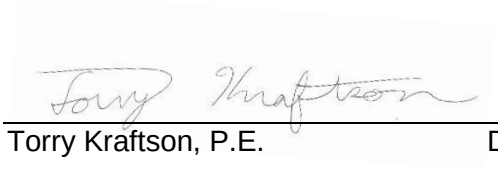
Princeton Dental

STORMWATER CALCULATIONS
BY
LARSON ENGINEERING

April 25, 2025

CONTENTS:

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.



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Torry Kraftson, P.E. Date Registration No.

Larson

Princeton Dental

SUMMARY OF STORMWATER RUNOFF

Introduction:
The project will consist of the construction of a new building, bituminous parking lot, sidewalks, stormwater basin, and related utilities. There are no wetland impacts associated with the project.

Curve Numbers used in the stormwater models:
-39, Pervious (SP Soils)
-98, Impervious

Erosion Control:
Silt fence/sediment logs shall line the down gradient slopes of the project and rock construction entrances will be used to help control sediment removal from the site. Inlet protection devices will also be implemented to help filter sediment. Erosion control blankets will be utilized to stabilize side slopes.

Stormwater Peak Runoff Rate:
Per City of Princeton' Runoff Control Requirements, proposed runoff rates shall not exceed existing runoff rates for the 1-year, 10-year, and 100-year 24 hour critical storm events using Atlas 14 storm distributions.

Peak Runoff Rates (in cubic feet per second):

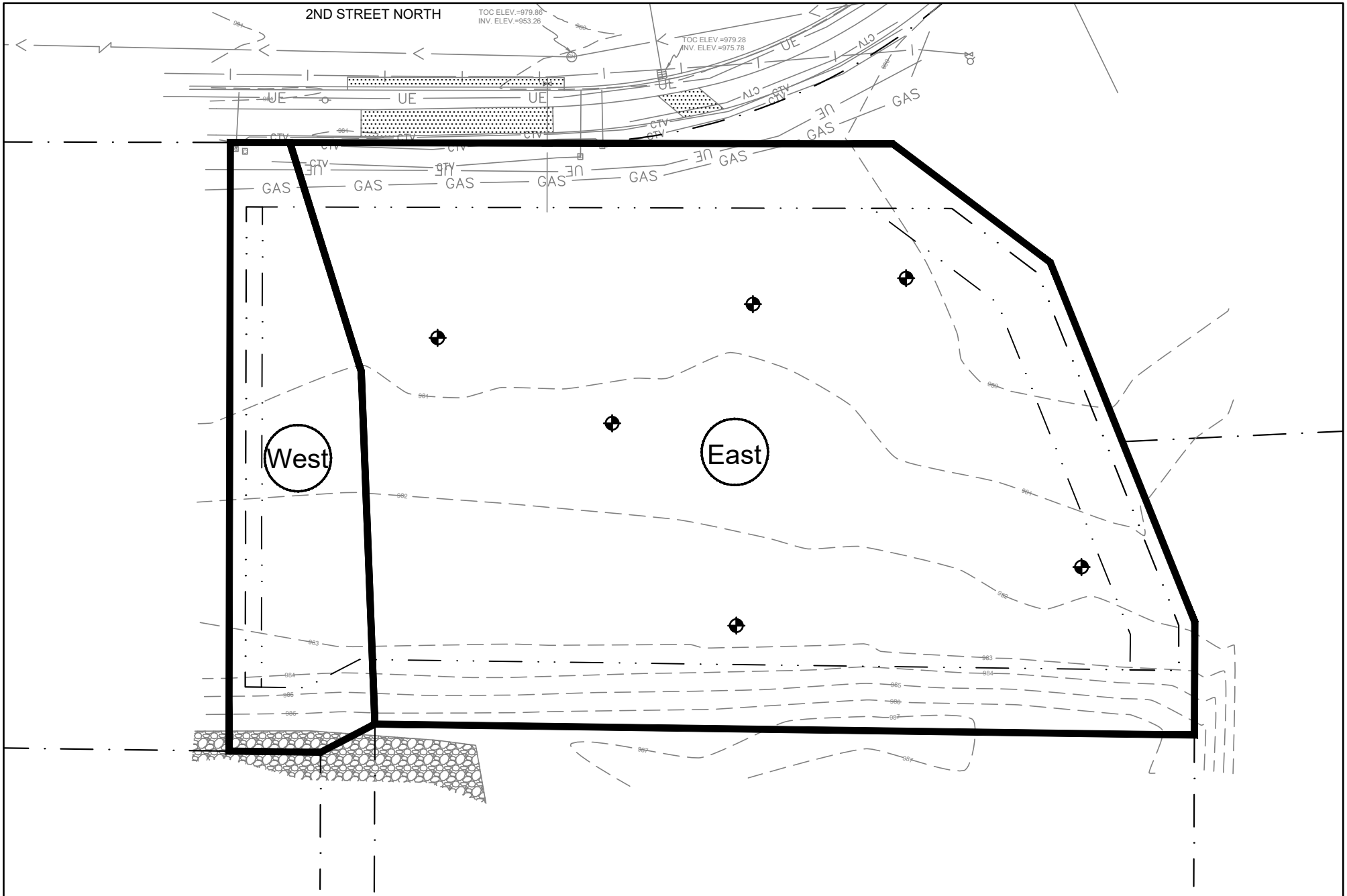
	Existing	Proposed
1-year event		
Offsite West [1R]	0.02	0.00
Offsite East [2R]	0.00	0.03*
10-year event		
Offsite West [1R]	0.03	0.00
Offsite East [2R]	0.01	0.05*
100-year event		
Offsite West [1R]	0.10	0.01
Offsite East [2R]	0.39	0.39

*Due to site constraints, it is not feasible to capture 337 SF of pavement from the entrance driveway. The 0.03 and 0.05 CFS increase in the 1-year and 10-year storm event do not represent a substantive increase. The flows to the west show a similar decrease in rate.

Water Quality
A volume equal to 1.1" of runoff from all new/reconstructed impervious surfaces on the site shall be infiltrated onsite. The attached geotechnical report shows SP soils in borings under infiltration basin locations correlating to a design infiltration rate of 0.8 in/hr. Stormwater runoff entering the basins will be pre-treated with a sump catch basin prior to entering the basin.

Total New/Reconstructed Impervious: 20,386 SF
Total Required Treatment Volume: 20,386 SF x 1.1" / 12 = 1,869 CF
Total Treatment Volume Provided: **4,334 CF > 1,869 CF**

Freeboard Requirement
The difference between the finished floor and the 100-year HWL of the basement is 6.01'.
Lowest Building FFE: 983.50'
Basin HWL: 977.49'



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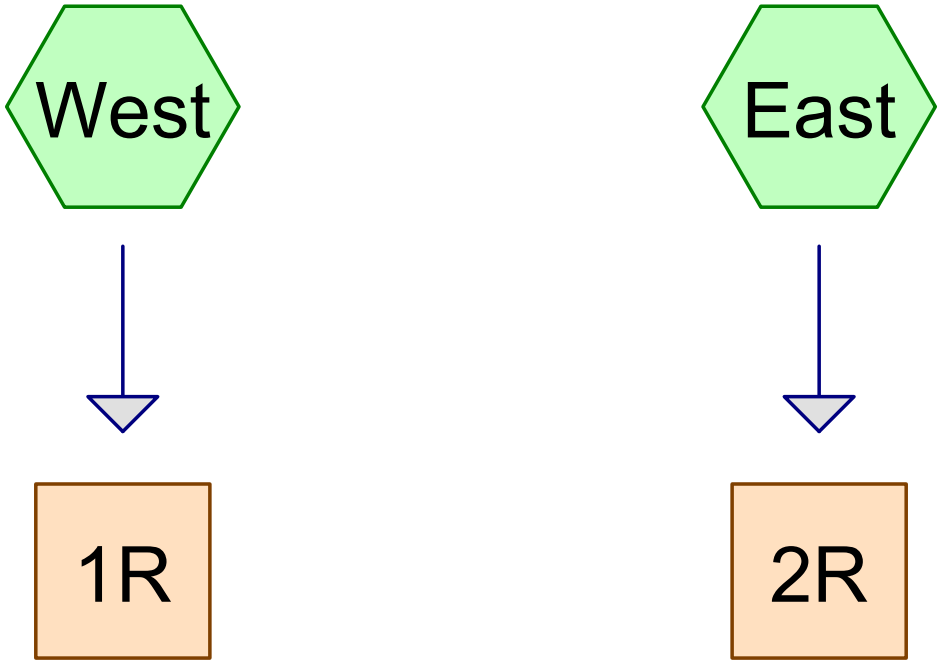
EXISTING DRAINAGE MAP

NORTH

0 20 40 80

Scale: 1":40'

4/17/2025



Subcat Reach Pond Link

Routing Diagram for Princeton - Existing
Prepared by Larson Engineering Inc, Printed 4/25/2025

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Year	MSE 24-hr	3	Default	24.00	1	2.34	2
2	10-Year	MSE 24-hr	3	Default	24.00	1	3.98	2
3	100-Year	MSE 24-hr	3	Default	24.00	1	6.37	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
49,527	39	>75% Grass cover, Good, HSG A (East, West)
218	98	Gravel (West)
49,745	**39**	**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEast: Runoff Area=42,605 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=209' Tc=10.7 min CN=39/0 Runoff=0.00 cfs 0 cf

SubcatchmentWest: Runoff Area=7,140 sf 3.05% Impervious Runoff Depth=0.06"
Flow Length=139' Tc=9.1 min CN=39/98 Runoff=0.02 cfs 38 cf

Reach 1R: Inflow=0.02 cfs 38 cf
Outflow=0.02 cfs 38 cf

Reach 2R: Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Total Runoff Area = 49,745 sf Runoff Volume = 38 cf Average Runoff Depth = 0.01"
99.56% Pervious = 49,527 sf 0.44% Impervious = 218 sf

Summary for Subcatchment East:

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach 2R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 1-Year Rainfall=2.34"

Area (sf)	CN	Description
42,605	39	>75% Grass cover, Good, HSG A
42,605	39	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	26	0.1350	0.29		**Sheet Flow,** Range n= 0.130 P2= 2.83"
7.3	74	0.0202	0.17		**Sheet Flow,** Range n= 0.130 P2= 2.83"
1.9	109	0.0189	0.96		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.7	209	Total			

Summary for Subcatchment West:

Runoff = 0.02 cfs @ 12.16 hrs, Volume= 38 cf, Depth= 0.06"
Routed to Reach 1R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 1-Year Rainfall=2.34"

	Area (sf)	CN	Description
	6,922	39	>75% Grass cover, Good, HSG A
*	218	98	Gravel
	7,140	41	Weighted Average
	6,922	39	96.95% Pervious Area
	218	98	3.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	27	0.1420	0.30		**Sheet Flow,** Range n= 0.130 P2= 2.83"
6.8	73	0.0232	0.18		**Sheet Flow,** Range n= 0.130 P2= 2.83"
0.8	39	0.0128	0.79		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.1	139	Total			

Summary for Reach 1R:

Inflow Area = 7,140 sf, 3.05% Impervious, Inflow Depth = 0.06" for 1-Year event
Inflow = 0.02 cfs @ 12.16 hrs, Volume= 38 cf
Outflow = 0.02 cfs @ 12.16 hrs, Volume= 38 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Reach 2R:

Inflow Area = 42,605 sf, 0.00% Impervious, Inflow Depth = 0.00" for 1-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEast: Runoff Area=42,605 sf 0.00% Impervious Runoff Depth=0.04"
Flow Length=209' Tc=10.7 min CN=39/0 Runoff=0.01 cfs 156 cf

SubcatchmentWest: Runoff Area=7,140 sf 3.05% Impervious Runoff Depth=0.16"
Flow Length=139' Tc=9.1 min CN=39/98 Runoff=0.03 cfs 93 cf

Reach 1R: Inflow=0.03 cfs 93 cf
Outflow=0.03 cfs 93 cf

Reach 2R: Inflow=0.01 cfs 156 cf
Outflow=0.01 cfs 156 cf

Total Runoff Area = 49,745 sf Runoff Volume = 250 cf Average Runoff Depth = 0.06"
99.56% Pervious = 49,527 sf 0.44% Impervious = 218 sf

Summary for Subcatchment East:

Runoff = 0.01 cfs @ 15.02 hrs, Volume= 156 cf, Depth= 0.04"
Routed to Reach 2R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=3.98"

Area (sf)	CN	Description
42,605	39	>75% Grass cover, Good, HSG A
42,605	39	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	26	0.1350	0.29		**Sheet Flow,** Range n= 0.130 P2= 2.83"
7.3	74	0.0202	0.17		**Sheet Flow,** Range n= 0.130 P2= 2.83"
1.9	109	0.0189	0.96		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.7	209	Total			

Summary for Subcatchment West:

Runoff = 0.03 cfs @ 12.16 hrs, Volume= 93 cf, Depth= 0.16"
Routed to Reach 1R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=3.98"

	Area (sf)	CN	Description
	6,922	39	>75% Grass cover, Good, HSG A
*	218	98	Gravel
	7,140	41	Weighted Average
	6,922	39	96.95% Pervious Area
	218	98	3.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	27	0.1420	0.30		**Sheet Flow,** Range n= 0.130 P2= 2.83"
6.8	73	0.0232	0.18		**Sheet Flow,** Range n= 0.130 P2= 2.83"
0.8	39	0.0128	0.79		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.1	139	Total			

Summary for Reach 1R:

Inflow Area = 7,140 sf, 3.05% Impervious, Inflow Depth = 0.16" for 10-Year event
Inflow = 0.03 cfs @ 12.16 hrs, Volume= 93 cf
Outflow = 0.03 cfs @ 12.16 hrs, Volume= 93 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Reach 2R:

Inflow Area = 42,605 sf, 0.00% Impervious, Inflow Depth = 0.04" for 10-Year event
Inflow = 0.01 cfs @ 15.02 hrs, Volume= 156 cf
Outflow = 0.01 cfs @ 15.02 hrs, Volume= 156 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEast: Runoff Area=42,605 sf 0.00% Impervious Runoff Depth=0.56"
Flow Length=209' Tc=10.7 min CN=39/0 Runoff=0.39 cfs 1,976 cf

SubcatchmentWest: Runoff Area=7,140 sf 3.05% Impervious Runoff Depth=0.73"
Flow Length=139' Tc=9.1 min CN=39/98 Runoff=0.10 cfs 432 cf

Reach 1R: Inflow=0.10 cfs 432 cf
Outflow=0.10 cfs 432 cf

Reach 2R: Inflow=0.39 cfs 1,976 cf
Outflow=0.39 cfs 1,976 cf

Total Runoff Area = 49,745 sf Runoff Volume = 2,408 cf Average Runoff Depth = 0.58"
99.56% Pervious = 49,527 sf 0.44% Impervious = 218 sf

Summary for Subcatchment East:

Runoff = 0.39 cfs @ 12.26 hrs, Volume= 1,976 cf, Depth= 0.56"
Routed to Reach 2R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=6.37"

Area (sf)	CN	Description
42,605	39	>75% Grass cover, Good, HSG A
42,605	39	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	26	0.1350	0.29		**Sheet Flow,** Range n= 0.130 P2= 2.83"
7.3	74	0.0202	0.17		**Sheet Flow,** Range n= 0.130 P2= 2.83"
1.9	109	0.0189	0.96		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.7	209	Total			

Summary for Subcatchment West:

Runoff = 0.10 cfs @ 12.20 hrs, Volume= 432 cf, Depth= 0.73"
Routed to Reach 1R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=6.37"

	Area (sf)	CN	Description
	6,922	39	>75% Grass cover, Good, HSG A
*	218	98	Gravel
	7,140	41	Weighted Average
	6,922	39	96.95% Pervious Area
	218	98	3.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	27	0.1420	0.30		**Sheet Flow,** Range n= 0.130 P2= 2.83"
6.8	73	0.0232	0.18		**Sheet Flow,** Range n= 0.130 P2= 2.83"
0.8	39	0.0128	0.79		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.1	139	Total			

Summary for Reach 1R:

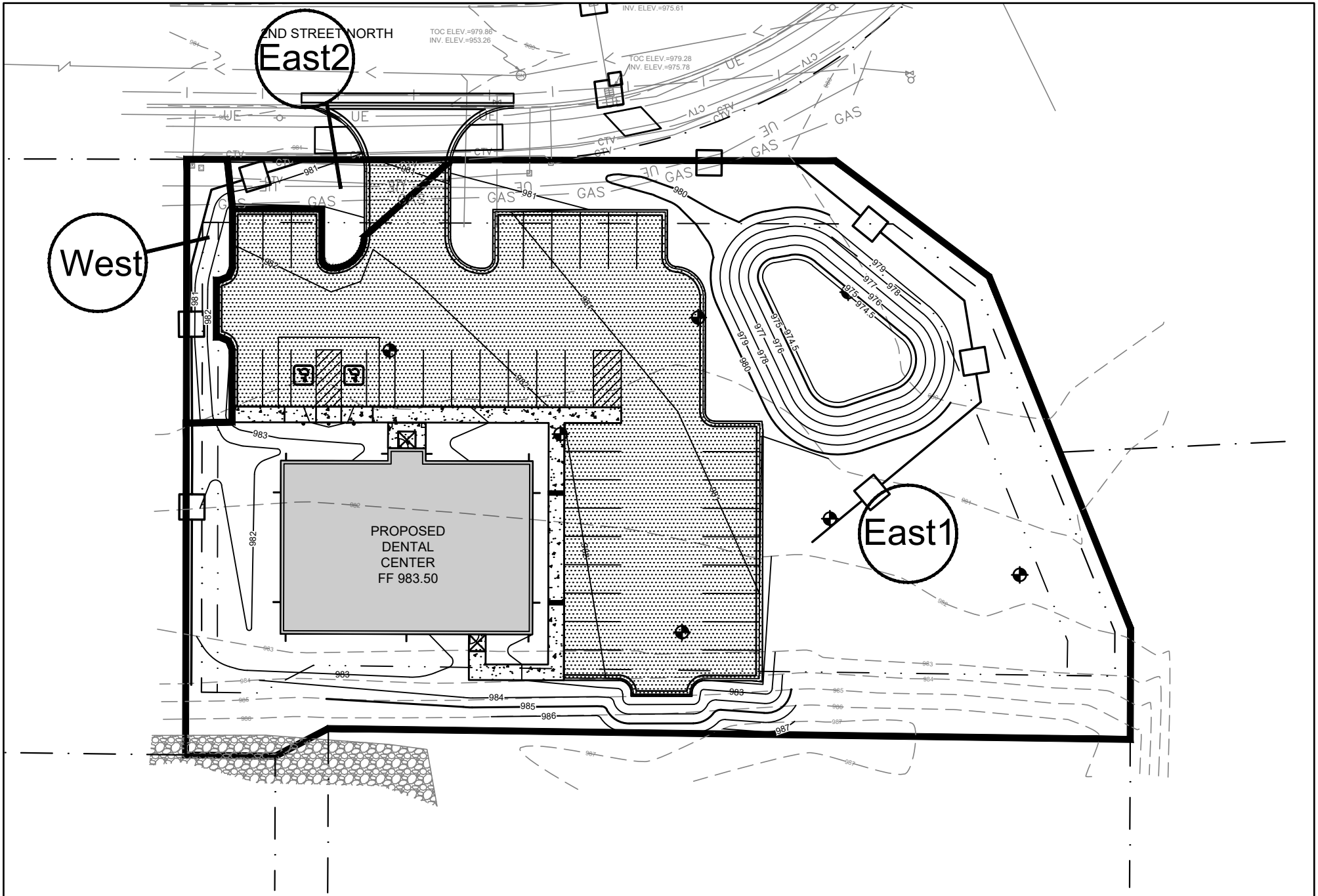
Inflow Area = 7,140 sf, 3.05% Impervious, Inflow Depth = 0.73" for 100-Year event
Inflow = 0.10 cfs @ 12.20 hrs, Volume= 432 cf
Outflow = 0.10 cfs @ 12.20 hrs, Volume= 432 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Reach 2R:

Inflow Area = 42,605 sf, 0.00% Impervious, Inflow Depth = 0.56" for 100-Year event
Inflow = 0.39 cfs @ 12.26 hrs, Volume= 1,976 cf
Outflow = 0.39 cfs @ 12.26 hrs, Volume= 1,976 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs



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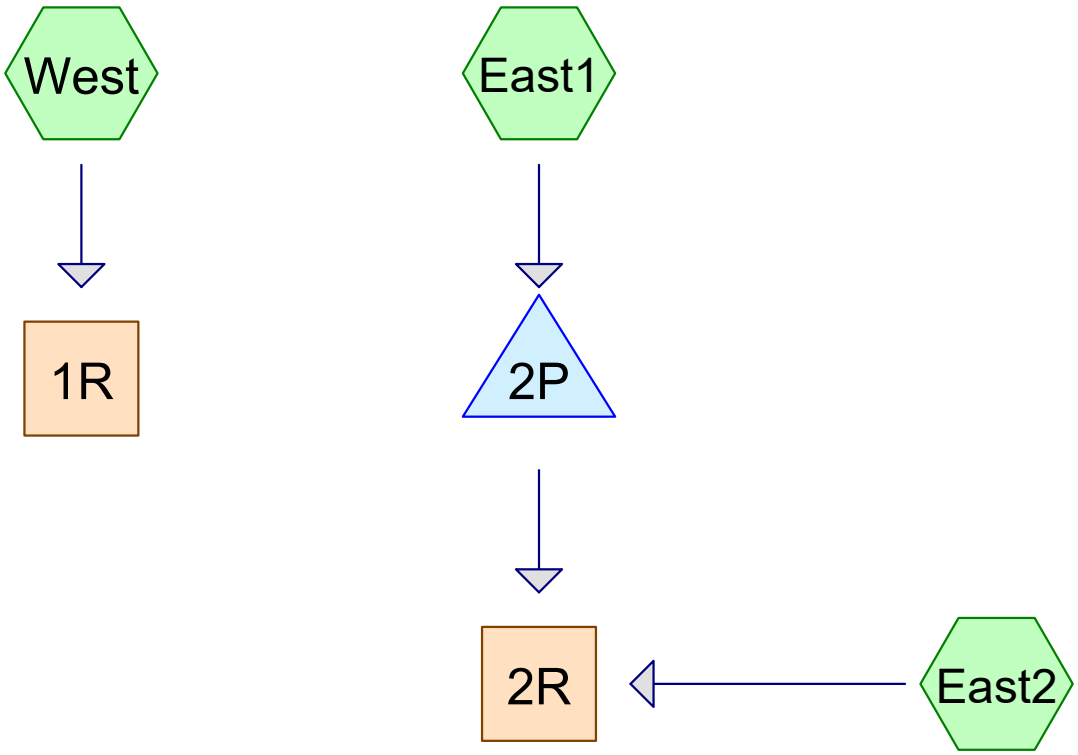
PROPOSED DRAINAGE MAP

NORTH

0 20 40 80

Scale: 1":40'

4/17/2025



Subcat Reach Pond Link

Routing Diagram for Princeton - Proposed
Prepared by Larson Engineering Inc, Printed 4/25/2025

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Year	MSE 24-hr	3	Default	24.00	1	2.34	2
2	10-Year	MSE 24-hr	3	Default	24.00	1	3.98	2
3	100-Year	MSE 24-hr	3	Default	24.00	1	6.37	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
29,355	39	>75% Grass cover, Good, HSG A (East1, East2, West)
4,448	98	Building (East1)
14,301	98	Parking lot (East1)
337	98	Paved parking, HSG A (East2)
1,300	98	Sidewalk (East1)
49,741	**63**	**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEast1: Runoff Area=47,408 sf 42.29% Impervious Runoff Depth=0.89"
Tc=6.0 min CN=39/98 Runoff=1.58 cfs 3,528 cf

SubcatchmentEast2: Runoff Area=1,236 sf 27.27% Impervious Runoff Depth=0.58"
Tc=6.0 min CN=39/98 Runoff=0.03 cfs 59 cf

SubcatchmentWest: Runoff Area=1,097 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=39/0 Runoff=0.00 cfs 0 cf

Reach 1R: Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Reach 2R: Inflow=0.03 cfs 59 cf
Outflow=0.03 cfs 59 cf

Pond 2P: Peak Elev=975.51' Storage=2,454 cf Inflow=1.58 cfs 3,528 cf
Discarded=0.03 cfs 3,496 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 3,496 cf

Total Runoff Area = 49,741 sf Runoff Volume = 3,587 cf Average Runoff Depth = 0.87"
59.02% Pervious = 29,355 sf 40.98% Impervious = 20,386 sf

Summary for Subcatchment East1:

Runoff = 1.58 cfs @ 12.13 hrs, Volume= 3,528 cf, Depth= 0.89"
Routed to Pond 2P :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 1-Year Rainfall=2.34"

	Area (sf)	CN	Description
	27,359	39	>75% Grass cover, Good, HSG A
*	14,301	98	Parking lot
*	1,300	98	Sidewalk
*	4,448	98	Building
	47,408	64	Weighted Average
	27,359	39	57.71% Pervious Area
	20,049	98	42.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment East2:

Runoff = 0.03 cfs @ 12.13 hrs, Volume= 59 cf, Depth= 0.58"
Routed to Reach 2R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 1-Year Rainfall=2.34"

Area (sf)	CN	Description
337	98	Paved parking, HSG A
899	39	>75% Grass cover, Good, HSG A
1,236	55	Weighted Average
899	39	72.73% Pervious Area
337	98	27.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment West:

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach 1R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 1-Year Rainfall=2.34"

Area (sf)	CN	Description
1,097	39	>75% Grass cover, Good, HSG A
1,097	39	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 1R:

Inflow Area = 1,097 sf, 0.00% Impervious, Inflow Depth = 0.00" for 1-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Reach 2R:

Inflow Area = 48,644 sf, 41.91% Impervious, Inflow Depth = 0.01" for 1-Year event
Inflow = 0.03 cfs @ 12.13 hrs, Volume= 59 cf
Outflow = 0.03 cfs @ 12.13 hrs, Volume= 59 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Pond 2P:

Inflow Area = 47,408 sf, 42.29% Impervious, Inflow Depth = 0.89" for 1-Year event
Inflow = 1.58 cfs @ 12.13 hrs, Volume= 3,528 cf
Outflow = 0.03 cfs @ 15.06 hrs, Volume= 3,496 cf, Atten= 98%, Lag= 176.0 min
Discarded = 0.03 cfs @ 15.06 hrs, Volume= 3,496 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 2R :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 975.51' @ 15.06 hrs Surf.Area= 1,661 sf Storage= 2,454 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 805.2 min (1,562.5 - 757.3)

Volume	Invert	Avail.Storage	Storage Description
#1	973.50'	15,576 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
973.50	814	0	0	814
974.00	1,004	454	454	1,011
975.00	1,424	1,208	1,662	1,449
976.00	1,902	1,657	3,319	1,948
977.00	2,436	2,164	5,482	2,507
978.00	3,027	2,726	8,208	3,126
979.00	3,675	3,346	11,554	3,806
980.00	4,379	4,022	15,576	4,545

Device	Routing	Invert	Outlet Devices
#1	Primary	976.50'	**12.0" Round Culvert** L= 58.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 976.50' / 975.80' S= 0.0121 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Discarded	973.50'	**0.800 in/hr Exfiltration over Wetted area**
#3	Device 1	977.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 1	976.50'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.03 cfs @ 15.06 hrs HW=975.51' (Free Discharge)
↑└**2=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=973.50' TW=0.00' (Dynamic Tailwater)
↑└**1=Culvert** (Controls 0.00 cfs)
  ↑├**3=Sharp-Crested Rectangular Weir**(Controls 0.00 cfs)
  └**4=Orifice/Grate** (Controls 0.00 cfs)

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEast1: Runoff Area=47,408 sf 42.29% Impervious Runoff Depth=1.61"
Tc=6.0 min CN=39/98 Runoff=2.72 cfs 6,358 cf

SubcatchmentEast2: Runoff Area=1,236 sf 27.27% Impervious Runoff Depth=1.05"
Tc=6.0 min CN=39/98 Runoff=0.05 cfs 108 cf

SubcatchmentWest: Runoff Area=1,097 sf 0.00% Impervious Runoff Depth=0.04"
Tc=6.0 min CN=39/0 Runoff=0.00 cfs 4 cf

Reach 1R: Inflow=0.00 cfs 4 cf
Outflow=0.00 cfs 4 cf

Reach 2R: Inflow=0.05 cfs 327 cf
Outflow=0.05 cfs 327 cf

Pond 2P: Peak Elev=976.60' Storage=4,546 cf Inflow=2.72 cfs 6,358 cf
Discarded=0.04 cfs 4,935 cf Primary=0.02 cfs 219 cf Outflow=0.06 cfs 5,154 cf

Total Runoff Area = 49,741 sf Runoff Volume = 6,470 cf Average Runoff Depth = 1.56"
59.02% Pervious = 29,355 sf 40.98% Impervious = 20,386 sf

Summary for Subcatchment East1:

Runoff = 2.72 cfs @ 12.13 hrs, Volume= 6,358 cf, Depth= 1.61"
Routed to Pond 2P :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=3.98"

	Area (sf)	CN	Description
	27,359	39	>75% Grass cover, Good, HSG A
*	14,301	98	Parking lot
*	1,300	98	Sidewalk
*	4,448	98	Building
	47,408	64	Weighted Average
	27,359	39	57.71% Pervious Area
	20,049	98	42.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment East2:

Runoff = 0.05 cfs @ 12.13 hrs, Volume= 108 cf, Depth= 1.05"
Routed to Reach 2R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=3.98"

Area (sf)	CN	Description
337	98	Paved parking, HSG A
899	39	>75% Grass cover, Good, HSG A
1,236	55	Weighted Average
899	39	72.73% Pervious Area
337	98	27.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment West:

Runoff = 0.00 cfs @ 15.01 hrs, Volume= 4 cf, Depth= 0.04"
Routed to Reach 1R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=3.98"

Area (sf)	CN	Description
1,097	39	>75% Grass cover, Good, HSG A
1,097	39	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 1R:

Inflow Area = 1,097 sf, 0.00% Impervious, Inflow Depth = 0.04" for 10-Year event
Inflow = 0.00 cfs @ 15.01 hrs, Volume= 4 cf
Outflow = 0.00 cfs @ 15.01 hrs, Volume= 4 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Reach 2R:

Inflow Area = 48,644 sf, 41.91% Impervious, Inflow Depth = 0.08" for 10-Year event
Inflow = 0.05 cfs @ 12.13 hrs, Volume= 327 cf
Outflow = 0.05 cfs @ 12.13 hrs, Volume= 327 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Pond 2P:

Inflow Area = 47,408 sf, 42.29% Impervious, Inflow Depth = 1.61" for 10-Year event
Inflow = 2.72 cfs @ 12.13 hrs, Volume= 6,358 cf
Outflow = 0.06 cfs @ 14.96 hrs, Volume= 5,154 cf, Atten= 98%, Lag= 169.7 min
Discarded = 0.04 cfs @ 14.96 hrs, Volume= 4,935 cf
Primary = 0.02 cfs @ 14.96 hrs, Volume= 219 cf
Routed to Reach 2R :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 976.60' @ 14.96 hrs Surf.Area= 2,213 sf Storage= 4,546 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 798.9 min (1,552.1 - 753.2)

Volume	Invert	Avail.Storage	Storage Description
#1	973.50'	15,576 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
973.50	814	0	0	814
974.00	1,004	454	454	1,011
975.00	1,424	1,208	1,662	1,449
976.00	1,902	1,657	3,319	1,948
977.00	2,436	2,164	5,482	2,507
978.00	3,027	2,726	8,208	3,126
979.00	3,675	3,346	11,554	3,806
980.00	4,379	4,022	15,576	4,545

Device	Routing	Invert	Outlet Devices
#1	Primary	976.50'	**12.0" Round Culvert** L= 58.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 976.50' / 975.80' S= 0.0121 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Discarded	973.50'	**0.800 in/hr Exfiltration over Wetted area**
#3	Device 1	977.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 1	976.50'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.04 cfs @ 14.96 hrs HW=976.60' (Free Discharge)
↑└**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.02 cfs @ 14.96 hrs HW=976.60' TW=0.00' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 0.02 cfs of 0.04 cfs potential flow)
↑├**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**4=Orifice/Grate** (Orifice Controls 0.02 cfs @ 1.06 fps)

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEast1: Runoff Area=47,408 sf 42.29% Impervious Runoff Depth=2.91"
Tc=6.0 min CN=39/98 Runoff=4.62 cfs 11,513 cf

SubcatchmentEast2: Runoff Area=1,236 sf 27.27% Impervious Runoff Depth=2.08"
Tc=6.0 min CN=39/98 Runoff=0.08 cfs 214 cf

SubcatchmentWest: Runoff Area=1,097 sf 0.00% Impervious Runoff Depth=0.56"
Tc=6.0 min CN=39/0 Runoff=0.01 cfs 51 cf

Reach 1R: Inflow=0.01 cfs 51 cf
Outflow=0.01 cfs 51 cf

Reach 2R: Inflow=0.39 cfs 4,965 cf
Outflow=0.39 cfs 4,965 cf

Pond 2P: Peak Elev=977.49' Storage=6,744 cf Inflow=4.62 cfs 11,513 cf
Discarded=0.05 cfs 5,340 cf Primary=0.38 cfs 4,751 cf Outflow=0.43 cfs 10,091 cf

Total Runoff Area = 49,741 sf Runoff Volume = 11,778 cf Average Runoff Depth = 2.84"
59.02% Pervious = 29,355 sf 40.98% Impervious = 20,386 sf

Summary for Subcatchment East1:

Runoff = 4.62 cfs @ 12.13 hrs, Volume= 11,513 cf, Depth= 2.91"
Routed to Pond 2P :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=6.37"

	Area (sf)	CN	Description
	27,359	39	>75% Grass cover, Good, HSG A
*	14,301	98	Parking lot
*	1,300	98	Sidewalk
*	4,448	98	Building
	47,408	64	Weighted Average
	27,359	39	57.71% Pervious Area
	20,049	98	42.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment East2:

Runoff = 0.08 cfs @ 12.14 hrs, Volume= 214 cf, Depth= 2.08"
Routed to Reach 2R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=6.37"

Area (sf)	CN	Description
337	98	Paved parking, HSG A
899	39	>75% Grass cover, Good, HSG A
1,236	55	Weighted Average
899	39	72.73% Pervious Area
337	98	27.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment West:

Runoff = 0.01 cfs @ 12.16 hrs, Volume= 51 cf, Depth= 0.56"
Routed to Reach 1R :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=6.37"

Area (sf)	CN	Description
1,097	39	>75% Grass cover, Good, HSG A
1,097	39	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 1R:

Inflow Area = 1,097 sf, 0.00% Impervious, Inflow Depth = 0.56" for 100-Year event
Inflow = 0.01 cfs @ 12.16 hrs, Volume= 51 cf
Outflow = 0.01 cfs @ 12.16 hrs, Volume= 51 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Reach 2R:

Inflow Area = 48,644 sf, 41.91% Impervious, Inflow Depth = 1.22" for 100-Year event
Inflow = 0.39 cfs @ 12.66 hrs, Volume= 4,965 cf
Outflow = 0.39 cfs @ 12.66 hrs, Volume= 4,965 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Pond 2P:

Inflow Area = 47,408 sf, 42.29% Impervious, Inflow Depth = 2.91" for 100-Year event
Inflow = 4.62 cfs @ 12.13 hrs, Volume= 11,513 cf
Outflow = 0.43 cfs @ 12.78 hrs, Volume= 10,091 cf, Atten= 91%, Lag= 38.5 min
Discarded = 0.05 cfs @ 12.78 hrs, Volume= 5,340 cf
Primary = 0.38 cfs @ 12.78 hrs, Volume= 4,751 cf
Routed to Reach 2R :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 977.49' @ 12.78 hrs Surf.Area= 2,718 sf Storage= 6,744 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 467.2 min (1,226.1 - 758.9)

Volume	Invert	Avail.Storage	Storage Description
#1	973.50'	15,576 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
973.50	814	0	0	814
974.00	1,004	454	454	1,011
975.00	1,424	1,208	1,662	1,449
976.00	1,902	1,657	3,319	1,948
977.00	2,436	2,164	5,482	2,507
978.00	3,027	2,726	8,208	3,126
979.00	3,675	3,346	11,554	3,806
980.00	4,379	4,022	15,576	4,545

Device	Routing	Invert	Outlet Devices
#1	Primary	976.50'	**12.0" Round Culvert** L= 58.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 976.50' / 975.80' S= 0.0121 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Discarded	973.50'	**0.800 in/hr Exfiltration over Wetted area**
#3	Device 1	977.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 1	976.50'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.05 cfs @ 12.78 hrs HW=977.49' (Free Discharge)
↑└**2=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.38 cfs @ 12.78 hrs HW=977.49' TW=0.00' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 0.38 cfs of 2.66 cfs potential flow)
  ↑├**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
  └**4=Orifice/Grate** (Orifice Controls 0.38 cfs @ 4.37 fps)

INDEPENDENT TESTING TECHNOLOGIES
337 31st Avenue South • Waite Park, MN 56387 • (320) 253-4338 • www.independenttestingtech.com

AUGUST 23, 2024

PROJECT 24-297
REPORT OF GEOTECHNICAL EXPLORATION

For

PRINCETON DENTAL
PRINCETON, MINNESOTA

Prepared For:

KEYSTONE DESIGN BUILD

INDEPENDENT TESTING TECHNOLOGIES
337 31st Avenue South • Waite Park, MN 56387 • (320) 253-4338 • www.independenttestingtech.com

August 23, 2024

Mr. Grant Mumm
Keystone Design Build
233 34th Avenue South
Princeton, MN 56387

RE: 24-297 Report of Geotechnical Exploration
Princeton Dental
Princeton, Minnesota

Dear Mr. Mumm:

Independent Testing Technologies, Inc. is pleased to submit the results of our subsurface investigation program for this project in Princeton, Minnesota. This report represents our work on this project as authorized by you. An electronic copy is submitted.

The soils on this site are well suited for the proposed building and site improvements. The soils encountered were mostly native fine grained poorly graded sands (SP). They were fairly loose. We recommend surface compacting the soils in the building area prior to placing any fill or foundations. Groundwater was observed in all of the borings at depths of 9.0 to 10.5 feet during our investigation and should not be an issue with design or construction.

Mr. Mumm, it has been our pleasure to work with you on this project. Independent Testing appreciated the opportunity to perform this geotechnical evaluation and look forward to continuing our participation during the construction phase of this project. Please contact Patrick Johnson if you have any questions regarding this report. Please contact Tyler Burkes if you would like a proposal for the materials testing services that may be needed.

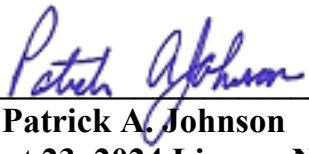
Sincerely,

Patrick A. Johnson, P.E.
Minnesota License #22037

Kevin T. Reller
President

CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of Minnesota.



Patrick A. Johnson
Date: August 23, 2024 License No.: 22037

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GEOTECHNICAL EXPLORATION
PRINCETON DENTAL
PRINCETON, MINNESOTA
PROJECT 24-297

A. Introduction

This report is being prepared for use by our client on this specific project. We intend to present this report and our findings in the same logical manner that led us to arrive at our recommendations. This report is based on some general assumptions regarding the anticipated construction based on experience with similar projects. These assumptions and the entire report should be reviewed immediately upon receipt.

Purpose:

The purpose of our investigation was to evaluate the existing soil and water conditions on this site and provide a report of our findings and recommendations regarding design and construction of the proposed improvements. The project will consist of construction of a one-story, slab-on-grade, stick framed structure on standard, cast-in-place concrete spread footings. In accordance with your written authorization, we have conducted a subsurface exploration program for the proposed project.

Scope of Services:

Our authorized scope of services included the following:

1. To investigate the subsurface soil and water conditions encountered at seven (7) split-spoon soil boring locations on the site. The borings were planned to depths of just under fifteen (15) feet at each location in the proposed building areas and ten (10) feet in the parking lot and stormwater pond areas.
2. To provide a report of our findings including the results of our subsurface investigation and recommendations regarding earthwork, fill and compaction, building foundation suitability, soil bearing capacity, estimated settlement, wall backfill, slab support, stormwater infiltration, parking lot subgrade preparation and bituminous pavement design.

General Site Conditions:

The site is currently a vacant parcel at 1921 2nd Street North on the west side of the City of Princeton. The site is on the south side of 2nd Street, between 19th Avenue North and 21st Avenue North. The site is in an industrial/ commercial area at the southwest quadrant of US Highway 169 and Minnesota Highway 95. The site is an open, level grassy field. The site is relatively flat with slopes of 0-4%

Available Subsurface Information:

According to the Geologic Map of Minnesota, Quaternary Geology, prepared by Howard C. Hobbs and Joseph E. Goebel (1982, Minnesota Geological Survey), this site lies within an outwash unit not associated with any particular moraine. This is associated with the Des Moines Lobe glaciation of Pleistocene, Late Wisconsinan age. The deposits generally consist of sandy outwash with significant limestone and shale portions. The drift is derived from parent material in Manitoba and eastern North Dakota.

According to the Soil Survey of Mille Lacs County prepared by the Soil Conservation Service, the site lies within Zimmerman fine sands. The individual soils mapped on this site are fine sands that have slight limitations for development of small commercial building sites due to locally shallow depth to seasonal groundwater.

B. Exploration Program

Seven (7) split-spoon soil borings were conducted on this project. The borings were advanced to 10 feet to just under 15 feet deep using a 3 ¼ inch I.D. hollow stem auger. Samples were obtained every 2 ½ feet for the first 10 feet and every 5 feet thereafter using a 2-inch O.D. split spoon sampler in accordance with the American Society for Testing and Materials (ASTM D1586). Standard penetration values (N-values) were obtained at each sample interval by driving the sampler into the soil using a 140-pound hammer falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler 12 inches is known as the standard penetration resistance or N-value. Where the sampler cannot be driven at least 6 inches by 50 blows of the hammer, the total number of blows as well as the distance driven is reported on the boring logs.

Groundwater levels were noted during drilling and immediately after completion. The holes were backfilled with auger cuttings. Some settlement of the bore holes may be expected. All of the borings were conducted with a truck mounted CME-45 drill rig. The ground surface elevations at each boring location are based on the assumed elevation of 100.0 for the top of the fire hydrant at the front of the lot.

Exploration Results:

All of the borings were conducted in the existing open lot and encountered topsoil material consisting of fine silty sand (SM) to depths of 4 to 8 inches.

Below the topsoil, all of the boring encountered native, fine grained poorly graded (SP) to their termination depths.

Penetration Test Results:

The standard penetration blow counts in the native, inorganic fine sands (SP) ranged from 3 to 25, which are very low to moderate, indicating that they are in a very loose to medium dense condition. The lowest blow counts were at the surface and generally became higher with increasing depth below the surface. This is typical of normally consolidated soils. Refusal of the spoon or auger did not occur in any of the borings. Drilling was relatively easy.

Water Level Observations:

Observations of the subsurface water conditions were made during drilling operations. Groundwater was encountered in all the borings at depths of 9.0 to 10.5 feet during drilling. The following table shows the depth of water at each location:

Boring	Water
SB-1	10.5 feet
SB-2	9.0 feet
SB-3	10.5 feet
SB-4	10.5 feet
SB-5	9.5 feet
SB-6	10.5 feet
SB-7	10.0 feet

The groundwater levels were observed over a relatively short period of time. However, we feel they are an accurate reflection of the true water levels at the time of our investigation due to the

relatively high permeability of the native sand soils. The soils were dry above the water levels.

It should be noted that fluctuations in the level of the groundwater can occur due to variations in rainfall, temperature, spring thaw and other factors not evident at the time of our investigation. Mottled soils were not observed. Mottled native soils are a historical indication of a temporarily or seasonally saturated soil condition. Grey soils were also not observed. Grey native soils are an indication of a permanently saturated soil condition.

Laboratory Testing

Moisture Content Tests- Moisture content tests were performed on every split spoon sample in accordance with ASTM method D2216; *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*. Individual test results are shown on the boring logs adjacent to the sample that was tested.

C. Engineering Review

Discussion:

Based on our findings, the site appears to be well suited for the proposed building and site improvements. The existing topsoil should be removed from all the building and parking lot areas. We estimate this will require an excavation of 4 to 8 inches across the site. After stripping the topsoil, we recommend watering and compacting the exposed soils in the proposed building area with three passes of a heavy vibratory roller in each of two perpendicular directions prior to placing any fill.

The building is expected to be a one- story, slab-on-grade, stick framed structure placed on standard, cast-in-place concrete spread footings. We assume exterior wall footings will be placed at elevations ranging from 2 to 3 feet below the existing ground level. We expect the foundation will be placed on the native fine grained sand soils.

Maximum foundation loads could be expected to be in the range of 4-6 kips per linear foot for wall footings and 150-200 kips for column loads. The native sand soils on this site appear suitable for support of the proposed building.

Groundwater is not expected to have an impact on the project. Natural moisture contents of the soil above the water level generally ranged from 5 to 19 percent. Optimum moisture is estimated to be between 12-16% for these soil types. We recommend that all fill placed in the building and parking lot areas consist of soil at or near optimum moisture for compaction.

D. Recommendations

The following recommendations are based on our understanding of the proposed project. If our understanding of the project is not accurate, or if changes are made to the project scope, please inform us so that our recommendations can be amended, if necessary. We have included recommendations regarding earthwork and construction that may help in cost estimates and aid in design. We should be allowed to review the proposed construction plans to provide further detailed recommendations, if necessary. Without the opportunity to review the final construction plans, the recommendations made in this report may no longer be valid.

Site Grading:

We recommend that all topsoil material be completely removed from the construction area prior to beginning grading. We estimate that this will require 4 to 8 inches of excavation across this site. The topsoil should be removed from the site, or it could be stockpiled and used for landscaping.

After removal of the topsoil and any uncontrolled fill, we recommend the native fine sands be wetted and compacted with three passes of a heavy vibratory roller in each of two perpendicular directions. This will help to increase the density of the fine sands and to make the soils consistent across the building. We recommend the bottom of the excavation be observed by a soils engineer or a qualified technician to verify that native, competent material has been reached. We recommend the excavation be oversized one foot for every foot of fill required to reach planned grade (1:1 oversizing). Soils can change dramatically over short horizontal distances; therefore, the recommended excavation depths should be used as a guide.

After removal of the topsoil and any soft, unsuitable soils, we recommend clean, mineral fill, meeting the requirements of structural fill, be placed, and compacted to bring the building and parking lot areas to grade. We recommend all standing water be removed from any excavation before placing fill.

Structural Fill:

The on-site soils consisting of poorly graded sands (SP) are considered excellent material for use as structural fill. These soils are easy to work with and easy to compact with vibratory compaction equipment.

We recommend that all fill consist of mineral soils meeting the following requirements. No organic soils, roots, stumps, logs, brush, etc. should be used as structural fill below any foundation or pavement section. We recommend that all fill material be free of soft, wet, or frozen soils, highly expansive soils, rubble, debris, and rocks in excess of 6 inches in diameter. The fill should be as uniform as possible both in composition and moisture content.

We recommend all fill be compacted to the minimum relative density levels shown in the table below:

Location	Recommended Compaction Level (percent of Std. Proctor ASTM D698)
Below Foundations	98 %
Below Slabs, including interior and exterior wall backfill	95%
Below Pavements, deeper than 3 feet from finished subgrade	95%
Below Pavements within 3 feet of finished subgrade	100%

We recommend all fill placed in the building and pavement areas be compacted in 8-inch loose lifts. All fill should be compacted at a moisture content within plus or minus 2% of the optimum moisture as determined by a standard proctor. We recommend compaction tests be taken on any fill in the building and pavement areas at a rate of one test per vertical foot per 2,500 square foot area, with a minimum of two tests per fill area.

Foundations:

It appears the existing native soils on this site are in a loose to medium dense condition capable of supporting the proposed structure. We recommend all footings be supported on native sands or properly compacted structural fill as recommended.

All exterior footings in heated building areas should be placed at a minimum depth of 60 inches

below the proposed final grade to provide protection from frost damage. Interior footings in heated areas can be placed at any convenient depth as long as they are placed on the native fine sands or properly compacted fill.

Any footings placed on native soils or on properly compacted fill should be proportioned for a maximum net allowable soil bearing pressure of 2000 psf. We recommend compaction tests be taken on any fill below the footings at a rate of one test per 50 linear feet for wall footings and one test per column footing. We recommend compaction tests be taken immediately prior to pouring the footings.

The recommended bearing pressure is a net value and represents the actual loads that may be transmitted to the soil independent of overburden pressures. We estimate total settlement to be less than 1inch with differential settlement about half of this if the recommendations in this report are followed.

Slabs

We recommend a minimum of 6 inches of clean, free draining washed sand with less than 5% passing a No. 200 sieve be placed beneath the floor slabs. This will provide a capillary break and a uniform level subgrade for the floor slabs. We recommend slabs be designed using a modulus of subgrade reaction of 250 pounds per cubic inch.

A vapor barrier should be placed under all concrete floors on ground that are likely to receive an impermeable floor finish or be used for any purpose where the passage of water vapor through the floor is undesirable. Floor coverings such as linoleum, vinyl tile, carpeting, wood, and synthetic surfacing effectively seal the moisture within the slab where it eventually may loosen, buckle, or blister the floor covering. We recommend a vapor moisture barrier consisting of a minimum of 6-mil polyethylene sheeting be placed under concrete slabs on grade. The plastic sheeting should be placed between the sand and the concrete, not below the sand.

In order to lessen the moisture post-construction, we recommend using a low water-cement ratio

concrete, less than .45. We recommend allowing the slab a 2-month drying period and testing the slab's moisture condition before installing any floor covering.

Wall Backfill

We assume the walls will be backfilled with on-site granular materials. We recommend all wall backfill be compacted to at least 95% of standard proctor maximum density. We recommend below grade walls be designed using a coefficient of active pressure (Ka) of 0.44, an at-rest coefficient (Ko) of 0.28, and a passive coefficient (Kp) of 3.5. We recommend below grade walls be designed using the bulk unit weight of 120 pounds per cubic foot.

Stormwater Pond:

The native sand soils on this site are good for infiltration treatment. According to the *Minnesota Stormwater Manual, November 2005*, prepared by the Minnesota Pollution Control Agency, it is our opinion that the native sands consisting of fine grained poorly graded sands (SP) are in Hydrologic Group "A."

We recommend using an assumed infiltration rate of 1.0 inches per hour for the design of infiltration facilities on this site that will extend into the fine grained, poorly graded sands. Infiltrometer testing may be warranted to verify this value due to the fine grained nature of the native soils. The pond bottom should be at least three feet above the ground water level for infiltration basins.

E. Pavement Recommendations

The expected subgrade soil will likely consist of poorly graded sands (SP). The soils encountered are classified as A-3 soils in accordance with the American Association of State Highway Transportation Officials (AASHTO) classification system. A-3 soils are rated excellent material for use as parking lot subgrade material. In no instance should organic soils be used as parking lot subgrade material. Without benefit of a laboratory R-value determination and based on MnDOT guidelines, an R-value of 70 can be assumed for these materials.

Based on an assumed R-value of 70, we recommend the following bituminous pavement section

for general car and light truck parking lots:

Thickness	Course/Description	G.E.
4.0”	MnDOT Superpave Bituminous	9.0”
6.0”	MnDOT 3138 Class 5 Aggregate Base	6.0”
10.0”	TOTAL	15.0”

For the concrete pavement section, we recommend 4.5 inches of Portland cement concrete mix with a minimum compressive strength of 4500 p.s.f. We recommend placing a minimum of 3 inches of aggregate under the concrete to provide a level, uniform surface for the concrete pavement. The subgrade should be dampened immediately prior to pouring the concrete pavement.

In using the assumed R-value for bituminous pavement or concrete design, it is essential that the subgrade be constructed of uniform soils at a moisture content and density in accordance with MnDOT specification 2105 and capable of passing a test roll in accordance with MnDOT specification 2111. The native, undisturbed soils may need preparation (drying and compacting) to pass a proof roll. If the subgrade is not compacted, uniform and capable of passing a test roll, then we recommend the subgrade be scarified and recompacted or subcut and replaced with geotextile fabric and select granular material meeting MnDOT specification 3149. The top of the subgrade should be compacted to a minimum of 100% of standard proctor maximum density. The subgrade should be sloped towards the edges to provide drainage.

F. Closing

Our work was performed for geotechnical purposes only and not to document the presence or extent of any contamination on the site. We can note that our crew did not detect any obvious contamination by sight or smell during drilling operations. However, human senses are limited in terms of contamination detection and, therefore, the lack of detection through human sensing does not preclude the possibility of the presence of contamination of the site.

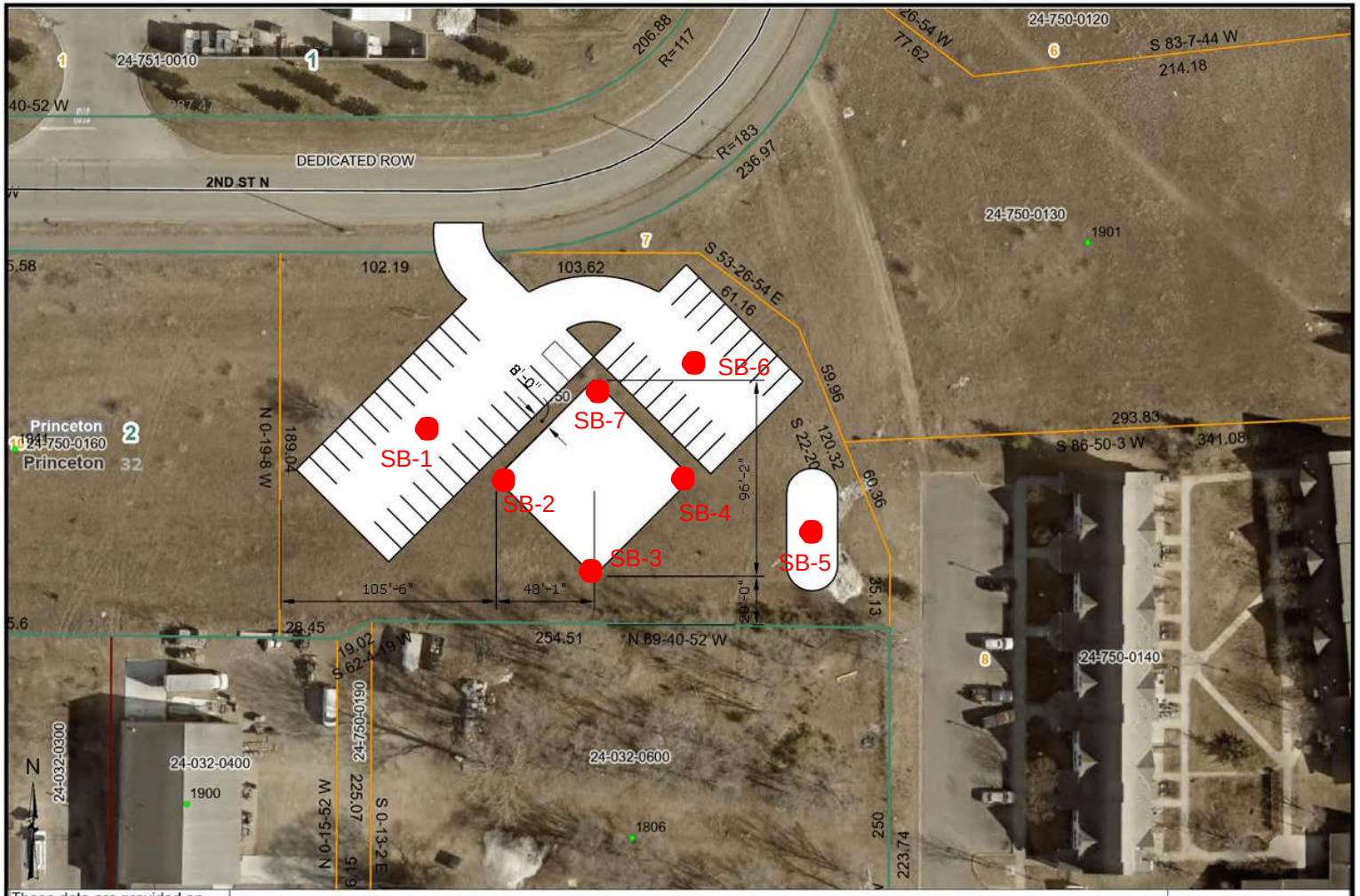
This report represents the result of our subsurface investigation and is based on information gathered at specific locations. Subsurface conditions can change a great deal over short horizontal

distances. Also, the actual interface between strata will likely be a gradual transition rather than an abrupt change as represented on the boring logs.

Geotechnical engineering is based extensively on opinion. Therefore, the data contained in this report should be used as a guide, and we recommend that construction monitoring be performed by a qualified geotechnical engineer or technician. We recommend ITT be retained due to our familiarity with the soils on this site. Any changes in the subsurface conditions from those found during this geotechnical investigation should be brought to the attention of a soils engineer.

APPENDIX 1

BORING LOCATION PLAN



These data are provided on an "AS-IS" basis, without warranty of any type, expressed or implied, including but not limited to any warranty as to their performance, merchantability, or fitness for any particular purpose.

Date: 7/31/2024

This map is not a substitute for accurate field surveys or for locating actual property lines and any adjacent features.

APPENDIX 2

SOIL BORING LOGS

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **24-297** **KEYSTONE DESIGN BUILD, INC.**
PRINCETON DENTAL
PRINCETON, MINNESOTA

DATE: **8/12/24** *12-Aug* **SB-1**
START TIME: **8:15** *END TIME:* **8:30**

METHOD: **3 ¼" I.D. Hollow Stem Auger**
CREW: **CD/RS**

LOCATION: **See Boring Location Plan**
ELEVATION:

Depth (Feet)	*ASTM Symbol*	*Soil Description*	*Sample #*	*N Value*	*W_n*	*Notes*
6.0"	**SM**	**SILTY SAND, fine grained, dark brown.**				
	SP	**POORLY GRADED SAND, fine grained, brown.**				
			1	**6**	5.6	
5.0						
			2	**10**	6.5	
			3	**7**	10.1	
10.0						
			4	**8**	26.4	**V Water encountered at 10.5 feet during drilling.**
11.5						
		Boring complete to 11.5 feet. **No water encountered during drilling.** **No water measured to cave-in at 8' 6" after completion.**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **24-297** **KEYSTONE DESIGN BUILD, INC.**
PRINCETON DENTAL
PRINCETON, MINNESOTA

DATE: **8/12/24** *12-Aug* **SB-2**
START TIME: **8:35** *END TIME:* **8:55**

METHOD: **3 ¼" I.D. Hollow Stem Auger**
CREW: **CD/RS**

LOCATION: **See Boring Location Plan**
ELEVATION:

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
5.0"	SM	SILTY SAND, fine grained, dark brown.				
	SP	POORLY GRADED SAND, fine grained, brown.				
			1	4	4.8	
5.0						
			2	5	4.8	
			3	3	18.7	V Water encounterd at 9 feet during drilling.
10.0						
			4	5	21.4	
			5	6	25.2	
14.9		Boring complete to 14.9 feet. Water encountered at 9 feet during drilling. No water measured to cave-in at 9 feet after completion.				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **24-297** **KEYSTONE DESIGN BUILD, INC.**
PRINCETON DENTAL
PRINCETON, MINNESOTA

DATE: **8/12/24** *12-Aug* **SB-3**
START TIME: **9:00** *END TIME:* **9:20**

METHOD: **3 ¼" I.D. Hollow Stem Auger**
CREW: **CD/RS**

LOCATION: **See Boring Location Plan**
ELEVATION:

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
6.0"	SM	SILTY SAND, fine grained, dark brown.				
	SP	POORLY GRADED SAND, fine grained, brown.				
			1	3	5.0	
5.0						
			2	4	8.4	
7.5						
			3	5	10.6	
10.0						
			4	5	19.5	V Water encounterd at 10.5 feet during drilling.
			5	6	28.4	
14.9						
		Boring complete to 14.9 feet. Water encountered at 10.5 feet during drilling. No water measured to cave-in at 9' 9" after completion.				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **24-297** **KEYSTONE DESIGN BUILD, INC.**
PRINCETON DENTAL
PRINCETON, MINNESOTA

DATE: **8/12/24** *12-Aug* **SB-4**
START TIME: **9:25** *END TIME:* **9:45**

METHOD: **3 ¼" I.D. Hollow Stem Auger**
CREW: **CD/RS**

LOCATION: **See Boring Location Plan**
ELEVATION:

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
4.0"	**SM**	**SILTY SAND, fine grained, dark brown.**				
	SP	**POORLY GRADED SAND, fine grained, loght brown.**				
			1	**5**	4.7	
5.0						
			2	**6**	4.4	
		brown	**3**	**4**	4.5	
10.0						
			4	**4**	19.9	**V Water encounterd at 10.5 feet during drilling.**
		fine to medium grained.	**5**	**6**	19.8	
14.9						
		Boring complete to 14.9 feet. **Water encountered at 10.5 feet during drilling.** **No water measured to cave-in at 9' after completion.**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **24-297** **KEYSTONE DESIGN BUILD, INC.**
PRINCETON DENTAL
PRINCETON, MINNESOTA

DATE: **8/12/24** *12-Aug* **SB-5**
START TIME: **9:50** *END TIME:* **10:05**

METHOD: **3 ¼" I.D. Hollow Stem Auger**
CREW: **CD/RS**

LOCATION: **See Boring Location Plan**
ELEVATION:

Depth (Feet)	*ASTM Symbol*	*Soil Description*	*Sample #*	*N Value*	*W_n*	*Notes*
4.0"	**SM**	**SILTY SAND, fine grained, dark brown.**				
	SP	**POORLY GRADED SAND, fine grained, tan, brown.**				
			1	**3**	3.5	
5.0						
			2	**4**	5.0	
			3	**5**	12.0	
						V Water encounterd at 9.5 feet during drilling.
10.0		**fine to medium grained.**				
			4	**4**	20.4	
11.5						
		Boring complete to 11.5 feet. **Water encountered at 9.5 feet during drilling.** **No water measured to cave-in at 9' after completion.**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **24-297** **KEYSTONE DESIGN BUILD, INC.**
PRINCETON DENTAL
PRINCETON, MINNESOTA

DATE: **8/12/24** *12-Aug* **SB-6**
START TIME: **10:10** *END TIME:* **10:30**

METHOD: **3 ¼" I.D. Hollow Stem Auger**
CREW: **CD/RS**

LOCATION: **See Boring Location Plan**
ELEVATION:

Depth (Feet)	*ASTM Symbol*	*Soil Description*	*Sample #*	*N Value*	*W_n*	*Notes*
5.0"	**SM**	**SILTY SAND, fine grained, dark brown.**				
	SP	**POORLY GRADED SAND, fine grained, dark brown.**				
			1	**10**	7.0	
5.0		**brown.**				
			2	**25**	6.0	
			3	**9**	12.8	
10.0		**fine to medium grained.**				
			4	**4**	21.5	**V Water encounterd at 10.5 feet during drilling.**
11.5		**Boring complete to 11.5 feet.** **Water encountered at 10.5 during drilling.** **No water measured to cave-in at 8' after completion.**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **24-297** **KEYSTONE DESIGN BUILD, INC.**
PRINCETON DENTAL
PRINCETON, MINNESOTA

DATE: **8/12/24** *12-Aug* **SB-7**
START TIME: **10:35** *END TIME:* **11:00**

METHOD: **3 ¼" I.D. Hollow Stem Auger**
CREW: **CD/RS**

LOCATION: **See Boring Location Plan**
ELEVATION:

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
8.0"	**SM**	**SILTY SAND, fine grained, dark brown.**				
	SP	**POORLY GRADED SAND, fine grained, brown.**				
			1	**9**	8.3	
5.0						
			2	**20**	6.2	
			3	**8**	17.1	
10.0						**V Water encounterd at 10 feet during drilling.**
		fine to medium grained.	**4**	**6**	19.3	
			5	**7**	18.7	
14.9						
		Boring complete to 14.9 feet. **Water encountered at 10 feet during drilling.** **No water measured to cave-in at 8' 6" after completion.**				

Unified Soil Classification (USC) System (from ASTM D 2487)

Major Divisions			Group Symbol	Typical Names
Course-Grained Soils More than 50% retained on the 0.075 mm (No. 200) sieve	**Gravels** 50% or more of course fraction retained on the 4.75 mm (No. 4) sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands 50% or more of course fraction passes the 4.75 (No. 4) sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils More than 50% passes the 0.075 mm (No. 200) sieve	**Silts and Clays** Liquid Limit 50% or less		ML	Inorganic silts, very fine sands, rock four, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays Liquid Limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

Prefix: G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic
Suffix: W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%