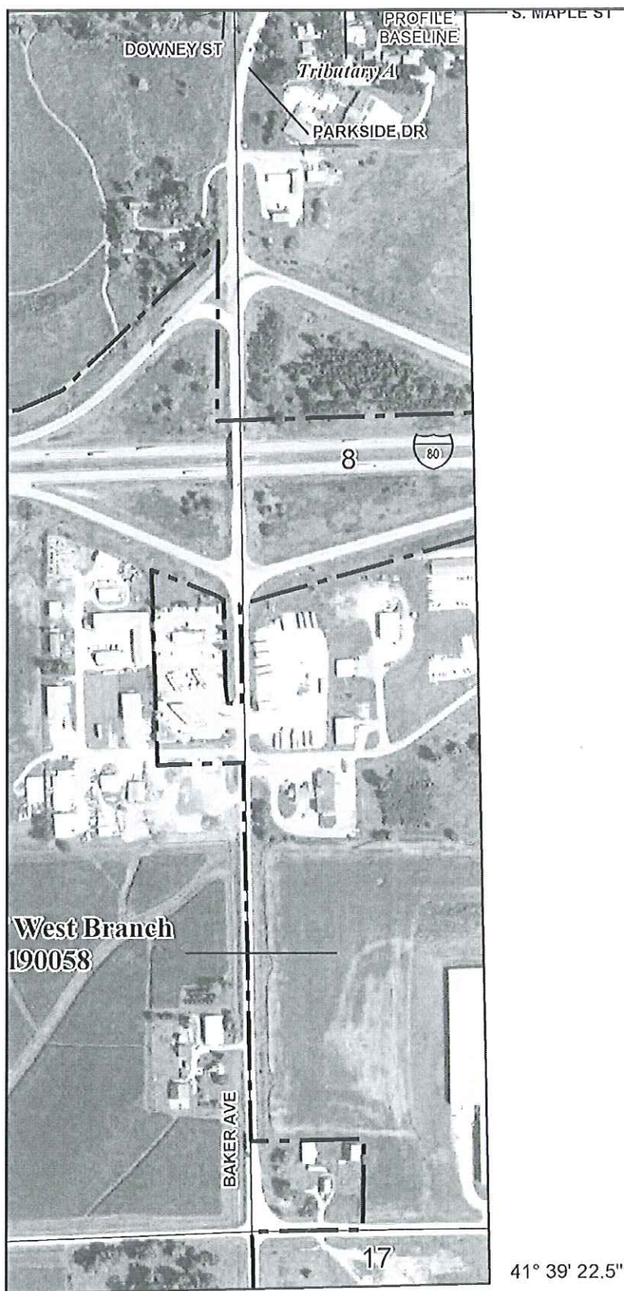
Water Features--Continued

Map symbol and soil name	Hydrologic group	Surface runoff	Month	Water table: Upper limit	Water table: Lower limit	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
				Ft	Ft	Ft				
120B:										
Tama	B	Low								
			January	---	---	---	---	None	---	None
			February	---	---	---	---	None	---	None
			March	---	---	---	---	None	---	None
			April	---	---	---	---	None	---	None
			May	---	---	---	---	None	---	None
			June	---	---	---	---	None	---	None
			July	---	---	---	---	None	---	None
			August	---	---	---	---	None	---	None
			September	---	---	---	---	None	---	None
			October	---	---	---	---	None	---	None
			November	---	---	---	---	None	---	None
			December	---	---	---	---	None	---	None
120C:										
Tama	B	Medium								
			January	---	---	---	---	None	---	None
			February	---	---	---	---	None	---	None
			March	---	---	---	---	None	---	None
			April	---	---	---	---	None	---	None
			May	---	---	---	---	None	---	None
			June	---	---	---	---	None	---	None
			July	---	---	---	---	None	---	None
			August	---	---	---	---	None	---	None
			September	---	---	---	---	None	---	None
			October	---	---	---	---	None	---	None
			November	---	---	---	---	None	---	None
			December	---	---	---	---	None	---	None
120C2:										
Tama, moderately eroded	B	Medium								
			January	---	---	---	---	None	---	None
			February	---	---	---	---	None	---	None
			March	---	---	---	---	None	---	None
			April	---	---	---	---	None	---	None
			May	---	---	---	---	None	---	None
			June	---	---	---	---	None	---	None
			July	---	---	---	---	None	---	None
			August	---	---	---	---	None	---	None
			September	---	---	---	---	None	---	None
			October	---	---	---	---	None	---	None
			November	---	---	---	---	None	---	None
			December	---	---	---	---	None	---	None

Physical Properties of the Soils--Continued

Map symbol and soil name	Pct. of map unit	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors Kw	Kf	T	Wind erodi-bility group	Wind erodi-bility index
		In	Pct	g/cc	In/hr	In/in	Pct	Pct					
110C:													
Lamont----------	85	0-8	10-15	1.50-1.55	2-6	0.16-0.18	0.0-2.9	0.5-1.5	.24	.24	4	3	86
		8-23	5-15	1.50-1.55	2-6	0.14-0.16	0.0-2.9	0.0-0.5	.24	.24			
		23-53	10-22	1.45-1.65	2-6	0.14-0.16	0.0-2.9	0.0-0.5	.24	.24			
		53-80	5-15	1.65-1.75	6-20	0.09-0.11	0.0-2.9	0.0-0.5	.17	.17			
110E:													
Lamont----------	95	0-8	10-15	1.50-1.55	2-6	0.16-0.18	0.0-2.9	0.5-1.5	.24	.24	4	3	86
		8-23	5-15	1.50-1.55	2-6	0.14-0.16	0.0-2.9	0.0-0.5	.24	.24			
		23-53	10-22	1.45-1.65	2-6	0.14-0.16	0.0-2.9	0.0-0.5	.24	.24			
		53-80	5-15	1.65-1.75	6-20	0.09-0.11	0.0-2.9	0.0-0.5	.17	.17			
118:													
Garwin----------	95	0-8	30-35	1.30-1.35	0.6-2	0.21-0.23	6.0-8.9	6.0-7.0	.28	.28	5	7	38
		8-18	30-35	1.30-1.35	0.6-2	0.21-0.23	6.0-8.9	3.0-5.0	.28	.28			
		18-42	27-35	1.28-1.35	0.6-2	0.18-0.20	6.0-8.9	1.0-2.0	.28	.28			
		42-80	20-26	1.35-1.45	0.6-2	0.20-0.22	3.0-5.9	0.0-0.5	.43	.43			
119:													
Muscatine----------	95	0-8	28-30	1.30-1.35	0.6-2	0.22-0.24	4.1-5.5	4.0-6.0	.28	.28	5	7	38
		8-20	28-30	1.30-1.35	0.6-2	0.22-0.24	5.0-5.5	4.0-6.0	.28	.28			
		20-42	30-35	1.28-1.35	0.6-2	0.18-0.20	5.5-6.8	1.0-2.0	.43	.43			
		42-64	22-30	1.35-1.40	0.6-2	0.18-0.20	3.5-5.5	0.5-1.0	.43	.43			
119B:													
Muscatine----------	95	0-8	28-30	1.30-1.35	0.6-2	0.22-0.24	4.1-5.5	4.0-6.0	.28	.28	5	7	38
		8-20	28-30	1.30-1.35	0.6-2	0.22-0.24	5.0-5.5	4.0-6.0	.28	.28			
		20-42	30-35	1.28-1.35	0.6-2	0.18-0.20	5.5-6.8	1.0-2.0	.43	.43			
		42-64	22-30	1.35-1.40	0.6-2	0.18-0.20	3.5-5.5	0.5-1.0	.43	.43			
120:													
Tama----------	100	0-8	22-30	1.25-1.30	0.6-2	0.22-0.24	3.0-5.9	3.0-4.0	.28	.28	5	6	48
		8-18	22-30	1.25-1.30	0.6-2	0.22-0.24	3.0-5.9	3.0-4.0	.28	.28			
		18-45	27-35	1.30-1.35	0.6-2	0.18-0.20	3.0-5.9	1.0-2.0	.43	.43			
		45-60	20-30	1.35-1.40	0.6-2	0.18-0.20	3.0-5.9	0.0-0.5	.43	.43			
120B:													
Tama----------	90	0-8	22-30	1.25-1.30	0.6-2	0.22-0.24	3.0-5.9	3.0-4.0	.28	.28	5	7	38
		8-18	22-30	1.25-1.30	0.6-2	0.22-0.24	3.0-5.9	3.0-4.0	.28	.28			
		18-45	27-35	1.30-1.35	0.6-2	0.18-0.20	3.0-5.9	1.0-2.0	.43	.43			
		45-60	20-30	1.35-1.40	0.6-2	0.18-0.20	3.0-5.9	0.0-0.5	.43	.43			
120C:													
Tama----------	80	0-8	22-30	1.25-1.30	0.6-2	0.22-0.24	3.0-5.9	3.0-4.0	.28	.28	5	7	38
		8-18	22-30	1.25-1.30	0.6-2	0.22-0.24	3.0-5.9	3.0-4.0	.28	.28			
		18-45	27-35	1.30-1.35	0.6-2	0.18-0.20	3.0-5.9	1.0-2.0	.43	.43			
		45-60	20-30	1.35-1.40	0.6-2	0.18-0.20	3.0-5.9	0.0-0.5	.43	.43			

APPENDIX B
FLOOD INSURANCE RATE MAP
CEDAR COUNTY, IOWA
AND INCORPORATED AREAS



41° 39' 22.5"

91° 20' 37.5"

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0211C

FIRM

FLOOD INSURANCE RATE MAP

CEDAR COUNTY, IOWA AND INCORPORATED AREAS

PANEL 211 OF 400

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CEDAR COUNTY	190050	0211	C
WEST BRANCH, CITY OF	190058	0211	C

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
19031C0211C

EFFECTIVE DATE
AUGUST 19, 2013

Federal Emergency Management Agency

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 19, 2013

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary

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

APPENDIX C
EXISTING CONDITION
DRAINAGE AREA MAP

APPENDIX D
EXISTING CONDITIONS CALCULATIONS
AND
POND PACK RESULTS

Worksheet 1: Time of Concentration (T_c) or Travel Time (T_t)

Project LNG Fueling Facility By DPB Date 8/21/13

Location West Branch, Iowa Checked _____ Date _____

Circle one: Present Developed

Circle one: T_c T_t through sub area

Notes: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	AB				
1. Surface description (Table 2).....		Woods				
2. Manning's roughness coeff., n (Table 2).....		0.40				
3. Flow Length, L (Total L less than or equal to 300')...	ft	160				
4. Two-year 24-hour rainfall, P_2.....	in	3.06				
5. Land slope, s.....	ft / ft	0.03				
6. $T_t = \frac{0.007(nL)^{0.8}}{(\sqrt{P_2})(s^{0.4})}$ Compute T_t.....	hr	0.45	+		=	0.45

Shallow concentrated flow	Segment ID	BC				
7. Surface description (paved or unpaved).....		Unpaved				
8. Flow length, L.....	ft	110				
9. Watercourse slope, s.....	ft / ft	0.0364				
10. Average velocity, V (Figure 1).....	ft / s	3.2				
11. $T_t = \frac{L}{3600V}$ Compute T_t.....	hr	0.01	+		=	0.01

Open channel flow	Segment ID					
12. Cross sectional flow area, a.....	ft^2					
13. Wetted perimeter, P_w.....	ft					
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r.....	ft					
15. Channel slope, s.....	ft / ft					
16. Manning's roughness coeff., n.....						
17. $V = \frac{1.49r^{2/3}s^{1/2}}{n}$ Compute V.....	ft / s					
18. Flow length, L.....	ft					
19. $T_t = \frac{L}{3600V}$ Compute T_t.....	hr		+		=	

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19)..... hr 0.46

KAW VALLEY ENGINEERING, INC.
Junction City, KS Ph 785-762-5040
Kansas City, MO Ph 816-468-5858
Lenexa, KS Ph 913-894-5150

Job LNG Site West Branch, Iowa
Sheet No. 1 Of 1
Calculated by DPB Date 8/21/13
Checked by Date
Scale

Existing Condition Peak Flow

Sheet flow - Woods Light Underbrush $n = 0.40$ (Table 2 2C-3)

$A = 1.26$ ac

$L = 160$ feet, $S = 4.8'/160' = 0.03$ ft/ft

Shallow Concentrated Flow

$L = 110'$, $S = 4'/110' = 0.0364$ ft/ft

Ave Velocity = 3.2 fps (Table 1 2C-3)

Time of Concentration, $T_c = 0.46$ hr = 27.6 min (Use 30 min)

Calculate Peak flow for 5-Year Storm Event

$Q = C_f C I A$ (2C-4)

$C_{f_5} = 1.0$

For Soil Group B, Undeveloped Condition

$C = 0.17$ (Table 1 2C-4)

Rainfall depth = 1.42 in/hr
Intensity = 2.84 in/hr (Table 2 2C-2)

$Q_5 = (1.0)(0.17)(2.84 \text{ in/hr})(1.26 \text{ ac})$

$\boxed{Q_5 = 0.61 \text{ cfs}}$

Subsection: Time of Concentration Calculations
Label: LNG SITE EXISTING CONDITION

Return Event: 5 years
Storm Event: 5 Year

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	160.00 ft
Manning's n	(N/A)
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.1 in
Average Velocity	0.10 ft/s
Segment Time of Concentration	0.450 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	110.00 ft
Is Paved?	False
Slope	0.036 ft/ft
Average Velocity	3.08 ft/s
Segment Time of Concentration	0.010 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.460 hours

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Storm Event	5 Year
Return Event	5 years
Duration	24.000 hours
Depth	3.8 in
Time of Concentration (Composite)	0.460 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.212 hours
Flow (Peak, Computed)	0.62 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.200 hours
Flow (Peak Interpolated Output)	0.61 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.7 in
Runoff Volume (Pervious)	0.075 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.074 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.460 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	3.10 ft^3/s
Unit peak time, Tp	0.307 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.227 hours
Total unit time, Tb	1.534 hours

Storm Event	10 Year
Return Event	10 years
Duration	24.000 hours
Depth	4.4 in
Time of Concentration (Composite)	0.460 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.212 hours
Flow (Peak, Computed)	0.98 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.200 hours
Flow (Peak Interpolated Output)	0.97 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.0 in
Runoff Volume (Pervious)	0.108 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.106 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.460 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	3.10 ft^3/s
Unit peak time, Tp	0.307 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.227 hours
Total unit time, Tb	1.534 hours

Storm Event	25 Year
Return Event	25 years
Duration	24.000 hours
Depth	5.4 in
Time of Concentration (Composite)	0.460 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.212 hours
Flow (Peak, Computed)	1.66 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.200 hours
Flow (Peak Interpolated Output)	1.66 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.6 in
Runoff Volume (Pervious)	0.170 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.168 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.460 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	3.10 ft^3/s
Unit peak time, Tp	0.307 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.227 hours
Total unit time, Tb	1.534 hours

Storm Event	50 Year
Return Event	50 years
Duration	24.000 hours
Depth	6.3 in
Time of Concentration (Composite)	0.460 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.150 hours
Flow (Peak, Computed)	2.31 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	2.31 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.2 in
Runoff Volume (Pervious)	0.228 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.227 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.460 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	3.10 ft^3/s
Unit peak time, Tp	0.307 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.227 hours
Total unit time, Tb	1.534 hours

Storm Event	100 Year
Return Event	100 years
Duration	24.000 hours
Depth	7.1 in
Time of Concentration (Composite)	0.460 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.150 hours
Flow (Peak, Computed)	3.01 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	3.01 ft^3/s

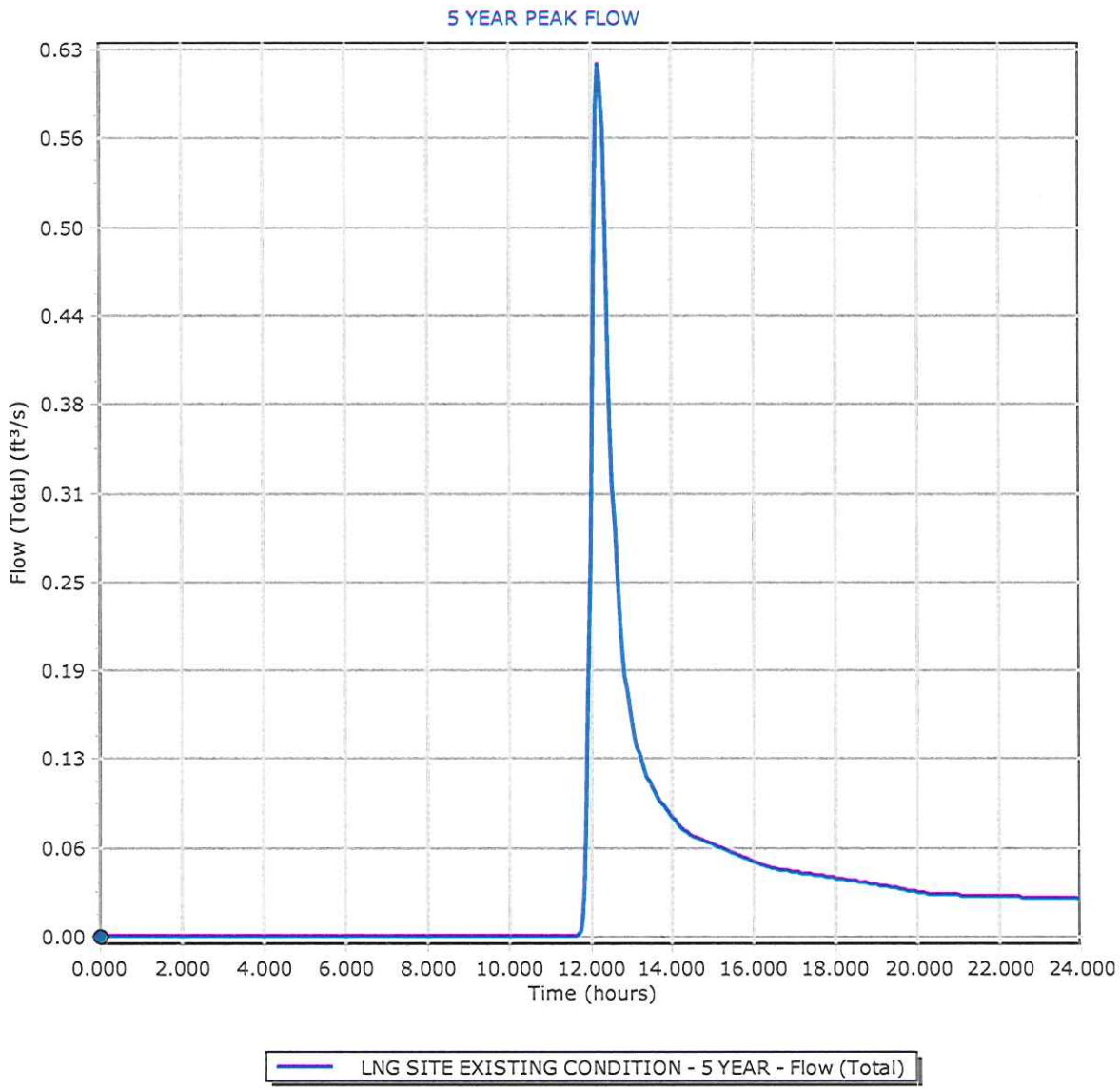
Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

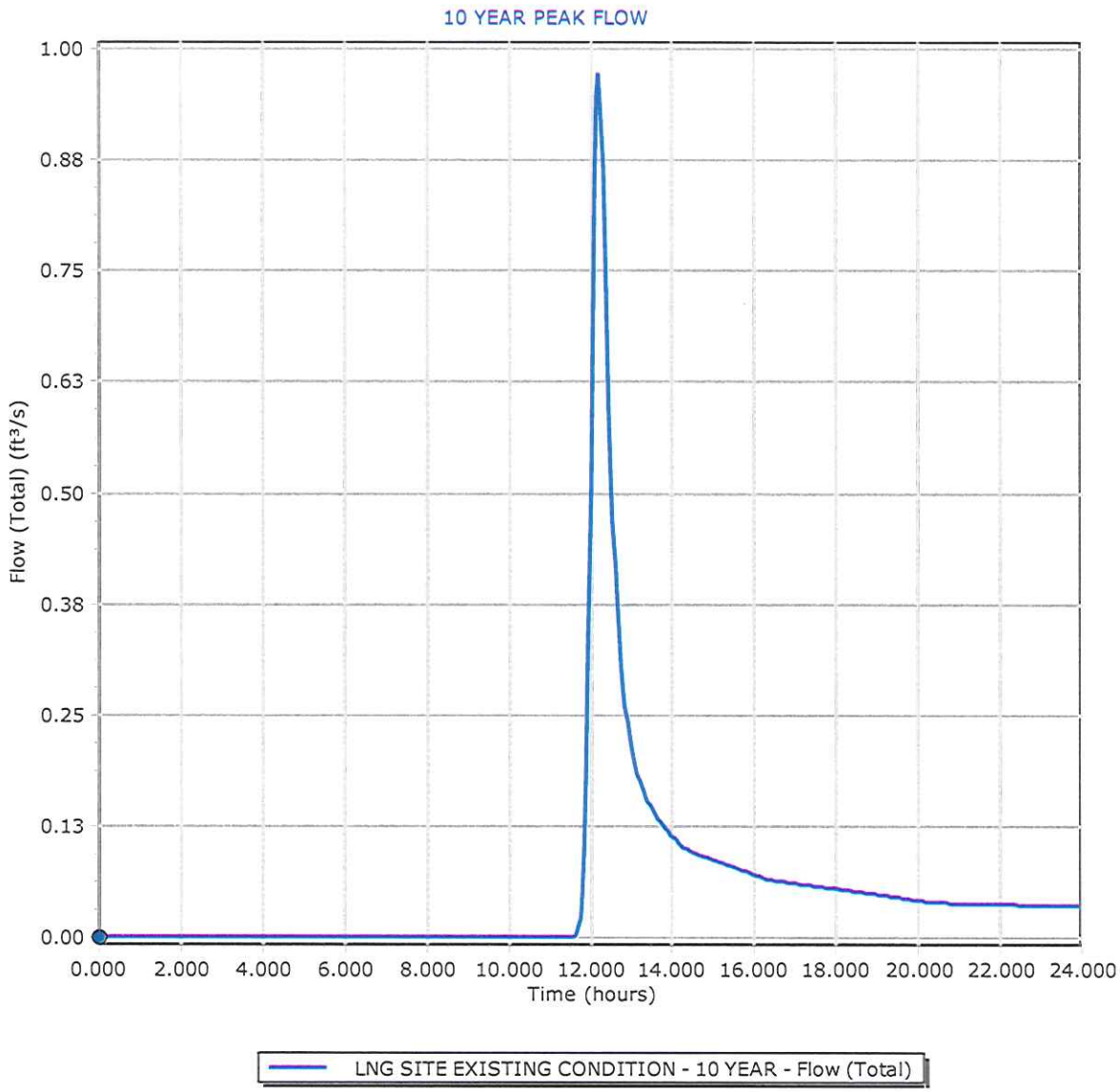
Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.8 in
Runoff Volume (Pervious)	0.291 ac-ft

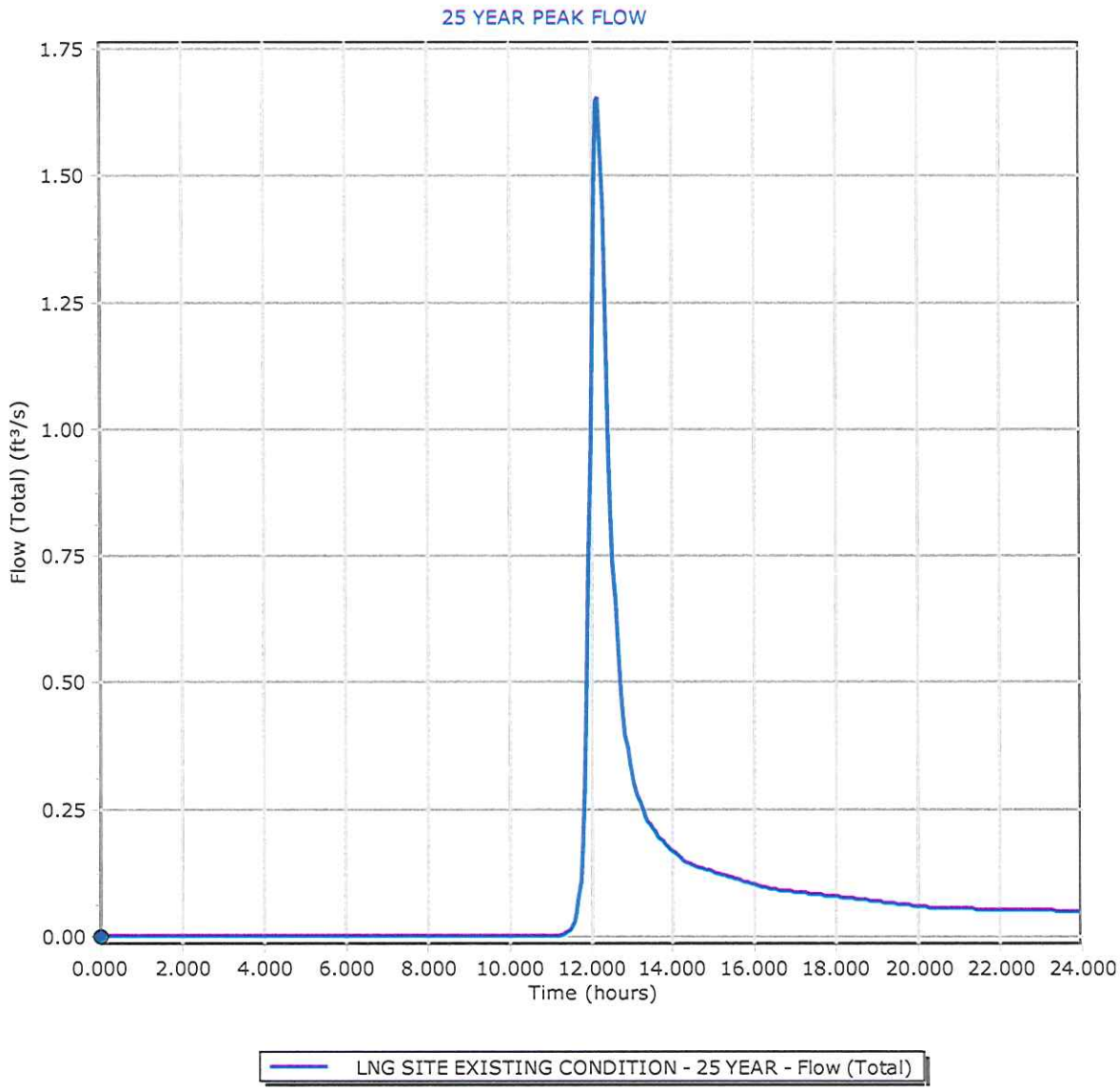
Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.289 ac-ft

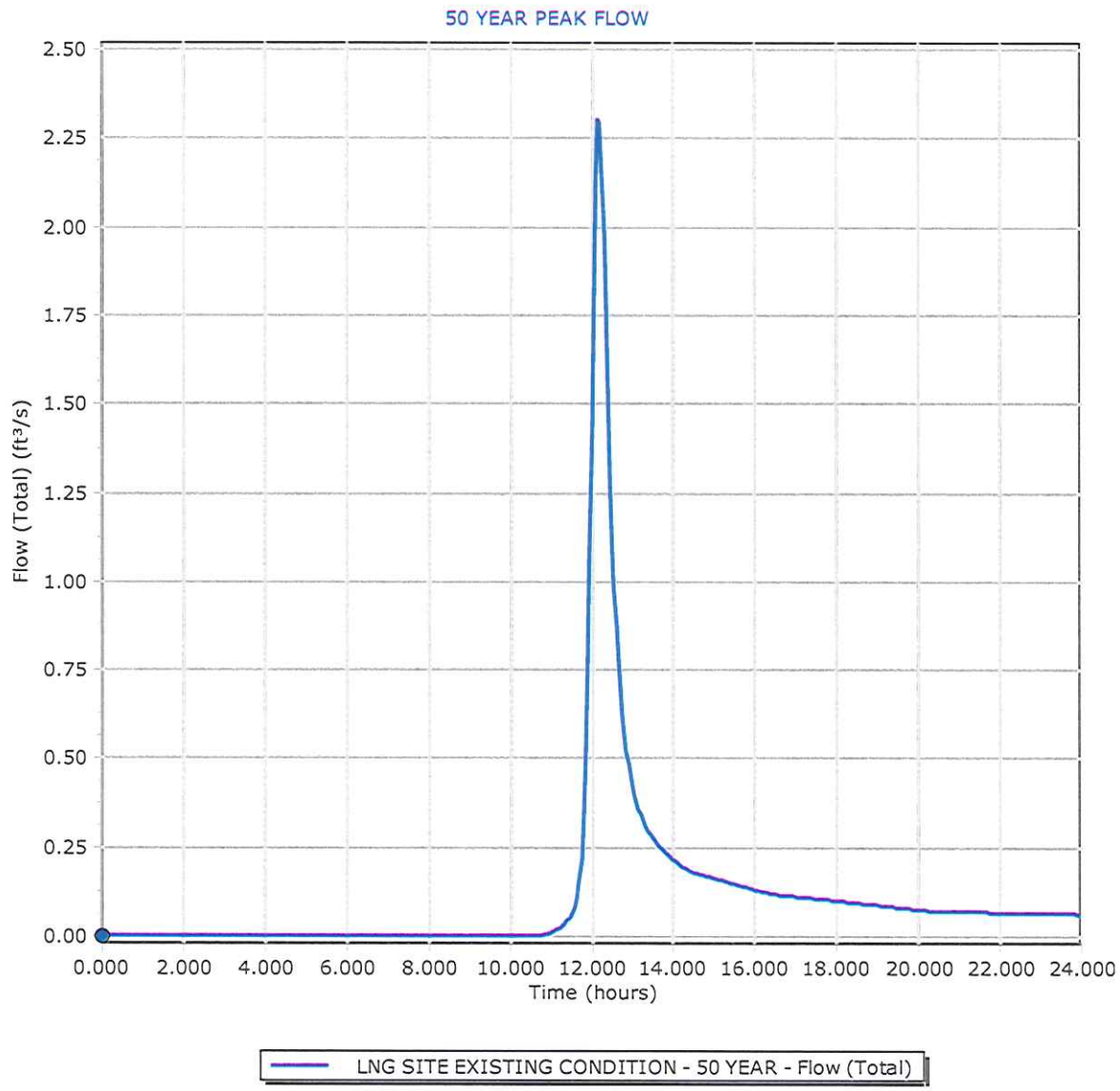
SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.460 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	3.10 ft^3/s
Unit peak time, Tp	0.307 hours

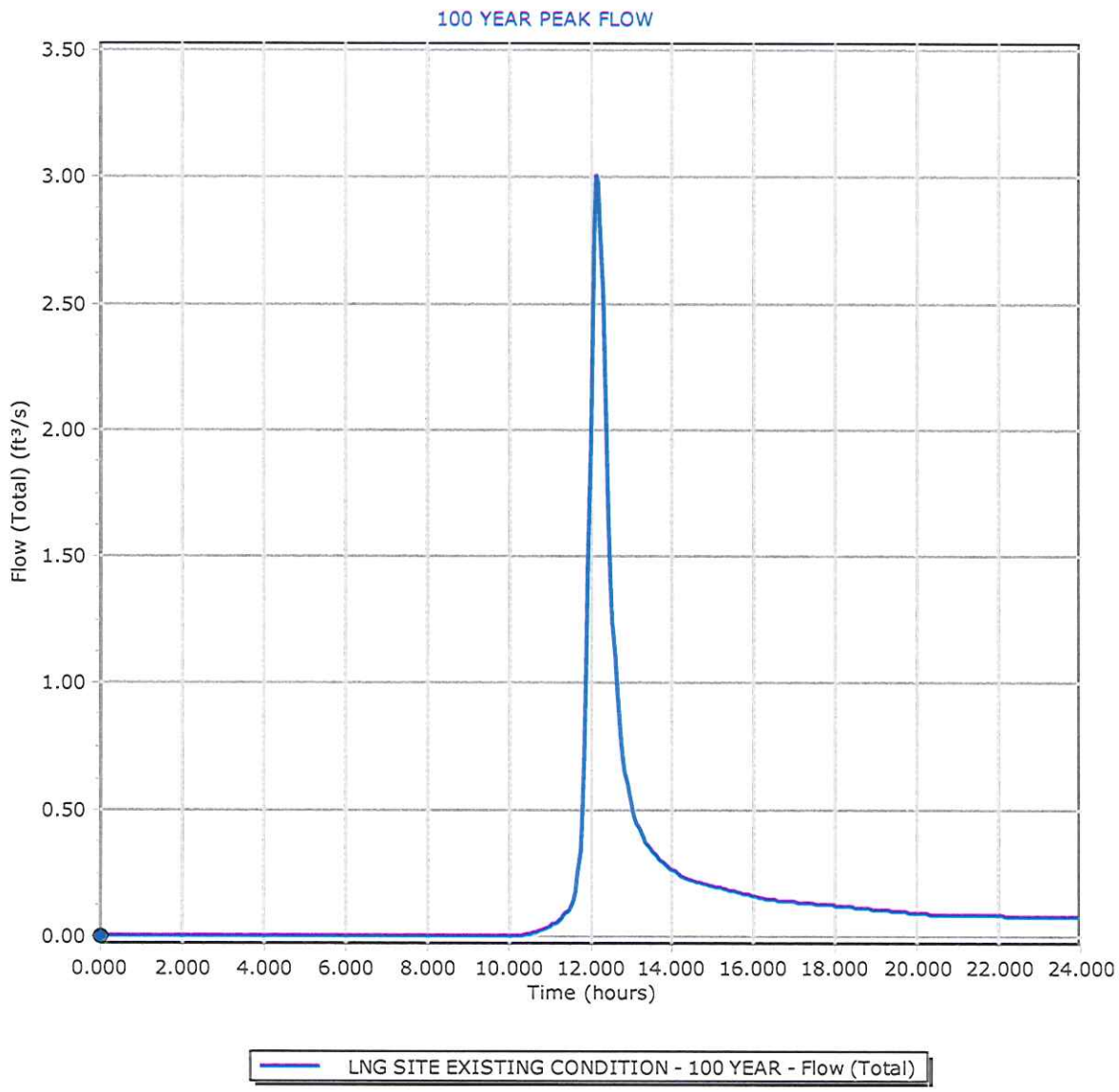
SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.227 hours
Total unit time, Tb	1.534 hours


5 YEAR PEAK FLOW
0.63
0.56
0.50
0.44
0.38
0.31
0.25
0.19
0.13
0.06
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LNG SITE EXISTING CONDITION - 5 YEAR - Flow (Total)


10 YEAR PEAK FLOW
1.00
0.88
0.75
0.63
0.50
0.38
0.25
0.13
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LNG SITE EXISTING CONDITION - 10 YEAR - Flow (Total)


25 YEAR PEAK FLOW
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LNG SITE EXISTING CONDITION - 25 YEAR - Flow (Total)


50 YEAR PEAK FLOW
Flow (Total) (ft³/s)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LNG SITE EXISTING CONDITION - 50 YEAR - Flow (Total)


100 YEAR PEAK FLOW
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LNG SITE EXISTING CONDITION - 100 YEAR - Flow (Total)

APPENDIX E
PROPOSED CONDITION
DRAINAGE AREA MAP

APPENDIX F
PROPOSED CONDITION CALCULATIONS
AND
POND PACK RESULTS

Worksheet 1: Time of Concentration (T_c) or Travel Time (T_t)

Project LNG Fueling Facility By DPB Date 8/21/13
Location West Branch, Iowa Checked _____ Date _____
Circle one: Present (Developed)
Circle one: (T_c) T_t through sub area
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

		Segment ID				
1.	Surface description (Table 2).....		AB			
2.	Manning's roughness coeff., n (Table 2).....		Paved			
3.	Flow Length, L (Total L less than or equal to 300')...		0.011			
4.	Two-year 24-hour rainfall, P_2.....	ft	60			
5.	Land slope, s.....	in	3.06			
6.	$T_t = \frac{0.007(nL)^{0.8}}{(\sqrt{P_2})(s^{0.4})}$ Compute T_t.....	ft / ft	0.026			
		hr	0.053	+	=	0.053

Shallow concentrated flow

		Segment ID				
7.	Surface description (paved or unpaved).....		Paved	Unpaved		
8.	Flow length, L.....	ft	115	40		
9.	Watercourse slope, s.....	ft / ft	0.02	0.032		
10.	Average velocity, V (Figure 1).....	ft / s	2.9	2.9		
11.	$T_t = \frac{L}{3600V}$ Compute T_t.....	hr	0.01	+ 0.004	=	0.014

Open channel flow

		Segment ID				
12.	Cross sectional flow area, a.....	ft^2				
13.	Wetted perimeter, P_w.....	ft				
14.	Hydraulic radius, $r = \frac{a}{P_w}$ Compute r.....	ft				
15.	Channel slope, s.....	ft / ft				
16.	Manning's roughness coeff., n.....					
17.	$V = \frac{1.49r^{2/3}s^{1/2}}{n}$ Compute V.....	ft / s				
18.	Flow length, L.....	ft				
19.	$T_t = \frac{L}{3600V}$ Compute T_t.....	hr		+	=	
20.	Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19).....				hr	0.067

Use 5 minutes

Subsection: Time of Concentration Calculations
Label: LGN SITE PROPOSED DA-1

Return Event: 5 years
Storm Event: 5 YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	60.00 ft
Manning's n	(N/A)
Slope	0.026 ft/ft
2 Year 24 Hour Depth	3.1 in
Average Velocity	1.35 ft/s
Segment Time of Concentration	0.012 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	115.00 ft
Is Paved?	True
Slope	0.020 ft/ft
Average Velocity	2.87 ft/s
Segment Time of Concentration	0.011 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.083 hours

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Storm Event	5 YEAR
Return Event	5 years
Duration	24.000 hours
Depth	3.8 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.922 hours
Flow (Peak, Computed)	4.83 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.900 hours
Flow (Peak Interpolated Output)	4.67 ft^3/s

Drainage Area	
SCS CN (Composite)	87.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	1.5 in
Maximum Retention (Pervious, 20 percent)	0.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.5 in
Runoff Volume (Pervious)	0.258 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.257 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.13 ft^3/s
Unit peak time, Tp	0.056 hours

Subsection: Unit Hydrograph Summary
Label: LGN SITE PROPOSED DA-1

Return Event: 5 years
Storm Event: 5 YEAR

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	10 YEAR
Return Event	10 years
Duration	24.000 hours
Depth	4.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.922 hours
Flow (Peak, Computed)	5.87 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.900 hours
Flow (Peak Interpolated Output)	5.69 ft^3/s

Drainage Area	
SCS CN (Composite)	87.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	1.5 in
Maximum Retention (Pervious, 20 percent)	0.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.0 in
Runoff Volume (Pervious)	0.316 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.315 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.13 ft^3/s
Unit peak time, Tp	0.056 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	25 YEAR
Return Event	25 years
Duration	24.000 hours
Depth	5.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.922 hours
Flow (Peak, Computed)	7.61 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.900 hours
Flow (Peak Interpolated Output)	7.41 ft^3/s

Drainage Area	
SCS CN (Composite)	87.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	1.5 in
Maximum Retention (Pervious, 20 percent)	0.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.9 in
Runoff Volume (Pervious)	0.414 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.414 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.13 ft^3/s
Unit peak time, Tp	0.056 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	50 Year
Return Event	50 years
Duration	24.000 hours
Depth	6.3 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.922 hours
Flow (Peak, Computed)	9.09 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.900 hours
Flow (Peak Interpolated Output)	8.86 ft^3/s

Drainage Area	
SCS CN (Composite)	87.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	1.5 in
Maximum Retention (Pervious, 20 percent)	0.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	4.8 in
Runoff Volume (Pervious)	0.499 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.499 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.13 ft^3/s
Unit peak time, Tp	0.056 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	100 YEAR
Return Event	100 years
Duration	24.000 hours
Depth	7.1 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	1.260 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.922 hours
Flow (Peak, Computed)	10.56 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.900 hours
Flow (Peak Interpolated Output)	10.31 ft^3/s

Drainage Area	
SCS CN (Composite)	87.000
Area (User Defined)	1.260 acres
Maximum Retention (Pervious)	1.5 in
Maximum Retention (Pervious, 20 percent)	0.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	5.6 in
Runoff Volume (Pervious)	0.585 ac-ft

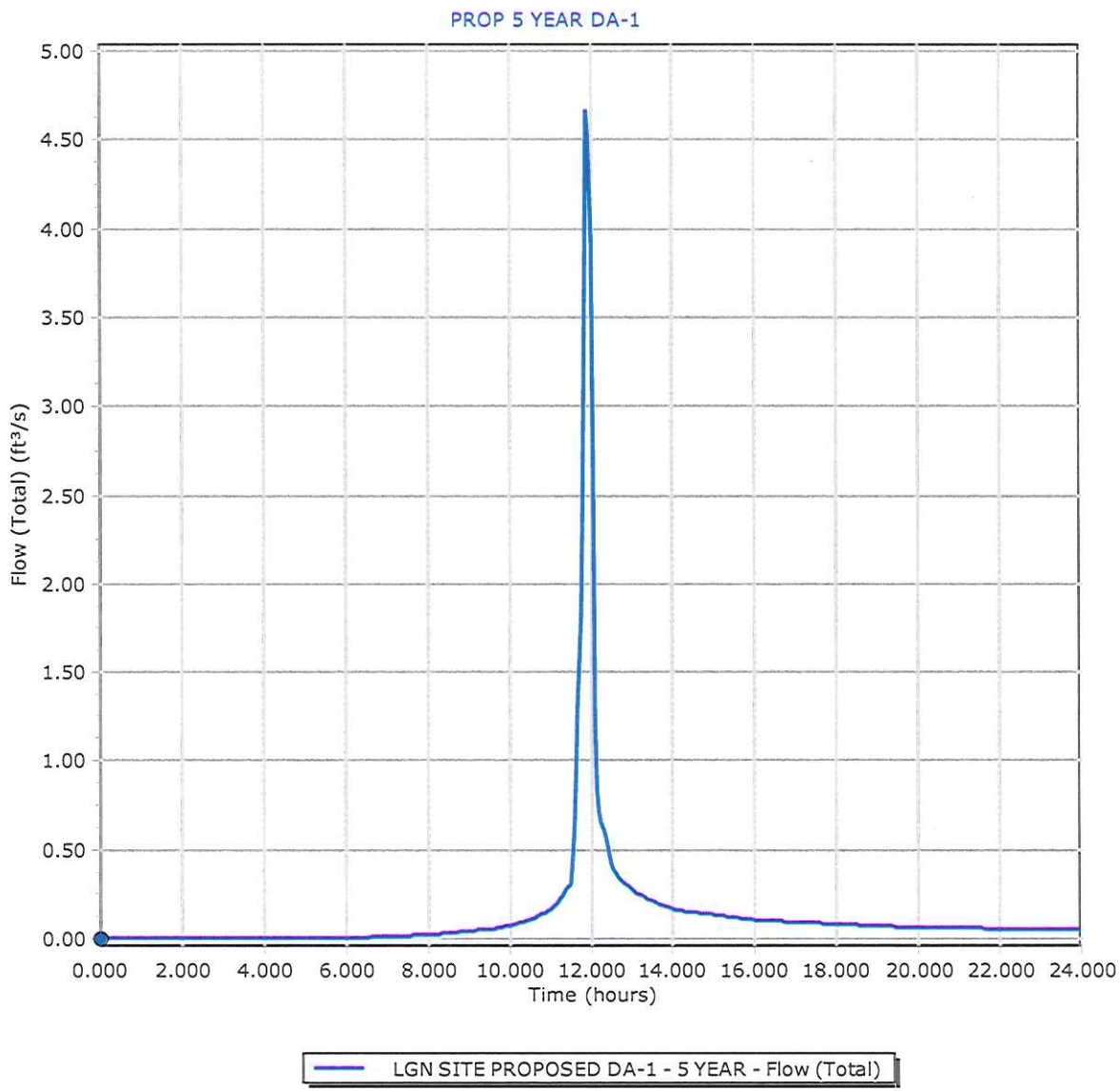
Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.585 ac-ft

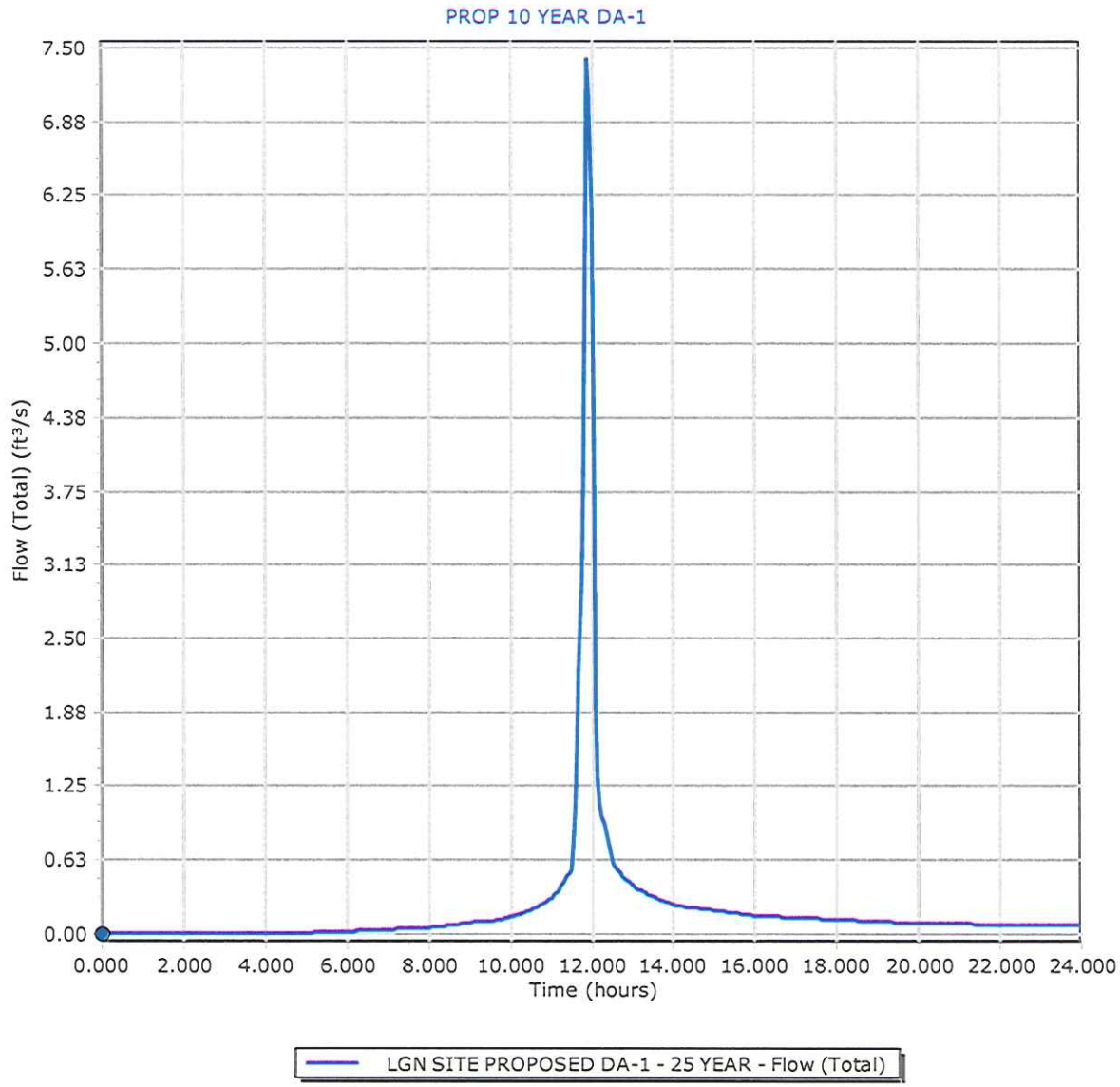
SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.13 ft^3/s
Unit peak time, Tp	0.056 hours

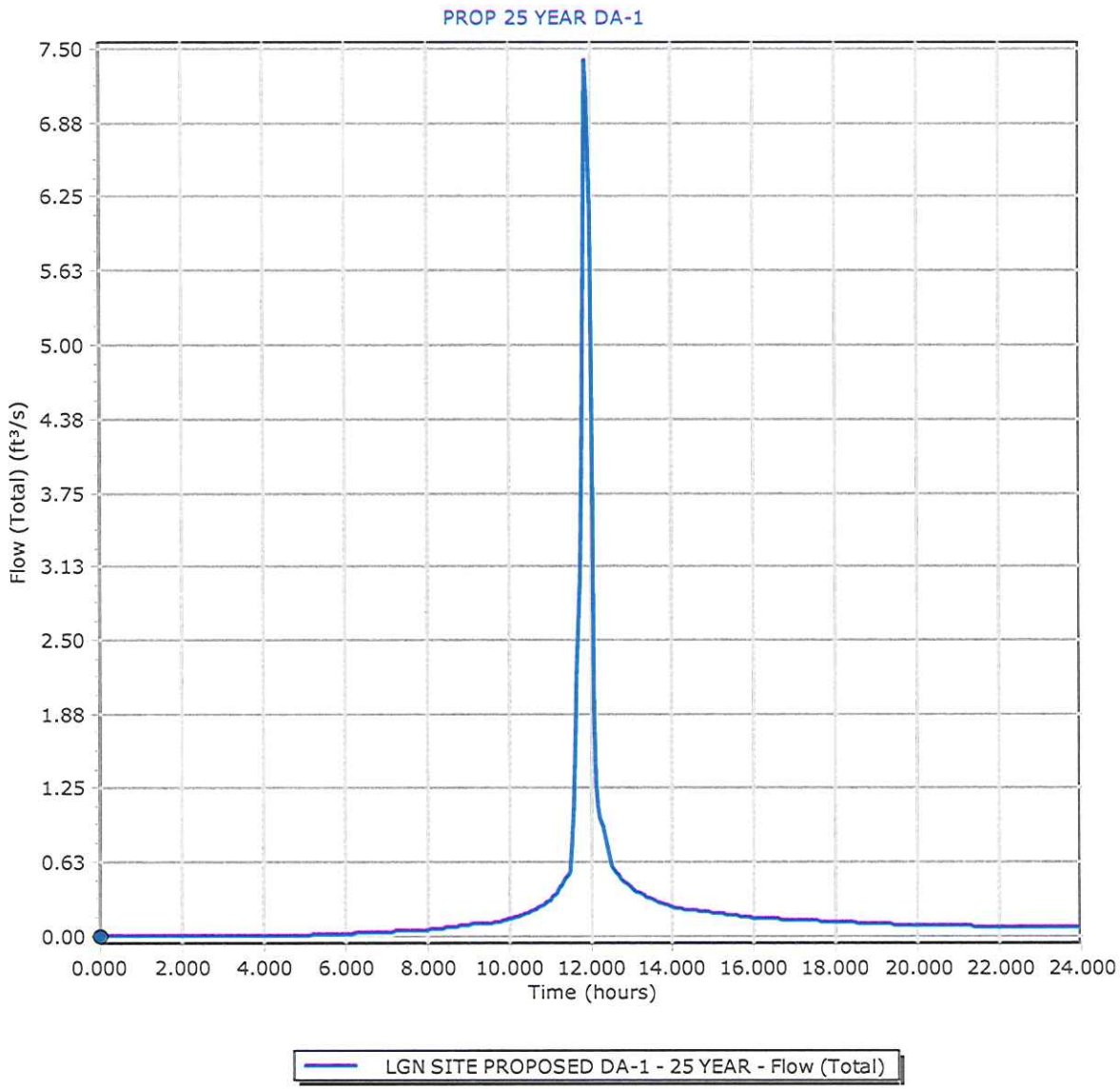
Subsection: Unit Hydrograph Summary
Label: LGN SITE PROPOSED DA-1

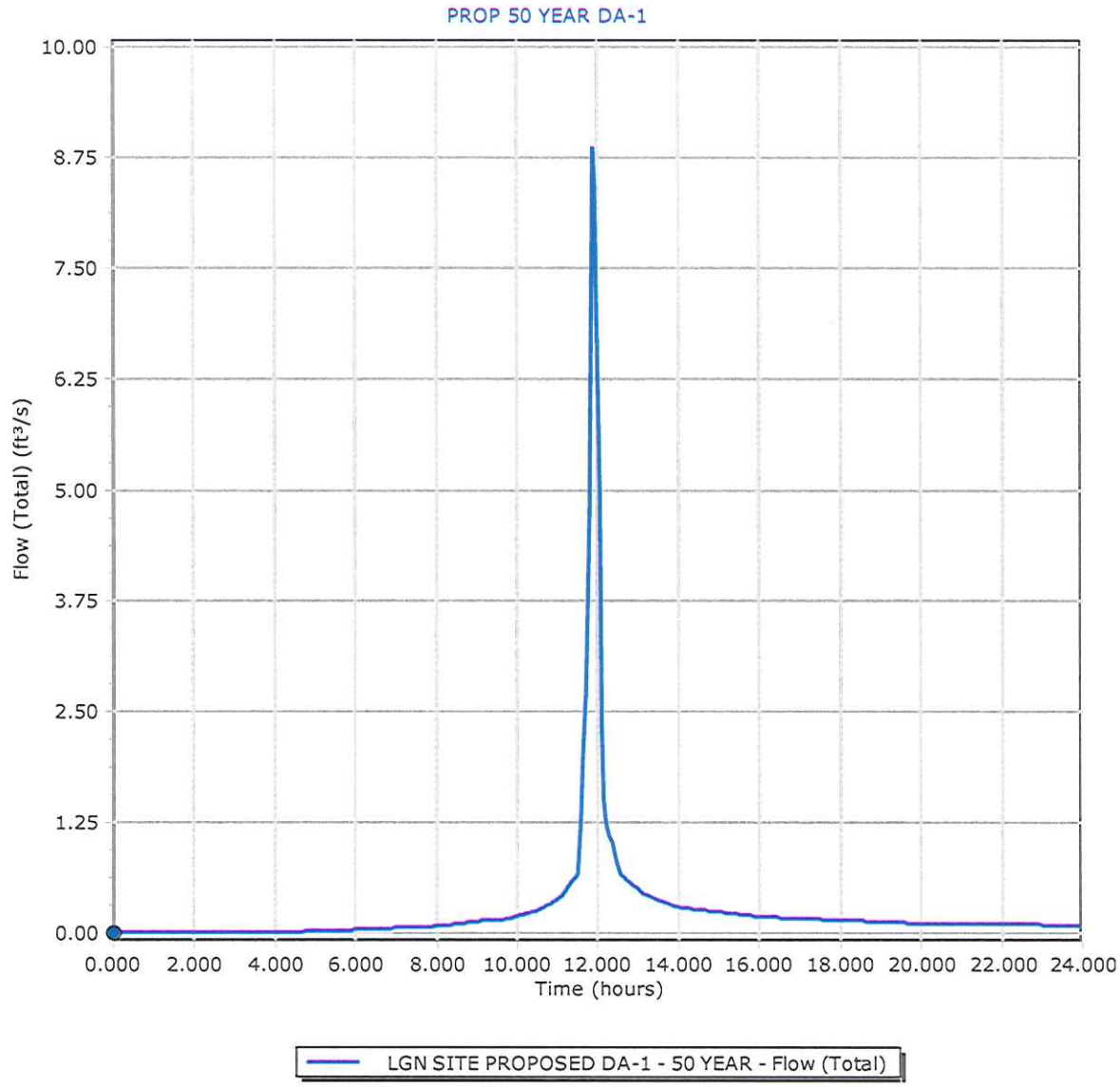
Return Event: 100 years
Storm Event: 100 YEAR

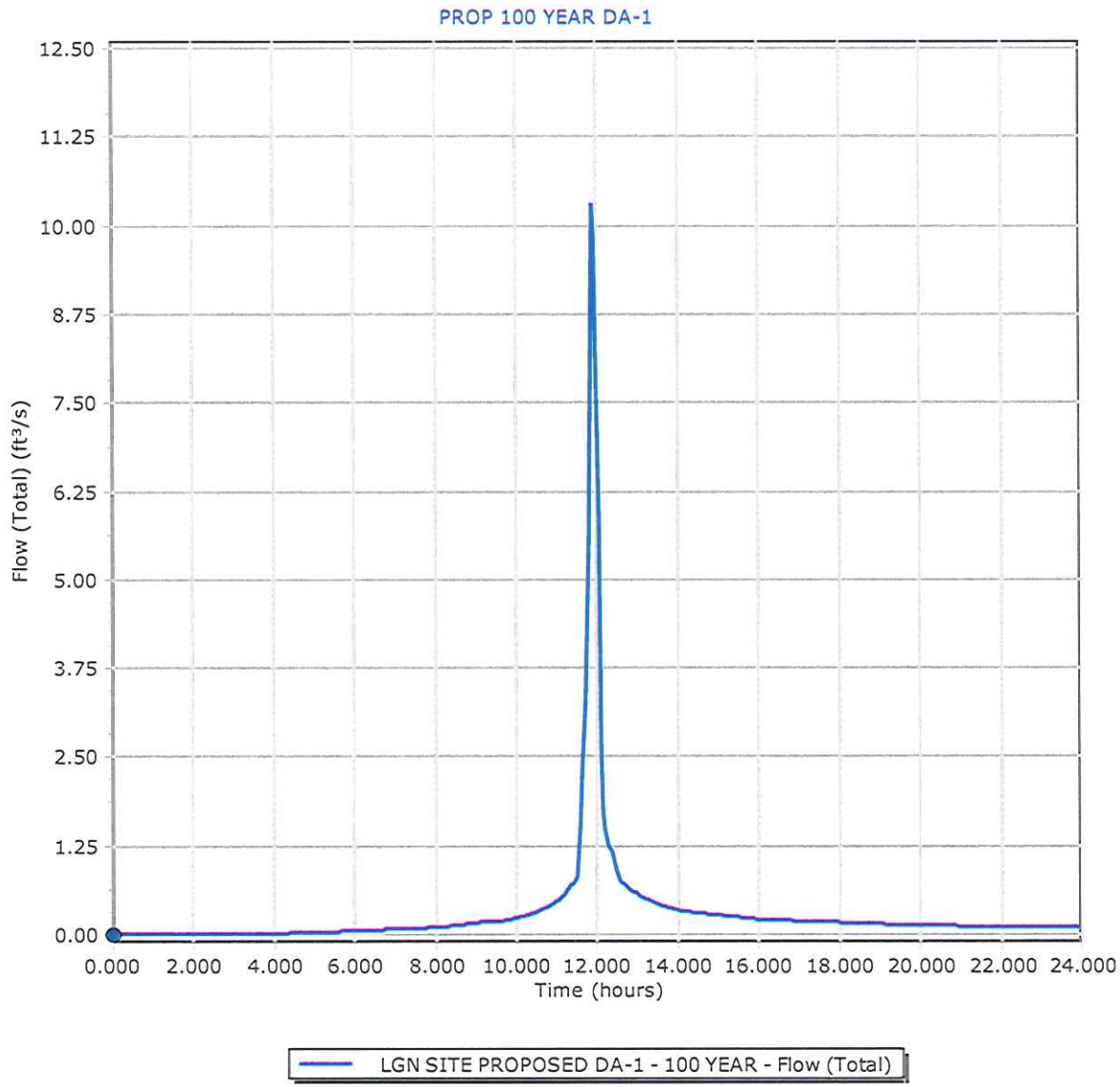
SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours


PROP 5 YEAR DA-1
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN SITE PROPOSED DA-1 - 5 YEAR - Flow (Total)


PROP 10 YEAR DA-1
7.50
6.88
6.25
5.63
5.00
4.38
3.75
3.13
2.50
1.88
1.25
0.63
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN SITE PROPOSED DA-1 - 25 YEAR - Flow (Total)


PROP 25 YEAR DA-1
7.50
6.88
6.25
5.63
5.00
4.38
3.75
3.13
2.50
1.88
1.25
0.63
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN SITE PROPOSED DA-1 - 25 YEAR - Flow (Total)


PROP 50 YEAR DA-1
10.00
8.75
7.50
6.25
5.00
3.75
2.50
1.25
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN SITE PROPOSED DA-1 - 50 YEAR - Flow (Total)


PROP 100 YEAR DA-1
12.50
11.25
10.00
8.75
7.50
6.25
5.00
3.75
2.50
1.25
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN SITE PROPOSED DA-1 - 100 YEAR - Flow (Total)

Subsection: Unit Hydrograph Summary
Label: LGN PROPOSED DA-2

Return Event: 5 years
Storm Event: 5 YEAR

Storm Event	5 YEAR
Return Event	5 years
Duration	24.000 hours
Depth	3.8 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	0.180 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.011 hours
Flow (Peak, Computed)	0.17 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.17 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	0.180 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.7 in
Runoff Volume (Pervious)	0.011 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.011 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.45 ft^3/s
Unit peak time, Tp	0.056 hours

Subsection: Unit Hydrograph Summary
Label: LGN PROPOSED DA-2

Return Event: 5 years
Storm Event: 5 YEAR

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	10 YEAR
Return Event	10 years
Duration	24.000 hours
Depth	4.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	0.180 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.26 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.26 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	0.180 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.0 in
Runoff Volume (Pervious)	0.015 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.015 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.45 ft^3/s
Unit peak time, Tp	0.056 hours

Subsection: Unit Hydrograph Summary
Label: LGN PROPOSED DA-2

Return Event: 10 years
Storm Event: 10 YEAR

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	25 YEAR
Return Event	25 years
Duration	24.000 hours
Depth	5.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	0.180 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.44 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.43 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	0.180 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.6 in
Runoff Volume (Pervious)	0.024 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.024 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.45 ft^3/s
Unit peak time, Tp	0.056 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	50 Year
Return Event	50 years
Duration	24.000 hours
Depth	6.3 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	0.180 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.60 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.58 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	0.180 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.2 in
Runoff Volume (Pervious)	0.033 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.033 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.45 ft^3/s
Unit peak time, Tp	0.056 hours

Subsection: Unit Hydrograph Summary
Label: LGN PROPOSED DA-2

Return Event: 50 years
Storm Event: 50 Year

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	100 YEAR
Return Event	100 years
Duration	24.000 hours
Depth	7.1 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	0.180 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.78 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.75 ft^3/s

Drainage Area	
SCS CN (Composite)	61.000
Area (User Defined)	0.180 acres
Maximum Retention (Pervious)	6.4 in
Maximum Retention (Pervious, 20 percent)	1.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.8 in
Runoff Volume (Pervious)	0.042 ac-ft

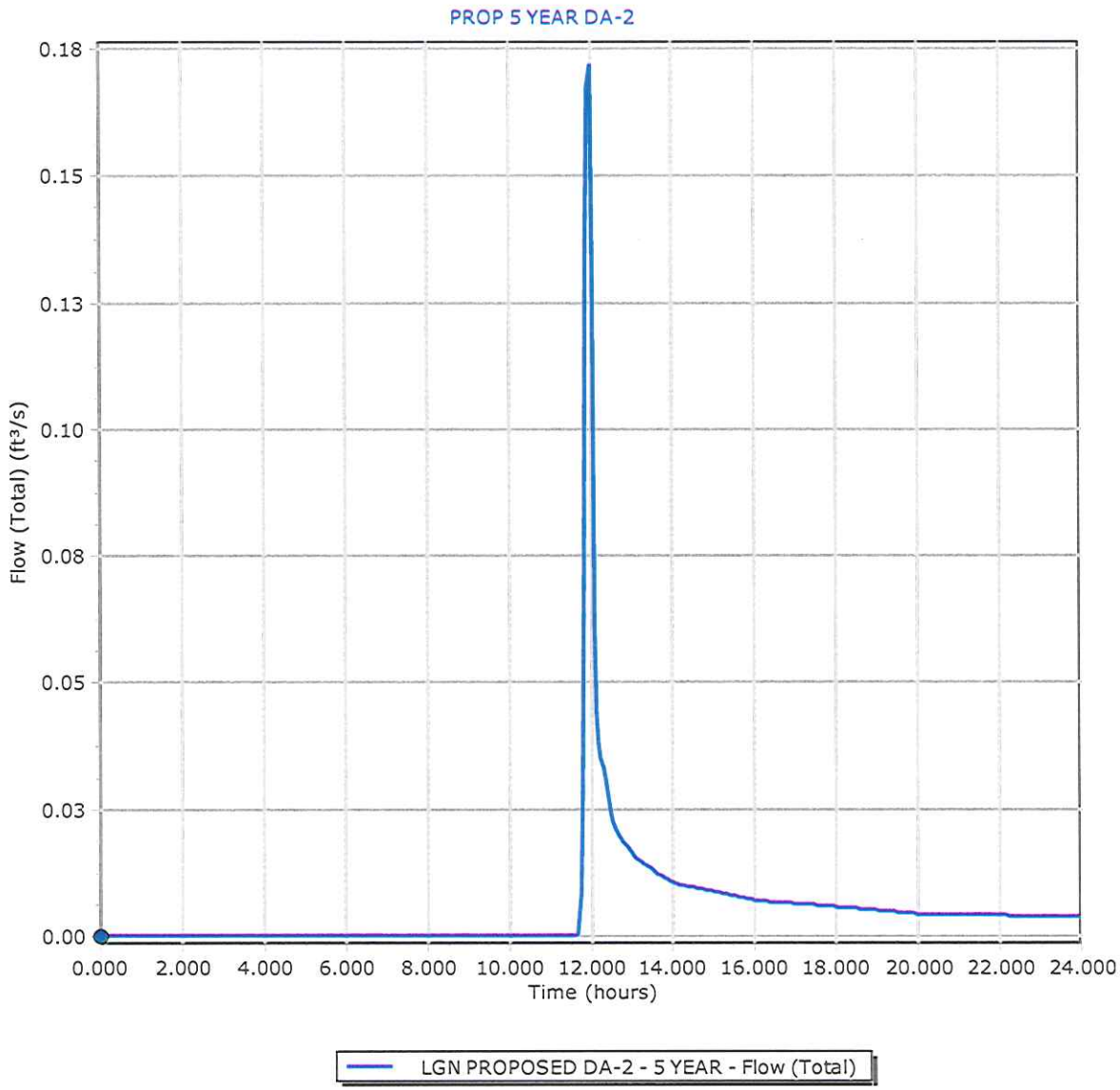
Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.042 ac-ft

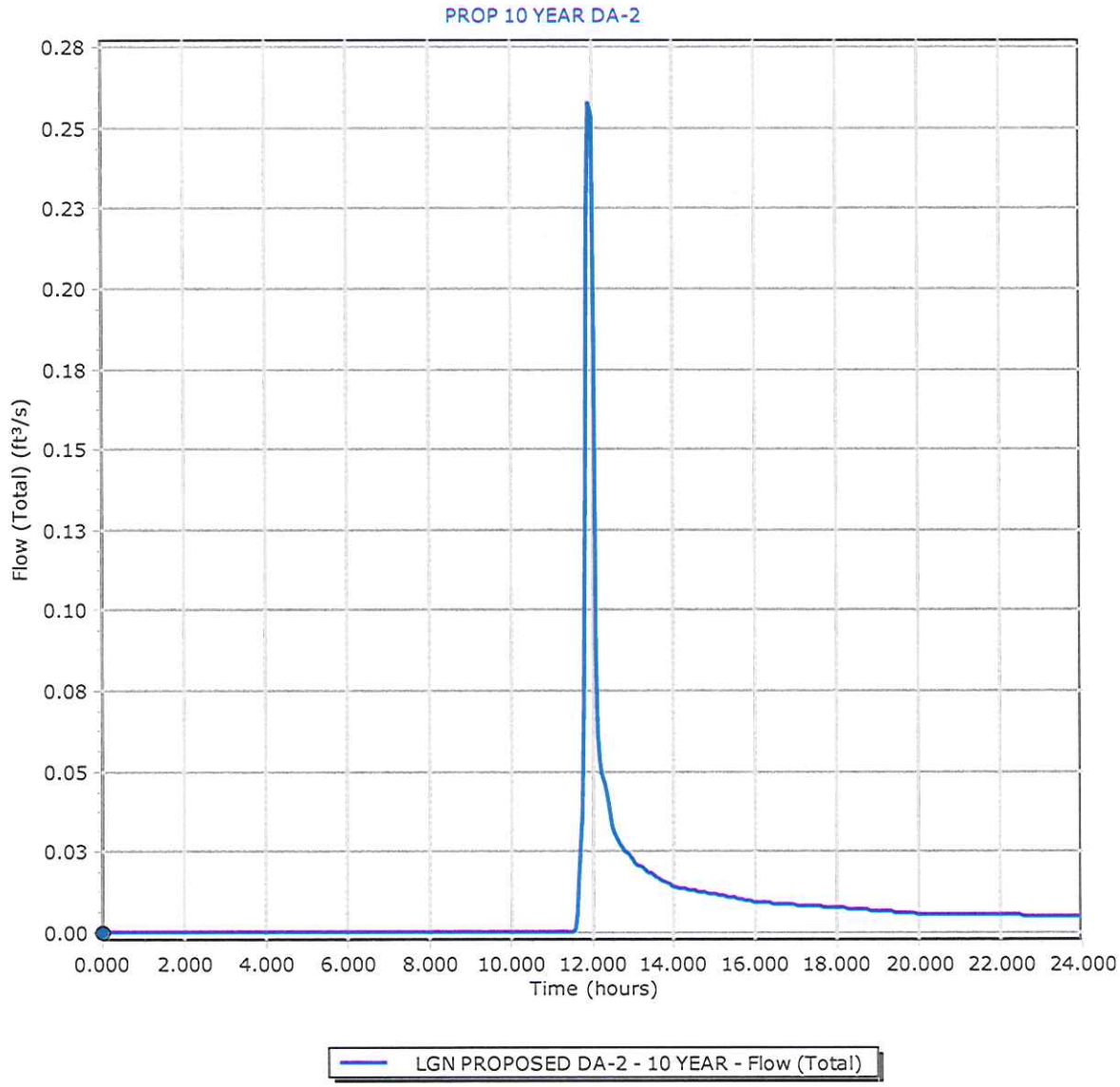
SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.45 ft^3/s
Unit peak time, Tp	0.056 hours

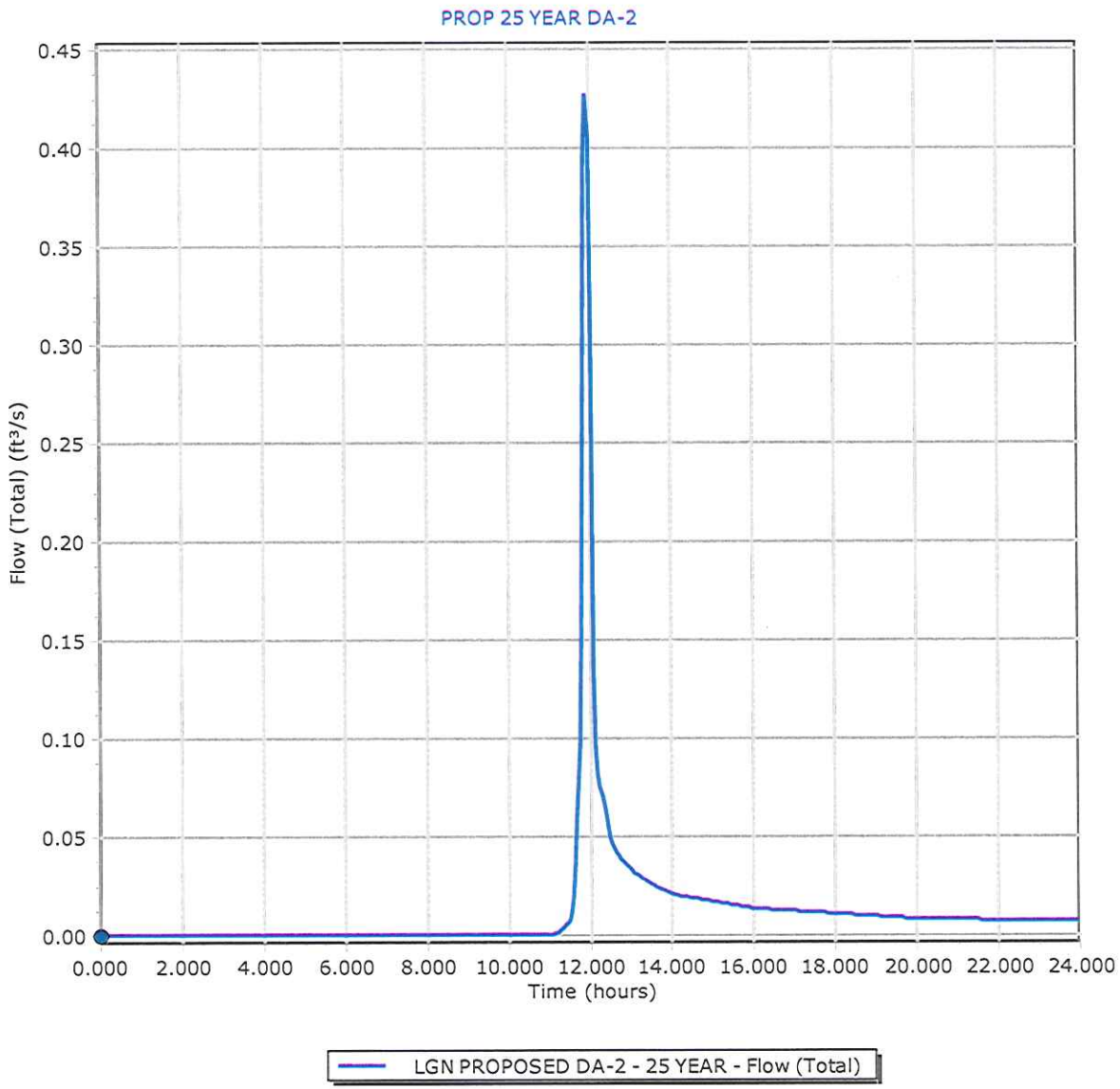
Subsection: Unit Hydrograph Summary
Label: LGN PROPOSED DA-2

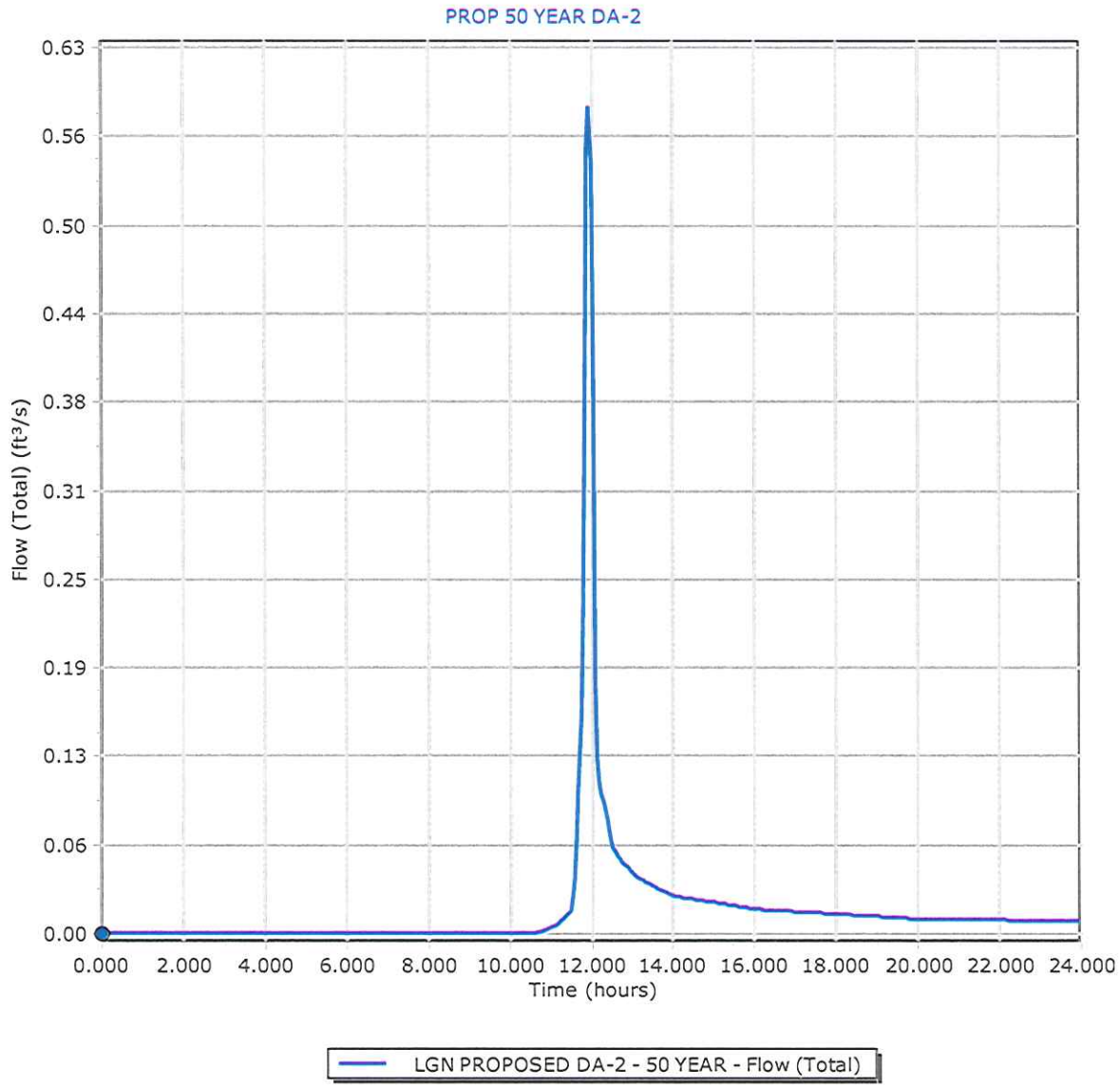
Return Event: 100 years
Storm Event: 100 YEAR

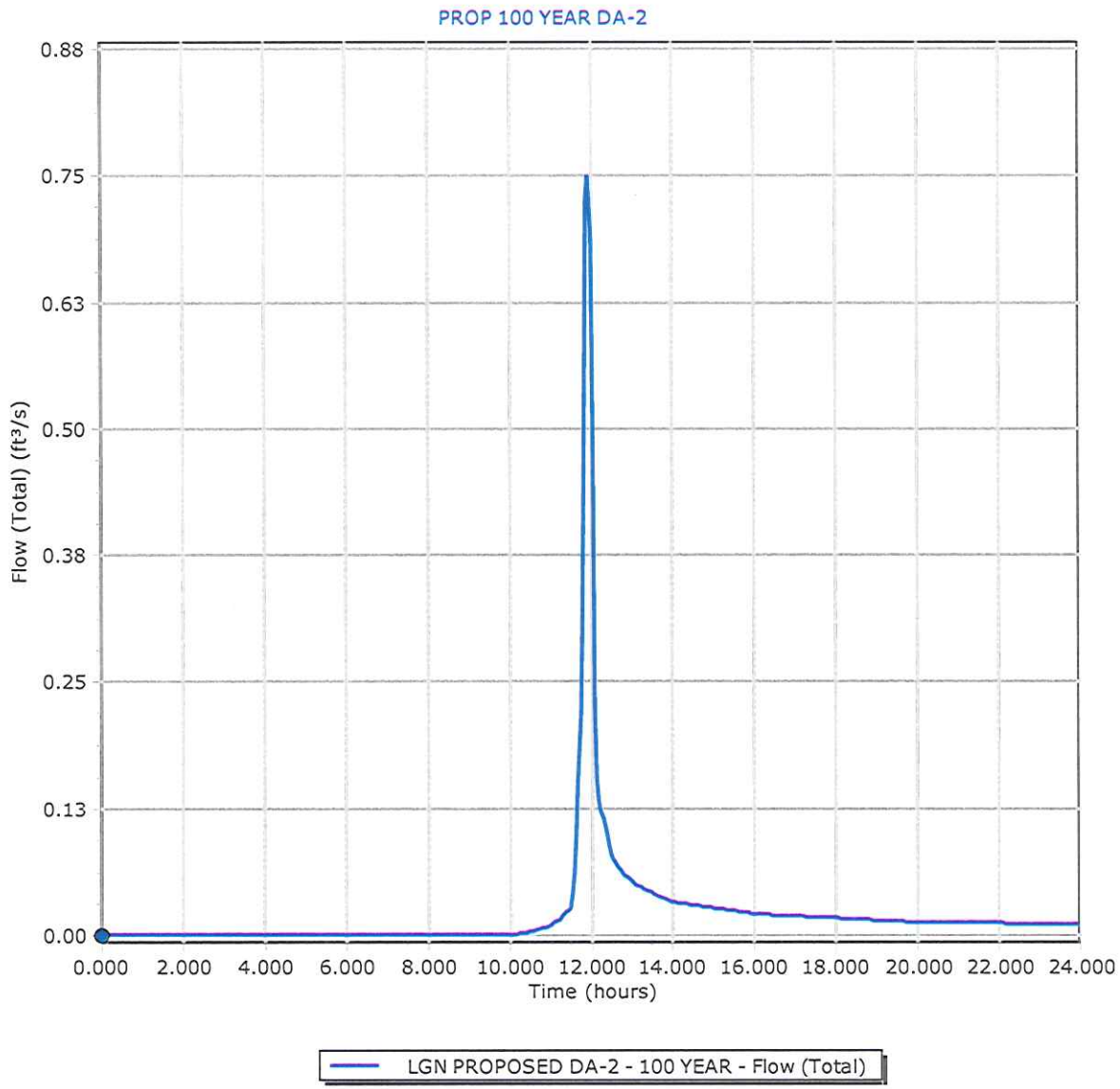
SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours


PROP 5 YEAR DA-2
0.18
0.15
0.13
0.10
0.08
0.05
0.03
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN PROPOSED DA-2 - 5 YEAR - Flow (Total)


PROP 10 YEAR DA-2
Flow (Total) (ft³/s)
0.28
0.25
0.23
0.20
0.18
0.15
0.13
0.10
0.08
0.05
0.03
0.00
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN PROPOSED DA-2 - 10 YEAR - Flow (Total)


PROP 25 YEAR DA-2
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN PROPOSED DA-2 - 25 YEAR - Flow (Total)


PROP 50 YEAR DA-2
Flow (Total) (ft³/s)
0.63
0.56
0.50
0.44
0.38
0.31
0.25
0.19
0.13
0.06
0.00
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN PROPOSED DA-2 - 50 YEAR - Flow (Total)


PROP 100 YEAR DA-2
0.88
0.75
0.63
0.50
0.38
0.25
0.13
0.00
Flow (Total) (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
LGN PROPOSED DA-2 - 100 YEAR - Flow (Total)

APPENDIX G
POND ROUTING SUMMARY

Subsection: Elevation-Area Volume Curve
Label: CLEAN ENERGY DETENTION

Return Event: 5 years
Storm Event: 5 YEAR

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
770.00	0.0	0.130	0.000	0.000	0.000
771.00	0.0	0.240	0.547	0.182	0.182
772.00	0.0	0.280	0.779	0.260	0.442

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 5 years
Storm Event: 5 YEAR

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	0.7200 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	769.50 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	4.67 ft³/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	0.13 ft³/s	Time to Peak (Infiltration)	12.450 hours
Flow (Peak Outlet)	0.32 ft³/s	Time to Peak (Flow, Outlet)	12.450 hours

Elevation (Water Surface, Peak)	770.54 ft
Volume (Peak)	0.130 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.257 ac-ft
Volume (Total Infiltration)	0.115 ac-ft
Volume (Total Outlet Outflow)	0.106 ac-ft
Volume (Retained)	0.036 ac-ft
Volume (Unrouted)	-0.001 ac-ft
Error (Mass Balance)	0.3 %

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 10 years
Storm Event: 10 YEAR

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	0.7200 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	769.50 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	5.69 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	0.15 ft^3/s	Time to Peak (Infiltration)	12.500 hours
Flow (Peak Outlet)	0.38 ft^3/s	Time to Peak (Flow, Outlet)	12.500 hours

Elevation (Water Surface, Peak)	770.69 ft
Volume (Peak)	0.160 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.315 ac-ft
Volume (Total Infiltration)	0.125 ac-ft
Volume (Total Outlet Outflow)	0.148 ac-ft
Volume (Retained)	0.041 ac-ft
Volume (Unrouted)	-0.001 ac-ft
Error (Mass Balance)	0.2 %

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 25 years
Storm Event: 25 YEAR

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	0.7200 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	769.50 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	7.41 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	0.17 ft^3/s	Time to Peak (Infiltration)	12.500 hours
Flow (Peak Outlet)	0.48 ft^3/s	Time to Peak (Flow, Outlet)	12.500 hours

Elevation (Water Surface, Peak)	770.95 ft
Volume (Peak)	0.218 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.414 ac-ft
Volume (Total Infiltration)	0.143 ac-ft
Volume (Total Outlet Outflow)	0.223 ac-ft
Volume (Retained)	0.048 ac-ft
Volume (Unrouted)	0.000 ac-ft
Error (Mass Balance)	0.1 %

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 50 years
Storm Event: 50 Year

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	0.7200 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	769.50 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	8.86 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	0.18 ft^3/s	Time to Peak (Infiltration)	12.550 hours
Flow (Peak Outlet)	0.54 ft^3/s	Time to Peak (Flow, Outlet)	12.550 hours

Elevation (Water Surface, Peak)	771.16 ft
Volume (Peak)	0.267 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.499 ac-ft
Volume (Total Infiltration)	0.158 ac-ft
Volume (Total Outlet Outflow)	0.287 ac-ft
Volume (Retained)	0.052 ac-ft
Volume (Unrouted)	-0.001 ac-ft
Error (Mass Balance)	0.2 %

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 100 years
Storm Event: 100 YEAR

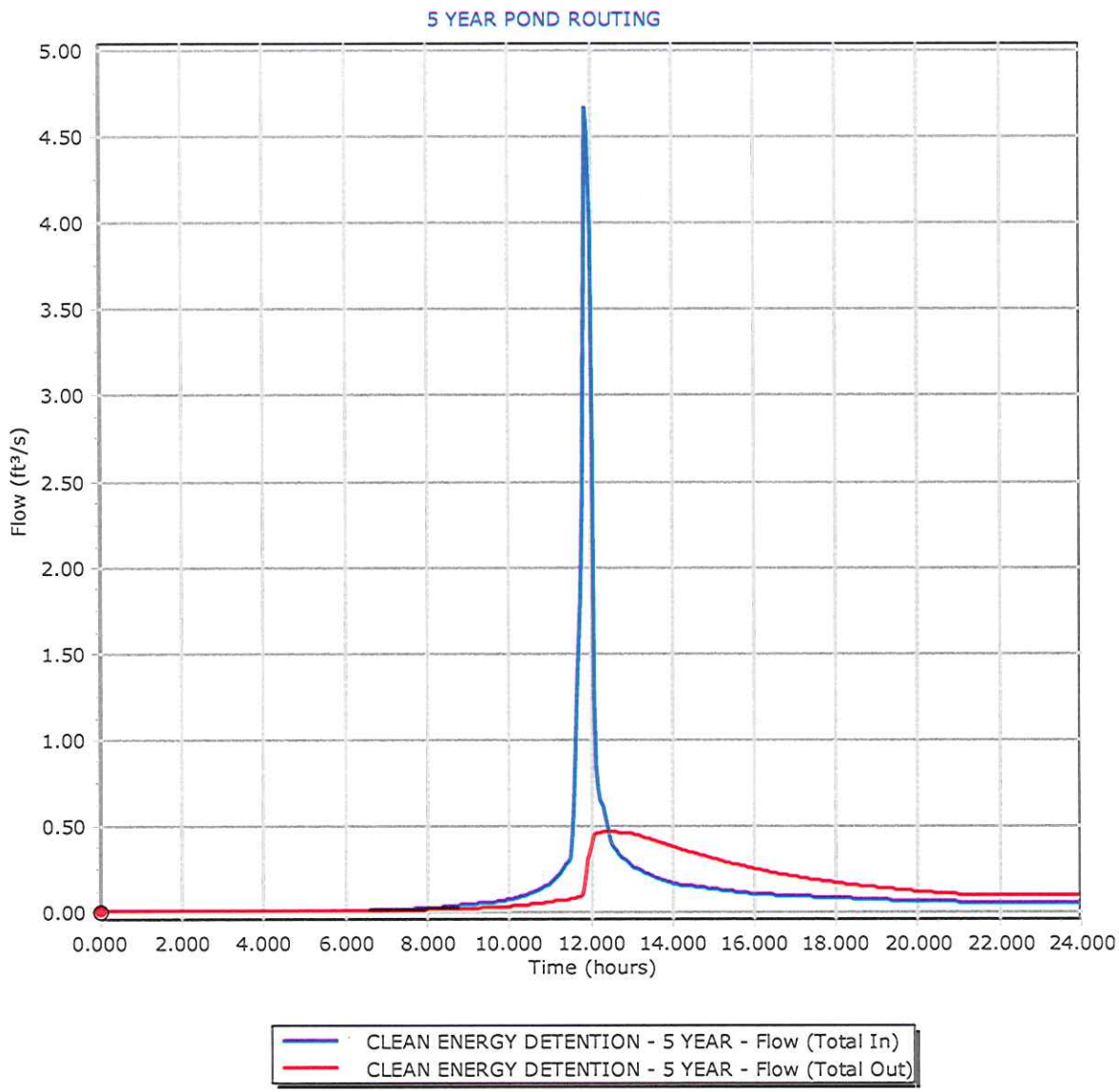
Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	0.7200 in/h

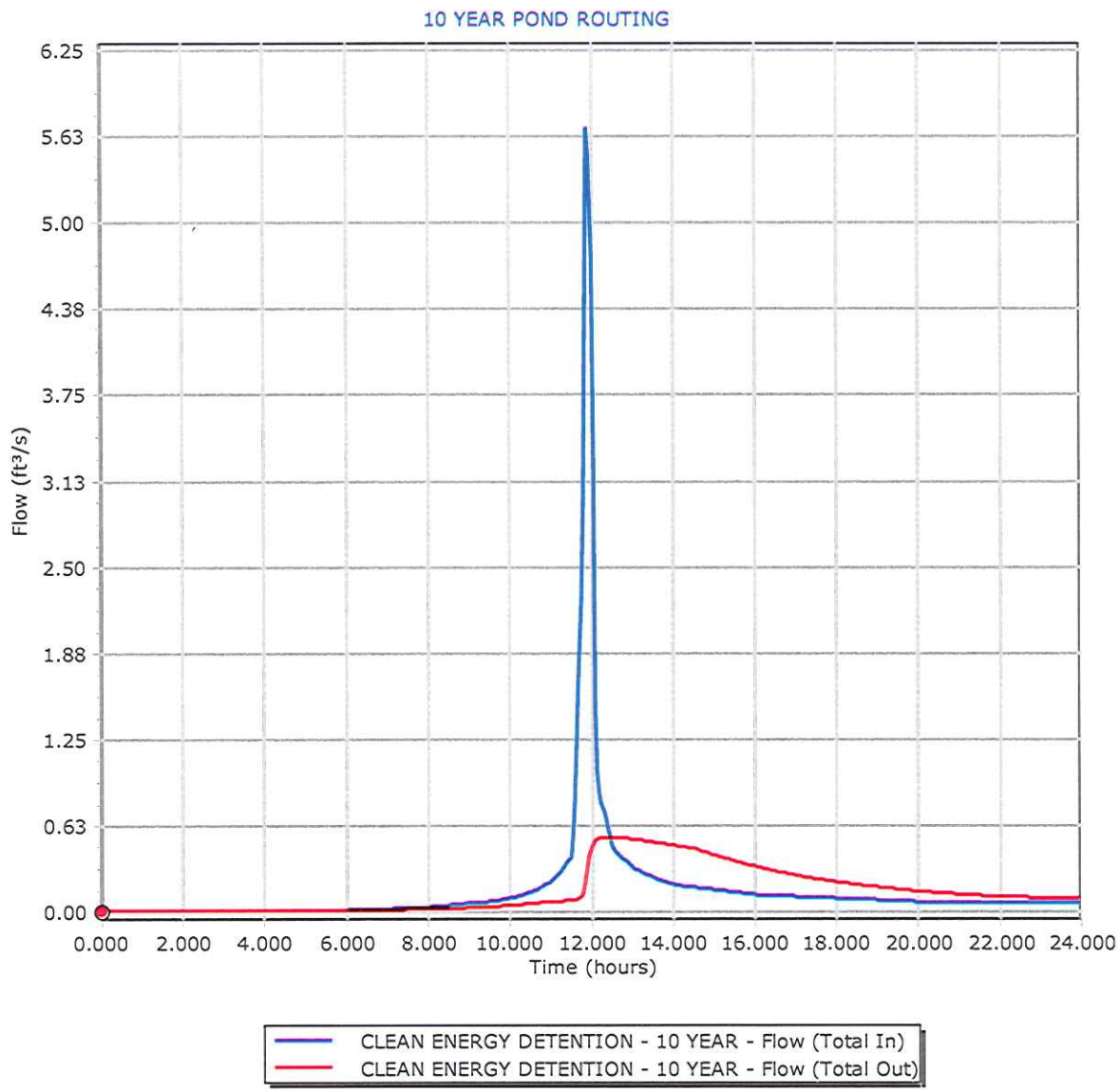
Initial Conditions	
Elevation (Water Surface, Initial)	769.50 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

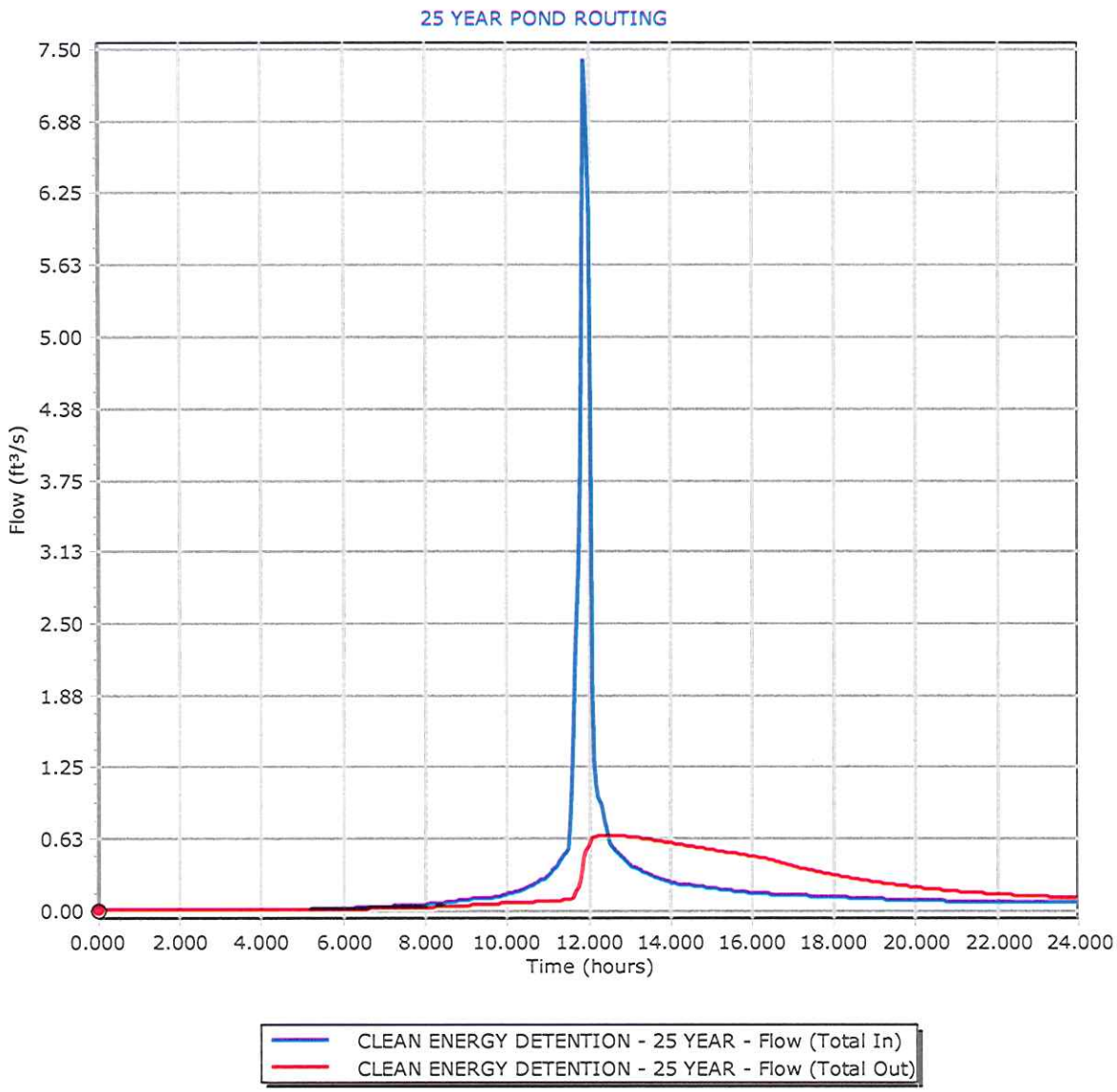
Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	10.31 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	0.18 ft^3/s	Time to Peak (Infiltration)	12.550 hours
Flow (Peak Outlet)	0.59 ft^3/s	Time to Peak (Flow, Outlet)	12.550 hours

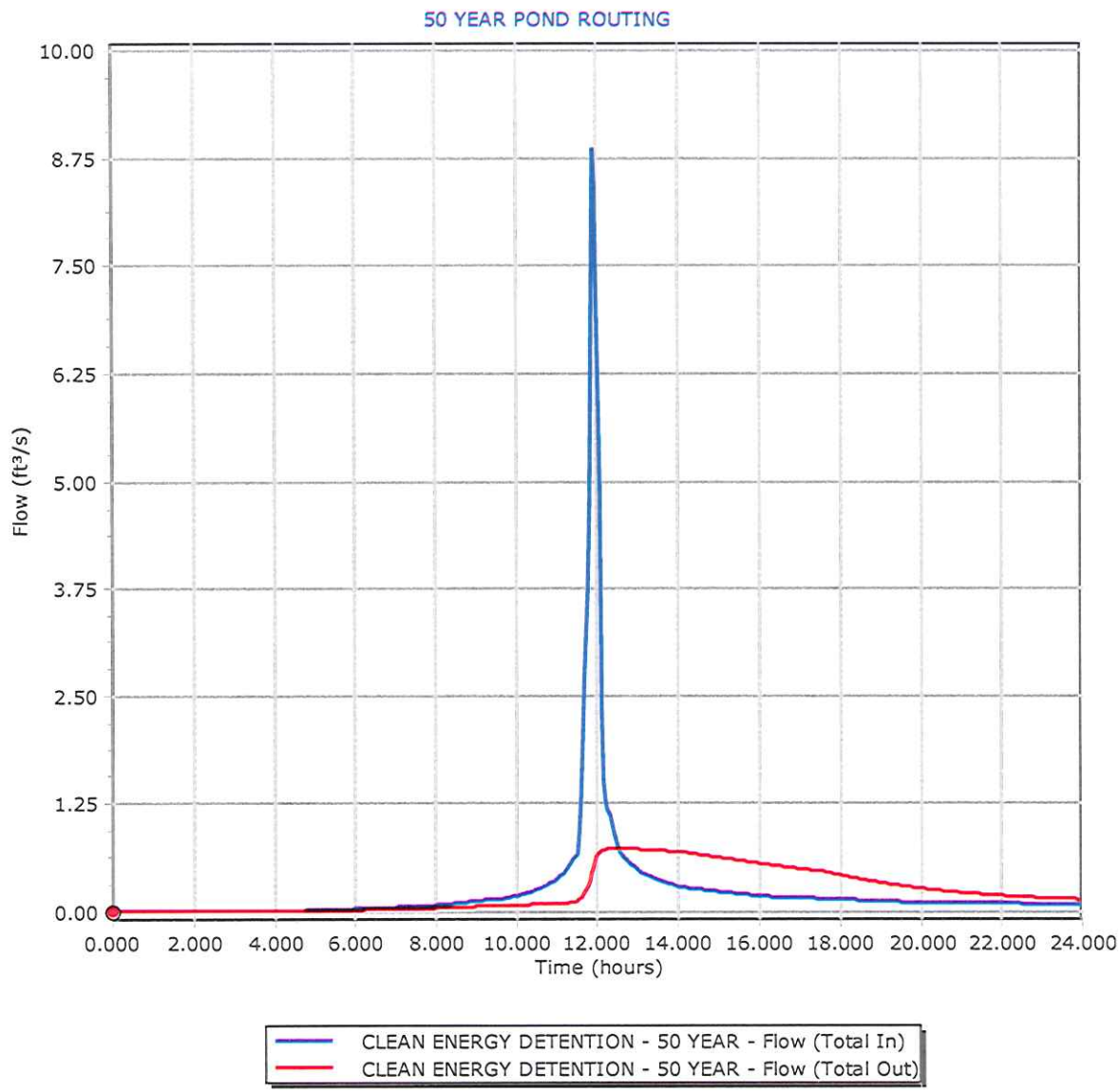
Elevation (Water Surface, Peak)	771.36 ft
Volume (Peak)	0.317 ac-ft

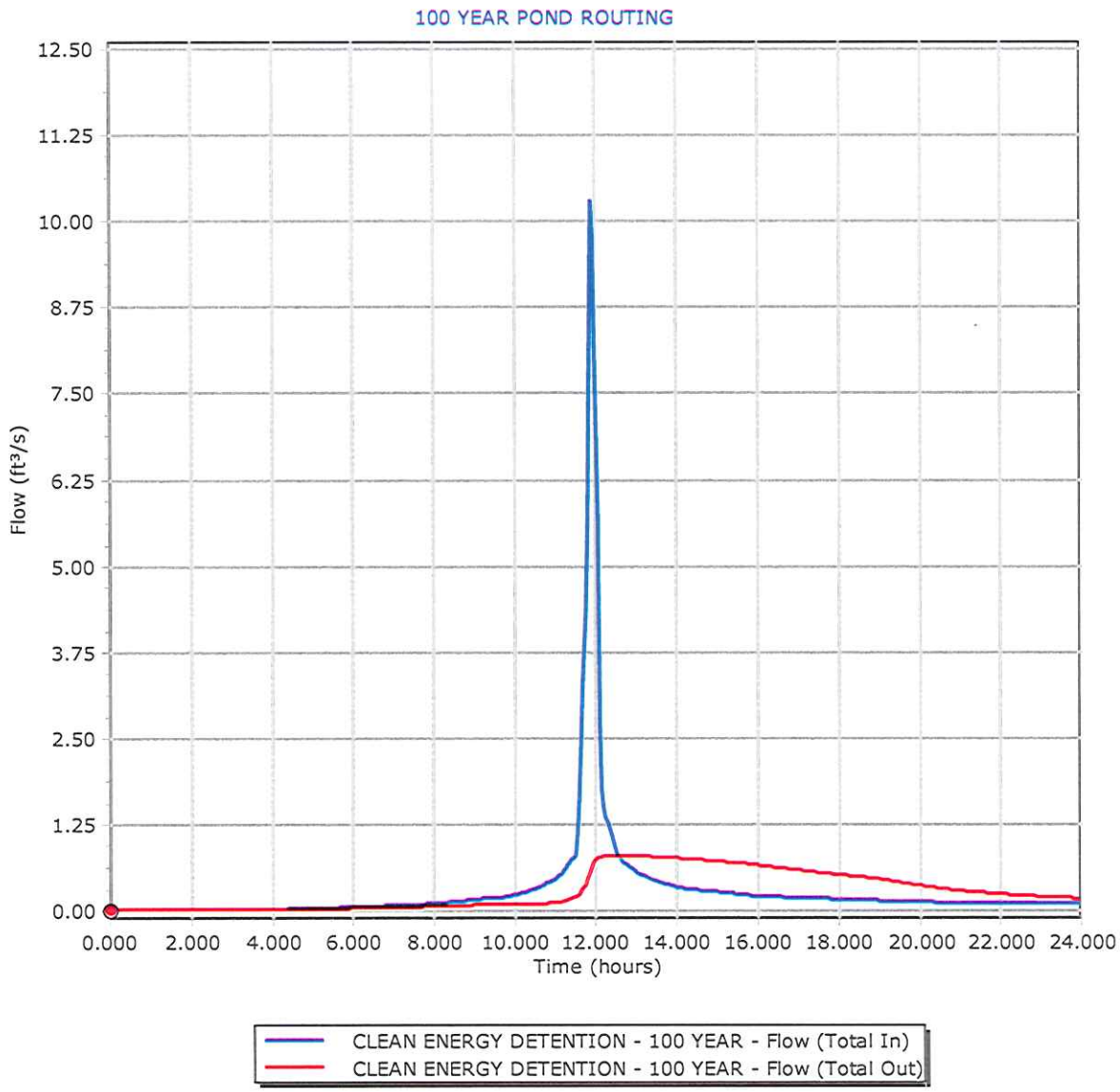
Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.585 ac-ft
Volume (Total Infiltration)	0.173 ac-ft
Volume (Total Outlet Outflow)	0.352 ac-ft
Volume (Retained)	0.058 ac-ft
Volume (Unrouted)	-0.002 ac-ft
Error (Mass Balance)	0.3 %


5 YEAR POND ROUTING
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
CLEAN ENERGY DETENTION - 5 YEAR - Flow (Total In)
CLEAN ENERGY DETENTION - 5 YEAR - Flow (Total Out)


10 YEAR POND ROUTING
6.25
5.63
5.00
4.38
3.75
3.13
2.50
1.88
1.25
0.63
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
CLEAN ENERGY DETENTION - 10 YEAR - Flow (Total In)
CLEAN ENERGY DETENTION - 10 YEAR - Flow (Total Out)


25 YEAR POND ROUTING
7.50
6.88
6.25
5.63
5.00
4.38
3.75
3.13
2.50
1.88
1.25
0.63
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
CLEAN ENERGY DETENTION - 25 YEAR - Flow (Total In)
CLEAN ENERGY DETENTION - 25 YEAR - Flow (Total Out)


50 YEAR POND ROUTING
10.00
8.75
7.50
6.25
5.00
3.75
2.50
1.25
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
CLEAN ENERGY DETENTION - 50 YEAR - Flow (Total In)
CLEAN ENERGY DETENTION - 50 YEAR - Flow (Total Out)


100 YEAR POND ROUTING
12.50
11.25
10.00
8.75
7.50
6.25
5.00
3.75
2.50
1.25
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
CLEAN ENERGY DETENTION - 100 YEAR - Flow (Total In)
CLEAN ENERGY DETENTION - 100 YEAR - Flow (Total Out)

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 5 years
Storm Event: 5 YEAR

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.6000 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	770.00 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	4.67 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	1.26 ft^3/s	Time to Peak (Infiltration)	12.100 hours
Flow (Peak Outlet)	0.06 ft^3/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	770.57 ft
Volume (Peak)	0.091 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.257 ac-ft
Volume (Total Infiltration)	0.253 ac-ft
Volume (Total Outlet Outflow)	0.001 ac-ft
Volume (Retained)	0.003 ac-ft
Volume (Unrouted)	0.000 ac-ft
Error (Mass Balance)	0.2 %

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 10 years
Storm Event: 10 YEAR

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.6000 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	770.00 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	5.69 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	1.35 ft^3/s	Time to Peak (Infiltration)	12.100 hours
Flow (Peak Outlet)	0.16 ft^3/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	770.68 ft
Volume (Peak)	0.112 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.315 ac-ft
Volume (Total Infiltration)	0.306 ac-ft
Volume (Total Outlet Outflow)	0.006 ac-ft
Volume (Retained)	0.003 ac-ft
Volume (Unrouted)	-0.001 ac-ft
Error (Mass Balance)	0.2 %

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 25 years
Storm Event: 25 YEAR

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.6000 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	770.00 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	7.41 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	1.49 ft^3/s	Time to Peak (Infiltration)	12.100 hours
Flow (Peak Outlet)	0.32 ft^3/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	770.87 ft
Volume (Peak)	0.152 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.414 ac-ft
Volume (Total Infiltration)	0.391 ac-ft
Volume (Total Outlet Outflow)	0.019 ac-ft
Volume (Retained)	0.004 ac-ft
Volume (Unrouted)	-0.001 ac-ft
Error (Mass Balance)	0.2 %

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 50 years
Storm Event: 50 Year

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.6000 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	770.00 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	8.86 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	1.60 ft^3/s	Time to Peak (Infiltration)	12.100 hours
Flow (Peak Outlet)	0.46 ft^3/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	771.02 ft
Volume (Peak)	0.188 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.499 ac-ft
Volume (Total Infiltration)	0.461 ac-ft
Volume (Total Outlet Outflow)	0.033 ac-ft
Volume (Retained)	0.004 ac-ft
Volume (Unrouted)	-0.001 ac-ft
Error (Mass Balance)	0.2 %

Subsection: Level Pool Pond Routing Summary
Label: CLEAN ENERGY DETENTION (IN)

Return Event: 100 years
Storm Event: 100 YEAR

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.6000 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	770.00 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft^3/s
Flow (Initial Infiltration)	0.00 ft^3/s
Flow (Initial, Total)	0.00 ft^3/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	10.31 ft^3/s	Time to Peak (Flow, In)	11.900 hours
Infiltration (Peak)	1.64 ft^3/s	Time to Peak (Infiltration)	12.100 hours
Flow (Peak Outlet)	0.61 ft^3/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	771.16 ft
Volume (Peak)	0.221 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.585 ac-ft
Volume (Total Infiltration)	0.528 ac-ft
Volume (Total Outlet Outflow)	0.051 ac-ft
Volume (Retained)	0.005 ac-ft
Volume (Unrouted)	-0.001 ac-ft
Error (Mass Balance)	0.2 %

Subsection: Addition Summary
Label: DOWNSTREAM PEAK DISCHARGE

Return Event: 5 years
Storm Event: 5 YEAR

Summary for Hydrograph Addition at 'DOWNSTREAM PEAK DISCHARGE'

Upstream Link	Upstream Node
6 INCH OUTLET PIPE	CLEAN ENERGY DETENTION
<Catchment to Outflow Node>	LGN PROPOSED DA-2

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	6 INCH OUTLET PIPE	0.001	12.100	0.06
Flow (From)	LGN PROPOSED DA -2	0.011	12.000	0.17
Flow (In)	DOWNSTREAM PEAK DISCHARGE	0.012	12.000	0.19

Subsection: Addition Summary
Label: DOWNSTREAM PEAK DISCHARGE

Return Event: 10 years
Storm Event: 10 YEAR

Summary for Hydrograph Addition at 'DOWNSTREAM PEAK DISCHARGE'

Upstream Link	Upstream Node
6 INCH OUTLET PIPE	CLEAN ENERGY DETENTION
<Catchment to Outflow Node>	LGN PROPOSED DA-2

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	6 INCH OUTLET PIPE	0.006	12.100	0.16
Flow (From)	LGN PROPOSED DA -2	0.015	11.950	0.26
Flow (In)	DOWNSTREAM PEAK DISCHARGE	0.021	12.000	0.35

Subsection: Addition Summary
Label: DOWNSTREAM PEAK DISCHARGE

Return Event: 25 years
Storm Event: 25 YEAR

Summary for Hydrograph Addition at 'DOWNSTREAM PEAK DISCHARGE'

Upstream Link	Upstream Node
6 INCH OUTLET PIPE	CLEAN ENERGY DETENTION
<Catchment to Outflow Node>	LGN PROPOSED DA-2

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	6 INCH OUTLET PIPE	0.019	12.100	0.32
Flow (From)	LGN PROPOSED DA -2	0.024	11.950	0.43
Flow (In)	DOWNSTREAM PEAK DISCHARGE	0.043	12.000	0.64

Subsection: Addition Summary
Label: DOWNSTREAM PEAK DISCHARGE

Return Event: 50 years
Storm Event: 50 Year

Summary for Hydrograph Addition at 'DOWNSTREAM PEAK DISCHARGE'

Upstream Link	Upstream Node
6 INCH OUTLET PIPE	CLEAN ENERGY DETENTION
<Catchment to Outflow Node>	LGN PROPOSED DA-2

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	6 INCH OUTLET PIPE	0.033	12.100	0.46
Flow (From)	LGN PROPOSED DA -2	0.033	11.950	0.58
Flow (In)	DOWNSTREAM PEAK DISCHARGE	0.065	12.000	0.90

Subsection: Addition Summary
Label: DOWNSTREAM PEAK DISCHARGE

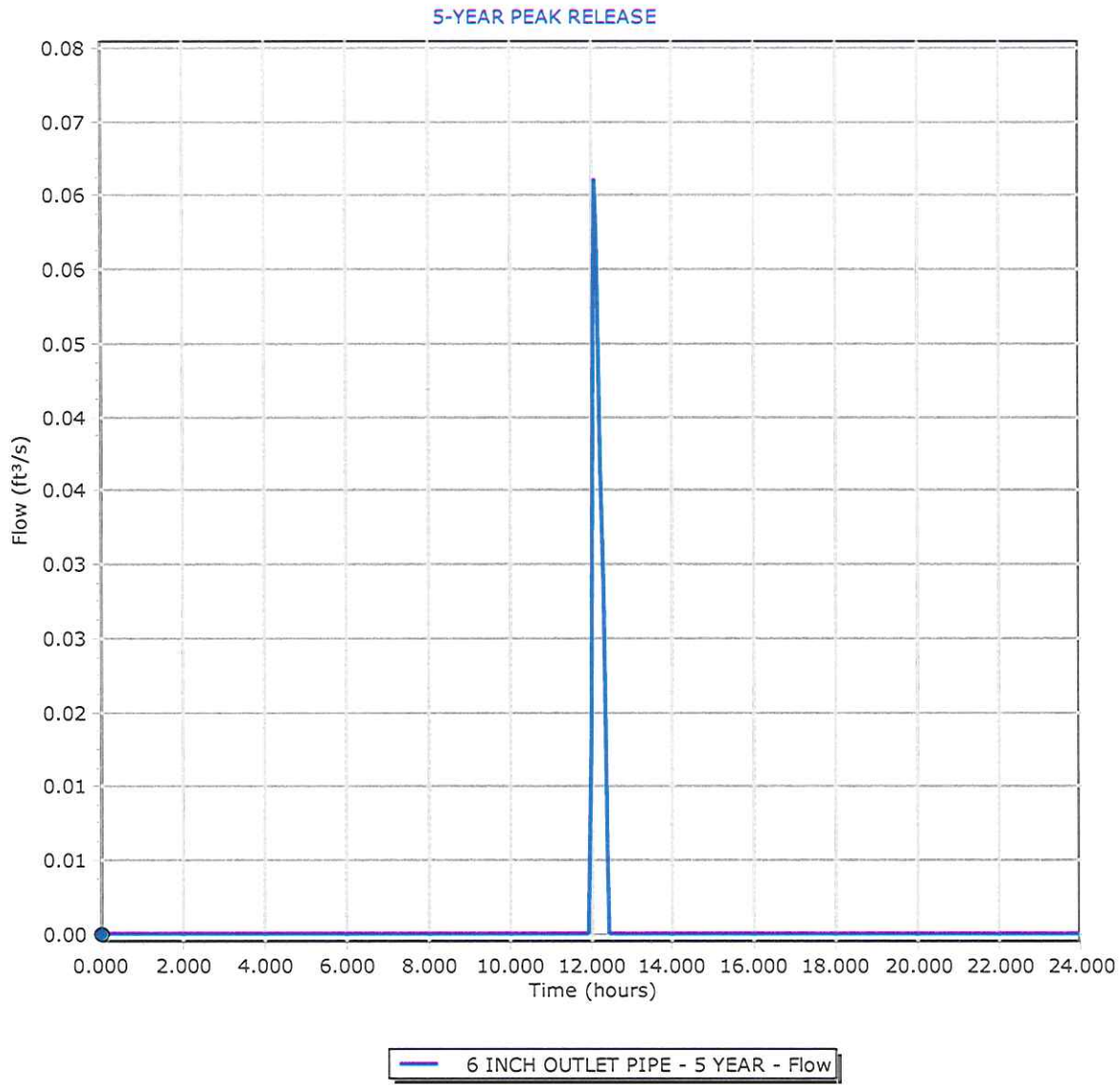
Return Event: 100 years
Storm Event: 100 YEAR

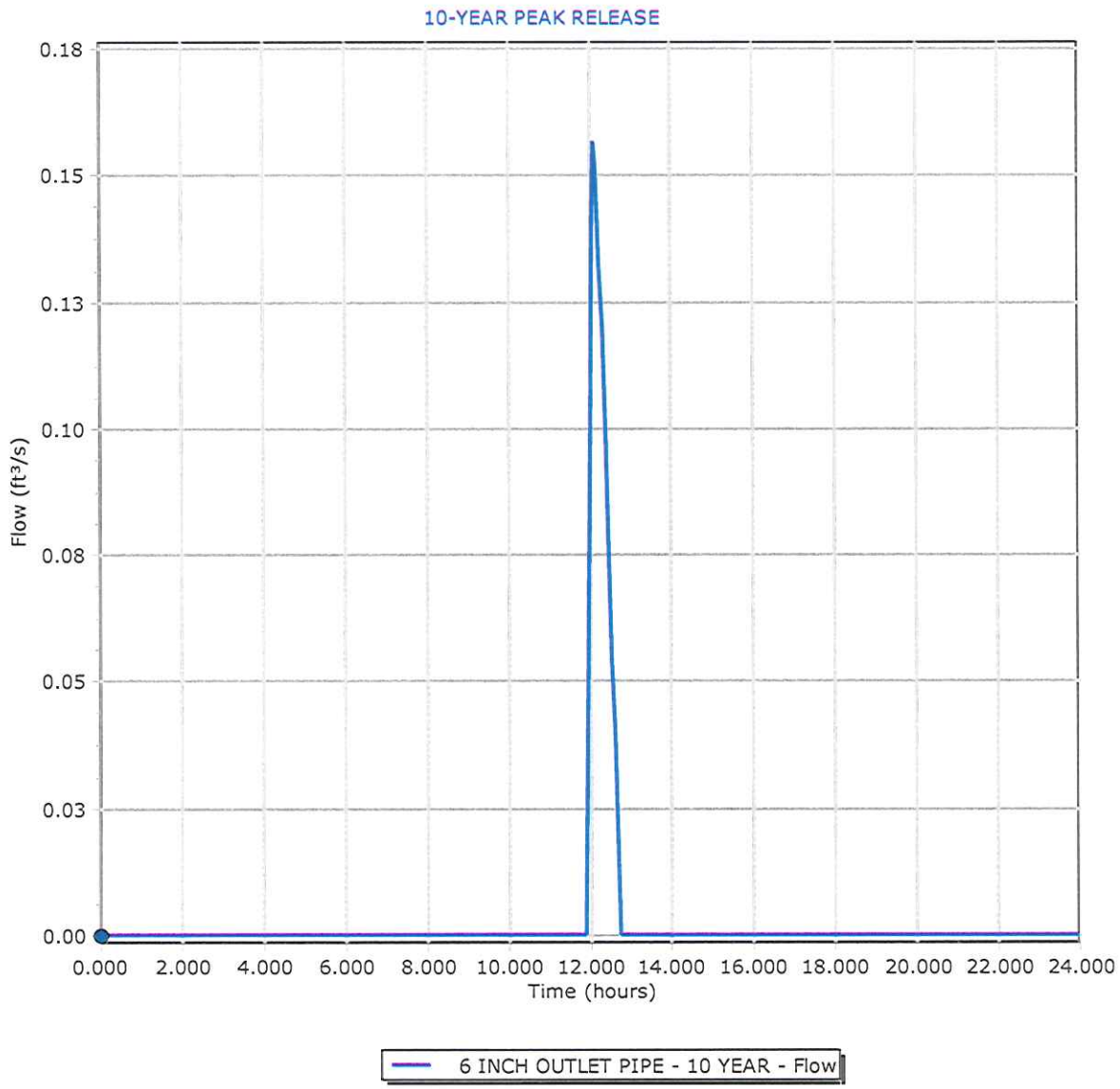
Summary for Hydrograph Addition at 'DOWNSTREAM PEAK DISCHARGE'

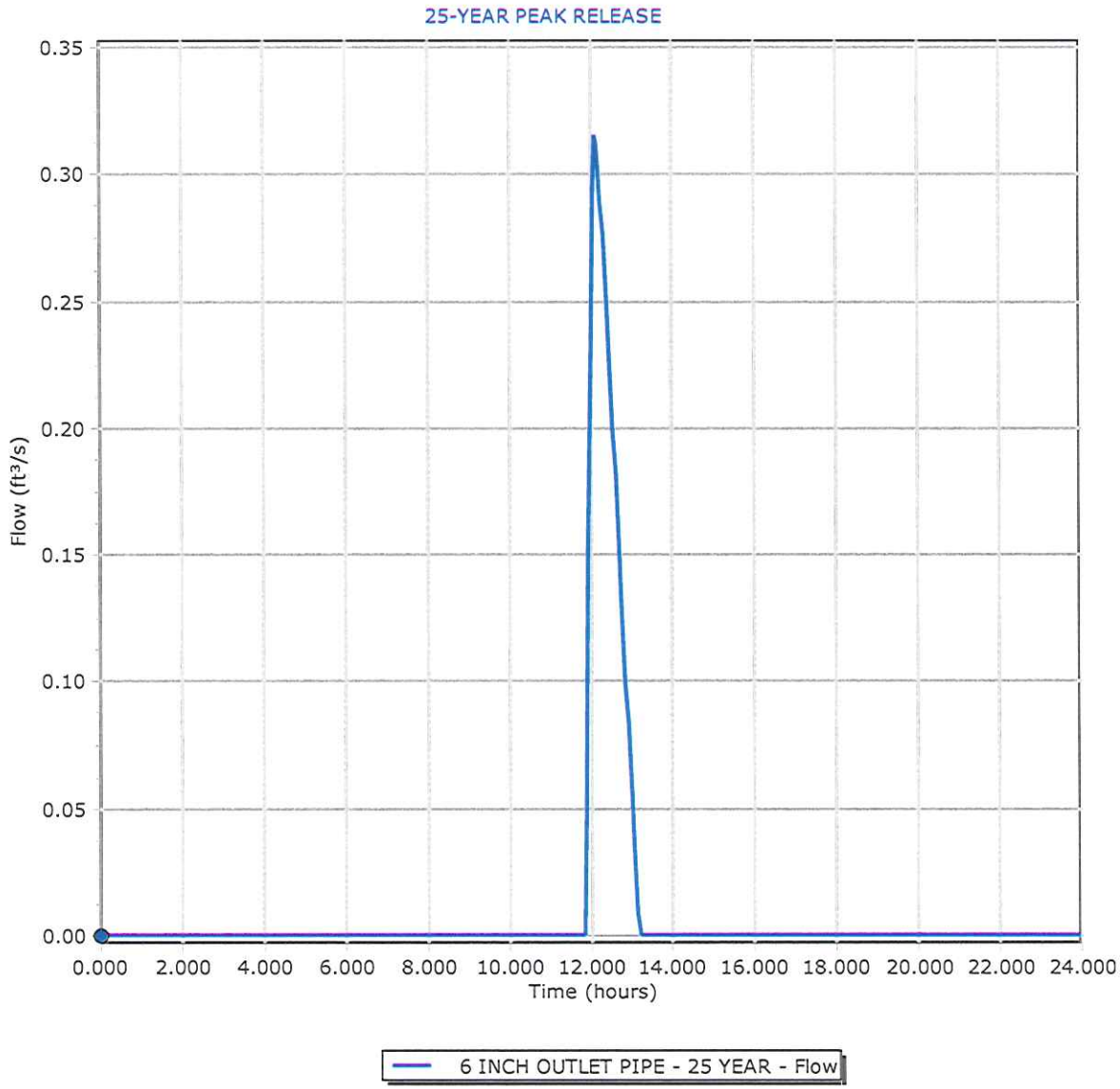
Upstream Link	Upstream Node
6 INCH OUTLET PIPE	CLEAN ENERGY DETENTION
<Catchment to Outflow Node>	LGN PROPOSED DA-2

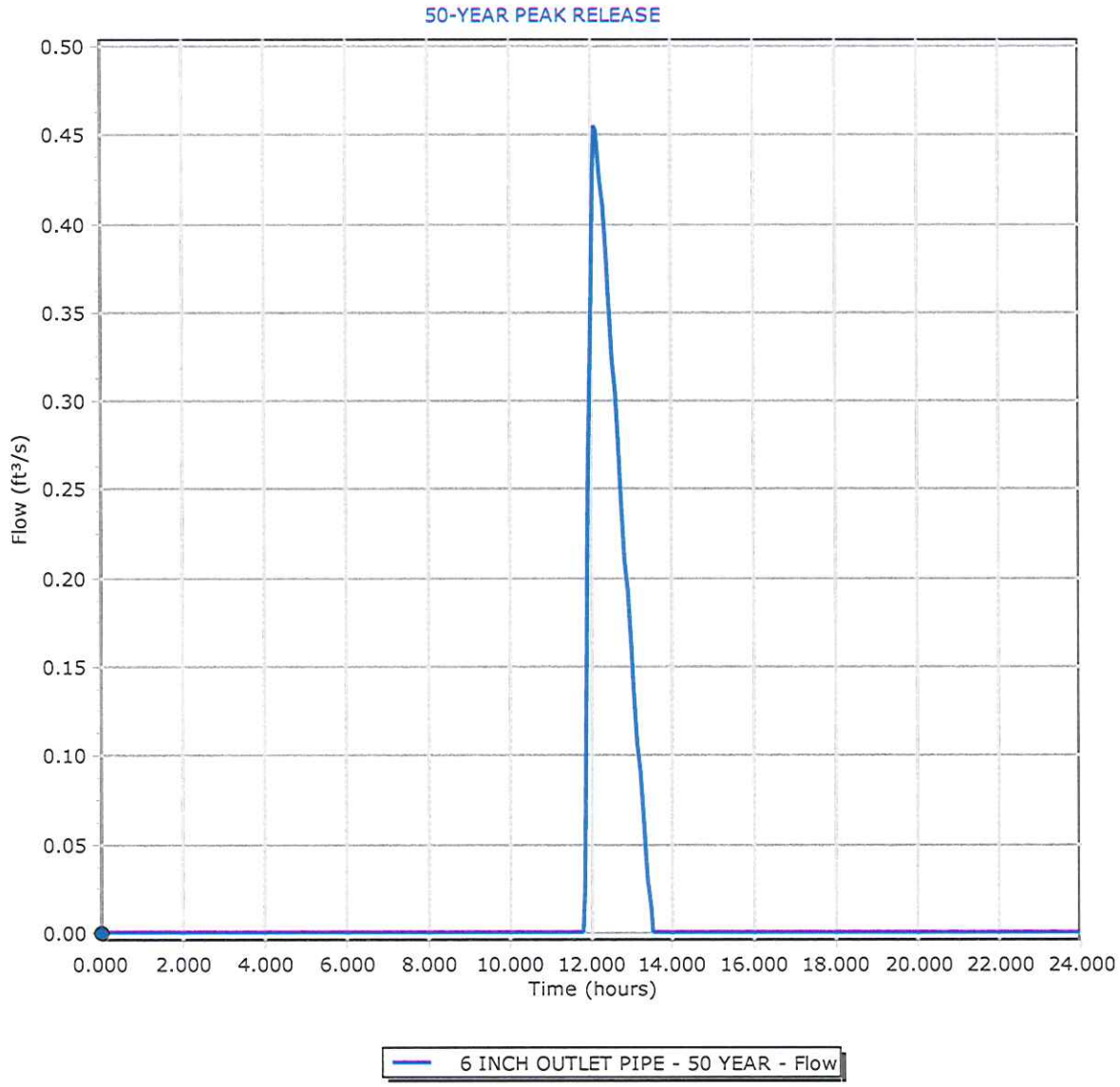
Node Inflows

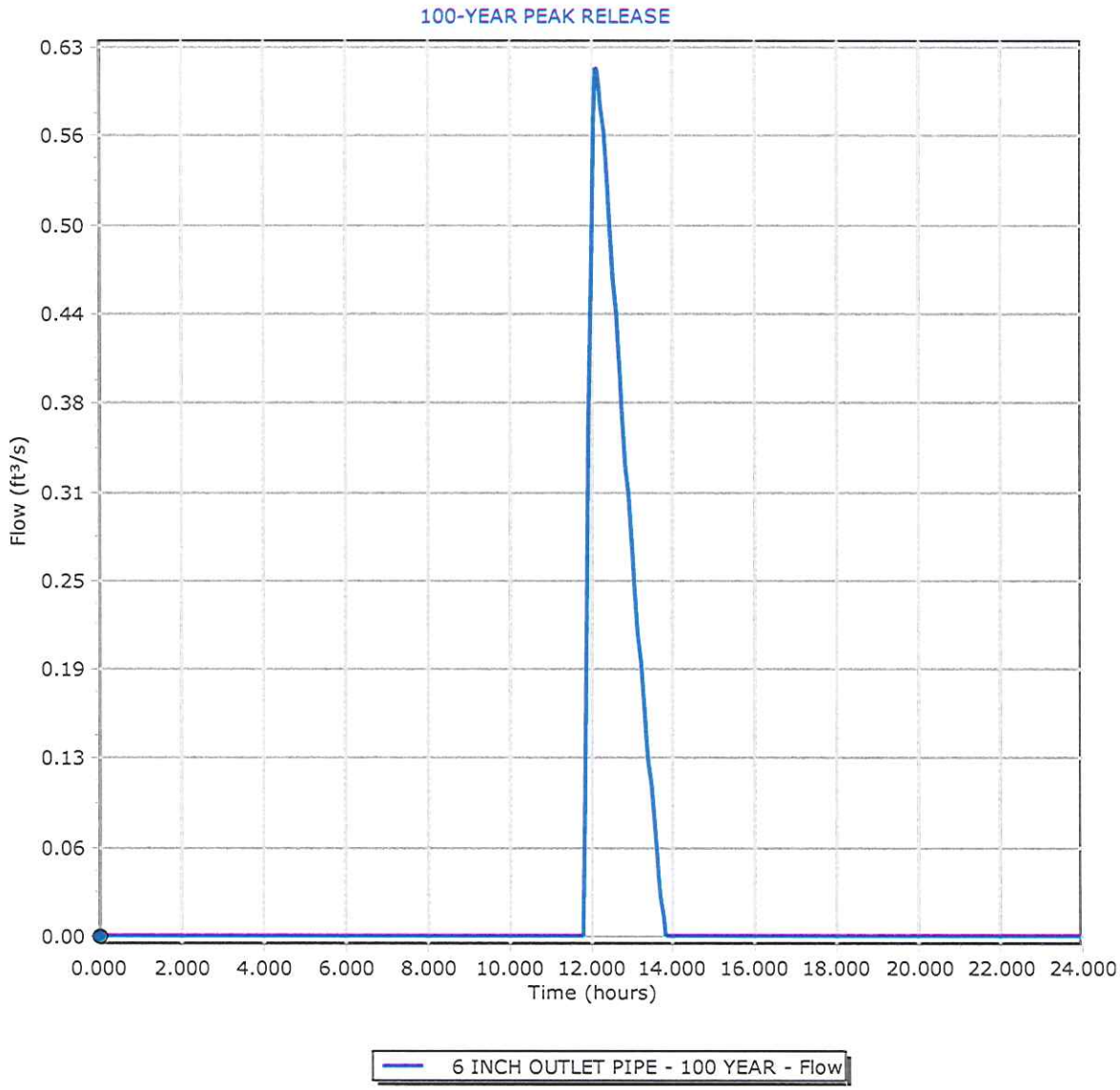
Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	6 INCH OUTLET PIPE	0.051	12.100	0.61
Flow (From)	LGN PROPOSED DA -2	0.042	11.950	0.75
Flow (In)	DOWNSTREAM PEAK DISCHARGE	0.092	12.000	1.17


5-YEAR PEAK RELEASE
0.08
0.07
0.06
0.06
0.05
0.04
0.04
0.03
0.03
0.02
0.01
0.01
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
6 INCH OUTLET PIPE - 5 YEAR - Flow


10-YEAR PEAK RELEASE
0.18
0.15
0.13
0.10
0.08
0.05
0.03
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
6 INCH OUTLET PIPE - 10 YEAR - Flow


25-YEAR PEAK RELEASE
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
6 INCH OUTLET PIPE - 25 YEAR - Flow


50-YEAR PEAK RELEASE
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
6 INCH OUTLET PIPE - 50 YEAR - Flow


100-YEAR PEAK RELEASE
0.63
0.56
0.50
0.44
0.38
0.31
0.25
0.19
0.13
0.06
0.00
Flow (ft³/s)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
Time (hours)
6 INCH OUTLET PIPE - 100 YEAR - Flow

APPENDIX H
FLOW CALCULATIONS
42" RISER
18" DISCHARGE PIPE

KAW VALLEY ENGINEERING, INC.
Junction City, KS Ph 785-762-5040
Kansas City, MO Ph 816-468-5858
Lenexa, KS Ph 913-894-5150
Salina, KS Ph 785-823-3400

Job LNG West Branch, Iowa
Sheet No. _____ Of _____
Calculated by DPB Date 11/25/13
Checked by _____ Date _____
Scale _____

Calculation for Riser Flow

Given:

Peak 100-year flow = 10.31 cfs
Top of Basin Elevation = 772.80'
100-year HWSE = 771.36'
Riser Diameter = 42"
Freeboard Requirement = 1.0'

Verify Riser will pass 100-year Storm

$Q = CLH^{3/2}$

Where:
C = Orifice Coefficient = 3.2
L = Pipe Circumference (ft)
H = Head (ft)

Solve for H

$H = (Q/CL)^{2/3}$

$L = \pi D = (3.14)(3.5') = 10.99'$

$H = (10.31 / 3.2 \times 10.99)^{0.667}$

$H = 0.44'$

Freeboard = 771.36' + 0.44' = 771.80' - 772.8 = 1.0' ✓

Calculation for Pipe Flow

Given
Pipe Diameter = 15" $A = 1.23\ ft^2$ $R = A/P = 1.23'/3.92' = 0.31$
$n = 0.012$
$S = 3.12\%$

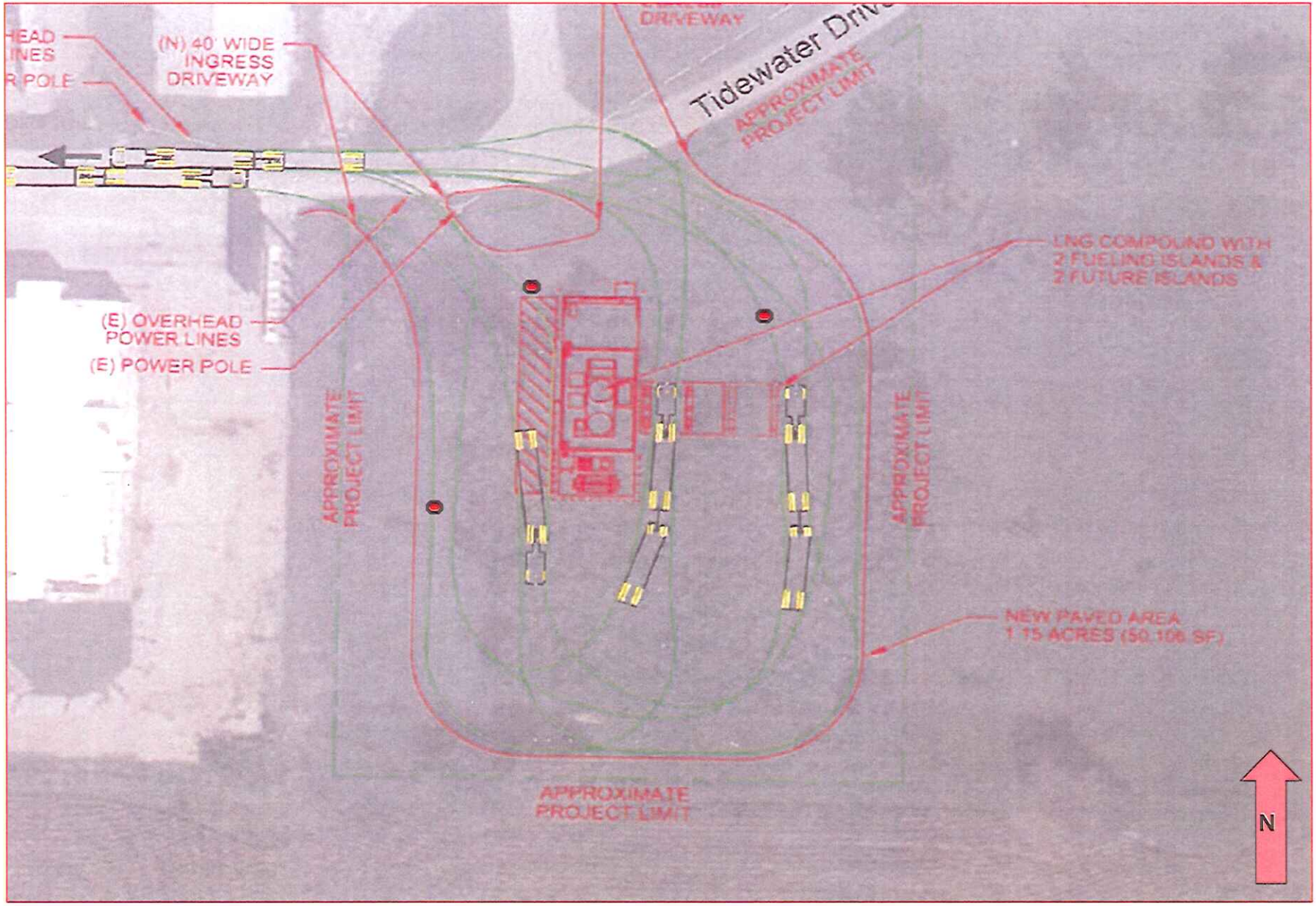
$Q = 1.486/n\ A R^{2/3} S^{1/2}$

$Q = \left(\frac{1.486}{0.016}\right)(1.23)(0.31^{2/3})(0.0312^{1/2})$

$Q = 12.36$ cfs > 10.31 cfs ✓

APPENDIX I
BORING LOCATIONS AND BORING LOGS

Professional Service Industries, Inc.



Boring Location Diagram LNG Fueling Station Tidewater Drive and Division Street West Branch, IA	PSI Project No.:	338-784
	Date: 7/31/2013	Drawn By: SDB

BORING B-01

DATE STARTED:	8/5/13	DRILL COMPANY:	PSI Inc
DATE COMPLETED:	8/5/13	DRILLER: DJK	LOGGED BY: JRB
COMPLETION DEPTH	30.0 ft	DRILL RIG:	CME-55
BENCHMARK:	N/A	DRILLING METHOD:	Hollow Stem Auger
ELEVATION:	776 ft	SAMPLING METHOD:	SS
LATITUDE:	41.3938°	HAMMER TYPE:	Automatic
LONGITUDE:	-91.2040°	EFFICIENCY	81%
STATION: N/A	OFFSET: N/A	REVIEWED BY:	AR

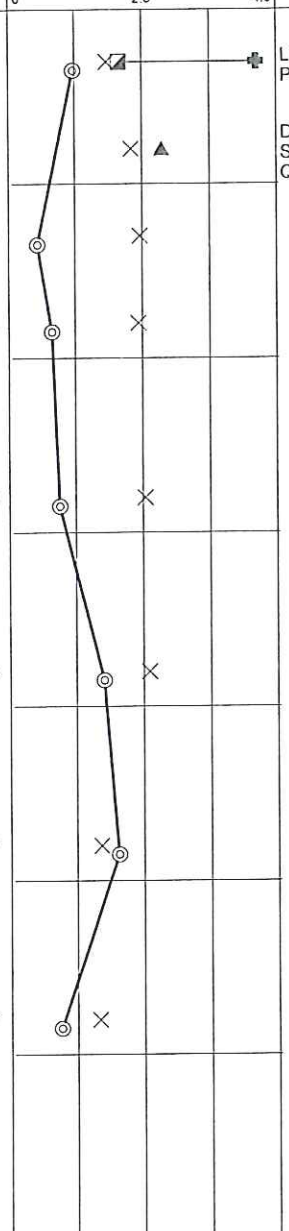
Water		
While Drilling	28 feet
Upon Completion	not observed
Delay	N/A

BORING LOCATION:
Northwest of Site

REMARKS: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			**ORGANIC LAYER - 4 inches**				
775		1	18	**LOW PLASTICITY CLAY**- light gray brown and light brown, moist, stiff Low plasticity clay, light gray brown and light brown		3-4-5 N_{60}=12	18	LL = 46 PL = 21
	5	2	5	Grading, light gray brown, with iron staining, firm			23	DD = 100 pcf Sat.=92% Q_u = 2.3 tsf
770		3	18		CL	2-2-2 N_{60}=5	25	
	10	4	18			4-3-3 N_{60}=8	24	
765								
		5	18	Grading, stiff **MEDIUM PLATSICTY CLAY**- gray, moist, very stiff		2-4-3 N_{60}=9	25	
760	15							
	20	6	14		CL-CH	5-6-7 N_{60}=18	26	
755								
	25	7	18			3-7-8 N_{60}=20	17	
750								
		8	18	**LOW PLASTICITY CLAY**- with fine grained sand, light brown, moist, stiff	CL	2-3-4 N_{60}=9	17	
	30			Boring terminated at 30 feet.				

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0



Professional Service Industries, Inc.
1211 W. Cambridge Circle Drive
Kansas City, KS 66103
Telephone: (913) 310-1600

PROJECT NO.: 338-784
PROJECT: LNG Fueling Station
LOCATION: Tidewater Drive
West Branch, IA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-02

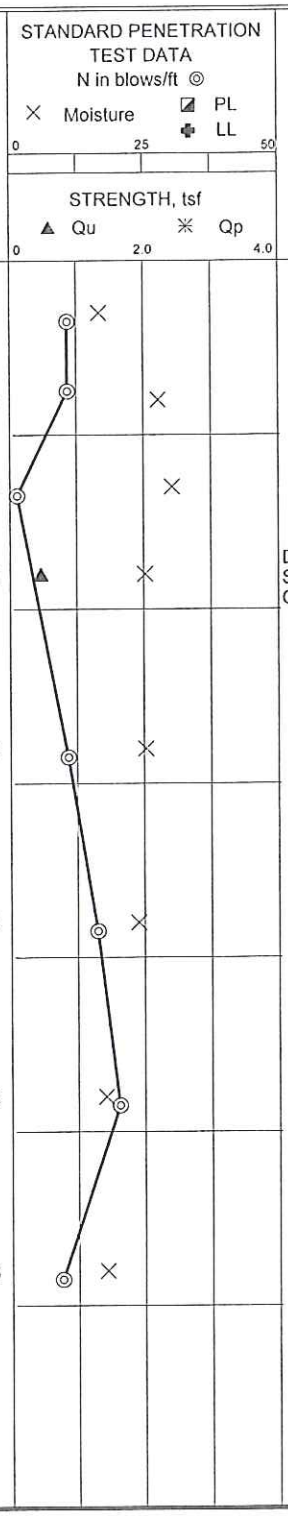
DATE STARTED:	8/5/13	DRILL COMPANY:	PSI Inc
DATE COMPLETED:	8/5/13	DRILLER: DJK	LOGGED BY: JRB
COMPLETION DEPTH	30.0 ft	DRILL RIG:	CME-55
BENCHMARK:	N/A	DRILLING METHOD:	Hollow Stem Auger
ELEVATION:	773 ft	SAMPLING METHOD:	SS
LATITUDE:	41.3938°	HAMMER TYPE:	Automatic
LONGITUDE:	-91.2040°	EFFICIENCY	81%
STATION: N/A	OFFSET: N/A	REVIEWED BY:	AR

Water		
While Drilling	not observed	
Upon Completion	not observed	
Delay	N/A	

BORING LOCATION: Northeast of Site

REMARKS: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			**ORGANIC LAYER - 4 inches**				
		1	9	**LOW PLASTICITY CLAY**- light gray brown and light brown, moist, stiff		4-4-4 N_{60}=11	17	
770		2	18	Grading, light gray brown, with iron staining		3-4-4 N_{60}=11	28	
	5	3	18	Grading, soft		0-0-1 N_{60}=1	30	
765		4	16	Grading, stiff	CL		25	DD = 97 pcf Sat.=93% Q_u = 0.5 tsf
	10							
760		5	12			3-3-5 N_{60}=11	25	
	15			**MEDIUM PLATSICTY CLAY**- gray, moist,stiff				
755		6	18			3-5-7 N_{60}=16	24	
	20				CL-CH			
750		7	18			3-7-8 N_{60}=20	18	
	25							
745		8	18	**LOW PLASTICITY CLAY**- with fine grained sand, light brown and light gray, moist, stiff	CL	2-3-4 N_{60}=9	18	
	30			Boring terminated at 30 feet.				



Professional Service Industries, Inc.
1211 W. Cambridge Circle Drive
Kansas City, KS 66103
Telephone: (913) 310-1600

PROJECT NO.: 338-784
PROJECT: LNG Fueling Station
LOCATION: Tidewater Drive
West Branch, IA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-03

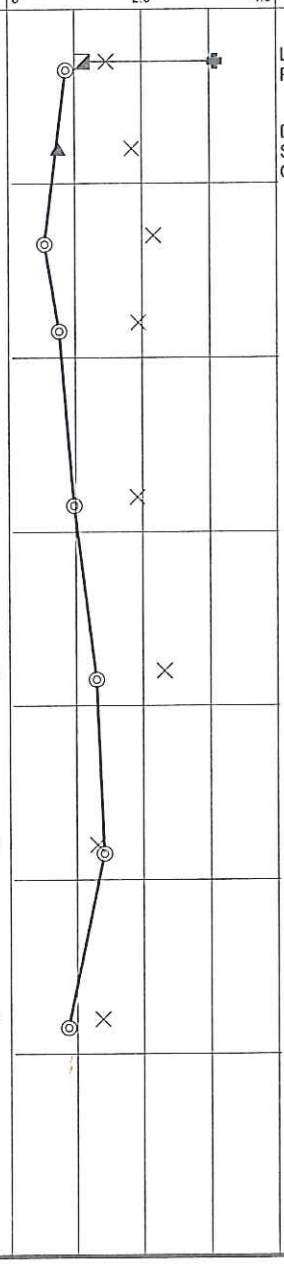
DATE STARTED:	8/5/13	DRILL COMPANY:	PSI Inc
DATE COMPLETED:	8/5/13	DRILLER: DJK	LOGGED BY: JRB
COMPLETION DEPTH	30.0 ft	DRILL RIG:	CME-55
BENCHMARK:	N/A	DRILLING METHOD:	Hollow Stem Auger
ELEVATION:	777 ft	SAMPLING METHOD:	SS
LATITUDE:	41.3938°	HAMMER TYPE:	Automatic
LONGITUDE:	-91.2040°	EFFICIENCY	81%
STATION: N/A	OFFSET: N/A	REVIEWED BY:	AR

Water		
While Drilling	not observed	
Upon Completion	not observed	
Delay	N/A	

BORING LOCATION: West of Site

REMARKS: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			**ORGANIC LAYER - 4 inches**				
775		1	6	**LOW PLASTICITY CLAY**- light gray brown and light brown, moist, stiff Low plasticity clay, light gray brown and light brown	CL	3-4-4 N_{60}=11	18	LL = 39 PL = 14
	5	2	11	Grading, light gray brown, with iron staining			23	DD = 97 pcf Sat.=86% Q_u = 0.8 tsf
770		3	14			2-3-2 N_{60}=7	27	
	10	4	15			3-4-3 N_{60}=9	24	
765								
	15	5	18			3-4-5 N_{60}=12	24	
760				**MEDIUM PLATSICTY CLAY**- gray, moist,stiff				
	20	6	18			4-6-6 N_{60}=16	29	
755					CL-CH			
	25	7	16	Grading, with fine grained sand, gray and brown		3-7-6 N_{60}=18	16	
750								
	30	8	15	**LOW PLASTICITY CLAY**- with fine grained sand, light brown, moist, stiff	CL	3-4-4 N_{60}=11	17	
				Boring terminated at 30 feet.				



Professional Service Industries, Inc.
1211 W. Cambridge Circle Drive
Kansas City, KS 66103
Telephone: (913) 310-1600

PROJECT NO.: 338-784
PROJECT: LNG Fueling Station
LOCATION: Tidewater Drive
West Branch, IA

The stratification lines represent approximate boundaries. The transition may be gradual.

APPENDIX J
PERCOLATION TESTS

Percolation Test for B-3 Completed on 8/6/13

Test Interval (minutes)	Depth to water (inches)	Drop in Water level (inches) between readings	Percolation rate minutes per inch
1	2.5	–	–
2	3.5	1	1.0
5	4	0.5	6.0
10	6	2	0.0
15	8	2	2.5
30	11	3	5.0
60	14	3	10.0
Water was added to refill hole to 6 inch from top elevation			
90	10.5	7	4.3
120	12	1.5	20.0
150	12.5	0	0.0
180	12.5	1	30.0

prec rate (minutes per inch) 8

Percolation Test

PSI drilled a 6 inch diameter soil boring to a depth of about 3 feet into the existing subgrade and filled the bottom 1 foot of the borehole with clean ¾-inch stone in preparation to performing a percolation test. The borehole was then filled to the surface with water and were allowed to permeate into the soil for a 24 hour period prior to performing the percolation test. PSI returned to the site the following morning to perform the percolation test and refilled the hole with water to the surface and started the percolation test. Results of the percolation test can be found in the appendix of this report

Percolation Test for B-2 Completed on 8/6/13

Test Interval (minutes)	Depth to water (inches)	Drop in Water level (inches) between readings	Percolation rate minutes per inch
1	2.5	_	_
2	2.5	0	0.0
5	4.5	2	1.5
10	4.5	0	0.0
15	6	1.5	3.3
30	9	3	5.0
60	11	2	15.0
Water was added to refill hole to 6 inch from top elevation			
90	10.5	7	4.3
120	12	1.5	20.0
150	12	0	0.0
180	13	1	30.0

prec rate (minutes per inch) 8

Percolation Test

PSI drilled a 6 inch diameter soil boring to a depth of about 3 feet into the existing subgrade and filled the bottom 1 foot of the borehole with clean ¾-inch stone in preparation to performing a percolation test. The borehole was then filled to the surface with water and were allowed to permeate into the soil for a 24 hour period prior to performing the percolation test. PSI returned to the site the following morning to perform the percolation test and refilled the hole with water to the surface and started the percolation test. Results of the percolation test can be found in the appendix of this report

Percolation Test for B-1 Completed on 8/6/13

Test Interval (minutes)	Depth to water (inches)	Drop in Water level (inches) between readings	Percolation rate minutes per inch
1	4	–	–
2	4.5	0.5	2.0
5	6	1.5	2.0
10	6	0	0.0
15	7.5	1.5	3.3
30	10	2.5	6.0
60	13	3	10.0
Water was added to refill hole to 6 inch from top elevation			
90	11	5	6.0
120	12	1	30.0
150	12	0	0.0
180	13	1	30.0

prec rate (minutes per inch) 9

Percolation Test

PSI drilled a 6 inch diameter soil boring to a depth of about 3 feet into the existing subgrade and filled the bottom 1 foot of the borehole with clean ¾-inch stone in preparation to performing a percolation test. The borehole was then filled to the surface with water and were allowed to permeate into the soil for a 24 hour period prior to performing the percolation test. PSI returned to the site the following morning to perform the percolation test and refilled the hole with water to the surface and started the percolation test. Results of the percolation test can be found in the appendix of this report

KAW VALLEY ENGINEERING, INC.
Junction City, KS Ph 785-762-5040
Kansas City, MO Ph 816-468-5858
Lenexa, KS Ph 913-894-5150
Salina, KS Ph 785-823-3400

Job LNG West Branch, Iowa
Sheet No. _____ Of _____
Calculated by DPB Date 11/25/19
Checked by _____ Date _____
Scale _____

Determine Infiltration Rate

$$\text{Infiltration Rate} = \frac{r \times 60\,\text{min/hr} \times \Delta h}{\Delta t\,(r + (2 \times H_{ave}))}$$

Given:

$\Delta h = 3''$,
$\Delta t = 15$ min
r = radius of perc test hole = 3"
depth of perc test hole = 36"

$h_{initial} = 36'' - 11'' = 25''$

$h_{final} = 36'' - 14'' = 22''$

$$H_{ave} = \frac{25 + 22}{2} = 23.5''$$

$$\text{Infiltration Rate} = \frac{(3'')(60\,\text{min/hr})(3'')}{15\,\text{min}\,(3'' + (2 \times 23.5''))} = \frac{540}{750}$$

Infiltration Rate = 0.72 in/hr