

THE WILLOWS STORMWATER MANAGEMENT

DATE: 03/08/2018

UPDATED:

SITE CONDITIONS

The proposed Willows apartment complex is proposed to be located on 3.25 acres of the Windermere development in Shakopee. The proposed apartment will consist of 60 apartments located in a three story slab on grade apartment building. The proposed stormwater for the apartment is designed within the constraints of the overall Windermere stormwater management plan. The apartment site falls within Windermere Subcatchment 1S and drains to Pond 1.

For the project two rain gardens and four landscaped depressed islands have been incorporated to handle the difference in impervious surfaces between what is being proposed and what was allocated for this property in the Windermere overall stormwater management plan. The Windermere modeling allocated an impervious surface of 37% for this portion of the site. The existing modeling for this property is modeling 3.25 acres at 37% impervious. The proposed stormwater system was then designed to infiltrate the increase in impervious surface above 37% and to limit the rate of runoff from this site to less than what was planned for in the overall development.

RATE CONTROL

An evaluation was made for both the Windermere Design and post-development peak runoff rates.

The following is a table summarizing the pre-development rates and post-development rates for the 2-year, 10-year and 100-year 24 hour storm events for the 3.25 acre apartment site.

	Windermere Development	Post Development
Drainage Area	100 yr (cfs)	100 yr (cfs)
Apartment Site	22.1	16.5

Drainage Area	10 yr (cfs)	10 yr (cfs)
Apartment Site	9.0	7.6

Drainage Area	2 yr (cfs)	2 yr (cfs)
Apartment Site	4.3	4.1

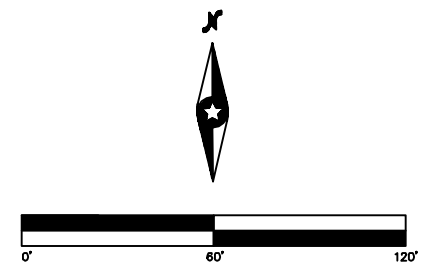
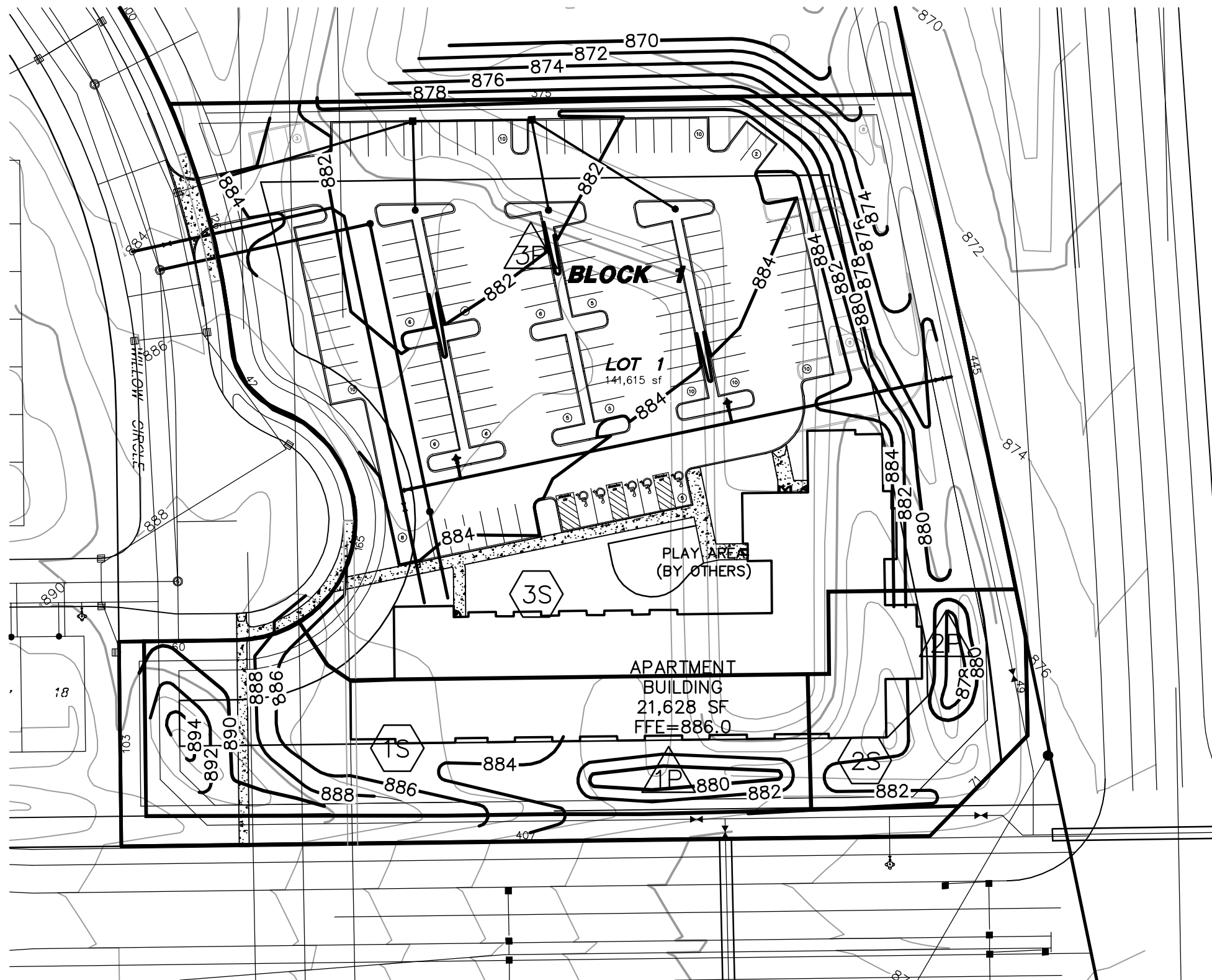
As shown in the tables above, existing discharge rates will not be exceeded with the proposed development.

SUMMARY

VOLUME CONTROL

Per the Windermere overall stormwater management plan, the proposed apartment complex must infiltrate the additional impervious surface above and beyond the 37% that was allocated for this site. The site currently has 53.8% impervious or 76,270 sf, which is 23,804 sf more than the allocated 52,466 sf. The site is designed to infiltrate 1.1" of runoff over the additional impervious surface which equates to an infiltration volume of 2,182 cf. The proposed rain gardens combined will infiltrate 6,336 cf and the infiltration swales in the landscaped islands is estimated to infiltrate 533 cf between all four islands. The design of the infiltration islands will be finalized during the final design process.

Drainage Map



Date: 03/08/18 Sheet: 1 OF 1
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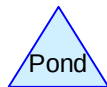
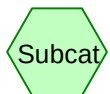
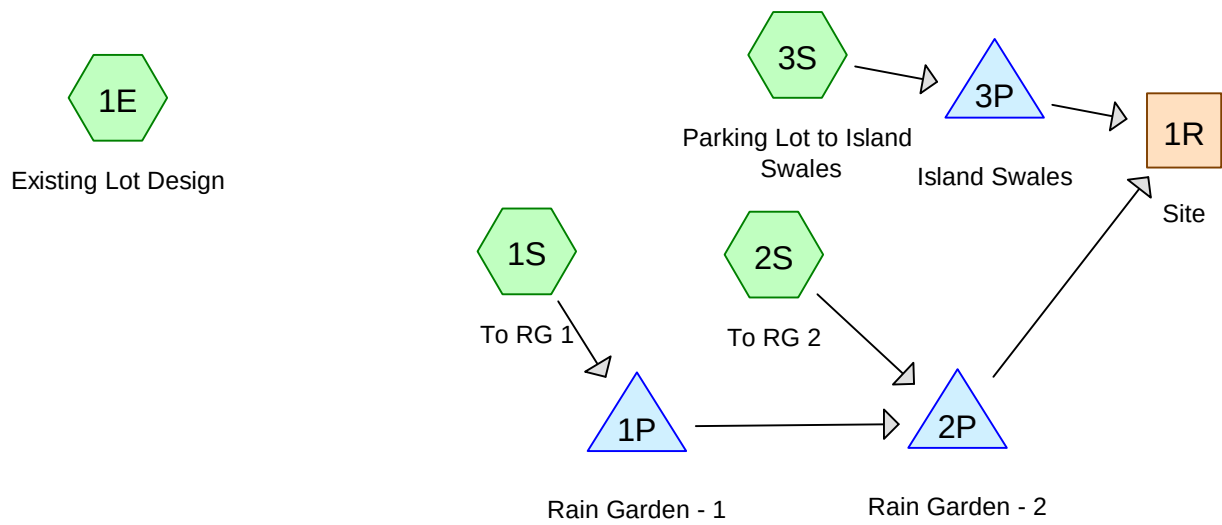
The Willows

Shakopee, Minnesota

**Proposed Drainage
Map**

Exhibit A

HydroCAD Model



Routing Diagram for 14559

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Summary for Subcatchment 1E: Existing Lot Design

Runoff = 4.29 cfs @ 12.19 hrs, Volume= 0.243 af, Depth= 0.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-Year Rainfall=2.90"

Area (sf)	CN	Description
52,466	98	Paved parking, HSG A
89,333	61	>75% Grass cover, Good, HSG B
141,799	75	Weighted Average
89,333		63.00% Pervious Area
52,466		37.00% Impervious Area

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

Summary for Subcatchment 1S: To RG 1

Runoff = 0.57 cfs @ 12.21 hrs, Volume= 0.035 af, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-Year Rainfall=2.90"

Area (sf)	CN	Description
15,647	61	>75% Grass cover, Good, HSG B
7,533	98	Roofs, HSG A
23,180	73	Weighted Average
15,647		67.50% Pervious Area
7,533		32.50% Impervious Area

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

Summary for Subcatchment 2S: To RG 2

Runoff = 0.23 cfs @ 12.21 hrs, Volume= 0.014 af, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-Year Rainfall=2.90"

Area (sf)	CN	Description
2,985	98	Roofs, HSG A
6,477	61	>75% Grass cover, Good, HSG B
9,462	73	Weighted Average
6,477		68.45% Pervious Area
2,985		31.55% Impervious Area

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MSE 24-hr 3 2-Year Rainfall=2.90"

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

Summary for Subcatchment 3S: Parking Lot to Island Swales

Runoff = 5.20 cfs @ 12.18 hrs, Volume= 0.285 af, Depth= 1.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-Year Rainfall=2.90"

Area (sf)	CN	Description
43,405	61	>75% Grass cover, Good, HSG B
65,752	98	Paved parking, HSG A
109,157	83	Weighted Average
43,405		39.76% Pervious Area
65,752		60.24% Impervious Area

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

Summary for Reach 1R: Site

Inflow Area = 3.255 ac, 53.79% Impervious, Inflow Depth = 0.81" for 2-Year event
Inflow = 4.07 cfs @ 12.25 hrs, Volume= 0.221 af
Outflow = 4.07 cfs @ 12.25 hrs, Volume= 0.221 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs

Summary for Pond 1P: Rain Garden - 1

Inflow Area = 0.532 ac, 32.50% Impervious, Inflow Depth = 0.80" for 2-Year event
Inflow = 0.57 cfs @ 12.21 hrs, Volume= 0.035 af
Outflow = 0.03 cfs @ 15.13 hrs, Volume= 0.035 af, Atten= 96%, Lag= 174.8 min
Discarded = 0.03 cfs @ 15.13 hrs, Volume= 0.035 af
Primary = 0.00 cfs @ 4.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
Peak Elev= 880.86' @ 15.13 hrs Surf.Area= 1,357 sf Storage= 926 cf

Plug-Flow detention time= 431.0 min calculated for 0.035 af (100% of inflow)
Center-of-Mass det. time= 431.0 min (1,272.5 - 841.5)

Volume #1	Invert 880.00'	Avail.Storage 5,702 cf	Storage Description Custom Stage Data (Prismatic) Listed below (Recalc)
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MSE 24-hr 3 2-Year Rainfall=2.90"

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Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
880.00	791	0	0
882.00	2,105	2,896	2,896
883.00	3,506	2,806	5,702

Device	Routing	Invert	Outlet Devices
#1	Discarded	880.00'	0.800 in/hr Exfiltration over Surface area
#2	Primary	882.50'	15.0' long x 8.0' breadth Broad-Crested Rectangular Weir
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00			
2.50 3.00 3.50 4.00 4.50 5.00 5.50			
Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64			
2.65 2.65 2.66 2.66 2.68 2.70 2.74			

Discarded OutFlow Max=0.03 cfs @ 15.13 hrs HW=880.86' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.03 cfs)**Primary OutFlow** Max=0.00 cfs @ 4.00 hrs HW=880.00' (Free Discharge)↑**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)**Summary for Pond 2P: Rain Garden - 2**

Inflow Area = 0.749 ac, 32.22% Impervious, Inflow Depth = 0.23" for 2-Year event
 Inflow = 0.23 cfs @ 12.21 hrs, Volume= 0.014 af
 Outflow = 0.01 cfs @ 14.86 hrs, Volume= 0.014 af, Atten= 95%, Lag= 158.7 min
 Discarded = 0.01 cfs @ 14.86 hrs, Volume= 0.014 af
 Primary = 0.00 cfs @ 4.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs

Peak Elev= 878.72' @ 14.86 hrs Surf.Area= 637 sf Storage= 361 cf

Plug-Flow detention time= 360.0 min calculated for 0.014 af (100% of inflow)

Center-of-Mass det. time= 360.1 min (1,201.6 - 841.5)

Volume	Invert	Avail.Storage	Storage Description
#1	878.00'	3,280 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
878.00	366	0	0
880.00	1,118	1,484	1,484
881.00	2,473	1,796	3,280

Device	Routing	Invert	Outlet Devices
#1	Discarded	878.00'	0.800 in/hr Exfiltration over Surface area
#2	Primary	880.50'	15.0' long x 8.0' breadth Broad-Crested Rectangular Weir
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00			
2.50 3.00 3.50 4.00 4.50 5.00 5.50			
Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64			
2.65 2.65 2.66 2.66 2.68 2.70 2.74			

Discarded OutFlow Max=0.01 cfs @ 14.86 hrs HW=878.72' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 4.00 hrs HW=878.00' (Free Discharge)

↑**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 3P: Island Swales

Inflow Area = 2.506 ac, 60.24% Impervious, Inflow Depth = 1.37" for 2-Year event
 Inflow = 5.20 cfs @ 12.18 hrs, Volume= 0.285 af
 Outflow = 4.19 cfs @ 12.25 hrs, Volume= 0.285 af, Atten= 19%, Lag= 4.3 min
 Discarded = 0.12 cfs @ 12.25 hrs, Volume= 0.065 af
 Primary = 4.07 cfs @ 12.25 hrs, Volume= 0.221 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
 Peak Elev= 881.40' @ 12.25 hrs Surf.Area= 6,236 sf Storage= 2,198 cf

Plug-Flow detention time= 45.3 min calculated for 0.285 af (100% of inflow)
 Center-of-Mass det. time= 45.4 min (859.8 - 814.4)

Volume	Invert	Avail.Storage	Storage Description
#1	880.75'	7,825 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
880.75	2,133	0	0
881.00	2,133	533	533
882.00	12,450	7,292	7,825

Device	Routing	Invert	Outlet Devices
#1	Discarded	880.75'	0.800 in/hr Exfiltration over Surface area
#2	Primary	881.00'	27.0" Vert. Orifice/Grate X 4.00 C= 0.600

Discarded OutFlow Max=0.12 cfs @ 12.25 hrs HW=881.40' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.12 cfs)

Primary OutFlow Max=4.06 cfs @ 12.25 hrs HW=881.40' (Free Discharge)

↑**2=Orifice/Grate** (Orifice Controls 4.06 cfs @ 2.15 fps)

Summary for Subcatchment 1E: Existing Lot Design

Runoff = 8.97 cfs @ 12.18 hrs, Volume= 0.493 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.20"

Area (sf)	CN	Description
52,466	98	Paved parking, HSG A
89,333	61	>75% Grass cover, Good, HSG B
141,799	75	Weighted Average
89,333		63.00% Pervious Area
52,466		37.00% Impervious Area

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

Summary for Subcatchment 1S: To RG 1

Runoff = 1.26 cfs @ 12.21 hrs, Volume= 0.074 af, Depth= 1.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.20"

Area (sf)	CN	Description
15,647	61	>75% Grass cover, Good, HSG B
7,533	98	Roofs, HSG A
23,180	73	Weighted Average
15,647		67.50% Pervious Area
7,533		32.50% Impervious Area

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

Summary for Subcatchment 2S: To RG 2

Runoff = 0.51 cfs @ 12.21 hrs, Volume= 0.030 af, Depth= 1.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.20"

Area (sf)	CN	Description
2,985	98	Roofs, HSG A
6,477	61	>75% Grass cover, Good, HSG B
9,462	73	Weighted Average
6,477		68.45% Pervious Area
2,985		31.55% Impervious Area

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MSE 24-hr 3 10-Year Rainfall=4.20"

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

Summary for Subcatchment 3S: Parking Lot to Island Swales

Runoff = 9.31 cfs @ 12.18 hrs, Volume= 0.514 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.20"

Area (sf)	CN	Description
43,405	61	>75% Grass cover, Good, HSG B
65,752	98	Paved parking, HSG A
109,157	83	Weighted Average
43,405		39.76% Pervious Area
65,752		60.24% Impervious Area

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

Summary for Reach 1R: Site

Inflow Area = 3.255 ac, 53.79% Impervious, Inflow Depth = 1.61" for 10-Year event
Inflow = 7.59 cfs @ 12.24 hrs, Volume= 0.437 af
Outflow = 7.59 cfs @ 12.24 hrs, Volume= 0.437 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs

Summary for Pond 1P: Rain Garden - 1

Inflow Area = 0.532 ac, 32.50% Impervious, Inflow Depth = 1.67" for 10-Year event
Inflow = 1.26 cfs @ 12.21 hrs, Volume= 0.074 af
Outflow = 0.03 cfs @ 15.27 hrs, Volume= 0.074 af, Atten= 97%, Lag= 183.5 min
Discarded = 0.03 cfs @ 15.27 hrs, Volume= 0.074 af
Primary = 0.00 cfs @ 4.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
Peak Elev= 881.66' @ 15.27 hrs Surf.Area= 1,884 sf Storage= 2,227 cf

Plug-Flow detention time= 749.1 min calculated for 0.074 af (100% of inflow)
Center-of-Mass det. time= 748.9 min (1,573.4 - 824.4)

Volume #1	Invert 880.00'	Avail.Storage 5,702 cf	Storage Description Custom Stage Data (Prismatic) Listed below (Recalc)
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Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
880.00	791	0	0
882.00	2,105	2,896	2,896
883.00	3,506	2,806	5,702

Device	Routing	Invert	Outlet Devices
#1	Discarded	880.00'	0.800 in/hr Exfiltration over Surface area
#2	Primary	882.50'	15.0' long x 8.0' breadth Broad-Crested Rectangular Weir
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00			
2.50 3.00 3.50 4.00 4.50 5.00 5.50			
Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64			
2.65 2.65 2.66 2.66 2.68 2.70 2.74			

Discarded OutFlow Max=0.03 cfs @ 15.27 hrs HW=881.66' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 4.00 hrs HW=880.00' (Free Discharge)

↑**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 2P: Rain Garden - 2

Inflow Area = 0.749 ac, 32.22% Impervious, Inflow Depth = 0.48" for 10-Year event
 Inflow = 0.51 cfs @ 12.21 hrs, Volume= 0.030 af
 Outflow = 0.02 cfs @ 15.18 hrs, Volume= 0.030 af, Atten= 97%, Lag= 178.4 min
 Discarded = 0.02 cfs @ 15.18 hrs, Volume= 0.030 af
 Primary = 0.00 cfs @ 4.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs

Peak Elev= 879.40' @ 15.18 hrs Surf.Area= 893 sf Storage= 882 cf

Plug-Flow detention time= 630.3 min calculated for 0.030 af (100% of inflow)

Center-of-Mass det. time= 630.1 min (1,454.5 - 824.4)

Volume	Invert	Avail.Storage	Storage Description
#1	878.00'	3,280 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
878.00	366	0	0
880.00	1,118	1,484	1,484
881.00	2,473	1,796	3,280

Device	Routing	Invert	Outlet Devices
#1	Discarded	878.00'	0.800 in/hr Exfiltration over Surface area
#2	Primary	880.50'	15.0' long x 8.0' breadth Broad-Crested Rectangular Weir
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00			
2.50 3.00 3.50 4.00 4.50 5.00 5.50			
Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64			
2.65 2.65 2.66 2.66 2.68 2.70 2.74			

Discarded OutFlow Max=0.02 cfs @ 15.18 hrs HW=879.40' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 4.00 hrs HW=878.00' (Free Discharge)

↑**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 3P: Island Swales

Inflow Area = 2.506 ac, 60.24% Impervious, Inflow Depth = 2.46" for 10-Year event
 Inflow = 9.31 cfs @ 12.18 hrs, Volume= 0.514 af
 Outflow = 7.74 cfs @ 12.24 hrs, Volume= 0.514 af, Atten= 17%, Lag= 3.9 min
 Discarded = 0.14 cfs @ 12.24 hrs, Volume= 0.076 af
 Primary = 7.59 cfs @ 12.24 hrs, Volume= 0.437 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
 Peak Elev= 881.55' @ 12.24 hrs Surf.Area= 7,802 sf Storage= 3,262 cf

Plug-Flow detention time= 30.5 min calculated for 0.514 af (100% of inflow)
 Center-of-Mass det. time= 30.7 min (833.2 - 802.5)

Volume	Invert	Avail.Storage	Storage Description
#1	880.75'	7,825 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
880.75	2,133	0	0
881.00	2,133	533	533
882.00	12,450	7,292	7,825

Device	Routing	Invert	Outlet Devices
#1	Discarded	880.75'	0.800 in/hr Exfiltration over Surface area
#2	Primary	881.00'	27.0" Vert. Orifice/Grate X 4.00 C= 0.600

Discarded OutFlow Max=0.14 cfs @ 12.24 hrs HW=881.55' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=7.52 cfs @ 12.24 hrs HW=881.55' (Free Discharge)

↑**2=Orifice/Grate** (Orifice Controls 7.52 cfs @ 2.52 fps)

Summary for Subcatchment 1E: Existing Lot Design

Runoff = 22.06 cfs @ 12.18 hrs, Volume= 1.222 af, Depth= 4.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-Year Rainfall=7.40"

Area (sf)	CN	Description
52,466	98	Paved parking, HSG A
89,333	61	>75% Grass cover, Good, HSG B
141,799	75	Weighted Average
89,333		63.00% Pervious Area
52,466		37.00% Impervious Area

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

Summary for Subcatchment 1S: To RG 1

Runoff = 3.24 cfs @ 12.20 hrs, Volume= 0.190 af, Depth= 4.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-Year Rainfall=7.40"

Area (sf)	CN	Description
15,647	61	>75% Grass cover, Good, HSG B
7,533	98	Roofs, HSG A
23,180	73	Weighted Average
15,647		67.50% Pervious Area
7,533		32.50% Impervious Area

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

Summary for Subcatchment 2S: To RG 2

Runoff = 1.32 cfs @ 12.20 hrs, Volume= 0.078 af, Depth= 4.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-Year Rainfall=7.40"

Area (sf)	CN	Description
2,985	98	Roofs, HSG A
6,477	61	>75% Grass cover, Good, HSG B
9,462	73	Weighted Average
6,477		68.45% Pervious Area
2,985		31.55% Impervious Area

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

Summary for Subcatchment 3S: Parking Lot to Island Swales

Runoff = 19.90 cfs @ 12.17 hrs, Volume= 1.129 af, Depth= 5.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-Year Rainfall=7.40"

Area (sf)	CN	Description
43,405	61	>75% Grass cover, Good, HSG B
65,752	98	Paved parking, HSG A
109,157	83	Weighted Average
43,405		39.76% Pervious Area
65,752		60.24% Impervious Area

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

Summary for Reach 1R: Site

Inflow Area = 3.255 ac, 53.79% Impervious, Inflow Depth = 4.01" for 100-Year event
Inflow = 16.54 cfs @ 12.23 hrs, Volume= 1.086 af
Outflow = 16.54 cfs @ 12.23 hrs, Volume= 1.086 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs

Summary for Pond 1P: Rain Garden - 1

Inflow Area = 0.532 ac, 32.50% Impervious, Inflow Depth = 4.28" for 100-Year event
Inflow = 3.24 cfs @ 12.20 hrs, Volume= 0.190 af
Outflow = 0.94 cfs @ 12.52 hrs, Volume= 0.190 af, Atten= 71%, Lag= 19.3 min
Discarded = 0.05 cfs @ 12.52 hrs, Volume= 0.138 af
Primary = 0.89 cfs @ 12.52 hrs, Volume= 0.051 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs
Peak Elev= 882.58' @ 12.52 hrs Surf.Area= 2,923 sf Storage= 4,364 cf

Plug-Flow detention time= 740.9 min calculated for 0.190 af (100% of inflow)
Center-of-Mass det. time= 741.8 min (1,546.9 - 805.1)

Volume #1	Invert 880.00'	Avail.Storage 5,702 cf	Storage Description Custom Stage Data (Prismatic) Listed below (Recalc)
--------------	-------------------	---------------------------	--

14559

MSE 24-hr 3 100-Year Rainfall=7.40"

Prepared by Westwood Professional Services, Inc.

Printed 3/8/2018

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Page 12

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
880.00	791	0	0
882.00	2,105	2,896	2,896
883.00	3,506	2,806	5,702

Device	Routing	Invert	Outlet Devices
#1	Discarded	880.00'	0.800 in/hr Exfiltration over Surface area
#2	Primary	882.50'	15.0' long x 8.0' breadth Broad-Crested Rectangular Weir
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00			
2.50 3.00 3.50 4.00 4.50 5.00 5.50			
Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64			
2.65 2.65 2.66 2.66 2.68 2.70 2.74			

Discarded OutFlow Max=0.05 cfs @ 12.52 hrs HW=882.58' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.05 cfs)**Primary OutFlow** Max=0.85 cfs @ 12.52 hrs HW=882.58' (Free Discharge)↑**2=Broad-Crested Rectangular Weir** (Weir Controls 0.85 cfs @ 0.69 fps)**Summary for Pond 2P: Rain Garden - 2**

Inflow Area = 0.749 ac, 32.22% Impervious, Inflow Depth = 2.07" for 100-Year event
 Inflow = 1.32 cfs @ 12.20 hrs, Volume= 0.129 af
 Outflow = 0.95 cfs @ 12.65 hrs, Volume= 0.129 af, Atten= 28%, Lag= 26.9 min
 Discarded = 0.04 cfs @ 12.65 hrs, Volume= 0.074 af
 Primary = 0.92 cfs @ 12.65 hrs, Volume= 0.055 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs

Peak Elev= 880.59' @ 12.65 hrs Surf.Area= 1,911 sf Storage= 2,371 cf

Plug-Flow detention time= 529.0 min calculated for 0.129 af (100% of inflow)

Center-of-Mass det. time= 529.9 min (1,331.9 - 802.0)

Volume	Invert	Avail.Storage	Storage Description
#1	878.00'	3,280 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
878.00	366	0	0
880.00	1,118	1,484	1,484
881.00	2,473	1,796	3,280

Device	Routing	Invert	Outlet Devices
#1	Discarded	878.00'	0.800 in/hr Exfiltration over Surface area
#2	Primary	880.50'	15.0' long x 8.0' breadth Broad-Crested Rectangular Weir
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00			
2.50 3.00 3.50 4.00 4.50 5.00 5.50			
Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64			
2.65 2.65 2.66 2.66 2.68 2.70 2.74			

Discarded OutFlow Max=0.04 cfs @ 12.65 hrs HW=880.59' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.91 cfs @ 12.65 hrs HW=880.59' (Free Discharge)

↑**2=Broad-Crested Rectangular Weir** (Weir Controls 0.91 cfs @ 0.71 fps)

Summary for Pond 3P: Island Swales

Inflow Area = 2.506 ac, 60.24% Impervious, Inflow Depth = 5.41" for 100-Year event
 Inflow = 19.90 cfs @ 12.17 hrs, Volume= 1.129 af
 Outflow = 16.74 cfs @ 12.23 hrs, Volume= 1.129 af, Atten= 16%, Lag= 3.7 min
 Discarded = 0.20 cfs @ 12.23 hrs, Volume= 0.098 af
 Primary = 16.54 cfs @ 12.23 hrs, Volume= 1.031 af

Routing by Stor-Ind method, Time Span= 4.00-84.00 hrs, dt= 0.05 hrs

Peak Elev= 881.83' @ 12.23 hrs Surf.Area= 10,702 sf Storage= 5,863 cf

Plug-Flow detention time= 19.1 min calculated for 1.128 af (100% of inflow)

Center-of-Mass det. time= 19.3 min (806.0 - 786.8)

Volume	Invert	Avail.Storage	Storage Description
#1	880.75'	7,825 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
880.75	2,133	0	0
881.00	2,133	533	533
882.00	12,450	7,292	7,825

Device	Routing	Invert	Outlet Devices
#1	Discarded	880.75'	0.800 in/hr Exfiltration over Surface area
#2	Primary	881.00'	27.0" Vert. Orifice/Grate X 4.00 C= 0.600

Discarded OutFlow Max=0.20 cfs @ 12.23 hrs HW=881.82' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=16.31 cfs @ 12.23 hrs HW=881.82' (Free Discharge)

↑**2=Orifice/Grate** (Orifice Controls 16.31 cfs @ 3.09 fps)

Windermere Supporting Documents

FINAL STORM WATER
RUNOFF NARRATIVE

Windermere
Shakopee, MN

Prepared for:

DR Horton, Inc.
20860 Kenbridge Court, Suite100
Lakeville, Minnesota 55044

Prepared by:

Westwood Professional Services, Inc.
7699 Anagram Drive
Eden Prairie, MN 55344
Phone 952-937-5150, Fax 952-937-5822

Revised: June 26, 2017
Project # 0000615.00

SUMMARY

The site is located at the southwest quadrant of Marystown Road and TH 169 in Shakopee, Minnesota. The proposed project will subdivide approximately 78.9 acres into 197 attached and detached homes and multiple commercial buildings.

Existing Conditions:

The existing site is approximately 79 acres, most of which is farmed. The soils are varied and are predominantly sand (SP), silty sand (SM), sandy lean clay (CL) and clayey sand (SC) with one and a half to two feet of clayey topsoil as indicated by the Geotechnical Exploration Report prepared by American Engineering Testing, Inc. dated July 19, 2004 and the Geotechnical Evaluation Report by Braun Interotec dated April 24, 2017. Groundwater was observed in the east-central part of the site at an elevation of approximately 862.0 and in the central part of the site at approximately 864.0. The other borings indicated no groundwater observed.

Proposed Conditions and Requirements:

The proposed development will result in 197 residential units and multiple commercial buildings. The majority of the site will be routed to proposed stormwater basins for rate control, water quality and volume reduction. As much as possible, the stormwater management has been designed to meet the design guidelines from the City of Shakopee, Scott Watershed Management Organization and the State of Minnesota, including:

- Volume abstraction via infiltration equal to 1.1 inch over all the site impervious area.
- Rate control of site runoff to equal or less than pre-settlement condition rates as defined by the City of Shakopee and described in this report for 2-year, 10-year and 0.3 cfs/ac for 100-year critical rain events ($78.88 \text{ ac} \times 0.3 \text{ cfs/ac} = 23.66 \text{ cfs}$). NOAA ATLAS 14 precipitation values were used to model the events.
- Discharge rate to Mn/DOT TH 169 ROW should not exceed the existing rate for the 2-yr, 10-yr and 100-year critical rain events.
- The infiltration basins will have pretreatment provided via wet ponds designed to NURP standards.
- Ponding and overflow capacity for the 100-year 10-day snow melt critical event.\
- Minnesota River TMDL requirement of reducing non-point source phosphorus loading to the Minnesota River by 30%.

SUMMARY

Consistent with the “Technical Release 55: Urban Hydrology for Small Watersheds” and City of Shakopee requirements, the following curve numbers were used to model the existing and proposed conditions:

- Pre-settlement condition, HSG B - CN 55
- Interim Condition of row crops, HGB B - CN 75
- Interim Condition of existing woods, HGB B – CN 55
- Impervious area - CN 98
- Developed open area, HSG B - CN 61

Proposed Treatment:

Rate Control

To confirm compliance with the City’s rate control requirements, the pre-settlement and ultimate developed conditions were modeled in HydroCAD.

The results of the peak runoff rate comparisons are summarized in the table below; please refer to the attached HydroCAD calculations and drainage diagrams for further detail.

Ultimate Condition Run-off Rates

Storm Event	Pre-Settlement Site Discharge Rate (cfs)	Proposed Site Discharge Rate (cfs)
2-Yr	3.65	1.63
10-Yr	23.24	5.48
100-Yr	120.18	24.33*

*Maximum 100-year discharge rate is $0.3 \text{ cfs/ac} \times 78.88 \text{ ac} = 23.66 \text{ cfs}$

The 100-year discharge rate exceeds the desired rate of 23.66 cfs slightly due to the City’s 8” minimum orifice size requirement.

Direct drainage currently entering the site from the offsite area to the southwest (PO-2) will be intercepted by a proposed 54” trunk storm sewer along 17th Avenue to be constructed under the City project. Direct drainage entering the site from the offsite area to the south (3CS) will pass through and does not count against the ultimate maximum discharge rate.

To confirm compliance with Mn/DOT’s rate control requirements, the existing and the interim conditions were modeled in HydroCAD. The interim condition includes the offsite areas that will drain through the trunk storm sewer to the TH 169 right-of-way.

Interim Run-off Rates to Mn/DOT TH 169

Storm Event	Existing Discharge Rate (cfs)	Interim Proposed Discharge Rate (cfs)
2-Yr	62.15	53.74
10-Yr	149.39	120.91
100-Yr	434.39	319.93

SUMMARY

Please refer to the attached HydroCAD calculations for further detail.

The 100-year 10-day snow melt event was also modeled and is presented in the appendix.

Water Quality

Water quality is provided primarily by wet ponds designed to NURP and City of Shakopee standards, which exceed the State of Minnesota guideline of 1,800 cubic feet of dead storage per acre draining to the pond. Also, infiltration basins provide additional water quality benefits.

The water quality storage of each NURP pond is summarized in the table below; please refer to the attached HydroCAD calculations for further detail.

Water Quality Volumes

Basin	Subcatchment NURP Volume Required (AF)	NURP/Dead Storage Provided (AF)
1P	2.39	2.95
2P	0.65	0.73
3P	0.65	0.88
4P	1.04	1.16

To confirm compliance with the City of Shakopee water quality management plan, which is designed to meet the Minnesota River TMDL requirement of 30% reduction of phosphorus compared to existing conditions, the proposed site was modeled in p8. The following table summarizes the pollutant removals for the proposed design. Please refer to the attached p8 modeling output for more information.

Total Pollutant Removal

Pollutant	Percent Removal
Total Suspended Solids	98.0
Total Phosphorus	90.2

Volume Control

Volume abstraction will be provided via multiple infiltration basins sized for the total proposed on-site impervious area 33.4 acres, a volume equal to 133,282 cubic feet. The volume control devices have been sized to infiltrate the treatment volume within 48 hours. Infiltration rates of 0.80 in/hr for Basin 1, 0.50 in/hr for Basin 2 and 0.80 in/hr for Basin 4 were assumed based on the Minnesota Stormwater Manual guidance for HSG A and HSG B soils. HSG A infiltration rates were used for Basins 1 and 4 based on the soils present at the proposed infiltration basin bottom. Pretreatment will be provided via wet ponds designed to NURP standards.

To model the infiltration benches, an infiltration flow rate was calculated for each bench and modeled in HydroCAD. The rate was calculated by multiplying the bench infiltration rate over

SUMMARY

the bench area and converting to cubic feet per second (cfs). The following table summarizes the infiltration flow rates for each bench.

Infiltration Flow Rates

Pond	Infiltration Bench Area (sf)	Design Infiltration Rate (in/hr)	Effective Infiltration Flow (cfs)
1	25,950	0.8	0.48
2	13,450	0.5	0.16
4	9,350	0.8	0.17

The required and proposed volume control is summarized in the table below; please refer to the attached volume control calculations for further detail.

Infiltration Volumes

Subcatchment	Infiltration Basin	Volume Reduction Required (CF)	Volume Reduction Provided (CF)
1S	Pond 1	67,514	83,040
2S	Pond 2	18,347	26,900
3S	N/A	18,174	0
4S	Pond 4	28,043	29,920
5S	N/A	1,203	0
Total Volumes (CF):		133,282	139,860

Conclusion:

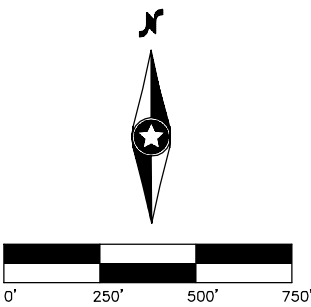
As demonstrated in this report and the attached appendices, the proposed Windermere development meets the intent of the stormwater management requirements of the City of Shakopee, Scott Watershed Management Organization and the State of Minnesota.

Appendix:

Appendix A	Drainage Maps
Appendix B	HyrdoCAD Calculations • Presettlement Condition • Ultimate Condition • Interim Condition
Appendix C	Volume Control Calculations
Appendix D	p8 Water Quality Modeling
Appendix E	Soil Borings from July 19, 2004 Geotechnical Exploration Report & April 24, 2017 Geotechnical Evaluation Report

APPENDIX A

DRAINAGE MAPS



NOT FOR CONSTRUCTION

0000615DRAN.dwg

Date: 6/1/17 Sheet: 1 OF 2

Windermere

Shakopee, Minnesota

Existing Drainage
Map

Westwood

Phone (952) 937-5150 7699 Anagram Drive
Fax (952) 937-5822 Eden Prairie, MN 55344
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

I hereby certify that this plan 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.

John Bender, PE

Date: License No. 43358

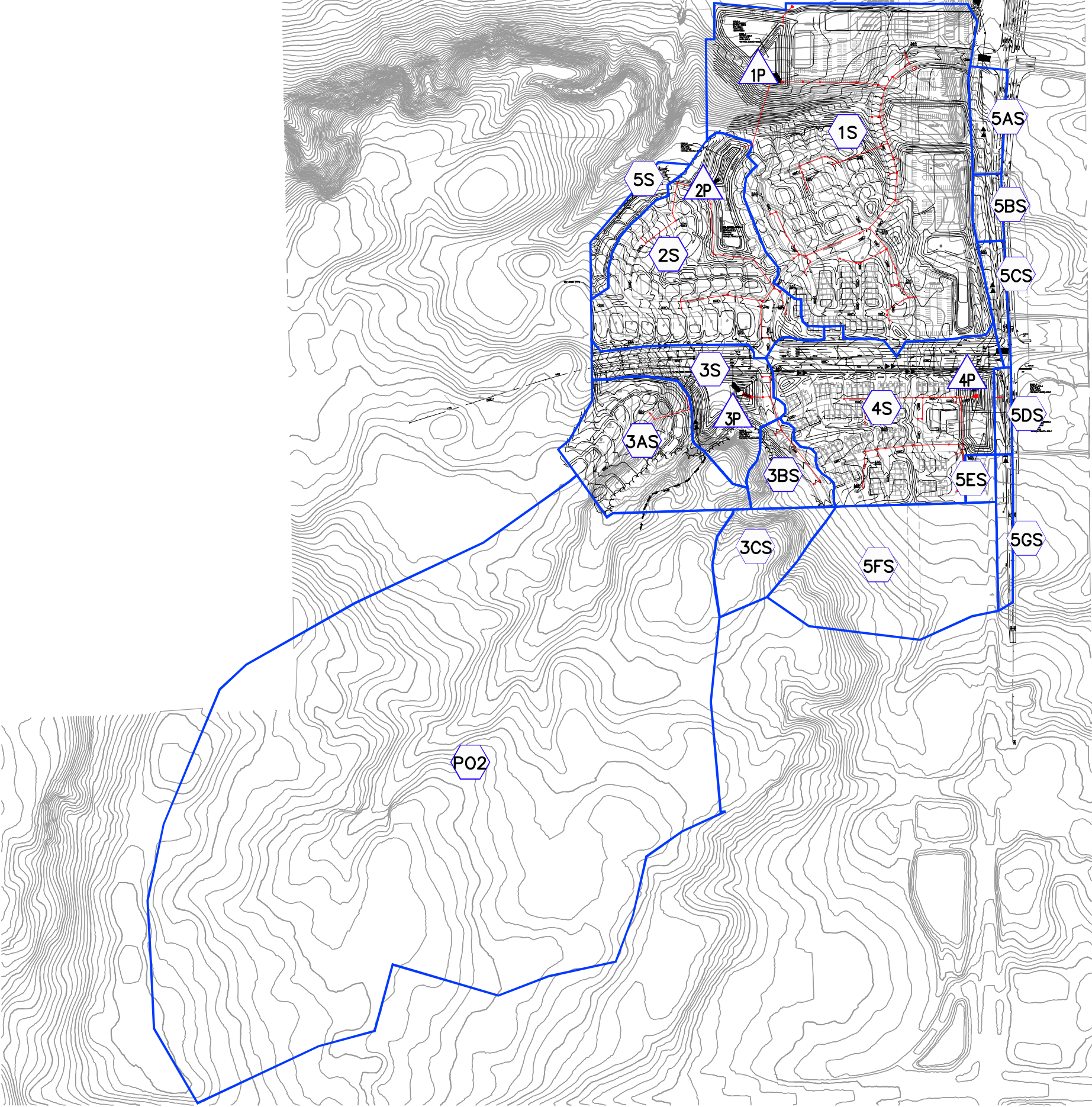
Revisions

Designed:	JB
Checked:	JB
Drawn:	KCP
Record Drawing by/date:	

Prepared for:

DR Horton, Inc. - Minnesota

20860 Kenbridge Court, Suite 100
Lakeville, Minnesota 55044



NOT FOR CONSTRUCTION

0000615DRAN.dwg

Date: 6/1/17 Sheet: 2 OF 2

Windermere

Shakopee, Minnesota

Proposed
Drainage Map

Westwood

Phone (952) 937-5150 7699 Anagram Drive
Fax (952) 937-5822 Eden Prairie, MN 55344
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

I hereby certify that this plan 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.

John Bender, PE

Date: License No. 43358

Revisions

Designed:	JB
Checked:	JB
Drawn:	KJP
Record Drawing by/date:	

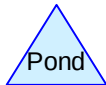
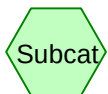
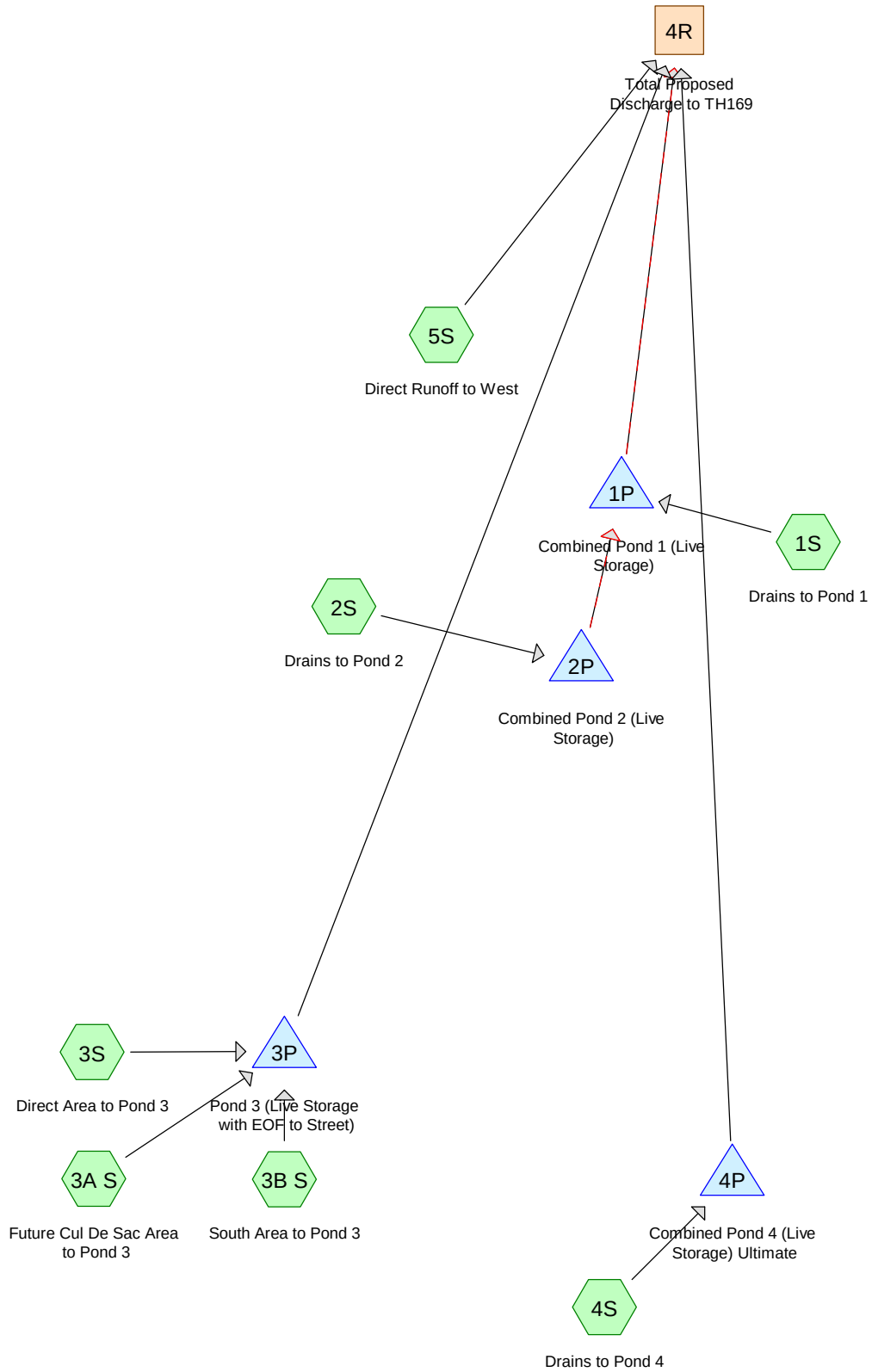
Prepared for:

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20860 Kenbridge Court, Suite 100
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APPENDIX B

HYDROCAD CALCULATIONS



Routing Diagram for 0000615.00 Final Ponding - 17-06-26 (Incorp WSB comments)
Prepared by Westwood Professional Services, Inc., Printed 6/29/2017
HydroCAD® 10.00-14 s/n 03363 © 2015 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Drains to Pond 1

Runoff = 253.41 cfs @ 12.17 hrs, Volume= 14.152 af, Depth= 4.95"

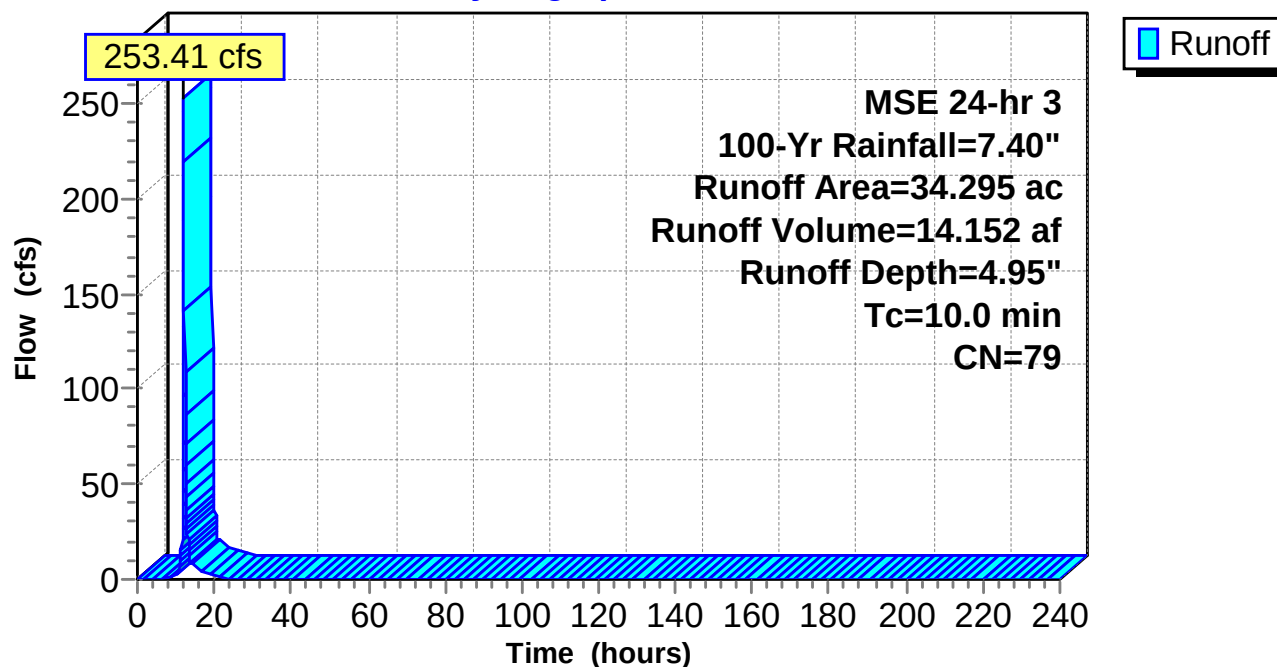
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
 MSE 24-hr 3 100-Yr Rainfall=7.40"

Area (ac)	CN	Description
* 8.188	98	Residential impervious area
* 8.720	98	Commercial impervious area
17.387	61	>75% Grass cover, Good, HSG B
34.295	79	Weighted Average
17.387		50.70% Pervious Area
16.908		49.30% Impervious Area

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

Subcatchment 1S: Drains to Pond 1

Hydrograph



Summary for Pond 1P: Combined Pond 1 (Live Storage)

Inflow Area = 47.081 ac, 45.67% Impervious, Inflow Depth = 4.50" for 100-Yr event
 Inflow = 254.85 cfs @ 12.17 hrs, Volume= 17.649 af
 Outflow = 18.24 cfs @ 13.47 hrs, Volume= 17.649 af, Atten= 93%, Lag= 77.8 min
 Discarded = 0.48 cfs @ 9.65 hrs, Volume= 4.379 af
 Primary = 17.76 cfs @ 13.47 hrs, Volume= 13.269 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
 Peak Elev= 828.53' @ 13.47 hrs Surf.Area= 1.835 ac Storage= 9.765 af

Plug-Flow detention time= 1,193.8 min calculated for 17.649 af (100% of inflow)
 Center-of-Mass det. time= 1,193.5 min (2,081.7 - 888.2)

Volume	Invert	Avail.Storage	Storage Description
#1	822.00'	12.574 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
822.00	1.173	0.000	0.000
824.00	1.366	2.539	2.539
826.00	1.561	2.927	5.465
828.00	1.777	3.337	8.802
830.00	1.995	3.772	12.574

Device	Routing	Invert	Outlet Devices
#1	Primary	823.70'	36.0" Round Culvert L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 823.70' / 821.00' S= 0.0270 ' /' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean, Flow Area= 7.07 sf
#2	Discarded	822.00'	0.48 cfs Exfiltration at all elevations
#3	Secondary	829.00'	20.0' long x 5.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#4	Device 1	823.70'	8.0" Vert. Orifice/Grate C= 0.600
#5	Device 1	827.60'	5.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

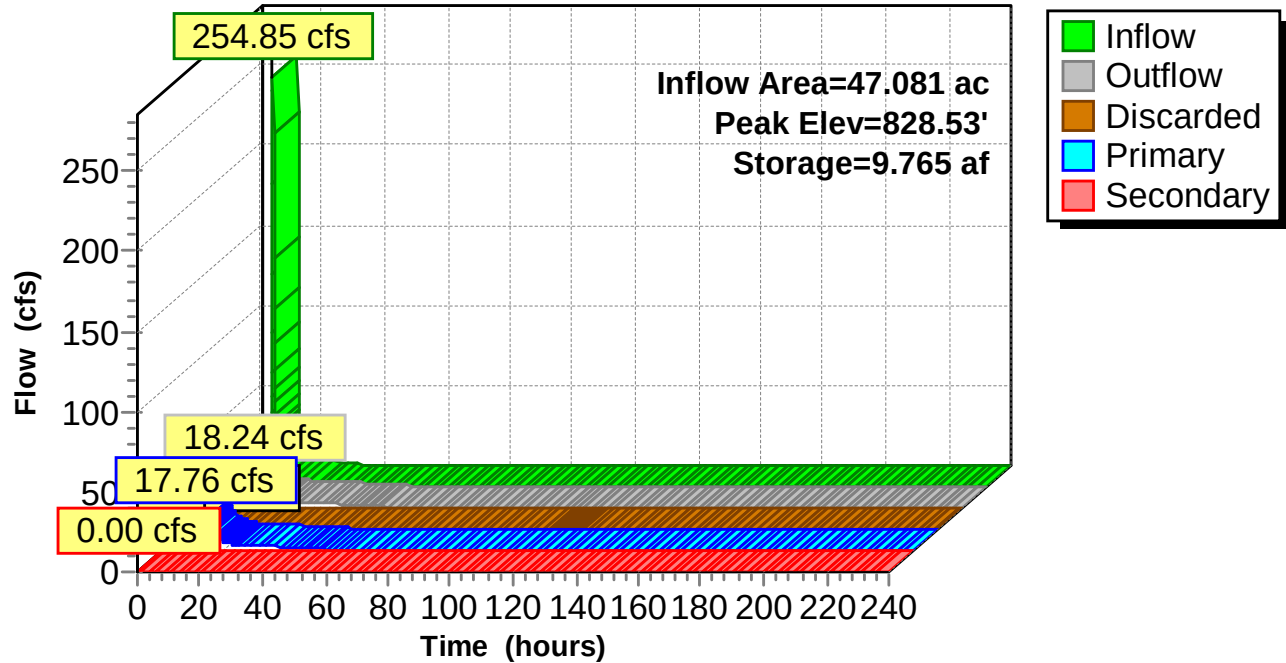
Discarded OutFlow Max=0.48 cfs @ 9.65 hrs HW=822.08' (Free Discharge)
 ↑ **2=Exfiltration** (Exfiltration Controls 0.48 cfs)

Primary OutFlow Max=17.74 cfs @ 13.47 hrs HW=828.53' (Free Discharge)
 ↑ **1=Culvert** (Passes 17.74 cfs of 62.13 cfs potential flow)
 ↑ **4=Orifice/Grate** (Orifice Controls 3.57 cfs @ 10.21 fps)
 ↑ **5=Sharp-Crested Rectangular Weir** (Weir Controls 14.18 cfs @ 3.16 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=822.00' (Free Discharge)
 ↑ **3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Combined Pond 1 (Live Storage)

Hydrograph



APPENDIX C

VOLUME CONTROL CALCULATIONS

Windermere
0000615.00
6/1/2017

Volume Control Calculations - Required Volume

Drainage Area 1S

Commercial Impervious Area	379,828 sf
Residential Impervious Area	356,691
	16.91 ac

Drainage Area 2S

Impervious Area	200,146 sf
	4.59 ac

Drainage Area 3S

Impervious Area	198,267 sf
	4.55 ac

Drainage Area 4S

Impervious Area	305,927 sf
	7.02 ac

Drainage Area 5S

Impervious Area	13,121 sf
	0.30 ac

Total Impervious Area	1,453,980 sf
	33.38 ac

Volume Requirement	1.1 inch over impervious area
--------------------	-------------------------------

Volume Control Required	133,282 cf
	3.06 af

Windermere
0000615.00
6/1/2017

Volume Control Calculations - Volume Provided

Infiltration Basin 1i

Soil Infiltration Rate (based MN SW Manual)	0.80 in/hr
Maximum Drawdown Time	48 hr
Proposed Infiltration Area	25,950 sf
Infiltration Bench Bottom Elevation	822.0 msl
Exfiltration Rate of Bench (area * inf. rate)	0.481 cfs
Volume Infiltrated in Drawdown Time	83,040 cf
Area of Total Basin at Bench Level (Including NURP Cell)	49,373 sf
Height of Outlet Above Bench (inf. vol. / total basin area)	1.70 ft
Basin Outlet Elevation	823.70 msl
Infiltration Volume Provided	83,040 cf

Infiltration Basin 2i

Soil Infiltration Rate (based MN SW Manual)	0.50 in/hr
Maximum Drawdown Time	48 hr
Proposed Infiltration Area	13,450 sf
Infiltration Bench Bottom Elevation	878.0 msl
Exfiltration Rate of Bench (area * inf. rate)	0.156 cfs
Volume Infiltrated in Drawdown Time	26,900 cf
Area of Total Basin at Bench Level (Including NURP Cell)	25,658 sf
Height of Outlet Above Bench (inf. vol. / total basin area)	1.10 ft
Basin Outlet Elevation	879.10 msl
Infiltration Volume Provided	26,900 cf

Volume Control Calculations - Volume Provided (continued)

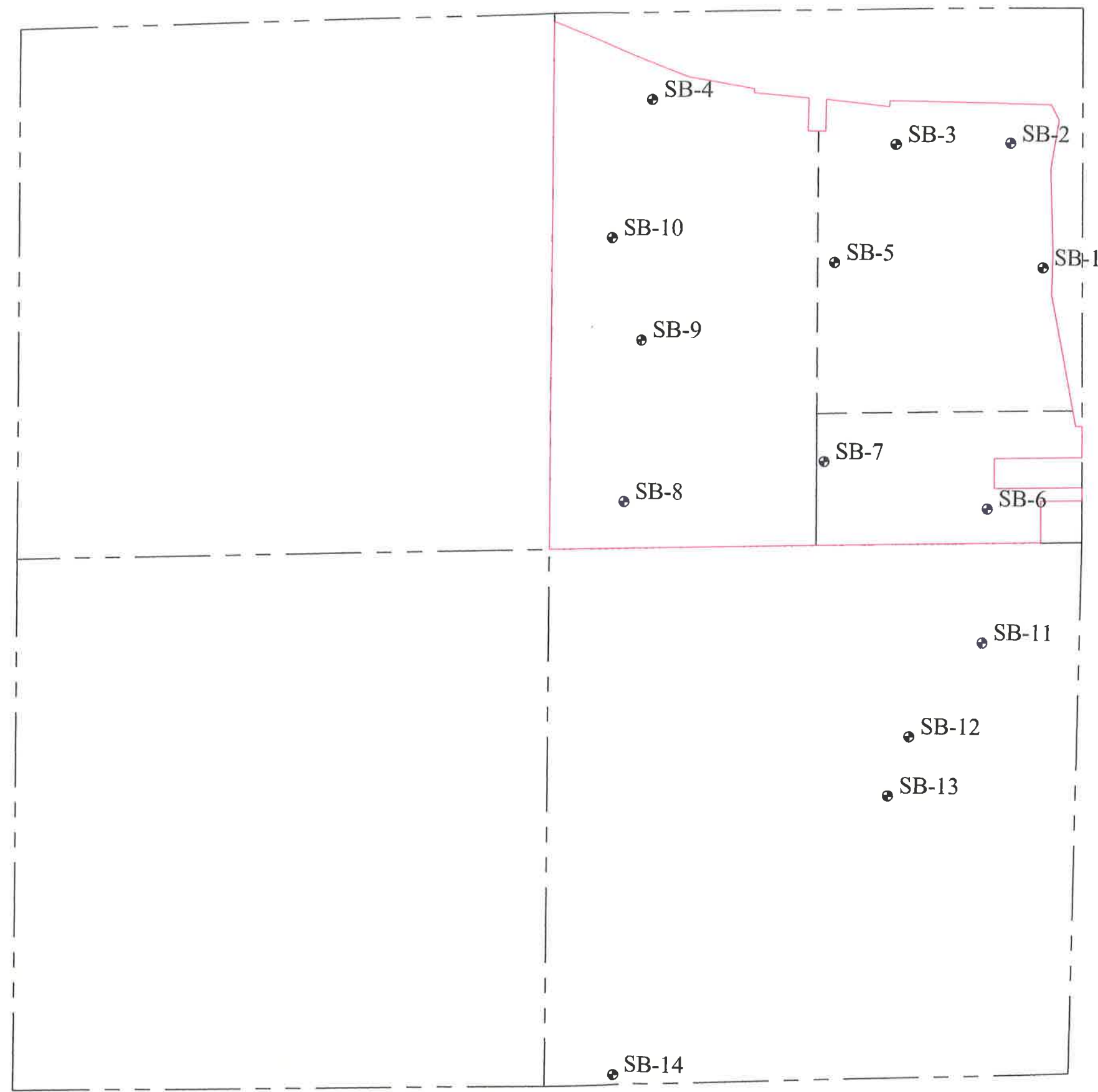
Infiltration Basin 4i

Soil Infiltration Rate (based MN SW Manual)	0.80 in/hr
Maximum Drawdown Time	48 hr
Proposed Infiltration Area	9,350 sf
Infiltration Bench Bottom Elevation	874.0 msl
Exfiltration Rate of Bench (area * inf. rate)	0.173 cfs
Volume Infiltrated in Drawdown Time	26,612 cf
Area of Total Basin at Bench Level (Including NURP Cell)	22,177 sf
Height of Outlet Above Bench (inf. vol. / total basin area)	1.20 ft
Basin Outlet Elevation	875.20 msl
Infiltration Volume Provided	26,612 cf

Total Volume Control Provided	136,552 cf 3.13 af
-------------------------------	-----------------------

APPENDIX D

SOIL BORINGS



AMERICAN
ENGINEERING
TESTING, INC.
550 Cleveland Avenue N.
St. Paul, MN 55114
Phone No. (651) 659-9001
Fax No. (651) 647-2744

CONSULTANTS

- MATERIALS
- GEOTECHNICAL
- ENVIRONMENTAL



AET JOB
NUMBER:
03-02040

Adapted BY: BJS

CHECKED BY:

SCALE: 1" = 600'

BORING LOCATION MAP
THEIS PARCEL



• Boring location



AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **03-02040**

LOG OF BORING NO. **6 (p. 1 of 1)**

PROJECT: **Norbert & Larry Theis Property; Shakopee, MN**

DEPTH IN FEET	SURFACE ELEVATION: 894.7 MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-200
1	FILL, mostly clayey sand, trace roots, black to dark brown	FILL	4	M	SS	10					
2	FILL, a mixture of silty sand and clayey sand, a little gravel, brown and dark brown										
3	SAND, a little gravel, medium to fine grained, brown, moist, medium dense (SP)		12	M	SS	12					
4											
5											
6											
7	SAND WITH GRAVEL, medium to coarse grained, brown, moist, medium dense to dense (SP)	COARSE ALLUVIUM	18	M	SS	10					
8											
9											
10											
11											
12											
13			24	M	SS	10					
14											
15			33	M	SS	12					
16	END OF BORING										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-14½'	3.25" HSA	5/11/04	9:45	16'	10.5'	13.3'		None	
BORING COMPLETED: 5/11/04									
CC: DS CA: JB Rig: 33C									

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nominal diameter in inches
CC:	Crew Chief (initials)
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In split-spoon (see notes) and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
REV:	Revert drilling fluid
SS:	Standard split-spoon sampler (steel; 1 1/4" is inside diameter; 2" outside diameter); unless indicated otherwise
SU:	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q _p :	Pocket Penetrometer strength, tsf (<u>approximate</u>)
q _c :	Static cone bearing pressure, tsf
q _u :	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designator in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remoulded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES

(Calibrated Hammer Weight)

The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N₆₀ values) and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM:D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").

UNIFIED SOIL CLASSIFICATION SYSTEM ASTM Designations: D 2487, D2488

AMERICAN
ENGINEERING
TESTING, INC.



Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	Group Name ^B
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well graded gravel ^F
			$Cu < 4$ and/or $1 > Cc > 3$ ^E	GP	Poorly graded gravel ^F
		Gravels with Fines more than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F,GH}
			Fines classify as CL or CH	GC	Clayey gravel ^{F,GH}
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^F
			$Cu < 6$ and $1 > Cc > 3$ ^E	SP	Poorly-graded sand ^F
		Sands with Fines more than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{GHI}
			Fines classify as CL or CH	SC	Clayey sand ^{GHI}
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silt and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line ^J	CL	Lean clay ^{KLM}
			PI < 4 or plots below "A" line ^J	ML	Silt ^{KLM}
		organic	Liquid limit—even dried < 0.75	OL	Organic clay ^{KLMN}
			Liquid limit – not dried		Organic silt ^{KLMO}
	Silt and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay ^{KLM}
			PI plots below "A" line	MH	Elastic silt ^{KLM}
		organic	Liquid limit—even dried < 0.75	OH	Organic clay ^{KCLMP}
			Liquid limit – not dried		Organic silt ^{KLMQ}
Highly organic soil		Primarily organic matter, dark in color, and organic in odor	PT	Peat ^R	

Notes

^ABased on the material passing the 3-in (75-mm) sieve.

^BIf field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^CGravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

^DSands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

^E $Cu = D_{60}/D_{10}$, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

^FIf soil contains $\geq 15\%$ sand, add "with sand" to group name.

^GIf fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^HIf fines are organic, add "with organic fines" to group name.

^IIf soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^JIf Atterberg limits plot is hatched area, soils is a CL-ML silty clay.

^KIf soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.

^LIf soil contains $\geq 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.

^MIf soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

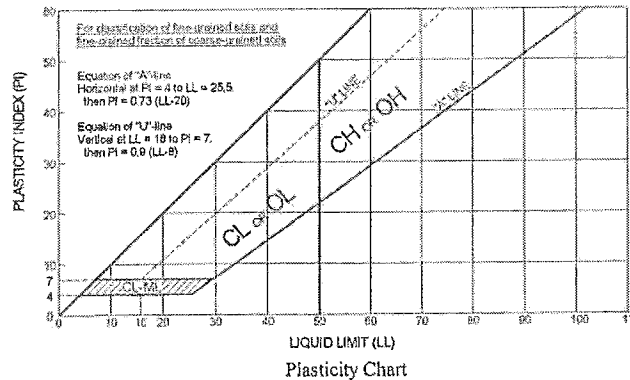
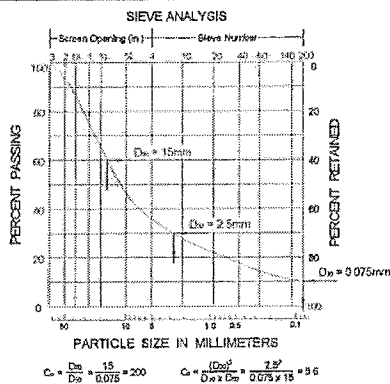
^NPI ≥ 4 and plots on or above "A" line.

^OPI < 4 or plots below "A" line.

^PPI plots on or above "A" line.

^QPI plots below "A" line.

^RFiber Content description shown below.



ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size		Gravel Percentages		Consistency of Plastic Soils		Relative Density of Non-Plastic Soils	
Term	Particle Size	Term	Percent	Term	N-Value, BPF	Term	N-Value, BPF
Boulders	Over 12"	A Little Gravel	3% - 14%	Very Soft	less than 2	Very Loose	0 - 4
Cobbles	3" to 12"	With Gravel	15% - 29%	Soft	2 - 4	Loose	5 - 10
Gravel	#4 sieve to 3"	Gravelly	30% - 50%	Firm	5 - 8	Medium Dense	11 - 30
Sand	#200 to #4 sieve			Stiff	9 - 15	Dense	31 - 50
Fines (silt & clay)	Pass #200 sieve			Very Stiff	16 - 30	Very Dense	Greater than 50
				Hard	Greater than 30		
Moisture/Frost Condition		Layering Notes		Fiber Content of Peat		Organic/Roots Description (if no lab tests)	
(MC Column)		Laminations: Layers less than 1/2" thick of differing material or color.		Fiber Content (Visual Estimate)		Soils are described as <i>organic</i> , if soil is not peat and is judged to have sufficient organic fines content to influence the soil properties. <i>Slightly organic</i> used for borderline cases.	
D (Dry):	Absence of moisture, dusty, dry to touch.			Term			
M (Moist):	Damp, although free water not visible. Soil may still have a high water content (over "optimum").			Fibric Peat:	Greater than 67%	With roots: Judged to have sufficient quantity of roots to influence the soil properties.	
W (Wet/ Waterbearing):	Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.	Lenses: Pockets or layers greater than 1/2" thick of differing material or color.		Hemic Peat:	33 - 67%	Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.	
F (Frozen):	Soil frozen			Sapric Peat:	Less than 33%		