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ENGINEERS

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Stormwater Report

Gallop Bend Subdivision – Weber County

HE Project No.: PG-888-1607

Storm Drainage System Calculations

December 2016

Dean Barker, PE
Horrocks Engineers

PROFESSIONAL ENGINEER
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DEAN G.
BARKER
12-8-16
STATE OF UTAH

Existing Conditions

The proposed Gallop Bend Subdivision is located north off of 2550 South between 3500 West and 3850 West in Weber County, UT. The project will consist of 20 single family residential lots at a minimum size of 40,000 SF. The property is currently being farmed with an old farm house located off of 2550 South. The property is approximately 22.35 acres and naturally drains from the northwest corner of the parcel to the southeast corner.

The existing storm water may infiltrate in the ground as it sheet flows to an existing drainage ditch on the north side of 2550 South. The ditch drains east and ties into the existing County storm drainage system at 3500 West. The system then drains to the south to an existing drainage.

There is an existing ditch along the west property line near the existing wire fence. The ditch is only about 8 to 10 inches deep. The existing ditch catches off site runoff from the west and conveys it south to an existing pipe installed on its end tied to an existing 15" RCP below ground on 2550 South. Offsite water from the west is expected to be very minor due to the existing topography. However, this ditch should be left in place. If removed during clearing and grubbing activities, the contractor should construct a "V" ditch approximately 12" deep to historically convey water to the south.

There are existing irrigation ditches that have been used for farming activities on the site. There is an existing concrete lined channel located near the north property line that has delivered water from the Wilson Canal. This channel will be removed and abandoned in accordance with the Wilson Irrigation Co. standards and specifications. All irrigation ditches will be removed from the property in the same manner.

The Wilson Canal runs about 200' north of the north property line of the site intercepting offsite flow from the north. However, there are relatively small fields located between the canal and the project site. As these fields are irrigated, there is a potential for offsite water to run onto the north portion of the proposed site. It is recommended to install a 1' high berm along the north property line to intercept runoff/irrigation water and convey it to the east property line. A 12" deep "V" ditch should be constructed on the east property line conveying offsite and onsite runoff to the southeast corner of the site where a detention pond will be constructed. The detention pond is sized for the onsite runoff volume with an overflow constructed to convey offsite water to the 2550 S. ditch.

Project Description

This report is intended to show that the proposed on-site storm systems are adequate for the new development and that off-site water can be conveyed through the project site properly. The grading plan is an integral part of this report and should be referred to while reviewing this document (see *Appendix A: Grading Plan*).

The project has been designed for one drainage area:

1. The stormwater runoff generated by the proposed development will be conveyed to a proposed detention pond in the southeast corner of the site by over land flow, pavement sheet flow, gutters, curb inlets, and pipes. The on-site runoff will be attenuated through the pond using an outlet structure with a 0.7' wide vertical slotted weir to restrict the flow at the predeveloped flow rates for the 2, 10, 25, 50 and 100 year storm events.

All off-site and on-site drainage will be conveyed separately and will not mix. However, off-site drainage may be routed to the pond overflow through perimeter ditches and conveyed to the existing ditch on 2550 South in large storm events. The drainage areas contributing to the on-site system include the roof tops, landscaped areas, sidewalks, and paved areas.

Hydraulic Analysis

The hydraulic analysis was completed using the rational method as was prescribed by the County *Standards*. The storage needs to be large enough to completely contain on-site runoff. Peak flow was calculated using the rational method as follows:

$$Q = ciA$$

Q = Peak Flow (cfs)
c = Rational Method Runoff Coefficient
i = Rainfall Intensity (in/hr)
A = Drainage Area (acres)

Predeveloped Flow Rate:

The historic predeveloped flow rates have been calculated for each storm event to ensure that post development release rates do not exceed the historical peak flows. A time of concentration of 15 min. was used, see calculations in Appendix. A conservative C value of 0.1 was used for the existing range land/farm land. See post development hydrographs in the Appendix for post development peak release rates through the outlet structure.

Storm Event (year)	Area (acres)	Intensity Tc=15 min. (in/hr)	Runoff Coefficient (c)	Q Peak Flow (cfs)
2	22.35	1.19	0.10	2.66
10	22.35	2.04	0.10	4.56
25	22.35	2.72	0.10	6.08
50	22.35	3.35	0.10	7.49
100	22.35	4.10	0.10	9.16

Storage

Detention Pond:

The on-site storage was ultimately calculated for a 100 year – 24 hour storm event. However, hydrographs have been included in the Appendix to ensure post development discharge does not exceed the predeveloped release rates and that the pond is adequately sized for each event. See Appendix for 100 year runoff volume calculations and pond sizing calculations.

Area	Runoff Coefficient (c)	Drainage Area (A)
Roof/Driveways	0.95 (roof)	1.47 acres
Landscaping	0.15 (grass)	19.10 acres
Sidewalks/Pavement	0.90 (concrete)	1.78 acres
Total	0.26 (weighted)	22.35 acres

Weighted Runoff Coefficient, c : ((0.95*1.47)+(0.15*19.10)+(0.90*1.78) / 22.35 = 0.26

*note: 3,200 SF was assumed for roof/driveway areas per lot.

Storm Elapsed Time, t : 24 hours

Required Volume, V_r : 13,441 cu ft

Provided Volume of Pond, V_{pond}: 13,900 cu ft

These calculations show that there is adequate volume in the detention Pond (Pond Capacity > Required Volume). The pond will be constructed with a vertical slotted weir restricting the flow. See Appendix for weir sizing calculations.

Conveyance System

On-site Drainage Areas:

The on-site conveyance is calculated for a 10 year storm event using a time of concentration of 15 minutes. The conveyance system to the detention pond is comprised of inlets and a 15" RCP at 0.50% min. slope or greater leading to the detention pond in the southeast corner of the property.

Pipe Calculations:

Mannings roughness coefficient for 15" RCP @ 0.25% = 0.013

15 minute Time of Concentration for 50% of site to first intersection:

Q_{10} = CiA = 0.26 * 2.04 in/hr * 11.17 acres = 5.92 cfs

15 minute Time of Concentration for 100% of site at last manhole in street:

Q_{10} = CiA = 0.26 * 2.04 in/hr * 22.35 acres = 11.85 cfs

Barrel capacity for 18" RCP @ 0.25% slope = 5.65 cfs

Barrel capacity for 24" RCP @ 0.25% slope = 12.17 cfs

See calculations in appendix.

Appendix A:

Site Exhibits

Appendix B:

Hydraulic Computations

Final Engineering Drainage Report

Drainage Area 1 - Detention Pond

Project Number:	**PG-888-1607**	**Gallop Bend Subdivision**	**Agency:**	**Weber County**
Design Engineer:	**D. Barker**		**Date:**	**1-Dec-16**

2550 South Weber County, Taylor, Utah

Watershed Properties

Design Event (yr)	Drainage Area (ac)	Land Use Breakdown: Land Use Type	[C] C	[A] Watershed Area (sq ft)	(ac)
100	22.35	Roof/Driveway	0.95	64000.00	1.47
Infiltration Rate	**Ground Water Depth**	Landscaping	0.15	832177.00	19.10
(in / hr)	**(ft)**	Sidewalks/Paved	0.90	77369.00	1.78
3.00	4.00	Composite	0.26	973546.00	22.35

Detention Pond Properties

Pond Top Elev. (ft)	Pond Bottom Elev. (ft)	Ground Water Elev. (ft)	Freeboard Elev. (ft)	Infiltration Rate (ft / day)	Release Rate (cfs)
4204.00	4201.50	4199.30	4205.00	6.00	9.208

Pond Volume Calculations

Elapsed Time (min)	[i] Rainfall Intensity (in/hr)	[Q] Accumulated Flow ciA (cfs)	Accumulated Volume (cu ft)	Allowable Release (cu ft)	Required Storage (cu ft)
10	4.97	29.11	17467.29	5524.92	11942.37
15	4.12	24.14	21728.63	8287.38	13441.25
30	2.76	16.17	29112.14	16574.76	12537.38
60	1.71	10.02	36073.74	33149.52	2924.22
120	0.94	5.48	39449.06	66299.04	0.00
180 (3 Hrs)	0.64	3.73	40250.70	99448.56	0.00
360 (6 Hrs)	0.36	2.08	44933.96	198897.12	0.00
720 (12 Hrs)	0.22	1.28	55186.50	397794.24	0.00
1,440 (24 Hrs)	0.12	0.71	61262.08	795588.48	0.00

Detention Pond Sizing

North Swale Dimensions (ft)		Elevation (ft)	Area (sq ft)	Volume (cu ft)	Accumulated Volume (cu ft)
Slope (rise)	1.00	4204.00	7588.00	0.00	0.00
Slope ((run)	3.00	4203.00	5936.00	6762.00	6762.00
Top Length	255.00	4202.00	4357.00	5146.50	11908.50
Top Width	36.50	4201.50	3594.00	1987.75	13896.25
Bottom Length	231.00				
Bottom Width	11.00				

Detention Pond Outflow

Required Storage (cu ft)	Storage (cu ft)	Pond Capacity (cu ft)	Release Rate (cfs)	Infiltration Surface (sq ft)	Infiltration Flow (cu ft / day)
13441.25	13441.25	13896.25	9.21	2541.00	15246.00
		Time for Pond to Drain at Max Volume		**Time for Pond to Infiltrate**	
		(hrs)	**(days)**	**(hrs)**	**(days)**
		0.41	0.02	10.64	0.44

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Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Thursday, 12 / 8 / 2016

Hyd. No. 1

Pre Developed

Hydrograph type	= Rational	Peak discharge	= 2.612 cfs
Storm frequency	= 2 yrs	Time to peak	= 16 min
Time interval	= 1 min	Hyd. volume	= 2,507 cuft
Drainage area	= 22.350 ac	Runoff coeff.	= 0.1
Intensity	= 1.169 in/hr	Tc by TR55	= 16.00 min
IDF Curve	= IDF curve for hydrographs.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Report

Hyd. No. 1

Pre Developed

Hydrograph type	= Rational	Peak discharge	= 4.483 cfs
Storm frequency	= 10 yrs	Time to peak	= 16 min
Time interval	= 1 min	Hyd. volume	= 4,304 cuft
Drainage area	= 22.350 ac	Runoff coeff.	= 0.1
Intensity	= 2.006 in/hr	Tc by TR55	= 16.00 min
IDF Curve	= IDF curve for hydrographs.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Report

Hyd. No. 1

Pre Developed

Hydrograph type	= Rational	Peak discharge	= 5.944 cfs
Storm frequency	= 25 yrs	Time to peak	= 16 min
Time interval	= 1 min	Hyd. volume	= 5,706 cuft
Drainage area	= 22.350 ac	Runoff coeff.	= 0.1
Intensity	= 2.660 in/hr	Tc by TR55	= 16.00 min
IDF Curve	= IDF curve for hydrographs.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 — Thursday, 12 / 8 / 2016

Hyd. No. 1

Pre Developed

Hydrograph type	= Rational	Peak discharge	= 7.313 cfs
Storm frequency	= 50 yrs	Time to peak	= 16 min
Time interval	= 1 min	Hyd. volume	= 7,020 cuft
Drainage area	= 22.350 ac	Runoff coeff.	= 0.1
Intensity	= 3.272 in/hr	Tc by TR55	= 16.00 min
IDF Curve	= IDF curve for hydrographs.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Thursday, 12 / 8 / 2016

Hyd. No. 1

Pre Developed

Hydrograph type	= Rational	Peak discharge	= 8.954 cfs
Storm frequency	= 100 yrs	Time to peak	= 16 min
Time interval	= 1 min	Hyd. volume	= 8,596 cuft
Drainage area	= 22.350 ac	Runoff coeff.	= 0.1
Intensity	= 4.006 in/hr	Tc by TR55	= 16.00 min
IDF Curve	= IDF curve for hydrographs.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Report

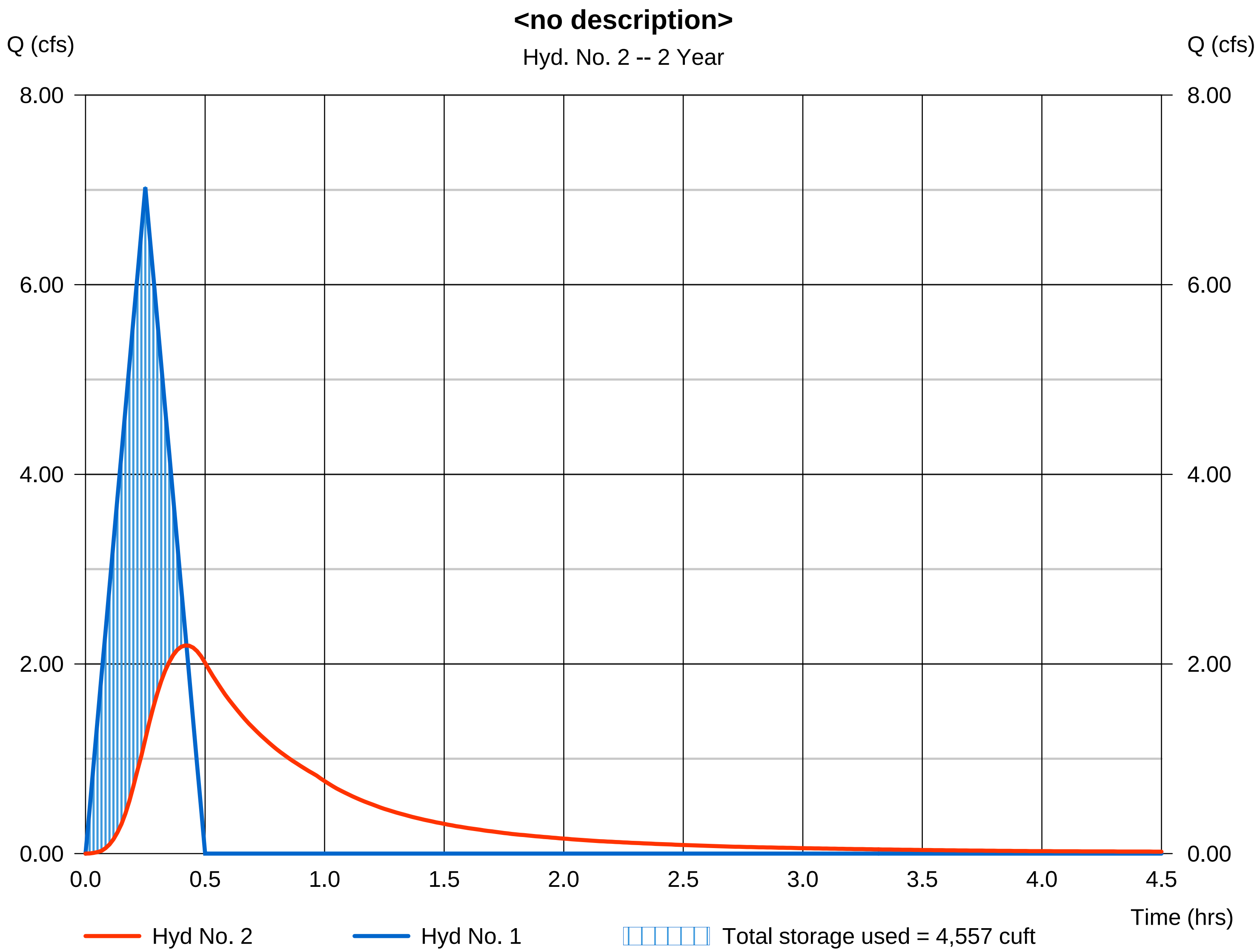
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 12 / 2 / 2016

Hyd. No. 2

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 2.195 cfs
Storm frequency	= 2 yrs	Time to peak	= 0.42 hrs
Time interval	= 1 min	Hyd. volume	= 6,317 cuft
Inflow hyd. No.	= 1 - Detention Pond	Max. Elevation	= 4202.46 ft
Reservoir name	= <New Pond>	Max. Storage	= 4,557 cuft

Storage Indication method used.



Hydrograph Report

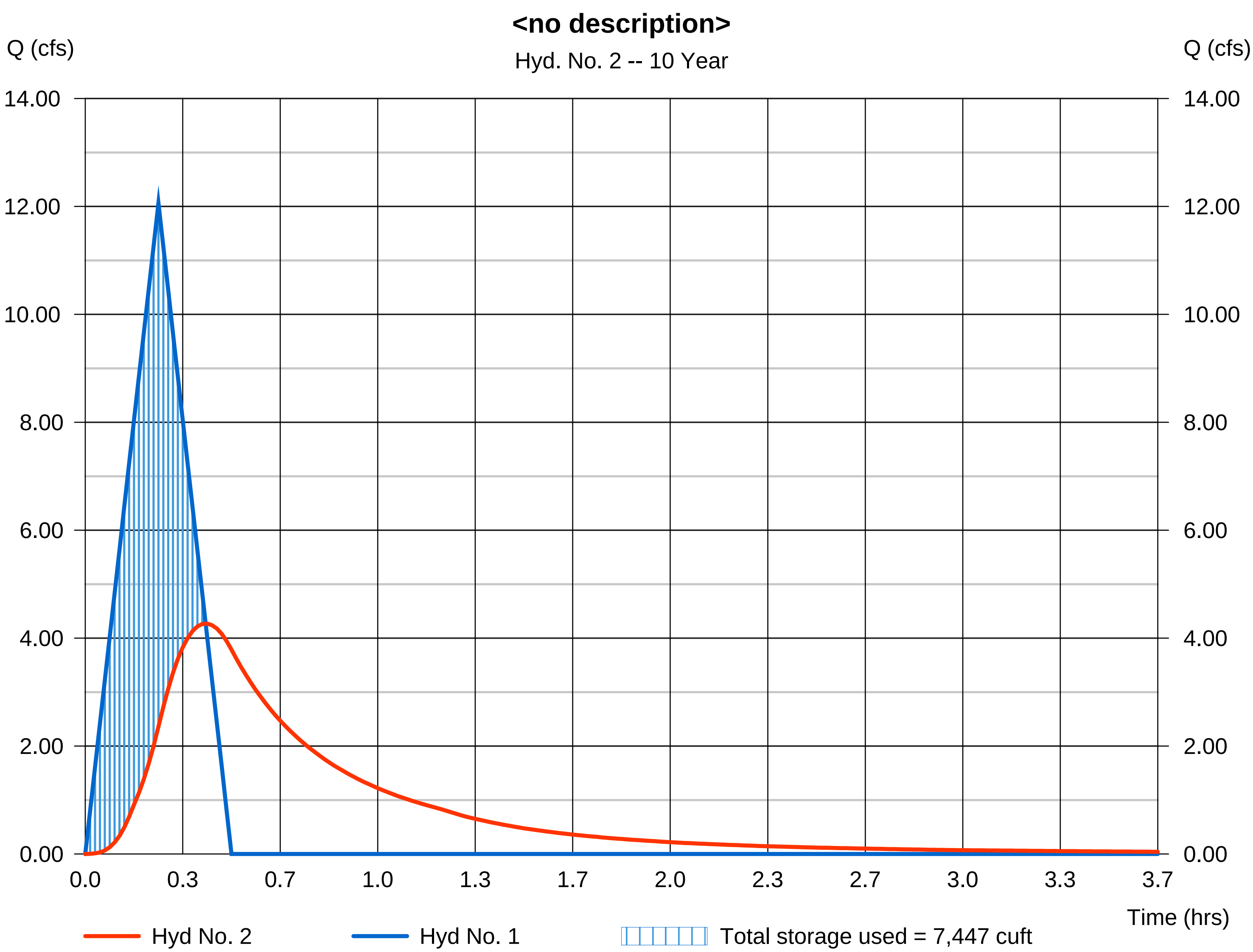
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 — Friday, 12 / 2 / 2016

Hyd. No. 2

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 4.270 cfs
Storm frequency	= 10 yrs	Time to peak	= 0.42 hrs
Time interval	= 1 min	Hyd. volume	= 10,847 cuft
Inflow hyd. No.	= 1 - Detention Pond	Max. Elevation	= 4203.00 ft
Reservoir name	= <New Pond>	Max. Storage	= 7,447 cuft

Storage Indication method used.



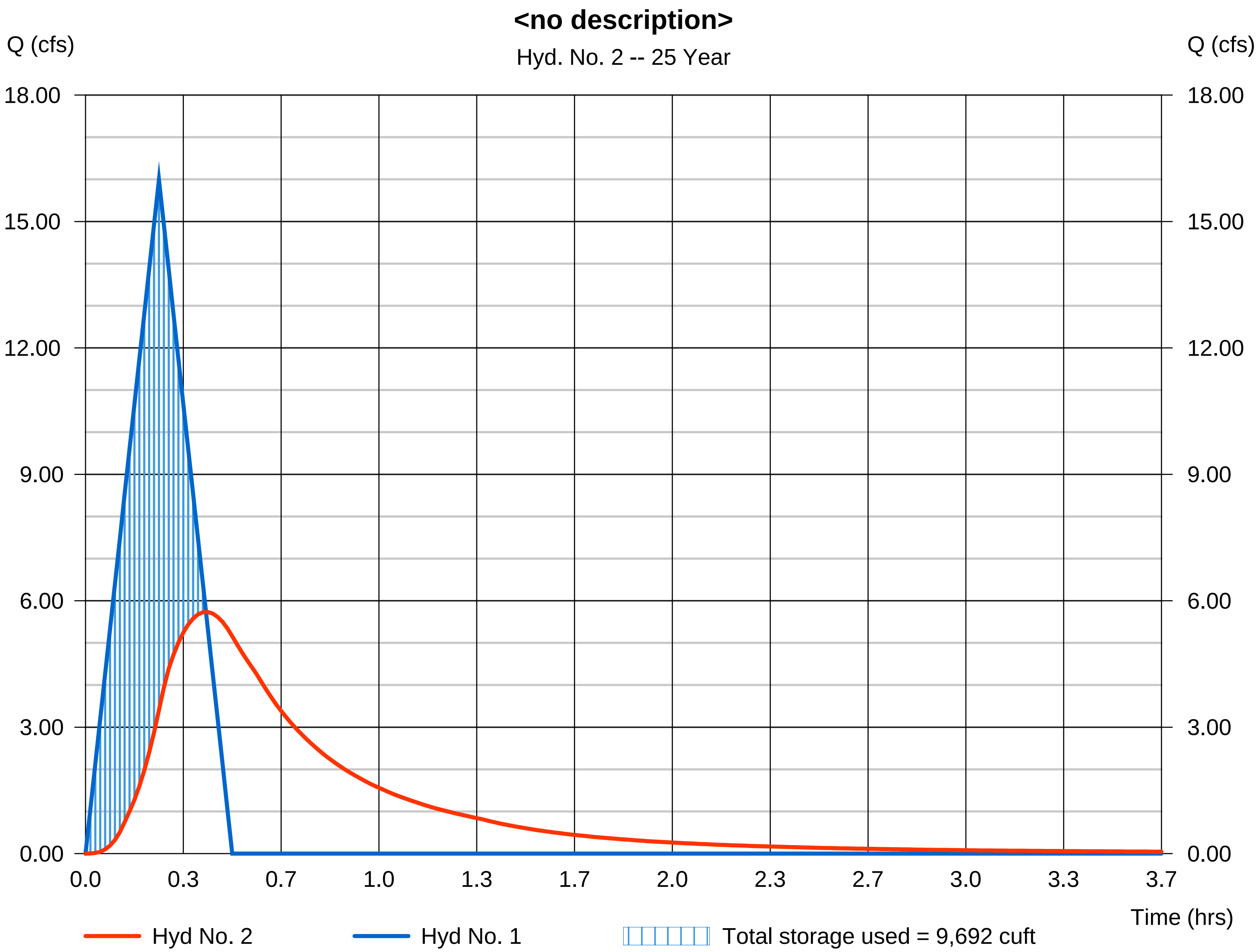
Hydrograph Report

Hyd. No. 2

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 5.732 cfs
Storm frequency	= 25 yrs	Time to peak	= 0.42 hrs
Time interval	= 1 min	Hyd. volume	= 14,385 cuft
Inflow hyd. No.	= 1 - Detention Pond	Max. Elevation	= 4203.32 ft
Reservoir name	= <New Pond>	Max. Storage	= 9,692 cuft

Storage Indication method used.



Hydrograph Report

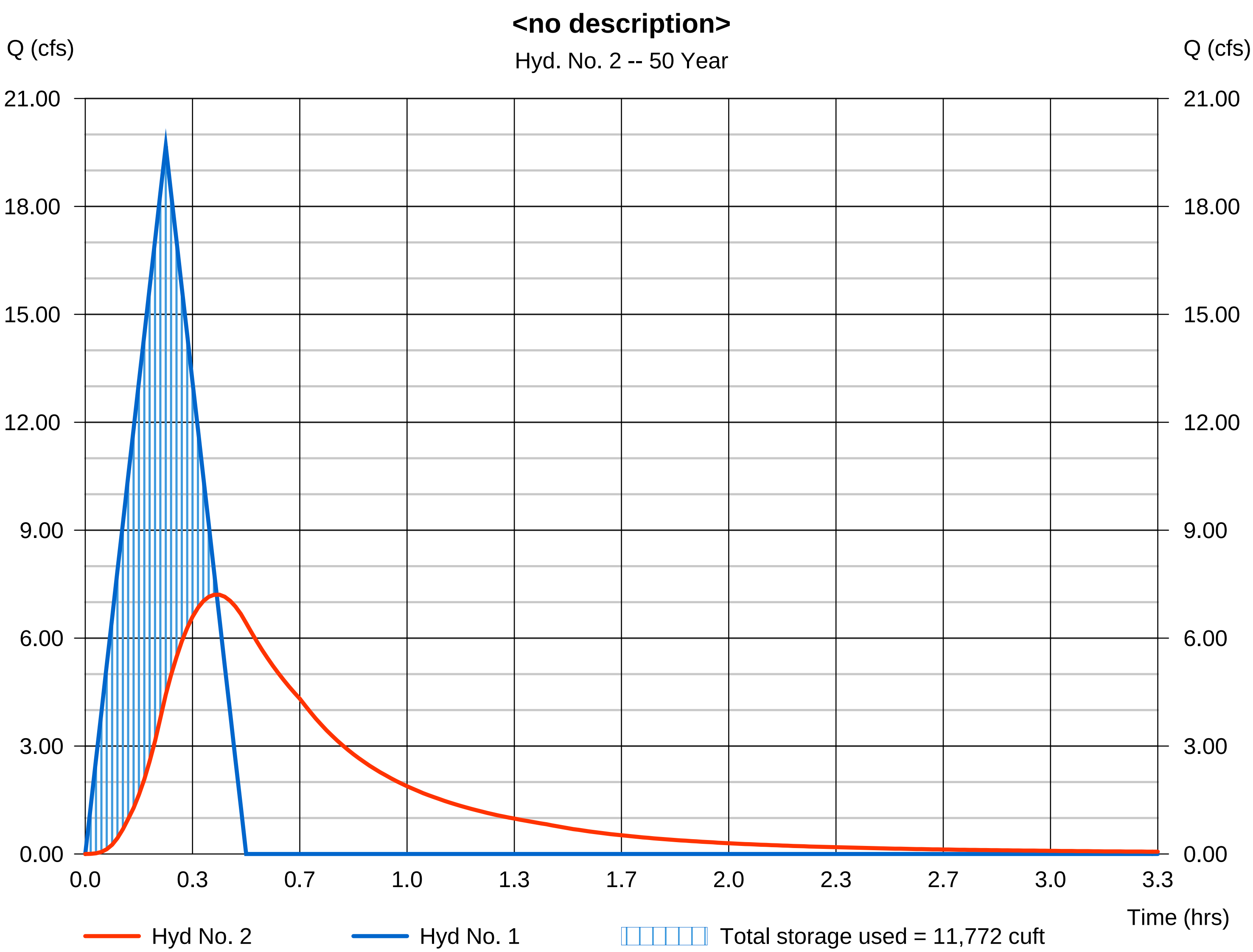
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 — Friday, 12 / 2 / 2016

Hyd. No. 2

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 7.206 cfs
Storm frequency	= 50 yrs	Time to peak	= 0.42 hrs
Time interval	= 1 min	Hyd. volume	= 17,701 cuft
Inflow hyd. No.	= 1 - Detention Pond	Max. Elevation	= 4203.62 ft
Reservoir name	= <New Pond>	Max. Storage	= 11,772 cuft

Storage Indication method used.



Hydrograph Report

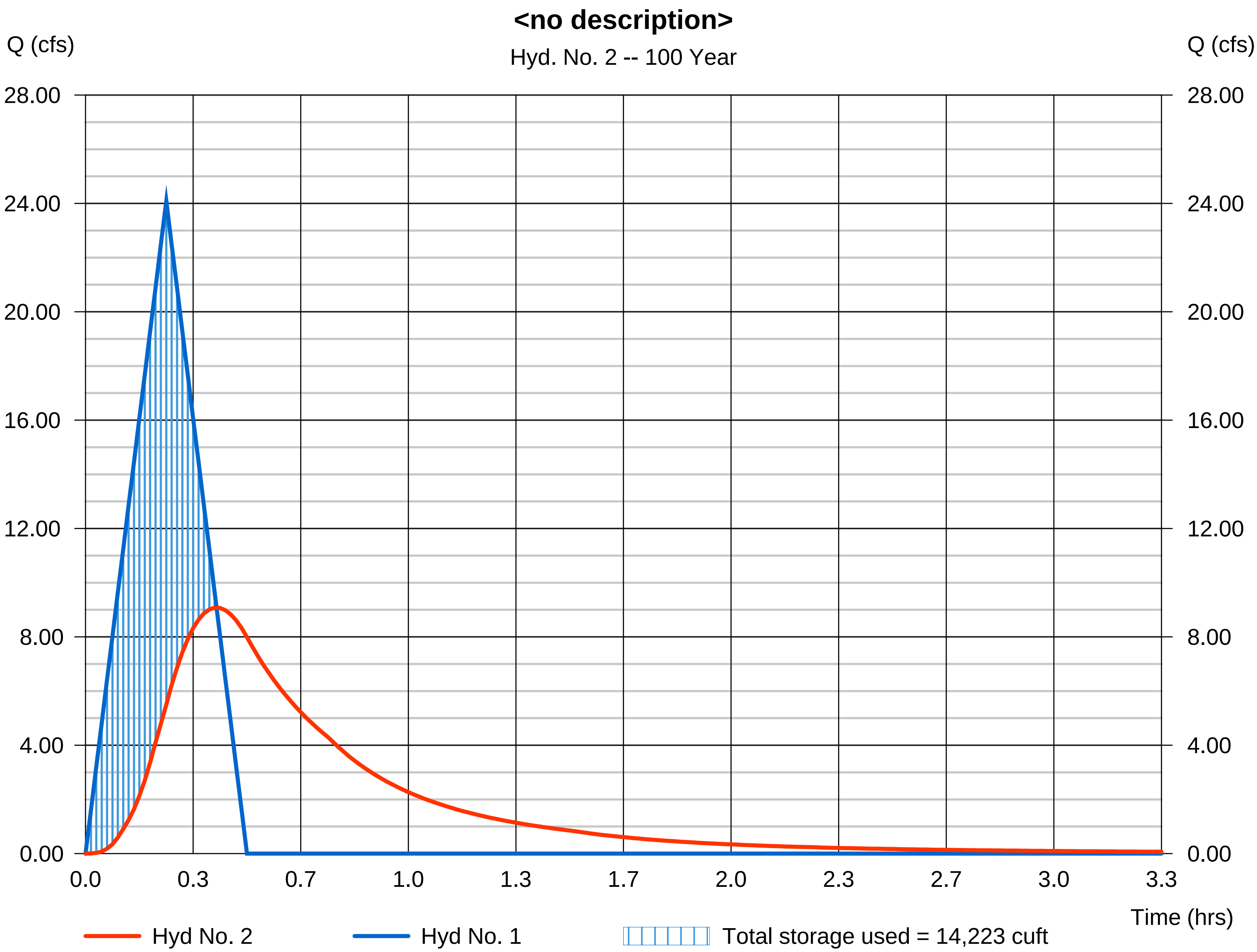
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 12 / 2 / 2016

Hyd. No. 2

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 9.076 cfs
Storm frequency	= 100 yrs	Time to peak	= 0.40 hrs
Time interval	= 1 min	Hyd. volume	= 21,673 cuft
Inflow hyd. No.	= 1 - Detention Pond	Max. Elevation	= 4203.98 ft
Reservoir name	= <New Pond>	Max. Storage	= 14,223 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - <New Pond>

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 4201.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	4201.50	3,750	0	0
0.50	4202.00	4,600	2,084	2,084
1.50	4203.00	6,200	5,380	7,463
2.50	4204.00	7,700	6,936	14,399

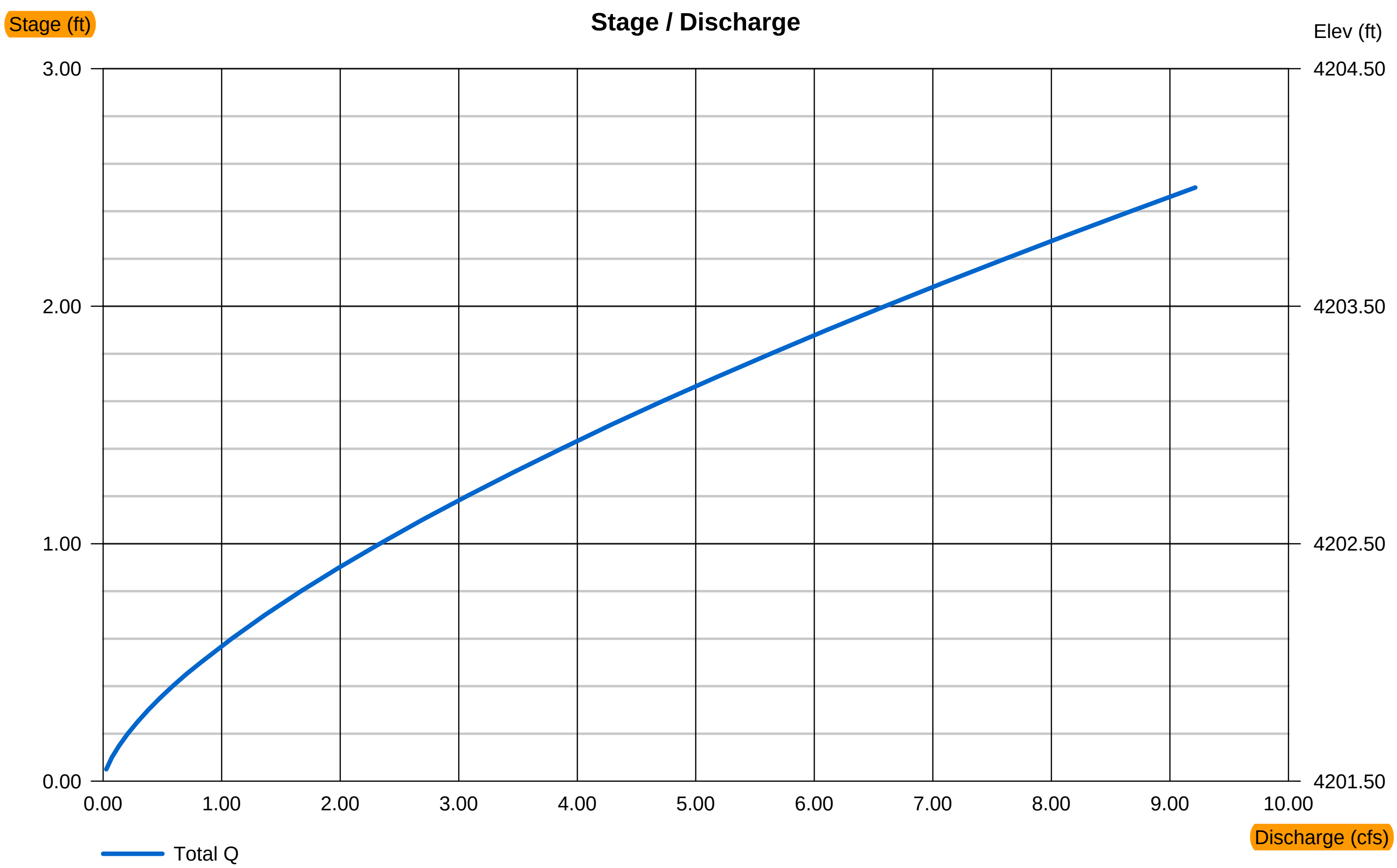
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.70	0.00	0.00	0.00
Crest El. (ft)	= 4201.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 12 / 2 / 2016

Pond No. 1 - <New Pond>

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 4201.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	4201.50	3,750	0	0
0.50	4202.00	4,600	2,084	2,084
1.50	4203.00	6,200	5,380	7,463
2.50	4204.00	7,700	6,936	14,399

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.70	0.00	0.00	0.00
Crest El. (ft)	= 4201.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	4201.50	---	---	---	---	0.00	---	---	---	---	---	0.000
0.50	2,084	4202.00	---	---	---	---	0.82	---	---	---	---	---	0.824
1.50	7,463	4203.00	---	---	---	---	4.28	---	---	---	---	---	4.282
2.50	14,399	4204.00	---	---	---	---	9.21	---	---	---	---	---	9.214

18" RCP

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00250	ft/ft
Normal Depth	1.50	ft
Diameter	1.50	ft

Results

Discharge	5.25	ft^3/s
Flow Area	1.77	ft^2
Wetted Perimeter	4.71	ft
Hydraulic Radius	0.38	ft
Top Width	0.00	ft
Critical Depth	0.88	ft
Percent Full	100.0	%
Critical Slope	0.00588	ft/ft
Velocity	2.97	ft/s
Velocity Head	0.14	ft
Specific Energy	1.64	ft
Froude Number	0.00	
Maximum Discharge	5.65	ft^3/s
Discharge Full	5.25	ft^3/s
Slope Full	0.00250	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

18" RCP

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	0.88	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.00588	ft/ft

24" RCP

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00250	ft/ft
Normal Depth	2.00	ft
Diameter	2.00	ft

Results

Discharge	11.31	ft^3/s
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Hydraulic Radius	0.50	ft
Top Width	0.00	ft
Critical Depth	1.21	ft
Percent Full	100.0	%
Critical Slope	0.00544	ft/ft
Velocity	3.60	ft/s
Velocity Head	0.20	ft
Specific Energy	2.20	ft
Froude Number	0.00	
Maximum Discharge	12.17	ft^3/s
Discharge Full	11.31	ft^3/s
Slope Full	0.00250	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

24" RCP

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.21	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.00544	ft/ft

Appendix C:

Resources

NOAA Atlas 14, Volume 1, Version 5
Location name: Ogden, Utah, USA*
Latitude: 41.2199°, Longitude: -112.0642°
Elevation: 4252.12 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.126 (0.109-0.146)	0.158 (0.140-0.184)	0.217 (0.190-0.252)	0.271 (0.236-0.316)	0.361 (0.306-0.422)	0.444 (0.364-0.527)	0.544 (0.431-0.652)	0.663 (0.505-0.811)	0.855 (0.615-1.08)	1.03 (0.707-1.34)
10-min	0.192 (0.166-0.223)	0.241 (0.213-0.280)	0.330 (0.289-0.383)	0.413 (0.359-0.481)	0.549 (0.466-0.642)	0.676 (0.555-0.802)	0.828 (0.656-0.993)	1.01 (0.769-1.24)	1.30 (0.936-1.64)	1.57 (1.08-2.03)
15-min	0.238 (0.206-0.276)	0.299 (0.264-0.347)	0.409 (0.358-0.474)	0.512 (0.445-0.596)	0.681 (0.577-0.796)	0.838 (0.687-0.993)	1.03 (0.813-1.23)	1.25 (0.953-1.53)	1.61 (1.16-2.04)	1.95 (1.33-2.52)
30-min	0.321 (0.278-0.371)	0.402 (0.356-0.468)	0.550 (0.482-0.639)	0.689 (0.599-0.802)	0.916 (0.777-1.07)	1.13 (0.925-1.34)	1.38 (1.09-1.66)	1.68 (1.28-2.06)	2.17 (1.56-2.74)	2.63 (1.80-3.39)
60-min	0.397 (0.344-0.459)	0.498 (0.440-0.579)	0.681 (0.596-0.790)	0.853 (0.741-0.992)	1.13 (0.962-1.33)	1.40 (1.15-1.66)	1.71 (1.35-2.05)	2.08 (1.59-2.55)	2.69 (1.93-3.40)	3.25 (2.22-4.20)
2-hr	0.499 (0.441-0.572)	0.625 (0.554-0.715)	0.807 (0.711-0.926)	0.984 (0.853-1.13)	1.28 (1.08-1.48)	1.55 (1.28-1.82)	1.87 (1.50-2.23)	2.25 (1.74-2.75)	2.87 (2.08-3.62)	3.44 (2.38-4.44)
3-hr	0.585 (0.526-0.658)	0.721 (0.646-0.814)	0.901 (0.807-1.02)	1.07 (0.950-1.21)	1.34 (1.17-1.53)	1.59 (1.36-1.84)	1.91 (1.59-2.25)	2.29 (1.84-2.77)	2.91 (2.22-3.66)	3.48 (2.54-4.48)
6-hr	0.795 (0.727-0.873)	0.967 (0.882-1.07)	1.17 (1.06-1.29)	1.35 (1.22-1.50)	1.63 (1.45-1.82)	1.87 (1.64-2.10)	2.13 (1.84-2.44)	2.43 (2.05-2.82)	3.05 (2.48-3.69)	3.61 (2.85-4.53)
12-hr	1.01 (0.935-1.10)	1.24 (1.14-1.35)	1.49 (1.37-1.63)	1.72 (1.56-1.88)	2.05 (1.85-2.26)	2.33 (2.07-2.59)	2.62 (2.29-2.96)	2.94 (2.52-3.37)	3.44 (2.85-4.04)	3.84 (3.10-4.60)
24-hr	1.24 (1.15-1.34)	1.52 (1.41-1.64)	1.81 (1.68-1.96)	2.06 (1.91-2.22)	2.39 (2.21-2.58)	2.65 (2.44-2.86)	2.91 (2.67-3.15)	3.17 (2.90-3.44)	3.53 (3.20-4.08)	3.88 (3.42-4.65)
2-day	1.44 (1.34-1.55)	1.76 (1.64-1.90)	2.09 (1.95-2.25)	2.36 (2.20-2.54)	2.73 (2.54-2.93)	3.00 (2.78-3.23)	3.28 (3.04-3.53)	3.56 (3.27-3.83)	3.92 (3.58-4.24)	4.19 (3.81-4.70)
3-day	1.57 (1.46-1.69)	1.92 (1.79-2.06)	2.28 (2.13-2.45)	2.58 (2.40-2.77)	2.98 (2.78-3.20)	3.30 (3.06-3.54)	3.62 (3.34-3.89)	3.93 (3.61-4.24)	4.35 (3.96-4.71)	4.67 (4.22-5.16)
4-day	1.69 (1.58-1.82)	2.07 (1.93-2.23)	2.47 (2.30-2.65)	2.80 (2.61-3.00)	3.25 (3.02-3.48)	3.59 (3.33-3.86)	3.95 (3.64-4.25)	4.31 (3.95-4.65)	4.78 (4.34-5.19)	5.14 (4.64-5.61)
7-day	2.00 (1.86-2.15)	2.44 (2.28-2.64)	2.91 (2.71-3.13)	3.29 (3.06-3.52)	3.79 (3.53-4.07)	4.18 (3.88-4.49)	4.58 (4.23-4.91)	4.97 (4.57-5.36)	5.47 (5.00-5.94)	5.85 (5.31-6.38)
10-day	2.26 (2.10-2.43)	2.77 (2.58-2.98)	3.28 (3.06-3.52)	3.68 (3.44-3.95)	4.21 (3.93-4.51)	4.60 (4.28-4.92)	4.98 (4.62-5.34)	5.35 (4.94-5.75)	5.81 (5.35-6.26)	6.14 (5.63-6.65)
20-day	2.90 (2.70-3.10)	3.55 (3.32-3.81)	4.19 (3.92-4.49)	4.67 (4.37-5.00)	5.29 (4.95-5.64)	5.72 (5.35-6.11)	6.13 (5.73-6.55)	6.52 (6.07-6.97)	6.98 (6.48-7.49)	7.29 (6.76-7.84)
30-day	3.48 (3.25-3.71)	4.25 (3.98-4.55)	4.98 (4.67-5.32)	5.54 (5.19-5.90)	6.24 (5.85-6.64)	6.74 (6.30-7.17)	7.21 (6.73-7.68)	7.64 (7.11-8.16)	8.17 (7.57-8.74)	8.53 (7.88-9.15)
45-day	4.27 (4.00-4.56)	5.21 (4.88-5.57)	6.09 (5.71-6.49)	6.76 (6.35-7.20)	7.61 (7.15-8.09)	8.21 (7.70-8.72)	8.77 (8.21-9.32)	9.27 (8.68-9.86)	9.87 (9.22-10.5)	10.2 (9.57-10.9)
60-day	5.05 (4.73-5.38)	6.16 (5.78-6.58)	7.20 (6.76-7.67)	7.99 (7.51-8.49)	8.98 (8.44-9.54)	9.68 (9.08-10.3)	10.3 (9.69-11.0)	10.9 (10.2-11.6)	11.6 (10.8-12.4)	12.1 (11.2-12.9)

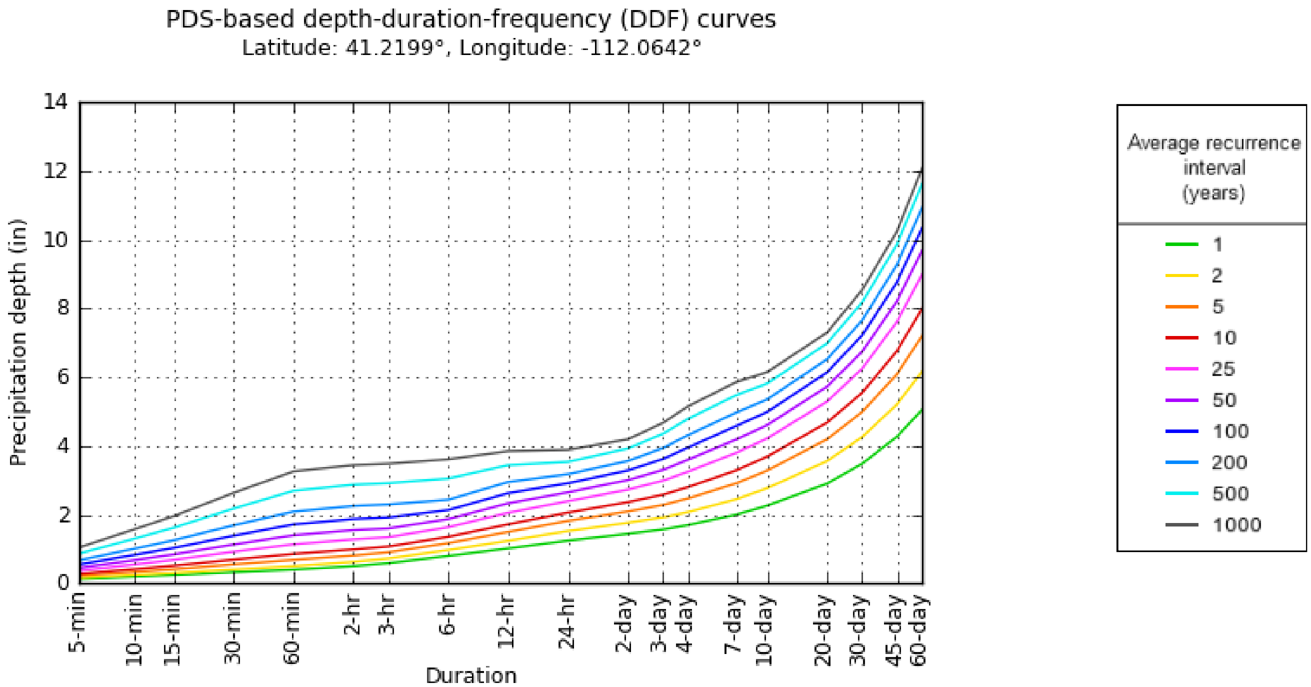
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

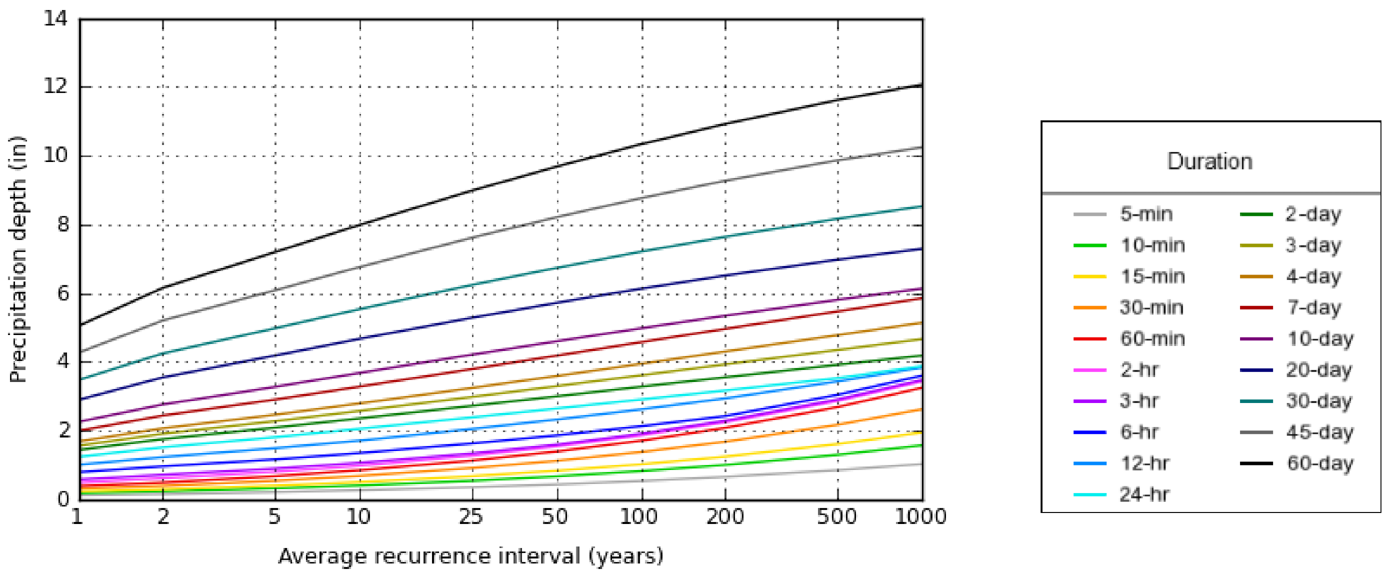
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper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

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



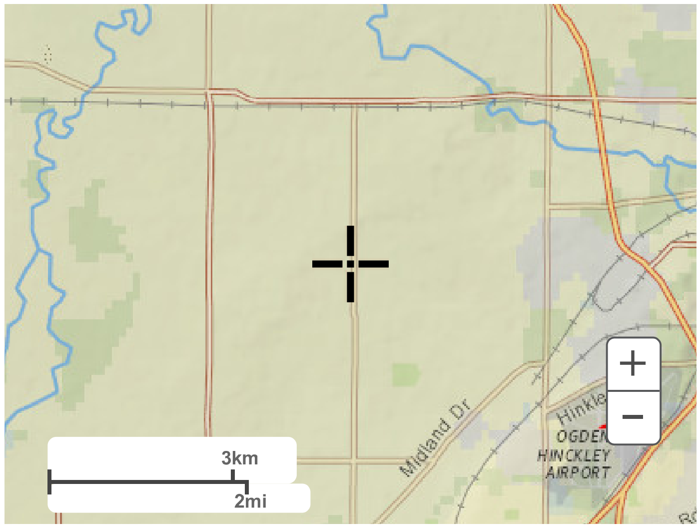


NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Mon Oct 3 22:24:43 2016

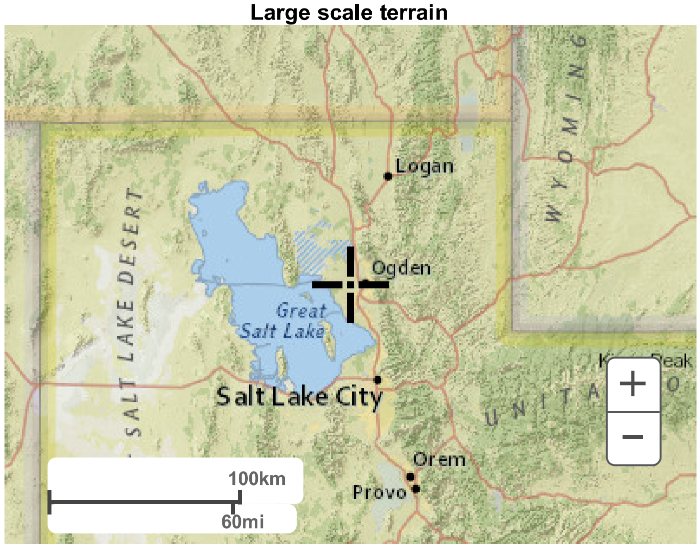
Back to Top

Maps & aerials

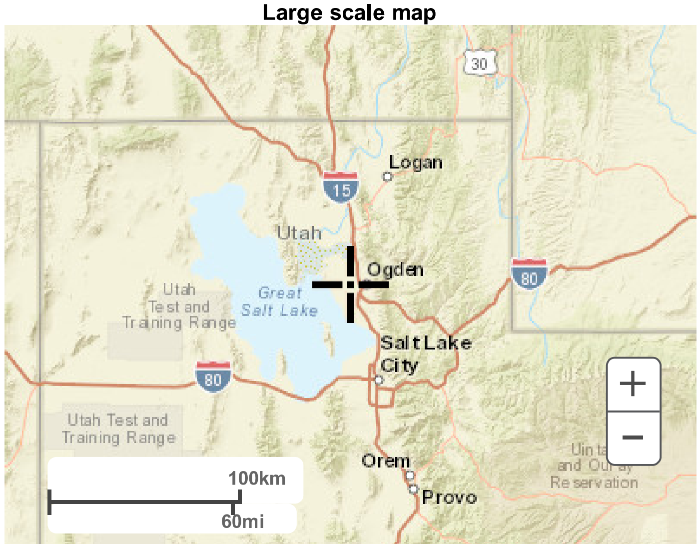
Small scale terrain



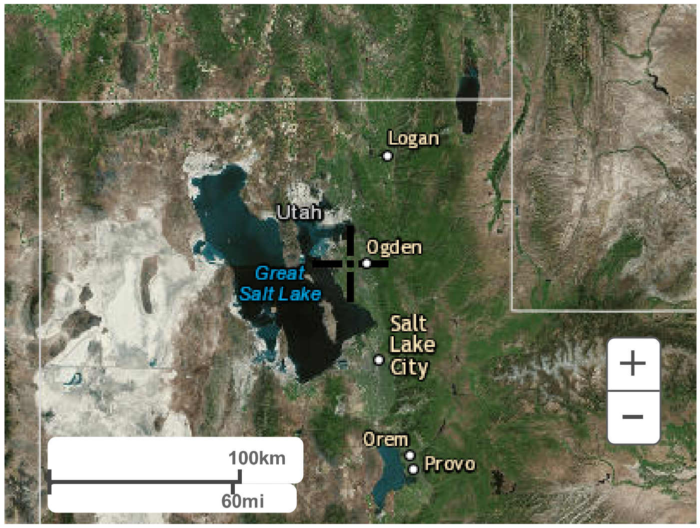
Large scale terrain



Large scale map



Large scale aerial



Back to Top

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

Appendix D:

Geotechnical Report

GSH

REPORT
GEOTECHNICAL STUDY
GALLOP BEND SUBDIVISION
ABOUT 3662 WEST 2550 SOUTH
TAYLOR, UTAH

Submitted To:

JF Capital
1148 West Legacy Crossing Boulevard, Suite 400
Centerville, Utah 84014

Submitted By:

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123

November 14, 2016

Job No. 2239-02N-16

November 14, 2016
Job No. 2239-02N-16

Mr. Brock Loomis, P.E.
JF Capital
1148 West Legacy Crossing Boulevard, Suite 400
Centerville, Utah 84014

Mr. Loomis:

Re: Report
Geotechnical Study
Gallop Bend Subdivision
About 3662 West 2550 South
Taylor, Utah

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed at the site of the proposed Gallop Bend Subdivision located at about 3662 West 2550 South in Taylor, Utah. The general location of the site with respect to surrounding roadways, as of 2016, is presented on Figure 1, Vicinity Map. A more detailed aerial view of the subject property with surrounding roadways and existing facilities is presented on Figure 2, Site Plan. The approximate locations of the borings drilled in conjunction with this study are also presented on Figure 2.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. Brock Loomis of JF Capital and Mr. Andrew Harris of GSH Geotechnical, Inc. (GSH).

In general, the objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions across the site.

2. Provide appropriate foundation, earthwork, and pavement recommendations, and geoseismic information to be utilized in the design and construction of the proposed development.

In accomplishing these objectives, our scope has included the following:

1. A field program consisting of the drilling, logging, and sampling of 8 borings.

2. A laboratory testing program.

3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this summary report.

1.3 AUTHORIZATION

Authorization was provided by returning a signed copy of our Proposal No. 16-0731Nrev1, dated September 22, 2016.

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the physical properties of the soils encountered in the exploration borings, projected groundwater conditions, and the layout and design data discussed in Section 2, Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, GSH must be informed so that our recommendations can be reviewed and amended, if necessary.

Our professional services have been performed, our findings developed, and our recommendations prepared in accordance with generally accepted engineering principles and practices in this area at this time.

2. PROPOSED CONSTRUCTION

The proposed project consists of subdividing and constructing a residential subdivision on the subject property located at about 3662 West 2550 South in Taylor, Utah. The development will include single-family residences, installation of utilities to service the proposed residences, and associated roadways and pavements.

Construction will likely consist of reinforced concrete footings and basement foundation walls supporting 1 to 3 wood-framed levels above grade with some stone, brick, or stucco veneer. Projected maximum column and wall loads are on the order of 10 to 25 kips and 1 to 3 kips per lineal foot, respectively.

New residential roadways will be part of the development. It is anticipated that the residential streets will be constructed of asphalt pavement with relatively light projected traffic that includes primarily passenger vehicles, daily delivery trucks, daily buses, and an occasional semi-tractor/trailer combination.

Site development will require a moderate amount of earthwork in the form of site grading. We estimate in general that maximum cuts and fills to achieve design grades will be on the order of 2 to 5 feet. Larger fills and cuts may be required at isolated areas.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 8 borings were drilled to depths of about 7.0 to 21.5 feet below existing grade within the proposed development. The borings were drilled using a truck-mounted drill rig equipped with hollow-stem augers. Approximate locations of the borings are presented on Figure 2.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the drilling operations, a log of the subsurface conditions encountered was maintained. In addition, relatively undisturbed and small disturbed samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications have been supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representations of the subsurface conditions encountered are presented on Figures 3A through 3H, Boring Logs. Soils were classified in accordance with the nomenclature described on Figure 4, Key to Boring Log (USCS).

A 3.25-inch outside diameter, 2.42-inch inside diameter drive sampler (Dames & Moore) and a 2.0-inch outside diameter, 1.38-inch inside diameter drive sampler (SPT) were utilized for subsurface sampling. The blow counts recorded on the boring logs were those required to drive the sampler 12 inches with a 140-pound hammer dropping 30 inches.

Following completion of drilling, a slotted 1.25 inch diameter PVC pipe was installed in borings B-3, B-5, B-6, B-7, and B-8 to facilitate continued measuring of groundwater levels. The borings were backfilled with auger cuttings.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was performed. The program included performing moisture, density, partial gradation, Atterberg limits, and chemical tests on representative subsurface soil samples. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density

To provide index parameters and to correlate other test data, moisture and density tests were performed on selected samples. The results of these tests are presented on the boring logs, Figures 3A through 3H.

3.2.3 Partial Gradation Tests

To aid in classifying the granular soils, partial gradation tests were performed. Results of the tests are tabulated below:

Boring No.	Depth (feet)	Moisture Content Percent	Percent Passing No. 200 Sieve	Soil Classification
B-1	4.0	20.9	4.9	SP/SM
B-1	10.0	24.6	2.1	SP
B-2	4.0	28.8	32.0	SM
B-2	10.0	25.5	40.7	SM/ML
B-3	9.0	23.1	8.3	SP/SM
B-4	10.0	26.2	6.0	SP/SM
B-5	5.0	28.0	1.1	SP
B-5	10.0	25.4	2.1	SP
B-6	5.0	17.7	8.1	SP/SM
B-7	2.0	13.2	19.3	SM
B-8	6.0	25.0	14.1	SM

3.2.4 Atterberg Limits Tests

To aid in classifying the soils, Atterberg limits tests were performed on a sample of the fine-grained cohesive soils. Results of the tests are tabulated below:

Boring No.	Depth (feet)	Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index (percent)	Soil Classification
B-6	3.0	Non-Plastic	Non-Plastic	Non-Plastic	SP/SM

3.2.5 Chemical Tests

In order to determine if the site soils will react detrimentally with concrete, chemical tests were performed on a representative sample of the on-site soils. The results of the chemical tests are tabulated below:

Boring No.	Depth (feet)	Soil Classification	pH	Total Water Soluble Sulfate SO_4 (mg/kg-dry)
B-1	2.5	SP/SM	7.84	8.77

4. SITE CONDITIONS

4.1 SURFACE

The subject property consists of a generally rectangular-shaped parcel located at about 3662 West 2550 South in Taylor, Utah. The site is currently used for agricultural purposes. Two existing residences are located at the south edge of the property and will likely be demolished as part of the development process. Vegetation at the site consists primarily of pumpkins, grasses, weeds, brush, and numerous trees. The subject property generally slopes downward to south/southeast, with an overall change in elevation of about 10 feet. The subject property is bordered on the north by similar undeveloped property, on the south by 2550 West, on the west by residential development, and on the east by undeveloped property and rural residential development.

4.2 SUBSURFACE SOIL

The soil conditions encountered were relatively similar across the site. At the majority of the boring locations, the upper 12 to 18 inches consisted of topsoil and loose/disturbed soils. Natural soils were encountered beneath the topsoil and disturbed soils to the full depth penetrated, about 7.0 to 21.5 feet, and consisted of fine to medium sand with varying silt/clay content, fine sandy silt, and occasional mixtures of these soils.

The granular soils encountered are loose to medium dense, moist to saturated, light brown to dark brown in color, and will exhibit moderate strength and low compressibility characteristics.

The fine-grained clay/silt soils encountered are very soft, very moist to saturated, brown in color, and will exhibit slightly moderate to moderate strength and moderate to moderately high compressibility characteristics.

The lines designating the interface between soil types on the boring logs generally represent approximate boundaries. In-situ, the transition between soil types may be gradual.

4.3 GROUNDWATER

Static groundwater measurements were taken on Friday, November 11, 2016, (about 32 days following drilling of borings). The results of these measurements are tabulated below:

Boring No.	Static Groundwater Level Below Existing Grade (feet)
	November 11, 2016
B-3	Pipe Damaged
B-5	3.8
B-6	3.7
B-7	2.9
B-8	2.8

Seasonal and longer-term groundwater fluctuations of 1 to 2 feet should be anticipated. The highest seasonal levels will generally occur during the late spring and summer months. The contractor should be prepared to dewater excavations as needed.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The results of our analyses indicate that the proposed structures may be supported upon conventional spread and/or continuous wall foundations established upon suitable natural soils or granular structural fill extending to suitable natural soils.

The most significant geotechnical aspects of the site are the moderate strength characteristics of the on-site silts/clays, the presence of surficial disturbed soils, and shallow groundwater.

All non-engineered fills and disturbed soils must be removed to suitable natural soils below buildings and rigid pavements. Existing in-situ non-engineered fills/disturbed soils may remain in flexible pavement areas if they are properly prepared, as discussed in this report.

The on-site soils may be re-utilized as structural site grading fill if they meet the requirements for such, as stated herein. However, it must be noted that from a handling and compaction standpoint, soils containing high amounts of fines (silts and clays) are very sensitive to changes in moisture content and will require very close moisture control during placement and compaction. This will be very difficult, if not impossible, during wet and cold periods of the year. Further, with shallow groundwater, the on-site soils are likely above optimum moisture content and, therefore, would require some drying prior to re-compacting.

Static groundwater was measured at 2.8 to 3.8 feet below the surface at the boring locations. The shallow groundwater encountered at the site may affect the installation of utilities and basements. Additionally, it is recommended that the top of the lowest habitable slab be kept a minimum of 3.0 feet above the existing groundwater level. If a land drain is constructed within the development, the top of slabs within the lowest habitable level are recommended to be 1.5 feet above the level controlled by land drains within the development. We recommend that the pavement section be maintained a minimum 2 feet above measured groundwater to reduce the potential amount of necessary subgrade stabilization.

A qualified geotechnical engineer from GSH will need to verify that all non-engineered fills, debris, topsoil, and/or disturbed soils have been completely removed prior to the placement of structural site grading fills, floor slabs, footings, foundations, or rigid pavements.

In the following sections, detailed discussions pertaining to design groundwater, earthwork, foundations, at-grade concrete slabs, pavements, and the geoseismic setting of the site are provided.

5.2 DESIGN GROUNDWATER

Shallow groundwater was encountered within the borings explored for this project. GSH recommends that the top of habitable floor slabs be established a minimum 3.0 feet above measured groundwater or a minimum 1.5 feet above the level controlled by a subdrain system. A subdrain system will depend on the availability of a down-gradient point of gravity discharge, such as a land drain. The depth of the land drain will control the allowable depth for foundations.

Site grading will greatly influence the allowable basement floor slab depths. Based on current site grades, basement floor slabs within the proposed development are likely to be limited to near the existing surface.

5.3 EARTHWORK

5.3.1 Site Preparation

Initial site preparation will consist of the demolition of the existing structure(s) and associated improvements and relocation/abandonment of existing utilities followed by the removal of surface vegetation, topsoil, debris, and other deleterious materials from beneath an area extending out at least 3 feet from the perimeter of the proposed buildings, pavements, and exterior flatwork areas. Existing stockpiles of fill material must be removed and/or evenly incorporated into site grading fills.

Additional site preparation will consist of the removal of existing non-engineered fills (if encountered) and loose/disturbed soils from an area extending out at least 3 feet from the perimeter of residential structures and rigid pavements. Non-engineered fill was not encountered at the boring locations; however, variation in the depth and lateral extent of non-engineered fill materials across the site and, more particularly, associated with existing structures is likely.

The non-engineered fills and loose/disturbed soils may remain in asphalt pavement and sidewalk areas as long as they are properly prepared. Rigid pavements are not recommended to be placed over any sequence of non-engineered fill or loose/disturbed soils.

Proper preparation shall consist of scarifying, moisture conditioning, and re-compacting the upper 12 inches to the requirements for structural fill. As an option to proper preparation and recompaction, the upper 12 inches of non-engineered fill (where encountered) and loose/disturbed soils may be removed and replaced with granular subbase over proof rolled subgrade. Even with proper preparation, pavements established overlying non-engineered fills and loose/disturbed soils may encounter some long-term movements unless the non-engineered fills and loose/disturbed soils are completely removed.

The fine-grained soils will require that very close moisture control be maintained during placement and compaction, which will be very difficult, if not impossible, to properly place and compact these fills during wet and cold periods of the year.

Subsequent to stripping and prior to the placement of structural site grading fill, pavements, driveway, and garage slabs on grade, the prepared subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered, they must be removed to a maximum depth of 2 feet and replaced with structural fill. Beneath footings, all loose and disturbed soils must be totally removed. Footings located within about 1.5 feet of groundwater may require subgrade stabilization as discussed later in this report.

Surface vegetation and other deleterious materials should generally be removed from the site. Topsoil, although unsuitable for utilization as structural fill, may be stockpiled for subsequent landscaping purposes.

5.3.2 Excavations

Temporary excavations up to 8 feet deep in fine-grained cohesive soils, above or below the water table, may be constructed with sideslopes no steeper than one-half horizontal to one vertical (0.5H:1.0V). Excavations deeper than 8 feet are not anticipated at the site.

For granular (cohesionless) soils, construction excavations above the water table, not exceeding 4 feet, should be no steeper than one-half horizontal to one vertical (0.5H:1.0V). For excavations up to 8 feet, in granular soils and above the water table, the slopes should be no steeper than one horizontal to one vertical (1H:1V). Excavations encountering saturated cohesionless soils will be very difficult and will require very flat sideslopes and/or shoring, bracing, and dewatering.

To reduce disturbance of the natural soils during excavation, it is recommended that smooth edge buckets/blades be utilized.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated.

5.3.3 Structural Fill

Structural fill will be required as site grading fill, as backfill over foundations and utilities, and possibly as replacement fill beneath some footings. All structural fill must be free of sod, rubbish, construction debris, frozen soil, and other deleterious materials.

Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. The maximum particle size within structural site grading fill should generally not exceed 4 inches; although, occasional particles up to 6 to 8 inches may be incorporated provided that they do not result in "honeycombing" or preclude the obtainment of the desired degree of compaction. In confined areas, the maximum particle size should generally be restricted to 2.5 inches.

On-site soils may be re-utilized as structural site grading fill if they do not contain construction debris or deleterious material and meet the requirements of structural fill. Fine-grained soils will require very close moisture control and may be very difficult, if not impossible, to properly place and compact during wet and cold periods of the year.

Only granular soils are recommended in confined areas such as utility trenches, below footings, etc. Generally, we recommend that all imported granular structural fill consist of a well graded mixture of sands and gravels with no more than 20 percent fines (material passing the No. 200 sieve) and no more than 30 percent retained on the three-quarter-inch sieve.

To stabilize soft subgrade conditions or where structural fill is required to be placed closer than 1.0 foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or 1.5- to 2.0-inch gravel (stabilizing fill) should be utilized. It may also help to utilize a stabilization fabric, such as Mirafi 600X or equivalent, placed on the native ground if 1.5- to 2.0-inch gravel is used as stabilizing fill.

Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.3.4 Fill Placement and Compaction

All structural fill shall be placed in lifts not exceeding 8 inches in loose thickness. Structural fills shall be compacted in accordance with the percent of the maximum dry density as determined by the ASTM[1] D-1557(AASHTO[2] T-180) compaction criteria in accordance with the table below:

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of the structure	0 to 8	95
Site grading fills outside area defined above	0 to 5	90
Site grading fills outside area defined above	5 to 8	95
Utility trenches within structural areas	--	96
Road base	-	96

Structural fills greater than 8 feet thick are not anticipated at the site.

Subsequent to stripping and prior to the placement of structural site grading fill, the subgrade shall be prepared as discussed in Section 5.3.1, Site Preparation, of this report. In confined areas, subgrade preparation should consist of the removal of all loose or disturbed soils.

Coarse gravel and cobble mixtures (stabilizing fill), if utilized, shall be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the stabilizing fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately compacted so that the “fines” are “worked into” the voids in the underlying coarser gravels and cobbles.

Utilization of a filter fabric, such as Mirafi 600X or equivalent, over soft subgrade may also be advantageous.

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

1 American Society for Testing and Materials
2 American Association of State Highway and Transportation Officials

5.3.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill shall be proof rolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proof rolling shall be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proof rolling, they shall be removed to a maximum depth of 2 feet below design finish grade and replaced with structural fill.

Most utility companies and City-County governments are now requiring that Type A-1a or A-1b (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities. These organizations are also requiring that in public roadways, the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

Fine-grained soil, such as silts and clays, are not recommended for utility trench backfill in structural areas.

Static groundwater was encountered as shallow as 2.8 feet below the existing ground surface. The utility contractor should be made aware of this condition. Dewatering of utility trenches may be required.

5.4 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.4.1 Design Data

The proposed structure may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Footings established within 1.5 feet of groundwater may require some subgrade stabilization as discussed previously. For design, the following parameters are provided:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Recommended Minimum Width for Continuous Wall Footings	- 16 inches

Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions	- 2,000 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

5.4.2 Installation

Footings shall not be installed over non-engineered fill, deleterious material, construction debris, soft or disturbed soils, frozen soil, or within ponded water. If the granular structural fill upon which the footings are to be established become disturbed, it should be recompacted to the requirements for structural fill or be removed and replaced with structural fill.

The width of structural fill, where placed below footings, should extend laterally at least 6 inches beyond the edges of the footings in all directions for each foot of fill thickness beneath the footings. For example, if the width of the footing is 2 feet and the thickness of the structural fill beneath the footing is 2 feet, the width of the structural fill at the base of the footing excavation would be a total of 4 feet, centered below the footing.

5.4.3 Settlements

Maximum settlements of foundations designed and installed in accordance with recommendations presented herein and supporting maximum anticipated loads as discussed in Section 2, Proposed Construction, are anticipated to be one inch or less.

Approximately 40 percent of the quoted settlement should occur during construction.

5.5 LATERAL RESISTANCE

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. For estimated frictional resistance, a coefficient of friction of 0.30 should be utilized. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

5.6 LATERAL PRESSURES

The lateral pressure parameters, as presented within this section, are for backfills which will consist of drained granular soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), granular backfill may be considered equivalent to a fluid with a density of 40 pounds per cubic foot in computing lateral pressures. For more rigid walls (moderately yielding), generally not exceeding 8 feet in height, granular backfill may be considered equivalent to a fluid with a density of 50 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is no steeper than 4 horizontal to 1 vertical and that the granular fill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

For seismic loading, a uniform pressure should be added. The uniform pressures based on different wall heights are provided in the following table:

Wall Height (feet)	Seismic Loading Active Case (psf)	Seismic Loading Moderately Yielding (psf)
4	25	55
6	40	85
8	55	115

5.7 FLOOR SLABS

Floor slabs may be established upon suitable natural soils and/or upon structural fill extending to suitable natural soils. Under no circumstances shall floor slabs be established over non-engineered fills, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. In order to facilitate construction and curing of the concrete and provide a capillary break, it is recommended that floor slabs be directly underlain by 4 inches of "free-draining" fill, such as "pea" gravel or three-quarters- to one-inch minus clean gap-graded gravel.

Settlement of lightly loaded floor slabs (average uniform pressure of 150 pounds per square foot or less) is anticipated to be less than one-quarter inch.

The tops of all floor slabs in habitable areas must be established at least 3.0 feet above the measured groundwater level or 1.5 feet above the maximum groundwater level controlled by subdrains.

5.8 SUBDRAINS

5.8.1 General

Groundwater at this site is shallow. A perimeter foundation subdrain is required for all structures with habitable levels below grade and basement floor slab depths should be limited as discussed in Section 5.2, Design Groundwater. We recommend that perimeter foundation subdrains be installed as indicated below.

5.8.2 Foundation Subdrains

Foundation subdrains should consist of a 4-inch diameter perforated or slotted plastic or PVC pipe enclosed in clean gravel. The invert of a subdrain should be at least 1.5 feet below the top of the lowest adjacent floor slab. The gravel portion of the drain should extend 2 inches laterally and below the perforated pipe and at least 1 foot above the top of the lowest adjacent floor slab. The gravel zone must be installed immediately adjacent to the perimeter footings and the foundation walls. To reduce the possibility of plugging, the pipe and surrounding gravel must be wrapped with a geotextile, such as Mirafi 140N or equivalent. Above the subdrain, a minimum 4-inch-wide zone of "free-draining" sand and gravel should be placed adjacent to the foundation walls and extend to within 2 feet of final grade. This zone of free-draining soil must be separated from the adjacent soils with a separation fabric such as Mirafi 140N or equivalent. The upper 2 feet of soils should consist of a compacted clayey cap to reduce surface water infiltration into the drain. As an alternative to the zone of permeable sand and gravel, a prefabricated "drainage board," such as Miradrain or equivalent, may be placed adjacent to the exterior below-grade walls. Prior to the installation of the footing subdrain, the below-grade walls should be dampproofed. The slope of the subdrain should be at least 0.3 percent. The gravel placed around the drain pipe should be clean 0.75-inch to 1.0-inch minus gap-graded gravel and/or "pea" gravel. The foundation subdrains shall be discharged into the area subdrains, storm drains, or other suitable down-gradient location.

5.9 PAVEMENTS

5.9.1 Design Criteria

It is projected that the proposed roadways will consist of primarily asphalt concrete. The existing natural fine-grained silt/clay soils encountered at the site will exhibit poor pavement support characteristics when saturated or near saturated.

All pavement areas must be prepared as previously discussed (see Section 5.3.1, Site Preparation). We recommend that the pavement section be maintained a minimum 2 feet above measured groundwater to reduce the potential amount of necessary subgrade stabilization. With the subgrade soils and the projected traffic as discussed in Section 2, Proposed Construction, the following pavement sections are recommended:

<u>Minor Streets/Cul-de-Sac Traffic</u>
(Light to Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-Weight Trucks,
and occasional Heavyweight Trucks)
[4 equivalent 18-kip axle loads per day]

<u>Flexible Pavement:</u>

3.0 inches	Asphalt concrete
10.0 inches	Aggregate base
Over	Suitable natural soils, properly prepared soils, and/or structural site grading fill extending to properly prepared/suitable natural soils.

<u>Or</u>

3.0 inches	Asphalt concrete
5.0 inches	Aggregate base
6.0 inches	Sub base
Over	Suitable natural soils, properly prepared soils, and/or structural site grading fill extending to properly prepared/suitable natural soils.

<u>Rigid*:</u>

5.0 inches	Portland cement concrete (non-reinforced)
5.0 inches	Aggregate base
Over	Suitable natural soils, and/or structural site grading fill extending to suitable stabilized natural soils.*

* Rigid pavements shall not be placed over non-engineered fills, even if properly prepared.

These above rigid pavement sections are for non-reinforced Portland cement concrete. Concrete should be designed in accordance with the American Concrete Institute (ACI) and joint details should conform to the Portland Cement Association (PCA) guidelines. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6 percent ±1 percent air-entrainment.

5.10 CEMENT TYPES

Laboratory tests indicate that the near-surface soils testing contain negligible amounts of water soluble sulfates. Therefore, all concrete which will be in contact with the site soils may be prepared using Type I or IA cement.

5.11 GEOSEISMIC SETTING

5.11.1 General

Utah municipalities adopted the International Building Code (IBC) 2015 and International Residential Code (IRC) for One- to Two-Family Dwellings 2015. The IBC and IRC 2015 codes determine the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The structures must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2015 edition.

5.11.2 Site Class

Static groundwater was measured 32 days after drilling at depths as shallow as 2.8 feet below the existing ground surface. Loose to medium dense, saturated sand soil layers were encountered in some of the borings completed at the site between depths ranging from about 4.0 and 13.0 feet below the existing ground surface. Our analysis shows that layers of these loose to medium dense, saturated sand soils could liquefy during the design seismic event (see Section 5.11.5, Liquefaction). According to the IBC 2015, which references ASCE-7-10, Chapter 20, "Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils..." are designated under site Class F. However, the potential settlements due to liquefaction are anticipated to be 2.5 inch or less at the top of the layer. This magnitude of settlement can typically be tolerated by an adequately designed structure to protect life safety. Therefore, we recommend the site be designated under Site Class D - Stiff Soil Profile for design.

5.11.3 Faulting

Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The nearest active fault is the Weber Zone of the Wasatch

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Fault, approximately 6.9 miles east of the site. The Wasatch Fault Zone is considered capable of generating earthquakes as large as magnitude 7.3[3].

5.11.4 Ground Motions

The IBC 2015 code is based on 2008 USGS mapping, which provides values of short and long period accelerations for the Site Class B boundary for the Maximum Considered Earthquake (MCE). This Site Class B boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for a MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the fourth column. Based on the site latitude and longitude (41.2217 degrees north and 112.0680 degrees west, respectively), the values for this site are tabulated below:

Spectral Acceleration Value, T	Site Class B Boundary [mapped values] (% g)	Site Coefficient	Site Class D [adjusted for site class effects] (% g)	Design Values (% g)
Peak Ground Acceleration	49.6	F_a = 1.004	49.8	33.2
0.2 Seconds (Short Period Acceleration)	S_S = 124.1	F_a = 1.004	S_{MS} = 124.6	S_{DS} = 83.1
1.0 Second (Long Period Acceleration)	S_1 = 41.1	F_v = 1.589	S_{M1} = 65.3	S_{D1} = 43.5

5.11.5 Liquefaction

The site is located in an area that has been identified by the Utah Geologic Survey as having "high" liquefaction potential. Liquefaction is defined as the condition when saturated, loose, finer-grained sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event.

Calculations were performed using the procedures described in the 2008 Soil Liquefaction During Earthquakes Monograph by Idriss and Boulanger[4] and the 2014 Soil Liquefaction During Earthquakes Monograph by Idriss and Boulanger[5]. Our analyses indicate that saturated granular and silt soils encountered at the site between depths of about 4.0 to 13.0 feet below existing

[3] Arabasz, W.J., Pechmann, J.C., and Brown, E.D., 1992, Observational seismology and the evaluation of earthquake hazards and risk in the Wasatch Front area, Utah, in Gori, P.L., and Hays, W.W., eds., Assessment of regional earthquake hazards and risk along the Wasatch Front, Utah: U.S. Geological Survey Professional Paper 1500-D, 36 p.

[4] Idriss, I. M., and Boulanger, R. W. (2008), Soil liquefaction during earthquakes: Monograph MNO-12, Earthquake Engineering Research Institute, Oakland, CA, 261 pp.

[5] Boulanger, R. W. and Idriss, I. M. (2014), "CPT and SPT Based Liquefaction Triggering Procedures." Report No. UCD/CGM-14/01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA, 134 p.

grade could liquefy under a major seismic event. Maximum anticipated settlement resulting from the liquefaction could be in the range of about 2.5 inches. This magnitude of settlement can typically be tolerated by an adequately designed structure to protect life safety. If such movements cannot be handled by the structural components of the building, ground improvement may be necessary. GSH can provide ground improvement recommendations if desired.

5.12 SITE VISITS

As stated previously, prior to placement of foundations, floor slabs, pavements, and site grading fills, a geotechnical engineer from GSH must verify that all topsoil and disturbed soils have been removed/properly prepared and suitable subgrade conditions encountered. Additionally, GSH must observe fill placement and verify in-place moisture content and density of fill materials placed at the site.

5.13 CLOSURE

If you have any questions or would like to discuss these items further, please feel free to contact us at 801.685.9190.

Respectfully submitted,

GSH Geotechnical, Inc.

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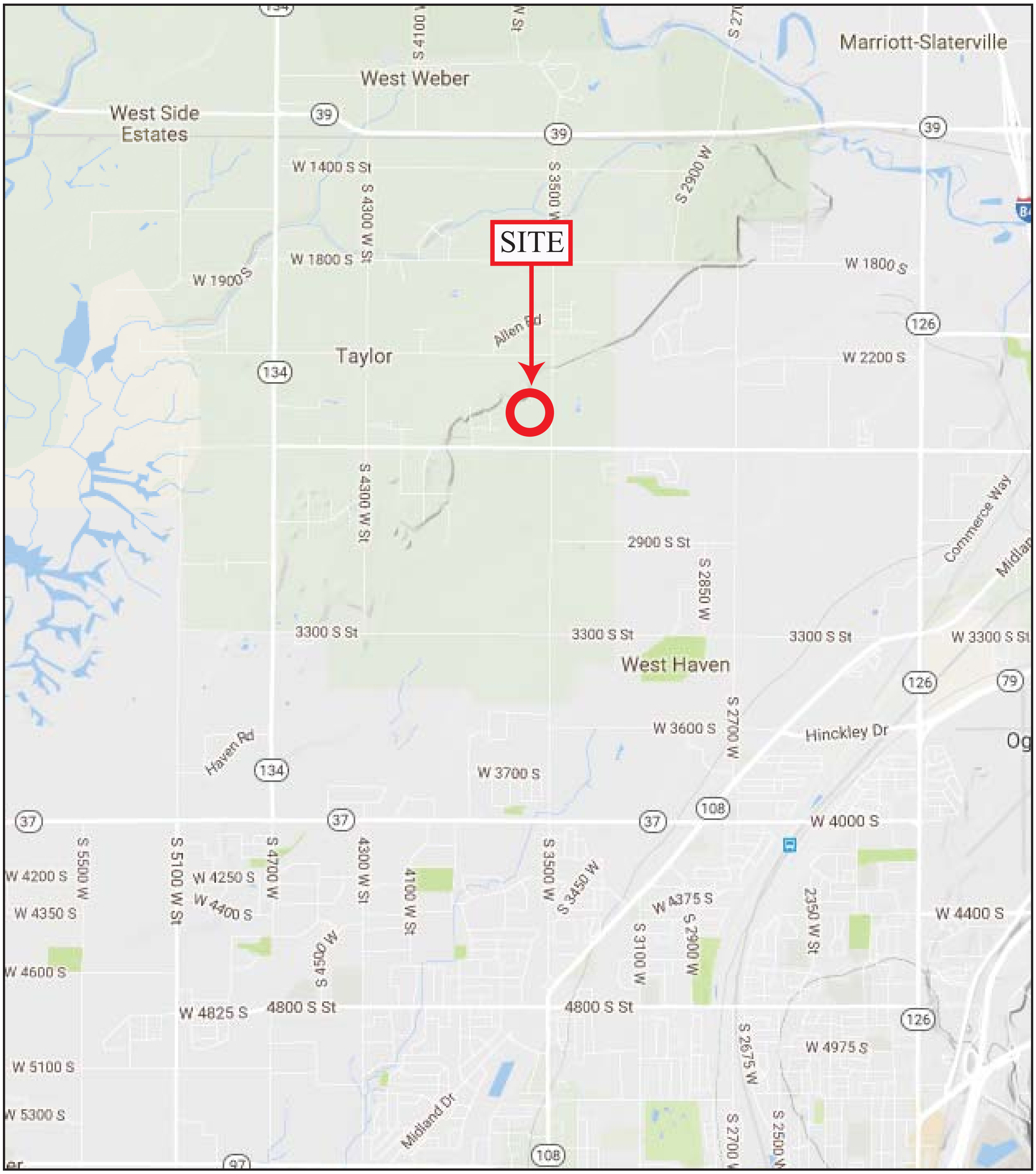
Senior Geotechnical Engineer

AMH/BNR:jlh

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A through 3H, Boring Logs
Figure 4, Key to Boring Log (USCS)

Addressee (email)

JF CAPITAL
JOB NO. 2239-02N-16



1 0 1 2 3 4 KM 5

1 0 1 MI 2

FIGURE 1
VICINITY MAP

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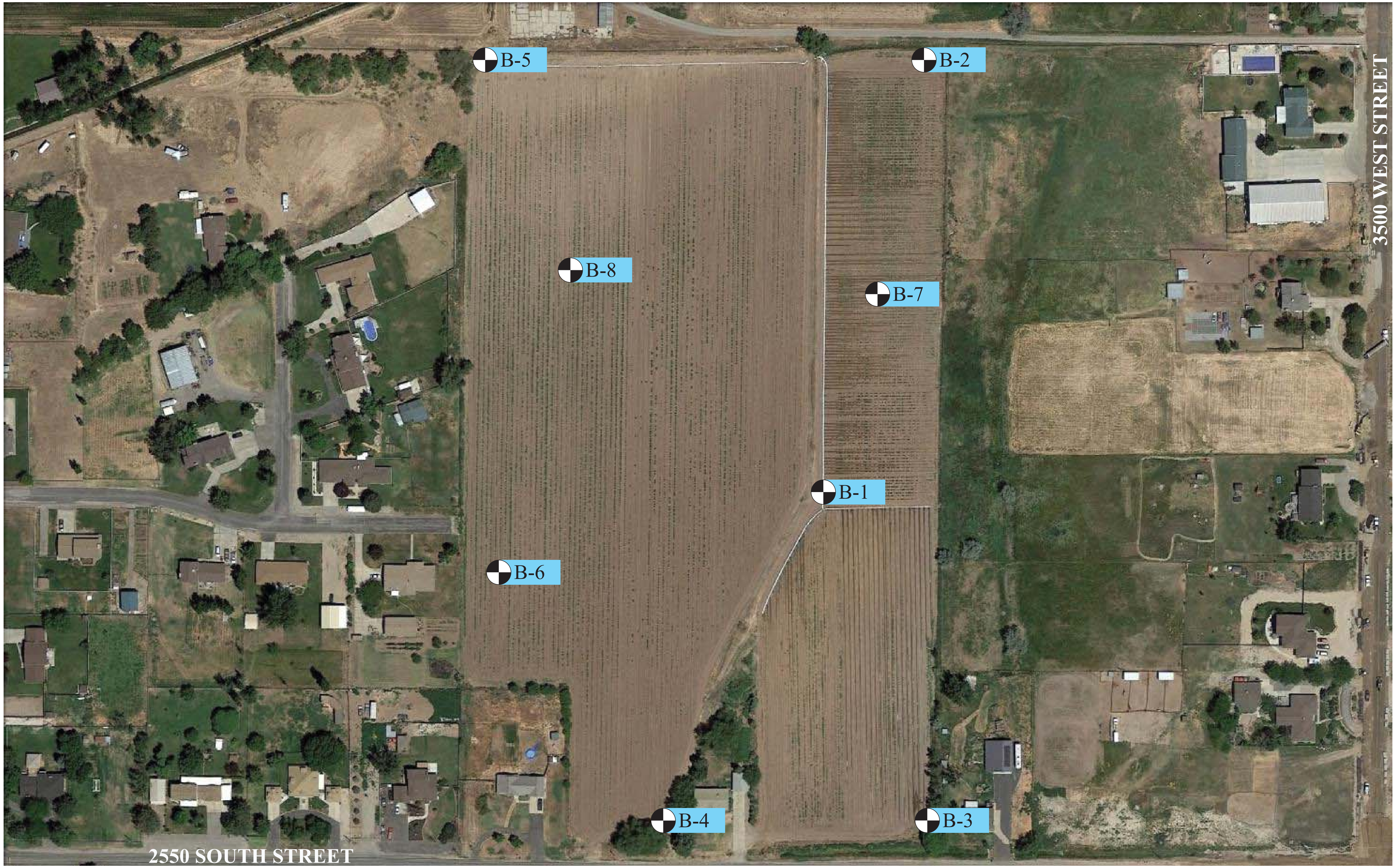
REFERENCE:
ALL TRAILS - NATIONAL GEOGRAPHIC TERRAIN
DATED 2016

JF CAPITAL
JOB NO. 2239-02N-16



NOT TO SCALE

REFERENCE:
ADAPTED FROM AERIAL PHOTOGRAPH
DOWNLOADED FROM GOOGLE EARTH
IMAGERY DATE: 7/8/2016

FIGURE 2
SITE PLAN

GSH

BORING LOG

BORING: B-1

CLIENT: JF Capital	PROJECT NUMBER: 2239-02N-16
PROJECT: Gallop Bend Subdivision	DATE STARTED: 10/10/16 DATE FINISHED: 10/10/16
LOCATION: About 3662 West 2550 South, Taylor, Utah	GSH FIELD REP.: AA
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger	HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: 4.0' (10/10/16)	ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	SP/SM	FINE TO MEDIUM SAND with silt; light brown	0								slightly moist loose
		grades light reddish-brown		6							moist
▼ (4.0')											saturated
			5	7		21		5			
	SP	FINE TO MEDIUM SAND with trace silt; light brown									
			10	11		25		2			medium dense
			15	18							
		grades light brownish-gray	20	18							
		End of Exploration at 21.5'									
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3A

GSH

BORING LOG

Page: 1 of 1

BORING: B-2

CLIENT: JF Capital | PROJECT NUMBER: 2239-02N-16

PROJECT: Gallop Bend Subdivision | DATE STARTED: 10/10/16 | DATE FINISHED: 10/10/16

LOCATION: About 3662 West 2550 South, Taylor, Utah | GSH FIELD REP.: AA

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: 3.0' (10/10/16) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	SP/ SM	FINE TO MEDIUM SAND with some silt; trace clay; brown	0								moist loose
▼ (3.0')				4	▮						saturated
	SM	SILTY FINE TO MEDIUM SAND with trace clay; light brown	5	3	▮	29		32			saturated loose
				11	▮	26		41			medium dense
		End of Exploration at 10.0'	10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3B

GSH

BORING LOG

BORING: B-3

CLIENT: JF Capital	PROJECT NUMBER: 2239-02N-16
PROJECT: Gallop Bend Subdivision	DATE STARTED: 10/10/16 DATE FINISHED: 10/10/16
LOCATION: About 3662 West 2550 South, Taylor, Utah	GSH FIELD REP.: AA
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger	HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: 4.0' (10/10/16)	ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	SP/ SM	FINE TO MEDIUM SAND with some silt; light brown	0								slightly moist loose
				13							
▼ (4.0')											saturated
			5								
		grades light reddish-brown									
			10	11		23		8			medium dense
		End of Exploration at 10.5' Installed 1.25" diameter slotted PVC pipe to 9.0'									
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

BORING LOG

Page: 1 of 1

BORING: B-4

CLIENT: JF Capital | PROJECT NUMBER: 2239-02N-16

PROJECT: Gallop Bend Subdivision | DATE STARTED: 10/10/16 | DATE FINISHED: 10/10/16

LOCATION: About 3662 West 2550 South, Taylor, Utah | GSH FIELD REP.: AA

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: 4.0' (10/10/16) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	SP/SM	FINE TO MEDIUM SAND with trace to some silt; light brown	0								slightly moist loose
				11							
▼		grades light reddish-brown									saturated
			5	4							
			10	12		26		6			medium dense
		End of Exploration at 11.5'									
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3D

BORING LOG

Page: 1 of 1

BORING: B-5

CLIENT: JF Capital	PROJECT NUMBER: 2239-02N-16
PROJECT: Gallop Bend Subdivision	DATE STARTED: 10/10/16 DATE FINISHED: 10/10/16
LOCATION: About 3662 West 2550 South, Taylor, Utah	GSH FIELD REP.: AA
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger	HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: 3.8' (11/11/16)	ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	SP	FINE TO MEDIUM SAND with trace silt; light brown	0								slightly moist loose
		grades light reddish-brown		4	‖						moist
▼ (3.8')											saturated
			5	5	‖	28		1			
			10	12	‖	25		2			medium dense
		End of Exploration at 11.5' Installed 1.25" diameter slotted PVC pipe to 10.0'									
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

BORING LOG

Page: 1 of 1

BORING: B-6

CLIENT: JF Capital	PROJECT NUMBER: 2239-02N-16
PROJECT: Gallop Bend Subdivision	DATE STARTED: 10/17/16 DATE FINISHED: 10/17/16
LOCATION: About 3662 West 2550 South, Taylor, Utah	GSH FIELD REP.: TT
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger	HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: 3.7' (11/11/16)	ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	SM	SILTY FINE SAND brown	0								moist medium dense
	ML	SANDY SILT brown			◢				NP	NP	moist very soft
					◢						
▼ (3.7')	SM	SILTY FINE SAND with occasional layers of fine sandy clay up to 3" thick; brown									saturated medium dense
			5		◢	18		8			
					◢						
		End of Exploration at 7.0' Installed 1.25" diameter slotted PVC pipe to 6.0'									
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3F

GSH

BORING LOG

Page: 1 of 1

BORING: B-7

CLIENT: JF Capital	PROJECT NUMBER: 2239-02N-16
PROJECT: Gallop Bend Subdivision	DATE STARTED: 10/17/16 DATE FINISHED: 10/17/16
LOCATION: About 3662 West 2550 South, Taylor, Utah	GSH FIELD REP.: TT
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger	HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: 2.9' (11/11/16)	ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	SM	SILTY FINE SAND dark brown	0								moist medium dense
					◣	13		19			
▼											saturated
		grades brown	5		◣						
					◣						
		End of Exploration at 7.0' Installed 1.25" diameter slotted PVC pipe to 6.0'									
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

GSH

BORING LOG

BORING: B-8

CLIENT: JF Capital	PROJECT NUMBER: 2239-02N-16
PROJECT: Gallop Bend Subdivision	DATE STARTED: 10/17/16 DATE FINISHED: 10/17/16
LOCATION: About 3662 West 2550 South, Taylor, Utah	GSH FIELD REP.: TT
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger	HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: 2.8' (11/11/16)	ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	SM	SILTY FINE SAND with occasional layers of fine sandy clay up to 3" thick; brown	0								moist medium dense
▽ (2.8')											saturated
			5								
						25		14			
		End of Exploration at 7.0' due to auger refusal Installed 1.25" diameter slotted PVC pipe to 6.0'									
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3H

CLIENT: JF Capital
PROJECT: Gallop Bend Subdivision
PROJECT NUMBER: 2239-02N-16

KEY TO BORING LOG

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫

COLUMN DESCRIPTIONS

① **Water Level:** Depth to measured groundwater table. See symbol below.

② **USCS:** (Unified Soil Classification System) Description of soils encountered; typical symbols are explained below.

③ **Description:** Description of material encountered; may include color, moisture, grain size, density/consistency,

④ **Depth (ft.):** Depth in feet below the ground surface.

⑤ **Blow Count:** Number of blows to advance sampler 12" beyond first 6", using a 140-lb hammer with 30" drop.

⑥ **Sample Symbol:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.

⑦ **Moisture (%):** Water content of soil sample measured in laboratory; expressed as percentage of dryweight of

⑧ **Dry Density (pcf):** The density of a soil measured in laboratory; expressed in pounds per cubic foot.

⑨ **% Passing 200:** Fines content of soils sample passing a No. 200 sieve; expressed as a percentage.

⑩ **Liquid Limit (%):** Water content at which a soil changes from plastic to liquid behavior.

⑪ **Plasticity Index (%):** Range of water content at which a soil exhibits plastic properties.

⑫ **Remarks:** Comments and observations regarding drilling or sampling made by driller or field personnel. May include other field and laboratory test results using the following abbreviations:

CEMENTATION:	MODIFIERS:	MOISTURE CONTENT (FIELD TEST):
Weakly: Crumbles or breaks with handling or slight finger pressure.	**Trace** <5%	**Dry:** Absence of moisture, dusty, dry to the touch.
Moderately: Crumbles or breaks with considerable finger pressure.	**Some** 5-12%	**Moist:** Damp but no visible water.
Strongly: Will not crumble or break with finger pressure.	**With** > 12%	**Saturated:** Visible water, usually soil below water table.

Descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on the logs apply only at the specific boring locations and at the time the borings were advanced; they are not warranted to be representative of subsurface conditions at other locations or times.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	**GRAVELS** More than 50% of coarse fraction retained on No. 4 sieve.	**CLEAN GRAVELS** (little or no fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (appreciable amount of fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS More than 50% of coarse fraction passing through No. 4 sieve.	**CLEAN SANDS** (little or no fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (appreciable amount of fines)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.	**SILTS AND CLAYS** Liquid Limit less than 50%		ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL	Organic Silts and Organic Silty Clays o f Low Plasticity
	SILTS AND CLAYS Liquid Limit greater than 50%		MH	Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Silts and Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT	Peat, Humus, Swamp Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications.

STRATIFICATION:

DESCRIPTION	THICKNESS
Seam	up to 1/8"
Layer	1/8" to 12"

Occasional: One or less per 6" of thickness

Numerous; More than one per 6" of thickness

TYPICAL SAMPLER GRAPHIC SYMBOLS

- Bulk/Bag Sample
- Standard Penetration Split Spoon Sampler
- Rock Core
- No Recovery
- 3.25" OD, 2.42" ID D&M Sampler
- 3.0" OD, 2.42" ID D&M Sampler
- California Sampler
- Thin Wall

WATER SYMBOL

Water Level

FIGURE 4

GSH

November 23, 2016
Job No. 2239-02N-16

Mr. Brock Loomis, P.E.
JF Capital
1148 West Legacy Crossing Boulevard, Suite 400
Centerville, Utah 84014

Mr. Loomis:

Re: Addendum I to Geotechnical Study
Gallop Bend Subdivision
About 3662 West 2550 South
Taylor, Utah

As requested by Mr. Brock Loomis, this letter is an addendum to the geotechnical study[1] prepared by GSH Geotechnical, Inc. (GSH) for the subject property in Taylor, Utah. The intent of this letter is to provide additional information related to soil infiltration rates.

Conclusions and Recommendations

Recently, GSH prepared the referenced geotechnical study for the subject property in Taylor, Utah. Additional information related to the infiltration rates of the soils at the site is required. An infiltration test was completed on October 10, 2016 in Boring B-3 at a depth of approximately 2.0 feet below the existing ground surface. The soils at the infiltration test location were relatively consistent throughout the depth observed and consisted of moist, brown in color, silty sand.

The test was completed by filling the test hole with water and measuring the drop in water level relative to time. Iterative measurements of the water level within the test hole were taken at 3 minute intervals until the infiltration rate stabilized. The measured infiltration rate was about 12 minutes per inch and reflects current natural site conditions at the test location. The infiltration rate measured during this test program is considered typical for the soil type. It is our experience that infiltration rate will decrease over the lifetime of the system due to siltation and the introduction of other materials. Accordingly, we recommend a design infiltration rate of 20 minutes per inch may be used for design purposes.

All recommendations in the referenced geotechnical study must be followed.

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1 "Report, Geotechnical Study, Gallop Bend Subdivision, About 3662 West 2550 South, Taylor, Utah," GSH Job No. 2239-02N-16, November 14, 2016.

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Closure

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 393-2012.

Respectfully submitted,

GSH Geotechnical, Inc.

Andrew M. Harris, P.E.
State of Utah No. 7420456
Senior Geotechnical Engineer

Reviewed by:

Bryan N. Roberts, P.E.
State of Utah No. 276476
Senior Geotechnical Engineer

AMH/BNR:jlh

Addressee (email)