Van Cleef

ENGINEERING ASSOCIATES, LLC

Storm Drainage Report
Prepared For
Block 516.01, Lot 1.01
Franklin Township
Somerset County, New Jersey

October 16, 2019

Prepared For
Pillar of Fire
10 Chapel Drive
Zarephath, NJ 08890

Prepared By:
Van Cleef Engineering Associates, LLC
32 Brower Lane
PO Box 5877
Hillsborough, New Jersey 08844

Michael K. Ford, NJ PE No. 34722

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Title

1.0   Introduction

This report outlines the results of a hydrologic and hydraulic storm water runoff analysis conducted by Van Cleef Engineering Associates (VCEA) with regard to the proposed construction on Lot 1.01 within Block 516.01 as designated by the Franklin Township Tax Maps. The total area of the lot is 144.8045 acres. The area of disturbance corresponding to this project is 4.25 acres.

This report has been prepared to summarize stormwater analysis design objectives, methodologies and calculations for the conveyance of stormwater runoff from the project area under pre and post-development conditions.

2.0   Site Description

2.1   Existing Conditions

The lot currently contains 6 athletic fields, a cemetery and 18 buildings of various sizes including a school along with appurtenant sidewalks, driveways and parking lots. The total existing impervious coverage is approximately 11.03 acres. The open space consists of grass cover in good condition as well as landscaping around the buildings. The site features a collection of state open waters, wetlands and a detention basin that discharges to the north. Currently, the area to be developed features a swale that collects runoff via overland flow and conveys it to the aforementioned basin. This area is treated as one drainage area 3.05 acres in size with a common point of analysis located at the end of the swale. The site consists of soils belonging to Hydrologic Soil Group A.

2.2   Proposed Conditions

The proposed development of the site involves the expansion of an existing parking lot which will result in 1.58 acres of additional pavement. The additional pavement will consist of 2 sections of porous pavement and one section of standard asphalt pavement.

3.0 Methodology

The assessment of stormwater runoff has been based upon the Soil Conservation Service Methodology as described in Technical Release No. 55 (TR55), "Urban Hydrology for Small Watershed." Theoretical storms are modeled with the 24-hour SCS Unit Dimensionless Hydrograph, utilizing a Type III rainfall distribution and recurrence intervals of 2, 10 and 100 years. Hydrographs Program Version 7.0 (Hydraflow 2012). The program is tailored to model the SCS Method for hydrograph generations and to perform interactive solutions of continuity equation (outflow = inflow +/- storage) with the intermediate values of the routing curve obtained through linear interpretation.

For Somerset County, New Jersey these 24-hour rainfall amounts are as follows:

2-years	=	3.3 inches
10-years	=	5.0 inches
100-years	=	8.2 inches

The Soil Conservation Service Soil Survey (SCS) for Somerset County was utilized in order to classify the soils within the watershed. Soils within the project area belong to Hydrologic Soil Group A.

The Rational Method was used for the pipe capacity analysis. Rainfall intensities have been based upon the Somerset County rainfall intensity/duration curve for all design storms.

4.0 Stormwater Management Objectives

The primary objective of the Stormwater Management Plan is to limit the post-development rate of runoff for the 2, 10 and 100 year frequency, 24-hour duration storms. This project will be developed in accordance with the Residential Site Improvements Standards and NJAC 7:8 with regards to peak stormwater runoff rate reductions and water quality requirements.

It is the intent of this report to demonstrate through hydrologic and hydraulic analysis that for stormwater leaving the site, post-construction runoff hydrographs for the 2, 10 and 100 year storm events do not exceed, at any point in time, the pre-construction runoff hydrographs for the same storm events.

5.0   Stormwater Runoff Control

The proposed impervious area contained within the drainage area shown in Appendix F consists entirely of the proposed pavement area. The runoff generated by the additional pavement that will result from this project will be infiltrated by one of the two porous pavement sections that will be installed. Each section will feature a stone bed whose thickness is dependent on the depth of ground water indicated by the soil tests performed within the area of the section. These stone beds were sized to infiltrate the volume of runoff generated by the 100-year storm event. Thus the peak flow rate at the Point of Analysis under proposed conditions will be lower than the peak flow rate corresponding to the existing conditions for every storm event.

Point of Analysis		
Storm Frequency	**Existing Condition Peak Flow (CFS)**	**Proposed Condition Peak Flow (CFS)**
2	0.33	0.00
10	0.50	0.04
100	2.37	0.97

6.0   Water Quality

The total amount of additional impervious coverage for the proposed site is approximately 1.58 acres. This additional surface area will be treated with porous pavement which provides 80% TSS removal per the NJBMP Manual. Refer to Appendix D for more information.

7.0   Groundwater Recharge

The groundwater recharge amount was calculated using the NJDEP GSR-32 Spreadsheet. (See Appendix for Spreadsheet Calculations). The BMP Effective Depth was calculated by averaging the maximum and minimum depth of porous pavement and factoring in the 33% void ratio. The results indicate that the porous pavement will provide groundwater recharge by infiltrating more than 100 percent of the Annual Recharge Deficit. The total annual recharge of the site under pre-developed conditions is 156,401 cf. The annual recharge under post-developed conditions is 78,467 cf resulting in a deficit of 77,934 cf. The annual recharge volume provided by the porous pavement is 204,171 cf and thus the groundwater recharge requirement is fulfilled. The stone bed will drain within 72 hours (see Appendix D). A permeability rate of 7.5 in/hr has been used in the calculations as that is fifty percent of the slowest rate observed.

8.0   Conclusion

The proposed development will result in lower peak flow rates than existing conditions. The site closely mirrors existing condition discharge patterns. Accordingly, the new development will not negatively impact runoff on-site or downstream. All engineering calculations and their associated drainage area maps are incorporated in the appendix for further review.

9.0   References

1. Urban Hydrology for Small Watersheds, TR-55, USDA Soil Conservation Service, 1986.
2. NJDEP Stormwater Management Rules, NJAC 7:8, June 20, 2016.
3. NJDEP Stormwater Best Management Practices Manual, February 2016.
4. Standards for Soil Erosion and Sediment Control in New Jersey, New Jersey State Soil Conservation Committee, January 2014.
5. Web Soil Survey, United States Department of Agriculture, Natural Resource Conservation Service, Version 8, 2008.
6. Franklin Township Municipal Code.
7. Bentley, StormCAD®, Version 8.11.02.75, 2011.
   Bently, Pond Pack version 8i, 2012.

Appendix A
Soil Map, CN Values and Time of Concentration

Soil Map—Somerset County, New Jersey
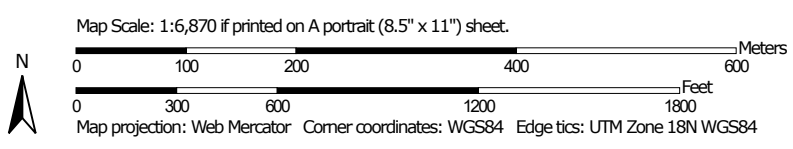
Worksheet 2: Runoff Curve Number

Project	9911FS.01		By	KH	Date	9/18/2019
Location	Township of Franklin		Checked		Date	
Select One:	Undeveloped					
Area Name	EX. PERV DA					

1. Runoff Curve Number

Names	Cover Description	CN			Area	Product
Soil Name and Hydrologic Group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/ connected area ratio)	Tab 2-2	Fig 2-3	Fig 2-4	acres miles %	CN x area
A	Open Space-Good Condition	39			2.93	114.27
				Totals	2.93	114.27

CN (weighted) = total product/ total area= $\dfrac{114.27}{2.93}$

Use CN = 39.00

Worksheet 2: Runoff Curve Number

Project	9911FS.01		By	KH	Date	9/18/2019
Location	Township of Franklin		Checked		Date	
Select One:	Undeveloped					
Area Name	EX. IMP DA					

1. Runoff Curve Number

Names	Cover Description	CN			Area	Product
Soil Name and Hydrologic Group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/ connected area ratio)	Tab 2-2	Fig 2-3	Fig 2-4	acres miles %	CN x area
A	Impervious Areas	98			0.12	11.76
				Totals	0.12	11.76

CN (weighted) = total product/ total area= $\dfrac{11.76}{0.12}$ Use CN = 98.00

Worksheet 3: Time of Concentration (Tc) or Travel Time (Tt)

Project	9911FS.01	By	KH	Date	9/18/2019
Location	Township of Franklin	Checked		Date	

Select One: Undeveloped
Select One: Tc
Area Name EX. DA

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a Map, schematic, or description of flow segments

Sheet Flow (Applicable to Tc only)		Segment ID	A-B	
1 Surface Description (table 3-1)			Grass	
2 Mannings Roughness Coeff.,n (table 3-1)			0.15	
3 Flow Length, L (total L < 300 ft)	ft		100	
4 Two-yr 24-hr rainfall, P_2	in		3.3	
5 land slope, s	ft/ft		0.01	
6 $T_t=(0.007*(nL)^{0.8}/((P_2^{0.5})*(s^{0.4}))$ Compute T_t	hr		0.21	0.21

Shallow Concentrated Flow		Segment ID	B-POA	
7 Surface Description (paved or unpaved)			Unpaved	
8 Flow Length, L	ft		668	
9 Watercourse Slope, s	ft/ft		0.011	
10 Average velocity, V (figure 3-1)	ft/s		1.7	
11 $T_t = L/(3600*V)$ Compute T_t	hr		0.11	0.11

Channel Flow		Segment ID		
12 Cross sectional flow area, a	ft^2			
13 Wetted Perimeter, Pw	ft			
14 Hydraulic Radius, r=a/Pw Compute r	ft			
15 Channel Slope, s	ft/ft			
16 Mannings roughness Coeff., n				
17 $V = 1.49(r^{2/3})*(s^{1/2})/n$ Compute V	ft/s			
18 Flow Length, L	ft			
19 $T_t = L/(3600*V)$ Compute T_t	hr			0.00
20 Water shed or Subarea Tc or Tt (add Tt in steps 6, 11,19)	hr			0.32
	min			19.28

Worksheet 2: Runoff Curve Number

Project	9911FS.01		By	KH	Date	9/18/2019
Location	Township of Franklin		Checked		Date	
Select One:	Developed					
Area Name	PR. PERV DA					

1. Runoff Curve Number

Names	Cover Description	CN			Area	Product
Soil Name and Hydrologic Group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/ connected area ratio)	Tab 2-2	Fig 2-3	Fig 2-4	acres miles %	CN x area
A	Open Space-Good Condition	39			1.47	57.33
				Totals	1.47	57.33

CN (weighted) = total product/ total area= $\dfrac{57.33}{1.47}$ Use CN =   39.00

Worksheet 2: Runoff Curve Number

Project	9911FS.01		By	KH	Date	9/18/2019
Location	Township of Franklin		Checked		Date	
Select One:	Developed					
Area Name	PR. IMP DA					

1. Runoff Curve Number

Names	Cover Description	CN			Area	Product
Soil Name and Hydrologic Group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/ connected area ratio)	Tab 2-2	Fig 2-3	Fig 2-4	acres miles %	CN x area
A	Impervious Areas (Infiltrated)	98			1.58	154.84
			Totals		1.58	154.84

CN (weighted) = total product/ total area= $\dfrac{154.84}{1.58}$ Use CN = **98.00**

Project	9911FS.01		By	KH	Date	9/18/2019
Location	Township of Franklin		Checked		Date	
Select One:	Developed					
Select One:	Tc					
Area Name	PR. DA					

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a Map, schematic, or description of flow segments

Sheet Flow (Applicable to Tc only)		Segment ID	A-B		
1 Surface Description (table 3-1)			Grass		
2 Mannings Roughness Coeff.,n (table 3-1)			0.15		
3 Flow Length, L (total L < 300 ft)	ft		100		
4 Two-yr 24-hr rainfall, P_2	in		3.3		
5 land slope, s	ft/ft		0.0085		
6 $T_t=(0.007*(nL)^{0.8}/((P_2^{0.5})*(s^{0.4}))$ Compute T_t	hr		0.23		0.23

Shallow Concentrated Flow		Segment ID	B-POA		
7 Surface Description (paved or unpaved)			Unpaved		
8 Flow Length, L	ft		846		
9 Watercourse Slope, s	ft/ft		0.012		
10 Average velocity, V (figure 3-1)	ft/s		1.8		
11 $T_t = L/(3600*V)$ Compute T_t	hr		0.13		0.13

Channel Flow		Segment ID			
12 Cross sectional flow area, a	ft^2				
13 Wetted Perimeter, Pw	ft				
14 Hydraulic Radius, r=a/Pw Compute r	ft				
15 Channel Slope, s	ft/ft				
16 Mannings roughness Coeff., n					
17 $V = 1.49(r^{2/3})*(s^{1/2})/n$ Compute V	ft/s				
18 Flow Length, L	ft				
19 $T_t = L/(3600*V)$ Compute T_t	hr				0.00
20 Water shed or Subarea Tc or Tt (add Tt in steps 6, 11,19)	hr				0.36
	min				21.42

Appendix B
Pre-Development Hydrograph

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)
EX PERV DA	2 yr	2	18.000	1,437.000	0.00
EX PERV DA	10 yr	10	2,104.000	774.000	0.09
EX PERV DA	100 yr	100	13,126.000	741.000	2.02
EX IMP DA	2 yr	2	1,335.000	726.000	0.33
EX IMP DA	10 yr	10	2,073.000	726.000	0.50
EX IMP DA	100 yr	100	3,465.000	726.000	0.82
PR PERV DA	2 yr	2	9.000	1,437.000	0.00
PR PERV DA	10 yr	10	1,054.000	777.000	0.04
PR PERV DA	100 yr	100	6,577.000	741.000	0.97
PR IMP DA (TO BE INFILTRATED)	2 yr	2	17,578.000	726.000	4.31
PR IMP DA (TO BE INFILTRATED)	10 yr	10	27,299.000	726.000	6.57
PR IMP DA (TO BE INFILTRATED)	100 yr	100	45,622.000	726.000	10.82

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)
EX POA	2 yr	2	1,353.000	726.000	0.33
EX POA	10 yr	10	4,177.000	726.000	0.50
EX POA	100 yr	100	16,591.000	738.000	2.37
PR POA	2 yr	2	9.000	1,437.000	0.00
PR POA	10 yr	10	1,054.000	777.000	0.04
PR POA	100 yr	100	6,577.000	741.000	0.97
TO BE INFILTRATED	2 yr	2	17,578.000	726.000	4.31
TO BE INFILTRATED	10 yr	10	27,299.000	726.000	6.57
TO BE INFILTRATED	100 yr	100	45,622.000	726.000	10.82

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Storm Event	Synthetic curve 2YR
Return Event	2 years
Duration	1,440.000 min
Depth	3.3 in
Time of Concentration (Composite)	6.000 min
Area (User Defined)	0.120 acres

Computational Time Increment	0.800 min
Time to Peak (Computed)	726.400 min
Flow (Peak, Computed)	0.33 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	726.000 min
Flow (Peak Interpolated Output)	0.33 ft³/s

Drainage Area

SCS CN (Composite)	98.000
Area (User Defined)	0.120 acres
Maximum Retention (Pervious)	0.2 in
Maximum Retention (Pervious, 20 percent)	0.0 in

Cumulative Runoff

Cumulative Runoff Depth (Pervious)	3.1 in
Runoff Volume (Pervious)	1,336.041 ft³

Hydrograph Volume (Area under Hydrograph curve)

Volume	1,335.000 ft³

SCS Unit Hydrograph Parameters

Time of Concentration (Composite)	6.000 min
Computational Time Increment	0.800 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.36 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	4.000 min
Unit receding limb, Tr	16.000 min
Total unit time, Tb	20.000 min

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Storm Event	Synthetic curve 10YR
Return Event	10 years
Duration	1,440.000 min
Depth	5.0 in
Time of Concentration (Composite)	6.000 min
Area (User Defined)	0.120 acres

Computational Time Increment	0.800 min
Time to Peak (Computed)	726.400 min
Flow (Peak, Computed)	0.50 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	726.000 min
Flow (Peak Interpolated Output)	0.50 ft³/s

Drainage Area

SCS CN (Composite)	98.000
Area (User Defined)	0.120 acres
Maximum Retention (Pervious)	0.2 in
Maximum Retention (Pervious, 20 percent)	0.0 in

Cumulative Runoff

Cumulative Runoff Depth (Pervious)	4.8 in
Runoff Volume (Pervious)	2,074.836 ft³

Hydrograph Volume (Area under Hydrograph curve)

Volume	2,073.000 ft³

SCS Unit Hydrograph Parameters

Time of Concentration (Composite)	6.000 min
Computational Time Increment	0.800 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, q_p	1.36 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	4.000 min
Unit receding limb, Tr	16.000 min
Total unit time, Tb	20.000 min

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Storm Event	Synthetic curve 100YR
Return Event	100 years
Duration	1,440.000 min
Depth	8.2 in
Time of Concentration (Composite)	6.000 min
Area (User Defined)	0.120 acres

Computational Time Increment	0.800 min
Time to Peak (Computed)	725.600 min
Flow (Peak, Computed)	0.82 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	726.000 min
Flow (Peak Interpolated Output)	0.82 ft³/s

Drainage Area	
SCS CN (Composite)	98.000
Area (User Defined)	0.120 acres
Maximum Retention (Pervious)	0.2 in
Maximum Retention (Pervious, 20 percent)	0.0 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	8.0 in
Runoff Volume (Pervious)	3,467.412 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	3,465.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	6.000 min
Computational Time Increment	0.800 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.36 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	4.000 min
Unit receding limb, Tr	16.000 min
Total unit time, Tb	20.000 min

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Storm Event	Synthetic curve 2YR
Return Event	2 years
Duration	1,440.000 min
Depth	3.3 in
Time of Concentration (Composite)	19.280 min
Area (User Defined)	2.930 acres

Computational Time Increment	2.571 min
Time to Peak (Computed)	1,439.573 min
Flow (Peak, Computed)	0.00 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	1,437.000 min
Flow (Peak Interpolated Output)	0.00 ft³/s

Drainage Area	
SCS CN (Composite)	39.000
Area (User Defined)	2.930 acres
Maximum Retention (Pervious)	15.6 in
Maximum Retention (Pervious, 20 percent)	3.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.0 in
Runoff Volume (Pervious)	19.842 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	18.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	19.280 min
Computational Time Increment	2.571 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	10.33 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	12.853 min
Unit receding limb, Tr	51.413 min
Total unit time, Tb	64.267 min

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Storm Event	Synthetic curve 10YR
Return Event	10 years
Duration	1,440.000 min
Depth	5.0 in
Time of Concentration (Composite)	19.280 min
Area (User Defined)	2.930 acres

Computational Time Increment	2.571 min
Time to Peak (Computed)	773.771 min
Flow (Peak, Computed)	0.09 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	774.000 min
Flow (Peak Interpolated Output)	0.09 ft³/s

Drainage Area	
SCS CN (Composite)	39.000
Area (User Defined)	2.930 acres
Maximum Retention (Pervious)	15.6 in
Maximum Retention (Pervious, 20 percent)	3.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.2 in
Runoff Volume (Pervious)	2,127.819 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	2,104.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	19.280 min
Computational Time Increment	2.571 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	10.33 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	12.853 min
Unit receding limb, Tr	51.413 min
Total unit time, Tb	64.267 min

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Storm Event	Synthetic curve 100YR
Return Event	100 years
Duration	1,440.000 min
Depth	8.2 in
Time of Concentration (Composite)	19.280 min
Area (User Defined)	2.930 acres

Computational Time Increment	2.571 min
Time to Peak (Computed)	740.352 min
Flow (Peak, Computed)	2.02 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	741.000 min
Flow (Peak Interpolated Output)	2.02 ft³/s

Drainage Area	
SCS CN (Composite)	39.000
Area (User Defined)	2.930 acres
Maximum Retention (Pervious)	15.6 in
Maximum Retention (Pervious, 20 percent)	3.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.2 in
Runoff Volume (Pervious)	13,208.648 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	13,126.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	19.280 min
Computational Time Increment	2.571 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	10.33 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	12.853 min
Unit receding limb, Tr	51.413 min
Total unit time, Tb	64.267 min

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Summary for Hydrograph Addition at 'EX POA'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX IMP DA
<Catchment to Outflow Node>	EX PERV DA

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	EX IMP DA	1,335.056	726.000	0.33
Flow (From)	EX PERV DA	18.214	1,437.000	0.00
Flow (In)	EX POA	1,353.270	726.000	0.33

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Summary for Hydrograph Addition at 'EX POA'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX IMP DA
<Catchment to Outflow Node>	EX PERV DA

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	EX IMP DA	2,073.345	726.000	0.50
Flow (From)	EX PERV DA	2,104.061	774.000	0.09
Flow (In)	EX POA	4,177.406	726.000	0.50

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Summary for Hydrograph Addition at 'EX POA'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX IMP DA
<Catchment to Outflow Node>	EX PERV DA

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	EX IMP DA	3,464.968	726.000	0.82
Flow (From)	EX PERV DA	13,126.263	741.000	2.02
Flow (In)	EX POA	16,591.230	738.000	2.37

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Appendix C
Post-Development Hydrograph

Storm Event	Synthetic curve 2YR
Return Event	2 years
Duration	1,440.000 min
Depth	3.3 in
Time of Concentration (Composite)	6.000 min
Area (User Defined)	1.580 acres

Computational Time Increment	0.800 min
Time to Peak (Computed)	726.400 min
Flow (Peak, Computed)	4.31 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	726.000 min
Flow (Peak Interpolated Output)	4.31 ft³/s

Drainage Area

SCS CN (Composite)	98.000
Area (User Defined)	1.580 acres
Maximum Retention (Pervious)	0.2 in
Maximum Retention (Pervious, 20 percent)	0.0 in

Cumulative Runoff

Cumulative Runoff Depth (Pervious)	3.1 in
Runoff Volume (Pervious)	17,591.206 ft³

Hydrograph Volume (Area under Hydrograph curve)

Volume	17,578.000 ft³

SCS Unit Hydrograph Parameters

Time of Concentration (Composite)	6.000 min
Computational Time Increment	0.800 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.90 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	4.000 min
Unit receding limb, Tr	16.000 min
Total unit time, Tb	20.000 min

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Storm Event	Synthetic curve 10YR
Return Event	10 years
Duration	1,440.000 min
Depth	5.0 in
Time of Concentration (Composite)	6.000 min
Area (User Defined)	1.580 acres

Computational Time Increment	0.800 min
Time to Peak (Computed)	726.400 min
Flow (Peak, Computed)	6.57 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	726.000 min
Flow (Peak Interpolated Output)	6.57 ft³/s

Drainage Area	
SCS CN (Composite)	98.000
Area (User Defined)	1.580 acres
Maximum Retention (Pervious)	0.2 in
Maximum Retention (Pervious, 20 percent)	0.0 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	4.8 in
Runoff Volume (Pervious)	27,318.677 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	27,299.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	6.000 min
Computational Time Increment	0.800 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.90 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	4.000 min
Unit receding limb, Tr	16.000 min
Total unit time, Tb	20.000 min

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Storm Event	Synthetic curve 100YR
Return Event	100 years
Duration	1,440.000 min
Depth	8.2 in
Time of Concentration (Composite)	6.000 min
Area (User Defined)	1.580 acres

Computational Time Increment	0.800 min
Time to Peak (Computed)	725.600 min
Flow (Peak, Computed)	10.82 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	726.000 min
Flow (Peak Interpolated Output)	10.82 ft³/s

Drainage Area

SCS CN (Composite)	98.000
Area (User Defined)	1.580 acres
Maximum Retention (Pervious)	0.2 in
Maximum Retention (Pervious, 20 percent)	0.0 in

Cumulative Runoff

Cumulative Runoff Depth (Pervious)	8.0 in
Runoff Volume (Pervious)	45,654.255 ft³

Hydrograph Volume (Area under Hydrograph curve)

Volume	45,622.000 ft³

SCS Unit Hydrograph Parameters

Time of Concentration (Composite)	6.000 min
Computational Time Increment	0.800 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.90 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	4.000 min
Unit receding limb, Tr	16.000 min
Total unit time, Tb	20.000 min

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Storm Event	Synthetic curve 2YR
Return Event	2 years
Duration	1,440.000 min
Depth	3.3 in
Time of Concentration (Composite)	21.420 min
Area (User Defined)	1.470 acres

Computational Time Increment	2.856 min
Time to Peak (Computed)	1,439.424 min
Flow (Peak, Computed)	0.00 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	1,437.000 min
Flow (Peak Interpolated Output)	0.00 ft³/s

Drainage Area	
SCS CN (Composite)	39.000
Area (User Defined)	1.470 acres
Maximum Retention (Pervious)	15.6 in
Maximum Retention (Pervious, 20 percent)	3.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.0 in
Runoff Volume (Pervious)	9.953 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	9.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	21.420 min
Computational Time Increment	2.856 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	4.67 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	14.280 min
Unit receding limb, Tr	57.120 min
Total unit time, Tb	71.400 min

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Storm Event	Synthetic curve 10YR
Return Event	10 years
Duration	1,440.000 min
Depth	5.0 in
Time of Concentration (Composite)	21.420 min
Area (User Defined)	1.470 acres

Computational Time Increment	2.856 min
Time to Peak (Computed)	776.832 min
Flow (Peak, Computed)	0.04 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	777.000 min
Flow (Peak Interpolated Output)	0.04 ft³/s

Drainage Area	
SCS CN (Composite)	39.000
Area (User Defined)	1.470 acres
Maximum Retention (Pervious)	15.6 in
Maximum Retention (Pervious, 20 percent)	3.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.2 in
Runoff Volume (Pervious)	1,067.541 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,054.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	21.420 min
Computational Time Increment	2.856 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	4.67 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	14.280 min
Unit receding limb, Tr	57.120 min
Total unit time, Tb	71.400 min

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Storm Event	Synthetic curve 100YR
Return Event	100 years
Duration	1,440.000 min
Depth	8.2 in
Time of Concentration (Composite)	21.420 min
Area (User Defined)	1.470 acres

Computational Time Increment	2.856 min
Time to Peak (Computed)	742.560 min
Flow (Peak, Computed)	0.98 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	741.000 min
Flow (Peak Interpolated Output)	0.97 ft³/s

Drainage Area	
SCS CN (Composite)	39.000
Area (User Defined)	1.470 acres
Maximum Retention (Pervious)	15.6 in
Maximum Retention (Pervious, 20 percent)	3.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.2 in
Runoff Volume (Pervious)	6,626.864 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	6,577.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	21.420 min
Computational Time Increment	2.856 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	4.67 ft³/s

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SCS Unit Hydrograph Parameters	
Unit peak time, Tp	14.280 min
Unit receding limb, Tr	57.120 min
Total unit time, Tb	71.400 min

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Summary for Hydrograph Addition at 'PR POA'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	PR PERV DA

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	PR PERV DA	9.047	1,437.000	0.00
Flow (In)	PR POA	9.047	1,437.000	0.00

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Summary for Hydrograph Addition at 'PR POA'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	PR PERV DA

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	PR PERV DA	1,054.302	777.000	0.04
Flow (In)	PR POA	1,054.302	777.000	0.04

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Summary for Hydrograph Addition at 'PR POA'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	PR PERV DA

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	PR PERV DA	6,577.460	741.000	0.97
Flow (In)	PR POA	6,577.460	741.000	0.97

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Summary for Hydrograph Addition at 'TO BE INFILTRATED'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	PR IMP DA (TO BE INFILTRATED)

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	PR IMP DA (TO BE INFILTRATED)	17,578.242	726.000	4.31
Flow (In)	TO BE INFILTRATED	17,578.242	726.000	4.31

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Summary for Hydrograph Addition at 'TO BE INFILTRATED'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	PR IMP DA (TO BE INFILTRATED)

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	PR IMP DA (TO BE INFILTRATED)	27,299.045	726.000	6.57
Flow (In)	TO BE INFILTRATED	27,299.045	726.000	6.57

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Summary for Hydrograph Addition at 'TO BE INFILTRATED'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	PR IMP DA (TO BE INFILTRATED)

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	PR IMP DA (TO BE INFILTRATED)	45,622.074	726.000	10.82
Flow (In)	TO BE INFILTRATED	45,622.074	726.000	10.82

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Appendix D
Water Quality Calculations & Soil Data

Water Quality Calculation Sheet

Design: KH   Date: September 27, 2019

Project No.: 9911FS.01

Pervious Pavement Sizing

Required Volume Per 100-Year Storm – 45,622 cf
Total Porous Pavement Area – 54,202 sf
Void Ratio: 33%

The volume of pervious pavement area within each of the two areas is calculated via the Average End Area Method as follows:

$V = (A1+A2)/2 * L *$ Void Ratio
$V =$ Volume
$A1 =$ End Area 1
$A2 =$ End Area 2
$L =$ Distance Between A1 and A2

<u>Area I:</u>
Surface Area = 5,905 sf
Bottom of Stone Bed Elevation = 51.08
Thickness of Pavement Above Stone Bed = 0.5 ft

$A1 = \dfrac{(52.25-51.08-0.5)+(52.43-51.08-0.5)}{2} * 18 = 13.68 \text{ sf}$

$A2 = \dfrac{(53.70-51.08-0.5)+(53.88-51.08-0.5)}{2} * 18 = 39.78 \text{ sf}$

$L1 = 306 \text{ ft}$

$V1 = (13.68+39.78)/2 * 306 * 0.33 = 2,699 \text{ cf}$

$A3 = \dfrac{(53.34-51.08-0.5)+(53.56-51.08-0.5)}{2} * 22.45 = 41.98 \text{ sf}$

$L2 = 18 \text{ ft}$

$V2 = (39.78+41.98)/2 * 18 * 0.33 = 243 \text{ cf}$

$V = V1+V2 = 2,699 + 243 = 2,942 \text{ cf}$

Area II:

Surface Area = 48,297 sf

Bottom of Stone Bed Elevation = 52.18

Thickness of Pavement Above Stone Bed = 0.5 ft

$$A1 = \frac{(53.56-52.18-0.5)+(55.82-52.18-0.5)}{2} * 63 = 126.63 \text{ sf}$$

$$A2 = \frac{(52.85-52.18-0.5)+(55.35-52.18-0.5)}{2} * 63 = 89.46 \text{ sf}$$

L1 = 260 ft

V1 = (126.63+89.46)/2 * 260 * 0.33 = 9,270 cf

$$A3 = \frac{(57.85-52.18-0.5)+(52.85-52.18-0.5)}{2} * 126 = 336.42 \text{ sf}$$

$$A4 = \frac{(58.66-52.18-0.5)+(53.66-52.18-0.5)}{2} * 126 = 438.48 \text{ sf}$$

L2 = 198 ft

V2 = (438.48+336.42)/2 * 198 * 0.33 = 25,316 cf

$$A5 = \frac{(58.38-52.18-0.5)+(53.70-52.18-0.5)}{2} * 117 = 393.12 \text{ sf}$$

L3 = 52 ft

V3 = (393.12+438.48)/2 * 52 * 0.33 = 7,135 sf

Volume of Pervious Pavement Beneath Emergency Access Drive:

A1 = (58.00-52.18-0.5) * 15 = 79.80 sf

A2 = (60.00-52.18-0.5) * 15 = 109.80 sf

L = 176 ft

V = (79.80+109.80)/2 * 176 * 0.33 = 5,506 cf

Total Volume of Pervious Pavement within Area II:

9,270 + 25,316 + 7,135 + 5,506 = 47,227 cf

Total Volume of Pervious Pavement (Area I + Area II):

2,942 + 47,227 = 50,169 cf

Stone Bed Drain Time

Thickest Stone Layer: 87.84 inches
Design Permeability Rate: 7.5 inches/hour (See Soil Log 3)

87.84 inches/(7.5 inches/hour) = 11.7 hours < 72 hours

Minimum Separation Between Stone Bed and SHGW Elevation

Area I: Bottom of Stone Bed Elevation = 51.08
        SHGW Elevation = 49.07 (See Soil Log 5)
        Minimum Separation = 51.08 – 49.07 = 2.01 feet

Area II: Bottom of Stone Bed Elevation = 52.18
        SHGW Elevation = 50.05 (See Soil Log 14)
        Minimum Separation = 52.18 – 50.05 = 2.13 feet

Water Quality Compliance

The porous pavement system is designed in accordance with Chapter 9.7 of the New Jersey Best Management Practices Manual. The stone bed beneath the pavement has been sized to store more than the water quality storm. The seasonal high ground water table has been established more than two feet below the system. An acceptable permeability rate for the system has been observed. The supporting data has been included in this appendix.

Storm Event	Synthetic curve 100YR
Return Event	100 years
Duration	1,440.000 min
Depth	8.2 in
Time of Concentration (Composite)	6.000 min
Area (User Defined)	1.580 acres

Computational Time Increment	0.800 min
Time to Peak (Computed)	725.600 min
Flow (Peak, Computed)	10.82 ft³/s
Output Increment	3.000 min
Time to Flow (Peak Interpolated Output)	726.000 min
Flow (Peak Interpolated Output)	10.82 ft³/s

Drainage Area

SCS CN (Composite)	98.000
Area (User Defined)	1.580 acres
Maximum Retention (Pervious)	0.2 in
Maximum Retention (Pervious, 20 percent)	0.0 in

Cumulative Runoff

Cumulative Runoff Depth (Pervious)	8.0 in
Runoff Volume (Pervious)	45,654.255 ft³

Hydrograph Volume (Area under Hydrograph curve)

Volume	45,622.000 ft³

SCS Unit Hydrograph Parameters

Time of Concentration (Composite)	6.000 min
Computational Time Increment	0.800 min
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.90 ft³/s

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10/31/2019

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Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number ___1___ Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

Depth	Color	Description
0 – 10"	5YR 4/4	Shale Gravel & Sandy Loam
10 – 38"	7.5YR 5/4	Sandy Loam; No Structure, Friable
38 – 72"	5YR 4/4	Sandy Loam; No Structure, Friable
72 – 120"	5YR 4/4	Fractured Shale; 10% Loam

                                No Mottles

                                Water @ 100"

3.   Ground Water Observations:
        _____ Seepage - Indicate Depth: _____
        _____ Pit/Boring Flooded - Depth After __24___ Hours = _____

4.   Soil Limiting Zones:
        __X__ Fractured Rock Substratum - Depth to Top _____ 120" _____
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator _____Kyle J. Paterson_____ Date 2/26/19 _____

Signature of Engineer _____ Date _____
                        Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number   2   Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

  0 – 16"   10YR 4/3   Sandy Loam; Weak Subangular Blocky, Friable

 16 – 26"   7.5YR 5/4   Sandy Loam; No Structure, Friable

 26 – 120"   5YR 4/4   Fractured Shale; 10% Loam

                                No Mottles

                                Water @ 92"

3.   Ground Water Observations:
        _____ Seepage - Indicate Depth: _____
        _____ Pit/Boring Flooded - Depth After   24   Hours = _____

4.   Soil Limiting Zones:
        _X_ Fractured Rock Substratum - Depth to Top _____ 120"
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator ____Kyle J. Paterson_____ Date 2/26/19

Signature of Engineer _____ Date _____
                      Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number   3   Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

  0 – 12"   10YR 4/3   Sandy Loam; Weak Subangular Blocky, Friable

 12 – 20"   7.5YR 5/4   Sandy Loam; No Structure, Friable

 20 – 36"   5YR 4/4   Sandy Loam; No Structure, Friable

 36 – 112"   5YR 4/4   Fractured Shale; 10% Loam

                              No Mottles

                              Seepage @ 80"

                              Machine Refusal @ 112"

3.   Ground Water Observations:
        _X_ _ Seepage - Indicate Depth: _____   80"_____
        _____ Pit/Boring Flooded - Depth After __24___ Hours = _____

4.   Soil Limiting Zones:
        __X_ Fractured Rock Substratum - Depth to Top _____   112"_____
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator ____Kyle J. Paterson_____ Date _2/26/19_____

Signature of Engineer _____ Date _____
                      Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number 4   Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

  0 –   6"   10YR 4/3   Sandy Loam; Weak Subangular Blocky, Friable

  6 – 30"   10YR 4/4   Sandy Loam; No Structure, Friable

30 – 102"   5YR 4/4   Fractured Shale; 10% Loam

                              No Mottles

3.   Ground Water Observations:
        _____ Seepage - Indicate Depth: _____
        _____ Pit/Boring Flooded - Depth After 24   Hours = _____

4.   Soil Limiting Zones:
        __X__ Fractured Rock Substratum - Depth to Top _____ 102" _____
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator ____Kyle J. Paterson_____ Date 2/26/19 _____

Signature of Engineer _____ Date _____
                    Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number 5   Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

 0 – 10"   10YR 4/3   Sandy Loam; Weak Subangular Blocky, Friable
10 – 90"   9YR 4/4   Fractured Shale; 10% Loam

                              No Mottles

                              Water @ 58"

_____ _____

3.   Ground Water Observations:
        _____ Seepage - Indicate Depth: _____
        _____ Pit/Boring Flooded - Depth After 24   Hours = _____

4.   Soil Limiting Zones:
        _X_ Fractured Rock Substratum - Depth to Top _____ 90" _____
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator ___Kyle J. Paterson_____ Date 2/26/19 _____

Signature of Engineer _____ Date _____
                      Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number   6   Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

  0 –   6"   10YR 3/3   Sandy Loam; Weak Subangular Blocky, Friable
  6 – 10"   5YR 4/4   Shaly Clay Loam, Fill; No Structure, Friable
 10 – 55"   10YR 5/4   Sandy Loam; No Structure, Friable
 55 – 120"   5YR 4/4   Fractured Shale; 10% Loam

                             No Mottles

                             Seepage @ 80"

                             Water @ 108"

3.   Ground Water Observations:
          X   Seepage - Indicate Depth: 80"
        _____ Pit/Boring Flooded - Depth After   24   Hours = _____

4.   Soil Limiting Zones:
          X   Fractured Rock Substratum - Depth to Top   120"
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator   Kyle J. Paterson   Date   2/26/19

Signature of Engineer _____ Date _____
                        Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number   13   Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

  0 –   6"   10YR 4/3   Loam Topsoil

  6 – 85"   5YR 4/4   Fractured Shale; 10% Loam

 85 – 114"   5YR 4/4   Fractured Shale; 5% Loam

                              No Mottles

                              Water @ 107"

                              Machine Refusal, Not Enough Water for Pit Bail

3.   Ground Water Observations:
        _____Seepage - Indicate Depth: _____
        _____ Pit/Boring Flooded - Depth After   24   Hours = _____

4.   Soil Limiting Zones:
          X   Fractured Rock Substratum - Depth to Top _____ 114" ____
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator _____Kyle J. Paterson_____ Date _2/26/19_____

Signature of Engineer _____ Date _____
                      Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block:__516.01__   Lot:__1.01____

1.   Log Number ___14___ Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19_____

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present_____

Description:

0 – 15"	7.5YR 4/3	Loam Topsoil
15 – 35"	7.5YR 4/4	Sandy Loam; No Structure, Friable
35 – 117"	5YR 4/4	Fractured Shale; 10% Loam

No Mottles

Water @ 107"

Seepage @ 97"

Machine Refusal @ 117", Not Enough Water for Pit Bail

_____

3.   Ground Water Observations:
        __X__ Seepage - Indicate Depth: _____97"_____
        _____ Pit/Boring Flooded - Depth After __24__ Hours = _____

4.   Soil Limiting Zones:
        __X__ Fractured Rock Substratum - Depth to Top _____117"_____
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator ____Kyle J. Paterson_____ Date _2/26/19_____

Signature of Engineer _____ Date _____
                      Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number 15   Method (Check One): Profile Pit:_____   Boring:_____

       Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   **Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %**
(inches)   **Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -**
Top-Bottom   **Abundance, Size and Contrast, If Present**

Description:

  0 –   10"   10YR 3/4   Sandy Loam Topsoil; Granular, Friable
 10 – 110"   5YR 4/4   Fractured Shale; 10% Loam
110 – 129"   5YR 4/4   Fractured Shale; 10% Loam

                               No Mottles

                               Water @ 105"

3.   Ground Water Observations:
       _____Seepage - Indicate Depth: _____
       _____ Pit/Boring Flooded - Depth After 24   Hours = _____

4.   Soil Limiting Zones:
       _X_ Fractured Rock Substratum - Depth to Top _____129"_____
       _____ Massive Rock Substratum - Depth to Top _____
       _____ Excessively Coarse Horizon - Depth Top to Bottom_____
       _____ Excessively Coarse Substratum - Depth to Top_____
       _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
       _____ Hydraulically Restrictive Substratum - Depth to Top_____
       _____ Perched Zone of Saturation - Depth Top to Bottom_____
       _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator ____Kyle J. Paterson_____ Date 2/26/19_____

Signature of Engineer _____ Date _____
                      Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number 16   Method (Check One): Profile Pit:_____   Boring:_____

         Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

0 – 12"	7.5YR 4/3	Loam Topsoil; Subangular Blocky, Friable
12 – 78"	5YR 4/4	Fractured Shale; 10% Clay Loam
78 – 117"	5YR 4/4	Fractured Shale; 10% Loam
		No Mottles
		Water @ 90"

3.   Ground Water Observations:
         _____Seepage - Indicate Depth: _____
         _____ Pit/Boring Flooded - Depth After 24   Hours = _____

4.   Soil Limiting Zones:
         _X_ Fractured Rock Substratum - Depth to Top _____117"_____
         _____ Massive Rock Substratum - Depth to Top _____
         _____ Excessively Coarse Horizon - Depth Top to Bottom_____
         _____ Excessively Coarse Substratum - Depth to Top_____
         _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
         _____ Hydraulically Restrictive Substratum - Depth to Top_____
         _____ Perched Zone of Saturation - Depth Top to Bottom_____
         _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator ____Kyle J. Paterson_____ Date 2/26/19_____

Signature of Engineer _____ Date _____
                      Michael K. Ford, PE NJ License No. 34722

Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number 17   Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   **Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %**
(inches)   **Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -**
Top-Bottom   **Abundance, Size and Contrast, If Present**

Description:

  0 – 12"   10YR 3/3   Sandy Loam; Granular, Friable
 12 – 53"   10YR 5/4   Sandy Loam; No Structure, Friable
 53 – 114"   5YR 4/4   Fractured Shale; 10% Loam

                            No Mottles

                            Water @ 84"

3.   Ground Water Observations:
        _____Seepage - Indicate Depth: _____
        _____ Pit/Boring Flooded - Depth After 24   Hours = _____

4.   Soil Limiting Zones:
        _X_ Fractured Rock Substratum - Depth to Top _____114"_____
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator ____Kyle J. Paterson_____ Date 2/26/19_____

Signature of Engineer _____ Date _____
                Michael K. Ford, PE NJ License No. 34722

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Form 2b
Soil Log and Interpretation

SOMERSET COUNTY/FRANKLIN TOWNSHIP   Block: 516.01   Lot: 1.01

1.   Log Number   24   Method (Check One): Profile Pit:_____   Boring:_____

        Date Recorded: 2/14/19 & 2/15/19 and 2/25/19 & 2/26/19

2.   Soil Log

Depth   Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume %
(inches)   Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling -
Top-Bottom   Abundance, Size and Contrast, If Present

Description:

    0 – 18"   10YR 3/3   Sandy Loam; Granular, Friable

    18 – 62"   7.5YR 4/3   Sandy Loam; Subangular Blocky Friable

    62 – 94"   5YR 4/4   Fractured Shale; 10% Loam

                               No Mottles

                               Seepage @ 75"

3.   Ground Water Observations:
          X   Seepage - Indicate Depth: _____ 75" _____
        _____ Pit/Boring Flooded - Depth After   24   Hours = _____

4.   Soil Limiting Zones:
          X Fractured Rock Substratum - Depth to Top _____ 94" _____
        _____ Massive Rock Substratum - Depth to Top _____
        _____ Excessively Coarse Horizon - Depth Top to Bottom_____
        _____ Excessively Coarse Substratum - Depth to Top_____
        _____ Hydraulically Restrictive Horizon - Depth Top to Bottom_____
        _____ Hydraulically Restrictive Substratum - Depth to Top_____
        _____ Perched Zone of Saturation - Depth Top to Bottom_____
        _____ Regional Zone of Saturation - Depth to Top_____

5.   Soil Suitability Classification:_____

I hereby certify that the information furnished on Form 2b of this application is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (NJSA 58:10a-1 et seq.) and is subject to penalties as prescribed in NJAC 7:14-8.

Signature of Site Evaluator _____Kyle J. Paterson_____ Date 2/26/19 _____

Signature of Engineer _____ Date _____
                        Michael K. Ford, PE NJ License No. 34722

FORM 3F - PIT-BAIL TEST DATA SHEET
= ======= == ====== ======== ======= ===== ===

Applicant: Al Shjarback   Date Tested: 2-15-19
Block: 516.01   Lot: 1   Prop. Lot: 1.01   FRANKLIN TWP.

==== ======= ======== = ======= == ====== ======== ======= ===== ======== ======== ========

SEE SOIL LOG   SL 1

==== ======= ======== = ======= == ====== ======== ======= ===== ======== ======== ========

PIT BAIL #:   SL 1
Depth to pit bottom: 10.00   ft.   24   static water level: 8.33   ft.
                                                                                                      (Dwater)

Depth to Impermeable Strata: 15.00 ft.; H = Dstratum - Dwater: 6.67   ft.
 (Dstratum)   1.5 x   pit depth assumed

==== ======= ======== = ======= == ====== ======== ======= ===== ======== ======== ========

Calculate the following values and enter into the table below:
       An = water surface area in square feet
       hrise = water level rise in inches
       Aav = average water surface area (An + previous An)/2 in sft.
       h = average height of water level above Dstratum
         (take average of current water level and previous water level,
         convert to feet, and subtract from Dstratum) in ft.
               2
       Ka = hrise/t x Aav/2.27 (H -h) x 60 min/hr (K in inches/hr)

==== ======= ======== = ======= == ====== ======== ======= ===== ======== ======== ========

Tn(min)		Dwater(in)	l, w (ft)		An(sft)	hrise(in)		Aav(sft)	) h(ft)	Ka
t0	0	120.00	0.00	0.00	0.00					
t1	20	115.00	4.67	3.17	14.78	5.00		7.39	5.21	2.82
t2	20	112.00	5.33	3.17	16.89	3.00		15.83	5.54	4.57
t3	20	109.50	6.00	3.17	19.00	2.50		17.94	5.77	5.32
t4	20	108.00	6.08	3.17	19.26	1.50		19.13	5.94	4.13
t5	20	107.00	6.83	3.17	21.64	1.00		20.45	6.04	3.40
t6	20	106.00	7.08	3.17	22.43	1.00		22.03	6.13	4.20

==== ======= ======== = ======= == ====== ======== ======= ===== ======== ======== ========

           Final pit depth (Dstratum)   10.00 ft.
           24-hour groundwater reading   8.33 ft.
       Height of 24 hour-reading above Dstratum   1.67 ft. (H)
        Average height of water level above Dstratum   1.13 ft. (h)
    (take average of d beginning and end of last time interval recorded,
      convert to feet, and subtract from Dstratum)

==== ======= ======== = ======= == ====== ======== ======= ===== ======== ======== ========

Calculate K using above data and final time interval of test:

    K = [hrise / t] x [Aav / 2.27 (H- h)] x 60 min/hr

     = [1.00 /   20   ]x[22.03 / 2.27 (2.78   -   1.27) x 60 min/hr

     =   19.26 in/hr

I hereby certify that the information furnished on this form is true and
accurate. I am aware that falsification of data is a violation of the Water
Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties
as prescribed in N.J.A.C. 7:14-8.

                                         N.J.P.E. #34722

_____ _____ _____ __ _____ __ _____   _____ _____ _____
Engineer's Signature Michael K. Ford   License # and Seal

FORM 3F - PIT-BAIL TEST DATA SHEET
= ====== == ====== ======== ======= === ===

Applicant:	Al Shjarback		Date Tested:	2-15-19	
Block:	516.01 Lot:	1	Prop. Lot: 1.01	Franklin Township	

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

SEE SOIL LOG
     SL 2

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

PIT BAIL #:   SL 2

Depth to pit bottom: 10.00 ft.   24   static water level: 7.67 ft.
                                                              (Dwater)

Depth to Impermeable Strata: 15.00 ft.; H = Dstratum - Dwater: 7.33 ft.
 (Dstratum)   1.5 x   pit depth assumed

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

Calculate the following values and enter into the table below:

        An = water surface area in square feet
        hrise = water level rise in inches
        Aav = average water surface area (An + previous An)/2 in sft.
        h = average height of water level above Dstratum
          (take average of current water level and previous water level,
          convert to feet, and subtract from Dstratum) in ft.

$$Ka = hrise/t \times Aav/2.27 \, (H - h^2) \times 60 \text{ min/hr} \quad (K \text{ in inches/hr})$$

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Tn(min)		Dwater(in)	I, w (ft)		An(sft)	hrise(in)	Aav(sft)	) h(ft)	Ka
t0	0.00	119.00	6.00	3.33	20.00				
t1	5.00	111.00	7.00	3.33	23.33	8.00	21.67	5.42	37.50
t2	5.00	108.00	7.67	3.33	25.56	3.00	24.44	5.88	20.13
t3	5.00	105.00	8.33	3.33	27.78	3.00	26.67	6.13	26.01
t4	5.00	103.00	9.17	3.33	30.56	2.00	29.17	6.33	22.56

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                Final pit depth (Dstratum)   10.00 ft.
                24-hour groundwater reading   7.67 ft.
       Height of 24 hour-reading above Dstratum   2.33 ft. (H)
       Average height of water level above Dstratum   1.33 ft. (h)
   (take average of d beginning and end of last time interval recorded,
     convert to feet, and subtract from Dstratum)

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

Calculate K using above data and final time interval of test:

     K =   [hrise / t] x [Aav / 2.27 (H - h)] x 60 min/hr

    = [2.00 /   5   ]x[29.17 / 2.27 (5.44   -   1.78) x 60 min/hr

    =   84.10 in/hr

I hereby certify that the information furnished on this form is true and
accurate. I am aware that falsification of data is a violation of the Water
Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties
as prescribed in N.J.A.C. 7:14-8.

                                               N.J.P.E. & L.S. #20792

____ _____ _____ _ _____ __ _____ ___   ___ _____ _____
Engineer's Signature   Michael K. Ford   License # and Seal

FORM 3F - PIT-BAIL TEST DATA SHEET
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Applicant:	Al Shjarback			Date Tested:	2-15-19
Block:	516.01	Lot:	1	Prop. Lot: 1.01	Franklin Township

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

SEE SOIL LOG
SL 3

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

PIT BAIL #:	SL 3				
Depth to pit bottom:	9.33 ft.	24	static water level:	6.67 ft.	
				(Dwater)	
Depth to Impermeable Strata:	14.00 ft.; H = Dstratum - Dwater:			7.33 ft.	
(Dstratum)	1.5 x	pit depth assumed			

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

Calculate the following values and enter into the table below:

An = water surface area in square feet

hrise = water level rise in inches

Aav = average water surface area (An + previous An)/2 in sft.

h = average height of water level above Dstratum

(take average of current water level and previous water level,

convert to feet, and subtract from Dstratum) in ft.

$$Ka = hrise/t \times Aav/2.27\ (H - h^2) \times 60\ min/hr\ \ (K\ in\ inches/hr)$$

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

Tn(min)		Dwater(in)	l, w (ft)		An(sft)	hrise(in)	Aav(sft)	) h(ft)	Ka
t0	0.00	112.00	0.00	0.00	0.00				
t1	5.00	106.00	3.00	2.92	8.75	6.00	4.38	4.92	4.69
t2	5.00	103.00	3.33	2.92	9.72	3.00	9.24	5.29	5.68
t3	5.00	101.50	4.00	2.92	11.67	1.50	10.69	5.48	3.57
t4	5.00	100.00	4.33	2.92	12.64	1.50	12.15	5.60	4.31

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

Final pit depth (Dstratum)	9.33	ft.
24-hour groundwater reading	6.67	ft.
Height of 24 hour-reading above Dstratum	2.67	ft. (H)
Average height of water level above Dstratum	0.94	ft. (h)

(take average of d beginning and end of last time interval recorded,

convert to feet, and subtract from Dstratum)

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

Calculate K using above data and final time interval of test:

$$K = [\ hrise/t\ ] \times [\ Aav/2.27\ (H-h)]\ \times 60\ min/hr$$

= [1.50 / 5]x[12.15 / 2.27 (7.11 - 0.88) x 60 min/hr

= 15.46 in/hr

I hereby certify that the information furnished on this form is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties as prescribed in N.J.A.C. 7:14-8.

N.J.P.E. & L.S. #20792

____ _____ _____ _ _____ __ _____ ___   ___ _____ _____

Engineer's Signature   Michael K. Ford   License # and Seal

FORM 3F - PIT-BAIL TEST DATA SHEET

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Applicant: Al Shjarback   Date Tested: 2-14-19
Block: 516.01   Lot: 1   Prop. Lot: 1.01   Franklin Township

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SEE SOIL LOG
    SL 5

==== ====== ======== = ====== == ====== ======== ======= === ======== ======== =======

PIT BAIL #:   SL 5
Depth to pit bottom: 6.67 ft.   24   static water level: 4.83 ft.
                                                                                                  (Dwater)

Depth to Impermeable Strata: 10.00 ft.; H = Dstratum - Dwater: 5.17 ft.
 (Dstratum)   1.5 x   pit depth assumed

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Calculate the following values and enter into the table below:
          An = water surface area in square feet
          hrise = water level rise in inches
          Aav = average water surface area (An + previous An)/2 in sft.
          h = average height of water level above Dstratum
            (take average of current water level and previous water level,
            convert to feet, and subtract from Dstratum) in ft.
                            2
          Ka = hrise/t x Aav/2.27 (H -h) x 60 min/hr (K in inches/hr)

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Tn(min)		Dwater(in)	l, w (ft)		An(sft)	hrise(in)	Aav(sft)	) h(ft)	Ka
t0	0.00	89.00	6.33	3.33	21.11				
t1	3.00	84.00	6.67	3.33	22.22	5.00	21.67	2.79	50.50
t2	3.00	81.00	7.00	3.33	23.33	3.00	22.78	3.13	35.56
t3	3.00	79.50	7.33	3.33	24.44	1.50	23.89	3.31	20.08
t4	3.00	76.50	7.67	3.33	25.56	3.00	25.00	3.50	45.75

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                    Final pit depth (Dstratum)   6.67 ft.
                    24-hour groundwater reading   4.83 ft.
              Height of 24 hour-reading above Dstratum   1.83 ft. (H)
              Average height of water level above Dstratum   0.17 ft. (h)
          (take average of d beginning and end of last time interval recorded,
            convert to feet, and subtract from Dstratum)

==== ====== ======== = ====== == ====== ======== ======= === ======== ======== =======

Calculate K using above data and final time interval of test:

          K = [hrise / t] x [Aav / 2.27 (H - h)] x 60 min/hr

          = [3.00 /   3   ]x[25.00 / 2.27 (3.36   -   0.03) x 60 min/hr

          =   198.24 in/hr

I hereby certify that the information furnished on this form is true and
accurate. I am aware that falsification of data is a violation of the Water
Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties
as prescribed in N.J.A.C. 7:14-8.

                                                         N.J.P.E. & L.S. #20792

____ _____ _____ _ _____ __ _____ ___   ___ _____ _____
Engineer's Signature   Michael K. Ford   License # and Seal

FORM 3E - PIT-BAIL TEST DATA SHEET
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| Applicant: | Al Shjarback | | | Date Tested: | 2-14-19 |
| Block: | 516.01 | Ex. Lot: ## | 1.01 Prop. Lot: | 1.01 | Franklin Township |

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SEE DESCRIPTION OF SOIL LOG
SL 6

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PIT BAIL #: SL 6

| Depth to pit bottom: | 10.17 ft. | 24 | static water level: | 9.00 ft. |
| | | | | (Dwater) |

| Depth to Impermeable Strata: | 15.25 ft.; H = Dstratum - Dwater: | 6.25 ft. |
| (PIT DEPTH x x 1.5) | (Dstratum) | |

==== ======= ======= = ====== == ========== ======= ====== === ======= ======= =======

Calculate the following values and enter into the table below:

An = water surface area in square feet

hrise = water level rise

Aav = average water surface area (An + previous An)/2

h = average height of water level above Dstratum
   (take average of current water level and previous water level,
   convert to feet, and subtract from Dstratum)

2

Ka = hrise/t x Aav/2.27 (H^2 -h^2) x 60 min/hr (K in inches/hr)

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Tn(min)		Dwater(in)	l, w (ft)		An(sft)	hrise(in)	Aav(sft)	) h(ft)	Ka
t0	0.00	122.00	0.00	0.00	0.00				
t1	10.00	117.00	4.58	3.00	13.75	5.00	6.88	5.29	8.21
t2	10.00	115.00	5.42	3.08	16.70	2.00	15.23	5.58	10.20
t3	10.00	114.00	6.00	3.17	19.00	1.00	17.85	5.71	7.28
t4	10.00	113.00	6.33	3.17	20.06	1.00	19.53	5.79	9.35
t5	10.00	112.00	6.42	3.17	20.32	1.00	20.19	5.88	11.74
t6	10.00	111.00	6.50	3.17	20.58	1.00	20.45	5.96	15.18
t7	10.00	110.00	6.58	3.17	20.85	1.00	20.72	6.04	21.38

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Final pit depth	10.17 ft.
24-hour groundwater reading	9.00 ft.
Height of 24 hour-reading above Dstratum	1.17 ft. (H)
Average height of water level above Dstratum	0.96 ft. (h)

(take average of d beginning and end of last time interval recorded,
convert to feet, and subtract from Dstratum)

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Calculate K using above data and final time interval of test:

K = [hrise / t] x [Aav / 2.27 (H^2 - h^2)] x 60 min/hr

= [1.00 / 10.00]x[20.72 / 2.27 (1.36   -   0.92) x 60 min/hr

=   123.68 in/hr

I hereby certify that the information furnished on this form is true and
accurate. I am aware that falsification of data is a violation of the Water
Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties
as prescribed in N.J.A.C. 7:14-8.

N.J.P.E. #34722

____ _____ _____ _ _____ __ _____ ___   ___ _____ _____

Engineer's Signature   Michael K. Ford   License # and Seal

FORM 3F - PIT-BAIL TEST DATA SHEET
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| Applicant: | Al Shjarback | | | Date Tested: | 2-26-19 |
| Block: | 516.01 | Lot: | ## | Prop. Lot: | 1.01 | Franklin Township |

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SEE SOIL LOG
SL 15

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PIT BAIL #: SL 15

Depth to pit bottom: 10.75 ft.   24   static water level: 8.75 ft.
(Dwater)

Depth to Impermeable Strata: 16.13 ft.; H = Dstratum - Dwater: 7.38 ft.
(Dstratum)   1.5 x   pit depth assumed

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Calculate the following values and enter into the table below:

An = water surface area in square feet
hrise = water level rise in inches
Aav = average water surface area (An + previous An)/2 in sft.
h = average height of water level above Dstratum
(take average of current water level and previous water level,
convert to feet, and subtract from Dstratum) in ft.

$Ka = hrise/t \times Aav/2.27 (H^2 - h^2) \times 60$ min/hr (K in inches/hr)

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Tn(min)		Dwater(in)	l, w (ft)		An(sft)	hrise(in)	Aav(sft)	) h(ft)	Ka
t0	0.00	125.00	6.67	3.17	21.11				
t1	5.00	119.00	7.50	3.33	25.00	6.00	23.06	5.96	38.71
t2	5.00	115.00	9.00	3.33	30.00	4.00	27.50	6.38	42.29
t3	5.00	112.00	10.00	3.33	33.33	3.00	31.67	6.67	50.49

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Final pit depth (Dstratum)   10.75 ft.
24-hour groundwater reading   8.75 ft.
Height of 24 hour-reading above Dstratum   2.00 ft. (H)
Average height of water level above Dstratum   1.29 ft. (h)
(take average of d beginning and end of last time interval recorded,
convert to feet, and subtract from Dstratum)

==== ======= ======= = ====== == ====== ======= ======= === ======= ======= =======

Calculate K using above data and final time interval of test:

$K = [hrise/t] \times [Aav/2.27 (H^2 - h^2)] \times 60$ min/hr

= [3.00 /   5   ]x[31.67 / 2.27 (4.00   -   1.67) x 60 min/hr

=   215.39 in/hr

I hereby certify that the information furnished on this form is true and
accurate. I am aware that falsification of data is a violation of the Water
Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties
as prescribed in N.J.A.C. 7:14-8.

N.J.P.E. . #34722

____ _____ _____ _ _____ __ _____ ___   ___ _____ _____
Engineer's Signature Michael K. Ford   License # and Seal

FORM 3F - PIT-BAIL TEST DATA SHEET
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Applicant:	Al Shjarback			Date Tested:		2-25-19
Block:	516.01	Lot:	##	Prop. Lot:	1.01	Franklin Township

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SEE SOIL LOG
    SL 16

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PIT BAIL #:   SL 16

Depth to pit bottom:	9.75 ft.	24	static water level:		7.50 ft.
					(Dwater)
Depth to Impermeable Strata:		14.63 ft.; H = Dstratum - Dwater:			7.13 ft.
(Dstratum)	1.5 x	pit depth assumed			

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Calculate the following values and enter into the table below:

    An = water surface area in square feet
    hrise = water level rise in inches
    Aav = average water surface area (An + previous An)/2 in sft.
    h = average height of water level above Dstratum
        (take average of current water level and previous water level,
        convert to feet, and subtract from Dstratum) in ft.

    Ka = hrise/t x Aav/2.27 (H^2 -h^2) x 60 min/hr (K in inches/hr)

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Tn(min)		Dwater(in)	l, w (ft)		An(sft)	hrise(in)	Aav(sft)	) h(ft)	Ka
t0	0.00	117.00	0.00	0.00	0.00				
t1	5.00	114.00	8.75	2.50	21.88	3.00	10.94	5.00	6.73
t2	16.00	104.00	10.67	2.50	26.67	10.00	24.27	5.54	19.99

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Final pit depth (Dstratum)	9.75	ft.
24-hour groundwater reading	7.50	ft.
Height of 24 hour-reading above Dstratum	2.25	ft. (H)
Average height of water level above Dstratum	5.42	ft. (h)

(take average of d beginning and end of last time interval recorded,
    convert to feet, and subtract from Dstratum)

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Calculate K using above data and final time interval of test:

    K = [hrise / t] x [Aav / 2.27 (H^2 - h^2)] x 60 min/hr

    = [10.00 /   16   ]x[24.27 / 2.27 (56.25   -   5.06) x 60 min/hr

    =   7.83 in/hr

I hereby certify that the information furnished on this form is true and
accurate. I am aware that falsification of data is a violation of the Water
Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties
as prescribed in N.J.A.C. 7:14-8.

N.J.P.E. . #34722

____ _____ _____ _ _____ __ _____ ___   ___ _____ _____
Engineer's Signature Michael K. Ford   License # and Seal
        F:\Jobfile\9911FS.01\ENG\Cor\Apns\Soil Tests\SL16PB3.xlsx

FORM 3F - PIT-BAIL TEST DATA SHEET
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Applicant: Al Shjarback   Date Tested: 2-26-19

Block: 516.01   Lot: 1   Prop. Lot: 1.01   Franklin Township

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SEE SOIL LOG
     SL 17

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PIT BAIL #:   SL 17

Depth to pit bottom: 9.50 ft.   24   static water level: 7.00 ft.
                                                                      (Dwater)

Depth to Impermeable Strata: 14.25 ft.; H = Dstratum - Dwater: 7.25 ft.

 (Dstratum)   1.5 x   pit depth assumed

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Calculate the following values and enter into the table below:

          An = water surface area in square feet

          hrise = water level rise in inches

          Aav = average water surface area (An + previous An)/2 in sft.

          h = average height of water level above Dstratum

            (take average of current water level and previous water level,

            convert to feet, and subtract from Dstratum) in ft.

                          2

          Ka = hrise/t x Aav/2.27 (H -h) x 60 min/hr (K in inches/hr)

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

Tn(min)		Dwater(in)	l, w (ft)		An(sft)	hrise(in)	Aav(sft)	) h(ft)	Ka
t0	0.00	114.00	0.00	0.00	0.00				
t1	3.00	111.00	5.83	2.00	11.67	3.00	5.83	4.88	5.35
t2	9.00	109.00	6.67	3.00	20.00	2.00	15.83	5.08	3.48
t3	30.00	104.75	8.67	3.33	28.89	4.25	24.44	5.34	3.81
t4	60.00	102.00	8.83	3.33	29.44	2.75	29.17	5.64	1.70

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                    Final pit depth (Dstratum)   9.50 ft.

                  24-hour groundwater reading   7.00 ft.

        Height of 24 hour-reading above Dstratum   2.50 ft. (H)

     Average height of water level above Dstratum   0.89 ft. (h)

   (take average of d beginning and end of last time interval recorded,

     convert to feet, and subtract from Dstratum)

==== ======= ======== = ====== == ====== ======== ======= === ======== ======== ========

Calculate K using above data and final time interval of test:

    K = [hrise / t] x [Aav / 2.27 (H - h)] x 60 min/hr

    = [2.75 /   60   ]x[29.17 / 2.27 (6.25   -   0.78) x 60 min/hr

    =   6.46 in/hr

I hereby certify that the information furnished on this form is true and accurate. I am aware that falsification of data is a violation of the Water Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties as prescribed in N.J.A.C. 7:14-8.

                                              N.J.P.E. & L.S. #20792

____ _____ _____ _ _____ __ _____ ___   ___ _____ _____

Engineer's Signature Michael K. Ford   License # and Seal

FORM 3F - PIT-BAIL TEST DATA SHEET
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Applicant: Al Shjarback   Date Tested: 2-26-19

Block: 516.01   Ex. Lot: Prop. Lo 1.01   Franklin Township

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SEE SOIL   LOG   SL 24

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PIT BAIL #: SL 24

Depth to pit bottom: 7.83 ft.   24.00 static water level: 6.25 ft.
                                                                 (Dwater)

Depth to Impermeable Strata: 11.75 ft.; H = Dstratum - Dwater: 5.50 ft.
 (Dstratum   = 1.5 x   pit depth assumed)

== ====== ========== = ===== = ===== ====== ===== = ======= ===== ======

Calculate the following values and enter into the table below:

        An = water surface area in square feet

        hrise = water level rise in inches

        Aav = average water surface area (An + previous An)/2 in sft.

        h = average height of water level above Dstratum

          (take average of current water level and previous water level,

          convert to feet, and subtract from Dstratum) in ft.

        Ka = hrise/t x Aav/2.27 (H^2 -h ^2) x 60 min/hr (K in inches/hr)

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Tn(min)		Dwater(in)	l, w (ft)		An(sft)	hrise(in)	Aav(sqft)	h(ft)	Ka
t0	0.00	94.00	0.00	0.00	0.00				
t1	5.00	87.00	5.25	4.00	21.00	7.00	10.50	4.21	30.98
t2	5.00	84.00	6.33	4.00	25.33	3.00	23.17	4.63	41.47
t3	5.00	82.50	7.33	4.00	29.33	1.50	27.33	4.81	30.57
t4	5.00	81.00	7.75	4.00	31.00	1.50	30.17	4.94	40.74
t5	5.00	80.00	8.17	4.00	32.67	1.00	31.83	5.04	34.83

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                      Final pit depth (Dstratum)   7.83 ft.

                      24-hour groundwater reading   6.25 ft.

        Height of 24 hour-reading above Dstratum   1.58 ft. (H)

       Average height of water level above Dstratum   1.13 ft. (h)

    (take average of d beginning and end of last time interval recorded,

      convert to feet, and subtract from Dstratum)

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Calculate K using above data and final time interval of test:

    K = [hrise / t] x [Aav / 2.27 (H^2 - h^2)] x 60 min/hr

      = [1.00 / 5.00]x 31.83 / 2.27 (2.51   -   1.27) x 60 min/hr

      =   135.57 in/hr

I hereby certify that the information furnished on this form is true and
accurate. I am aware that falsification of data is a violation of the Water
Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and is subject to penalties
as prescribed in N.J.A.C. 7:14-8.

                                      N.J.P.E. #34722

__ _____ _____ _____ _____ ___   __ ____ _____

Engineer's Signature MICHAEL K. FORD   License # and Seal

Appendix E
Groundwater Recharge Worksheet

New Jersey Groundwater Recharge Spreadsheet
Version 2.0
November 2003

Annual Groundwater Recharge Analysis (based on GSR-32)

Project Name:	**Pillar of Fire**
Description:	**9911FS.01**
Analysis Date:	**10/16/19**

Select Township ↓
SOMERSET CO., HILLSBOROUGH TWP

	Average Annual P (in)	Climatic Factor
	45.7	1.50

Pre-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	2.93	Open space	Dunellen	14.7	156,401
2	0.12	Impervious areas	Dunellen	0.0	-
3					
4					
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	3.1			Total Annual Recharge (in) 14.1	Total Annual Recharge (cu.ft) 156,401

Procedure to fill the Pre-Development and Post-Development Conditions Tables

For each land segment, first enter the area, then select TR-55 Land Cover, then select Soil. Start from the top of the table
and proceed downward. Don't leave blank rows (with A=0) in between your segment entries. Rows with A=0 will not be
displayed or used in calculations. For impervious areas outside of standard lots select "Impervious Areas" as the Land Cover.
Soil type for impervious areas are only required if an infiltration facility will be built within these areas.

Post-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	1.47	Open space	Dunellen	14.7	78,467
2	1.58	Impervious areas	Dunellen	0.0	-
3					
4					
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	3.1			Total Annual Recharge (in) 7.1	Total Annual Recharge (cu.ft) 78,467

Annual Recharge Requirements Calculation ↓

% of Pre-Developed Annual Recharge to Preserve =	100%	Total Impervious Area (sq.ft)
Post-Development Annual Recharge Deficit=	**77,934**	(cubic feet)

68,825

Recharge Efficiency Parameters Calculations (area averages)

| RWC= | #N/A | (in) | DRWC= | #N/A | (in) |
| ERWC = | #N/A | (in) | EDRWC= | #N/A | (in) |

Project Name		Description			Analysis Date	BMP or LID Type
Pillar of Fire		9911FS.01			10/16/19	

Recharge BMP Input Parameters

Parameter	Symbol	Value	Unit
BMP Area	ABMP	54202.0	sq.ft
BMP Effective Depth, this is the design variable	dBMP	14.9	in
Upper level of the BMP surface (negative if above ground)	dBMPu	6.0	in
Depth of lower surface of BMP, must be >=dBMPu	dEXC	51.0	in
Post-development Land Segment Location of BMP , Input Zero if Location is distributed or undetermined	SegBMP	2	unitless

Parameters from Annual Recharge Worksheet

Parameter	Symbol	Value	Unit
Post-D Deficit Recharge (or desired recharge volume)	Vdef	77,934	cu.ft
Post-D Impervious Area (or target Impervious Area)	Aimp	68,825	sq.ft
Root Zone Water Capacity	RWC	2.97	in
RWC Modified to consider dEXC	DRWC	0.00	in
Climatic Factor	C-factor	1.50	no units
Average Annual P	Pavg	45.7	in
Recharge Requirement over Imp. Area	dr	13.6	in

How to solve for different recharge volumes: By default the spreadsheet assigns the values of total deficit recharge volume "Vdef" and total proposed impervious area "Aimp" from the "Annual Recharge" sheet to "Vdef" and "Aimp" on this page. This allows solution for a single BMP to handle the entire recharge requirement assuming the runoff from entire impervious area is available to the BMP. To solve for a smaller BMP or a LID-IMP to recharge only part of the recharge requirement, set Vdef to your target value and Aimp to impervious area directly connected to your infiltration facility and then solve for ABMP or dBMP. To go back to the default configuration clik the "Default Vdef & Aimp" button.

Root Zone Water capacity Calculated Parameters

Parameter	Symbol	Value	Unit
Empty Portion of RWC under Post-D Natural Recharge	ERWC	0.74	in
ERWC Modified to consider dEXC	EDRWC	0.00	in
Empty Portion of RWC under Infilt. BMP	RERWC	0.00	in

BMP Calculated Size Parameters

Parameter	Symbol	Value	Unit
ABMP/Aimp	Aratio	0.79	unitless
BMP Volume	VBMP	67,075	cu.ft

System Performance Calculated Parameters

Parameter	Symbol	Value	Unit
Annual BMP Recharge Volume		204,171	cu.ft
Avg BMP Recharge Efficiency		100.0%	Represents % Infiltration Recharged
%Rainfall became Runoff		77.9%	%
%Runoff Infiltrated		100.0%	%
%Runoff Recharged		100.0%	%
%Rainfall Recharged		77.9%	%

Recharge Design Parameters

Parameter	Symbol	Value	Unit
Inches of Runoff to capture	Qdesign	2.83	in
Inches of Rainfall to capture	Pdesign	3.06	in
Recharge Provided Avg. over Imp. Area		35.6	in
Runoff Captured Avg. over imp. Area		35.6	in

CALCULATION CHECK MESSAGES

Volume Balance--> **Solve Problem to satisfy Annual Recharge**
dBMP Check----> **OK**
dEXC Check----> **OK**

BMP Location----> **OK**

OTHER NOTES

Pdesign is accurate only after after BMP dimensions are updated to make rech volume= deficit volume. The portion of BMP infiltration prior to filling and the area occupied by BMP are ignored in these calculations. Results are sensetive to dBMP, make sure dBMP selected is small enough for BMP to empty in less than 3 days. For land Segment Location of BMP if you select "impervious areas" RWC will be minimal but not zero as determined by the soil type and a shallow root zone for this Land Cover allowing consideration of lateral flow and other losses.

Appendix F
Watershed Area Maps & Soil Log Exhibit