PROJECT NARRATIVE AND STORMWATER MANAGEMENT REPORT

for:

CHAMPLIN HILLS

ASSESSORS PLAT 20/4, LOTS 2113 and 2117
SCITUATE AVENUE
CRANSTON, RHODE ISLAND

***Owner/Applicant*:**

West Bay, LLC
1414 Atwood Avenue
Cranston, Rhode Island 02919

Prepared by:

Garofalo & Associates, Inc.
85 Corliss Street, Providence, RI 02940
Tel.: (401).273.6000; Fax: (401).273.1000

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I. INTRODUCTION

This Project Narrative and Stormwater Management Report outlines a proposed multi-family development with two structures that house sixty-three (72) residential units (total) and a club house. The project site is located at 280 Scituate Avenue, Cranston, RI, A.P. 20/4, Lots 2113 and 2117 (Figure 1). The owner/developer of the property is West Bay, LLC. The site lies within the A-20 and B-2 Zoning district as defined by the City of Cranston, Zoning Ordinance. Lot 2113 is developed as single-family residential while Lot 2117 is undeveloped and can be characterized as wooded with wetlands and a river (< 10' wide). The project requires permitting from the RI Department of Environmental Management (RIDEM) for a preliminary determination and underground injection control (UIC) and RI Department of Transportation (RIDOT) for a Physical Alteration Permit.

Generally, the project proposes two (2) multi-unit structures (72 total dwelling units), a club house and pool, parking, and required sanitary and water services. Telephone, electric, sewer, and water services are all available from Scituate Avenue.

Existing and proposed drainage patterns have been evaluated and, due to a proposed infiltration pond and a water quality structures, the results have shown no increase in post-development net runoff from the site. Drainage conveyance is primarily through ADS N-12 piping and is sized to accommodate 100-year storm events.

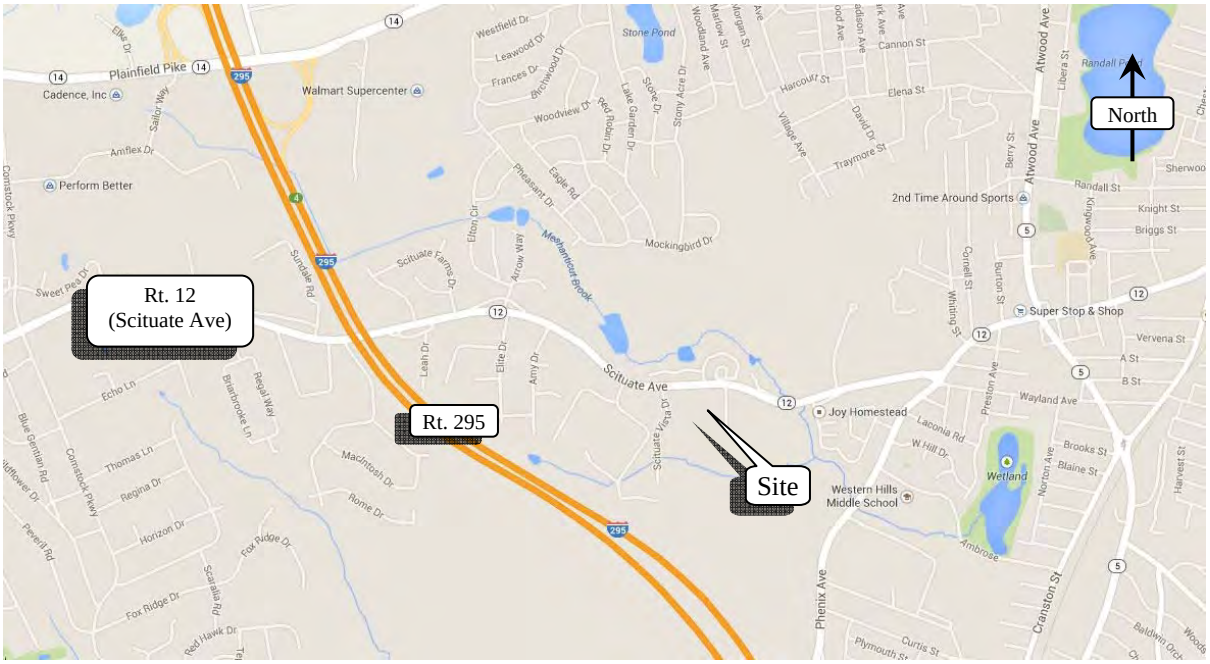


Figure 1. Locus Map

II. EXISTING CONDITIONS

2.1 Site Characteristics

The existing 7.93-acre parcel is located at 280 Scituate Avenue, Smithfield, RI, A.P. 20/4, Lots 2113 and 2117. Presently, Lot 2113 is developed as single-family residential while Lot 2117 is undeveloped and can be characterized as wooded with wetlands and a stream (< 10' wide). The front portion of the property slopes toward Scituate Avenue while portions of the site slope toward the East and into an existing Area Subject to Storm Flow (ASSF) and South to an existing river. Grades generally range from approximately 2% to 10% with small portions exceeding 15%.

The total land area of the subject lots is approximately 7.93 acres. The site is bordered by existing multi-family developments along Scituate Avenue on its southern, eastern, and western boundaries, and by Scituate Avenue to the north.

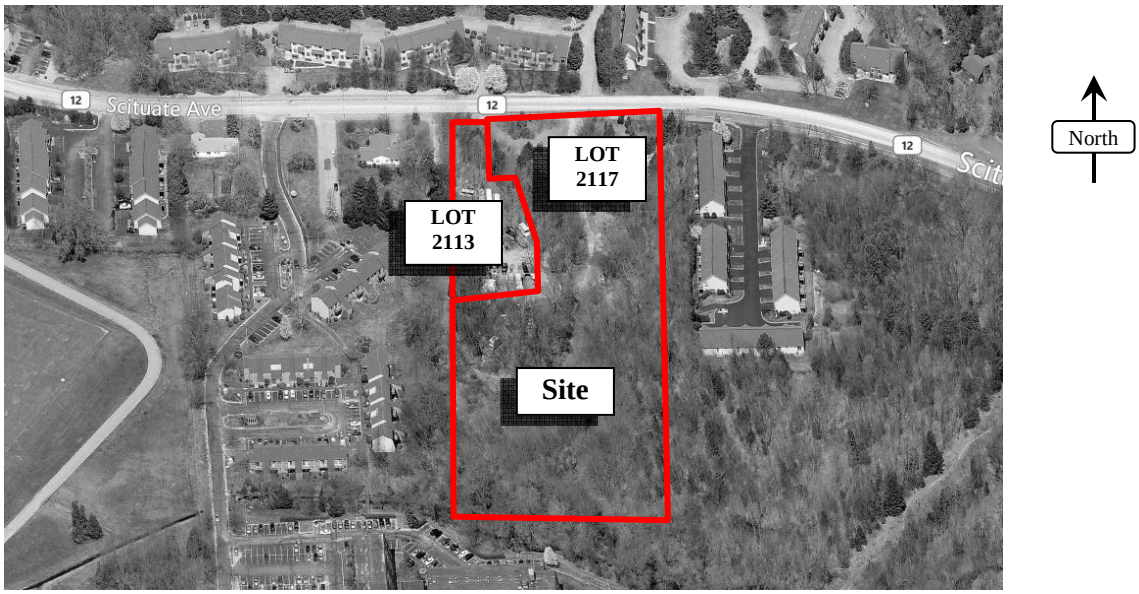


Figure 2. Existing Characteristics

2.2 Zoning

All dimensional requirements shall be in conformance with the City of Cranston Zoning Code. According to the City of Cranston Zoning Map and Comprehensive Plan Land Use Map, Lot 2113 is zoned A-20 while Lot 2117 is zoned B-2. Lot 2113 will require a zone change to B-2, which permits multi-family dwellings.

Dimensional requirements are listed in the table below:

District	Min. Front Yard (ft.)	Min. Rear Yard (ft.)	Min. Side Yard (ft.)	Max. Lot Coverage (%)	Max. Bldg. Height (ft.)
B-2	25	20	8	50	35

The minimum lot density for multifamily housing is calculated as follows (City of Cranston, Zoning Ordinance, Section 17.20.090):

…*For multi-family dwellings the minimum lot area shall be six thousand (6,000) square feet for the first dwelling unit, plus four thousand (4,000) square feet for each of the next nine dwelling units, plus three thousand five hundred (3,500) square feet for each dwelling unit in excess of ten (10) dwelling units.*

Per the City of Cranston, Subdivision Regulations, Section IV, Special Requirements, the total number of dwelling units shall be based on land free of unsuitable constraints. Unsuitable development areas include wetland areas, FEMA 100-year flood zone areas, and any public or privately held above-ground utility easements.

Total Site Area: 345,449 SF

Total Wetland Area: 17,002 SF

Total Site Area Suitable for Development: 328,447 SF

Maximum Dwelling Units:

= 10 units + [Land Area – 6,000 sf (*unit 1*) – (9 x 4,000 sf) (*units 2-10*)] / 3500 sf/unit (*units beyond 10*)

= 10 units + [328,447 sf – (6,000 sf + 36,000 sf)]/3,500 sf/unit = 10 units + 71.8 units = **Use 81 Units**

2.3 Soils

The *Soil Survey of Rhode Island* prepared by the US Department of Agriculture, Soil Conservation Service depicts the underlying soils of the site to be comprised primarily of Canton and Charlton fine sandy loam, Enfield and Raypol silt loam, Hinkley-Enfield complex, Narragansett silt and stony silt loam, and Udorthents (urban land complex). The portion of the property closest to Scituate Avenue is classified as a "A" hydrologic soil group while the rear portion of the property is classified as hydrologic soil group "B" (Refer to Appendix J, *Supporting Documentation*).

Five (5) on-site soil evaluations were conducted on March 20, 2014 by a licensed, Rhode Island, Class IV Soil Evaluator (Steven Henry, RI #D4026). Soils on the northern portion of the site (closest to Scituate Avenue) were found to consist of sandy loam, fine sand, and granular sands, while soils toward the southern portion of the site, soils were found to consist primarily of silt, fine sandy loam, and clay sand. Seasonal high groundwater tables were found to vary from 4 to 6 feet below existing grade.

Additional testing was performed to determine infiltration rates at the northern portion of the property. The soil was found to have general infiltration rate of 6.07 in/hour. Utilizing the RIDEM Stormwater Manual factor of safety of 2, the infiltration rate becomes 3.04 in/hour within the area of the testing.

2.4 Wetlands

A wetland (approximately 17,002 s.f.) has been identified and flagged by John Kupa, PhD. Additionally, an ASSF directs stormwater flow from the wetland in a north-easterly direction, discharging storm flow to the easterly abutter.

A river (< 10' wide) located in the southwest corner of the project site, with an associated 100-foot Riverbank Wetland, consists of approximately 670 square feet of land area.

2.5 FEMA

The site lies within Zone "X" (defined as area outside of the 0.2% annual chance floodplain) of the National Flood Insurance Rate Maps for Providence County, Map Number 44007C0313G, effective March 2, 2009 (Refer to Appendix J, *Supporting Documentation*).

A flood study has been performed to assess potential 100-yr flood conditions and has concluded that during a 100-yr storm event, the stream elevation is expected to be approximately 1.04 feet above normal conditions. The study has separated the watershed into three (3) sub-watersheds, WS-1A, -1B, and -1C. WS-1C flows to a topographic depression that helps to provide some volume storage before discharging to WS-1B. Wetlands within WS-1B further store volume prior to discharge to WS-1A. Flow to WS-1A is through a Route 295 overpass by shallow channel. Combined, flows then move toward the project site along an unnamed stream. Approximately 300 ft. prior to the subject site, the stream flows under an access road within two (2) 24-inch culverts. Additional storage is expected at this roadway, as the road acts as a weir structure and forms an impoundment. To remain conservative, the 100-year storm elevation calculation treats the crossing as un-restricted flow. Other restrictions may occur but are unconfirmed because portions of the watershed are un-accessible and protected by the neighboring Providence Water Supply Board (Refer to Appendix I, Flood Study Analysis)

2.6 Natural Resource Inventory

According to Rhode Island Department of Environmental Management (RIDEM) Geographic Information System (GIS) mapping, the site has no State-designated Natural Heritage Areas.

2.7 Drainage Analysis

The stormwater management systems have been designed to meet the standards of the *Rhode Island Stormwater Design and Installation Standards Manual* and the City of Cranston. The comparative pre-development vs. post-development hydrologic analysis was performed using the Soil Conservation Service, Technical Release 20 and 55 (TR-20 and TR-55) methodology. The 1, 2, 10, 25 and 100-year storm events were modeled for a 24-hour, Type III storm utilizing HydroCAD version 8.50.

2.7.1 Pre-development Stormwater Runoff

The existing site has been divided into three (3) sub-watersheds, A, B, and C. Stormwater runoff from sub-watersheds A generally flows toward Scituate Avenue. Sub-watershed B flows toward the eastern property line and into an existing ASSF. Sub-watershed C is directed toward the southern boundary and into a stream. (refer to Appendix A, *Existing Watershed Plan*). HydroCAD Stormwater Modeling software was utilized to demonstrate existing peak runoff flows at the property (Table 1, *Existing Runoff Rates*).

Table 1: Existing Runoff Rate

Storm Event	Rainfall Intensity	Sub- Watershed EWS-A1 & A2 (cfs)	Sub-Watershed EWS-B (cfs)	Sub- Watershed EWS-C (cfs)
2-year	3.3 in.	0.62	0.46	0.51
10-year	4.9 in.	0.95	1.83	2.30
25-year	6.1 in.	1.24	3.29	4.00
100-year	8.7 in.	3.12	7.13	8.28

III. PROPOSED CONDITIONS

3.1 Proposed Development

The proposal is for multi-family residential development. Specifically, the proposal includes two 3-story structures with sixty-three (72) total dwelling units, a club house, access roadway and parking, utilities, and associative mitigating drainage structures.

The project requires a Physical Alteration Permit from RIDOT and a Preliminary Determination from RIDEM.

3.2 Utilities

Public water, sewer, electric, and telephone are available within Scituate Avenue. It is anticipated that the proposed development will connect into all available utilities within Scituate Avenue, pending required approvals.

3.3 Post-development Stormwater Runoff

Stormwater analyses were performed to model 1, 2, 10, 25, and 100-year Type III 24-hour duration storm events. As shown, the site was first modeled under current conditions followed by an analysis that reflects proposed improvements incorporating the impervious and landscaping surfaces. The proposed development makes an effort to replicate the existing conditions with infiltration chambers and bioretention structures.

The proposed development is divided into six (6) subcatchments (refer to Appendix A, *Proposed Watershed Plan).* Each follows a similar configuration as described in Section II, *Existing Conditions.* Runoff discharge from existing subcatchments EWS-A1 and A2, EWS-B, and EWS-C (as described) generally match proposed sub-watersheds although the proposed configuration is further separated into PWS-A1, A2, and A3, PWS-B1 and B2, and PWS-C. Runoff from PWS-A1 is directed to an infiltration pond located near Scituate while Subcatchment PWS-B2 is solely for roof runoff and is directed to a sand filter. Subcatchments PWS-B1and -C have no proposed impervious services and are directed as they presently flows. Combined Subcatchment data shown in each of the following tabulations includes routing through proposed infiltration and water quality structures.

The following data represents the post-development findings pertaining to subcatchment PWS-A1, -A2, and –A3. Runoff from PWS-A1 is routed through a water quality structure (sand filter) and an infiltration basin (BMP-1 and 2) while PWS-A3 is routed through infiltration chambers (BMP-4).

Table 2: Sub-watershed PWS-A1, PWS-A2, and PWS-A3 Runoff Rates

Storm Event	Rainfall Intensity	PWS-A1 (cfs)	PWS-A2 (cfs)	PWS-A3 (cfs)	Combined PWS-A1 -A2 & -A3 (cfs)
2-year	3.3 in.	7.16	0.24	0.39	0.24
10-year	4.9 in.	11.11	0.36	0.58	0.46
25-year	6.1 in.	14.63	0.46	0.73	0.60
100-year	8.7 in.	22.75	0.89	1.04	1.08

Subcatchment PWS-B1 and PWS-B2 are consistent with EWS-B. The findings for sub-watershed PWS-B1 and PWS-B2 (routed through sand filter) are as follows.

Table 3: Sub-watershed PWS-B1 and PWS-B2 Runoff Rates

Storm Event	Rainfall Intensity	PWS-B1 (cfs)	PWS-B2 (cfs)	Combined PWS-B1 & -B2 (cfs)
2-year	3.3 in.	0.14	1.64	0.14
10-year	4.9 in.	0.82	2.51	0.96
25-year	6.1 in.	1.60	3.17	2.24
100-year	8.7 in.	3.68	4.62	4.71

Runoff from PWS-C is routed as EWS-C presently flows. The following data represents the post-development findings pertaining to subcatchment PWS-C1 and PWS-C2.

Table 4: Sub-watershed PWS-C1 and PWS-C2 Runoff Rates

Storm Event	Rainfall Intensity	PWS-C (cfs)
2-year	3.3 in.	0.32
10-year	4.9 in.	1.19
25-year	6.1 in.	2.03
100-year	8.7 in.	4.13

IV. DRAINAGE ANALYSIS

4.1 Methodology

The proposed stormwater management system is designed to meet the standards of the *Rhode Island Stormwater Design and Installation Standards Manual* and the City of Cranston. The comparative pre-development vs. post-development hydrologic analysis was performed using the Soil Conservation Service, Technical Release 20 and 55 (TR-20 and TR-55) methodology. The 1, 2, 10, 25 and 100-year storm events were modeled for a 24-hour, Type III storm utilizing HydroCAD version 8.50.

No increase in stormwater flows is expected with the proposed improvements. When all drainage structures are in place, calculations show a modest decrease in net runoff during all design storm events. The following tabulation demonstrates net changes in peak runoff flows for the development, including volume of flow from corresponding storm events.

Table 5: Comparative Analysis for Sub-watershed ECS-A and PWS-A1/A2

Storm Event	EWS-A1 & A2 (cfs)	PWS-A1& A-2 (cfs)	Net Increase (cfs)	Net Increase in Volume (cf)
2-year	0.62	0.24	-0.38	-1,611
10-year	0.95	0.46	-0.49	-827
25-year	1.24	0.60	-0.64	-958
100-year	3.12	1.08	-2.04	-3,223

Table 6: Comparative Analysis for Sub-watershed EWS-B and PWS-B1/B2

Storm Event	EWS-B (cfs)	PWS-B1 & B-2) (cfs)	Net Increase (cfs)	Net Increase in Volume (cf)
2-year	0.46	0.14	-0.32	-2,919
10-year	1.83	0.96	-0.87	-5,532
25-year	3.29	2.24	-1.05	-7,579
100-year	7.13	4.71	-2.42	-12,937

Table 7: Comparative Analysis for Sub-watershed EWS-C and PWS-C

Storm Event	EWS-C (cfs)	PWS-C (cfs)	Net Increase (cfs)	Net Increase in Volume (cf)
2-year	0.51	0.32	-0.19	-566
10-year	2.30	1.19	-1.11	-1,829
25-year	4.00	2.03	-1.97	-3,092
100-year	8.28	4.13	-4.15	-6,359

The infiltration structure is situated a minimum of 2-feet above groundwater elevation (GWE) as required for residential use. GWE has been established by soil evaluation (refer to Appendix J, *Supporting Documentation.*) and is measuring down from the center of the proposed system. For PWS-A1, water quality is addressed prior to the infiltration pond (BMP-2) with a sand filter (BMP-1). Approximately 6,733 cf of treatment is proposed, with 25% designated as pre-treatment (sediment storage). PWS-B2 volume is also treated within a sand filter (BMP-3) that has approximately 2,131 sf of storage, no pretreatment is required when the flow is limited to roof run-off. Lastly, drainage conveyance is primarily through ADS N-12 piping and is sized to accommodate 100-year storm events.

4.2 Mounding Analysis

Because BMP-2 has a proposed bottom elevation that is less than 4-feet above groundwater elevation, a groundwater mounding analysis has been performed and has shown a potential **1.34-foot mounding** increase. The mounding analysis uses the Hantush (1967) methodology and includes design parameters as follows:

R	Recharge (infiltration) rate (feet/day) ***Per RI Stormwater Design and Installation Manual***
Sy	Specific yield, Sy (dimensionless, between 0 and 1) ***Per US Department of the Interior, Specific Yield – course sand***
K	Horizontal hydraulic conductivity, Kh (feet/day) ***Per Civil Eng. Reference Manual, Table 21.1 - gravel/sand***
x	1/2 length of basin (x direction, in feet) ***Per Plan measurement***
y	1/2 width of basin (y direction, in feet) hours days ***Per Plan measurement***
t	duration of infiltration period (days) ***Per HydroCAD Hydrograph***
hi(0)	initial thickness of saturated zone (feet) ***Per Soils Evaluation***

Refer to Appendix J, *Supporting Documentation,* for referenced attachments and calculation.

4.3 Flow Splitting

Flow splitting is provided for the Water Quality Flow (1.2 inch Storm) for offline treatment of the Water Quality Volume. As shown in Appendix D, Proposed Off-line Water Quality Calculation, using the pervious/impervious feature, the Water Quality Flow is completely diverted to the appropriate infiltration systems (BMP 1 and BMP-3) for treatment. Flows larger than the water quality volume cannot be stored within the proposed water quality system and will be diverted over the associative weir structure.

V. STORMWATER STANDARDS

The proposed development has been designed meet all of the minimum standards identified in the Rhode Island Stormwater Design and Installation Standards Manual by incorporating low impact development techniques including maintenance planning and subsurface infiltration. (Refer to Appendix E, *Stormwater Management Standards / Calculations* for referenced calculations and Appendix F, *RIDEM Stormwater Management Checklist*.)

5.1 Standard 1: LID Planning and Design Strategies

LID site planning and design strategies must be used to the maximum extent practicable.

Standard Met

No untreated stormwater runoff from the proposed parking facility will be discharged off-site. LID practices of a sand filter, on-site infiltration, and maintenance planning have been included in the stormwater management design. Proposed drainage patterns will closely mimic those of existing conditions, including reduction of pre-development peak runoff rates and volumes through infiltration practices.

5.2 Standard 2: Groundwater Recharge

Stormwater must be recharged within the same subcatchment to maintain base flow at pre-development recharge levels to the maximum extent practicable.

Standard Met

Groundwater recharge will be provided on-site through an infiltration basin. The proposal includes 2.61 acres total impervious surfaces that will require 4,232 ft^3 recharge. Analysis of the proposed infiltration basin suggests the proposed infiltration volume exceeds the requirement and provides more than 35,500 ft^3 of recharge volume.

5.3 Standard 3: Water Quality

Stormwater runoff must be treated prior to discharge.

Standard Met

Paved surfaces will be collected into a closed drainage system and routed through a sand filters before being diverted into an infiltration basin. Water quality treatment is provided for the Water Quality Volume as outlined below.

Subcatchment PWS-A1:	Required Water Quality Volume:	6,044 ft^3
	Provided Water Quality Treatment:	6,733 ft^3 (at weir elev. 197.2)
	Required Pre-treatment Volume:	2,015 ft^3

	Provided Pre-treatment Volume:	2,413 ft^3
	Required Bottom Area:	657 ft^2
	Proposed Bottom Area:	1,520 ft^2
Subcatchment PWS-A3:	Required Water Quality Volume:	508 ft^3
	Provided Water Quality Volume:	590 ft^3 (at elev. 207.50)
Subcatchment PWS B2:	Required Water Quality Volume:	1,361 ft^3
	Provided Water Quality Volume:	2,131 ft^3 (at weir elev. 210.5)
	Required Bottom Area:	222 ft^2
	Proposed Bottom Area:	2,000 ft^2

5.4 Standard 4: Conveyance and Natural Channel Protection

This standard is designed to prevent erosive flow within natural channels and drainage ways.

Standard Met / Standard Not Applicable

The project proposes an infiltration basin for peak runoff and volume control.

5.5 Standard 5: Overbank Flood Protection

Downstream overbank flood protection must be provided by attenuating the post development peak discharge rate to the pre-development levels for the 10-year and 100-year, Type III design storm events.

Standard Met / Standard Not Applicable

The site has been designed to provide post-development peak discharges that are less than the pre-development peak discharges in both volume and rate for the 1, 2, 10, 25 and 100 year storm events. From the HydroCAD analysis, the design shows that the drain time for the infiltration structure falls within the allowed 24-hour period and it is expected that the drain time will be approximately 20-hours.

5.6 Standard 6: Redevelopment and Infill Projects

For redevelopment sites with 40% or more existing impervious surface coverage and infill sites, only Standards 2, 3, and 7-11 must be addressed.

Standard Applicable

The proposed project is not considered a Redevelopment or Infill Project.

5.7 Standard 7: Pollution Prevention

All development sites require the use of source control and pollution prevention measures to minimize the impact that the land use may have on stormwater runoff quality.

Standard Met

A Soil Erosion and Sediment Control Plan (SESCP) is prepared in accordance with the RISDISM.

5.8 Standard 8: Land Uses with Higher Potential Pollutant Loads

Stormwater discharges from land uses with higher potential pollutant loads (LUHPPLs) require the use of specific source control and pollution prevention measures and the specific stormwater BMPs approved for such use.

Standard Applicable

The residential project proposed does not meet the definition of a LUHPPL as defined in the Manual, Section 3.2.8.

5.9 Standard 9: Illicit Discharges

All illicit discharges to stormwater management systems are prohibited, including discharges from OWTS, and sub-drains and French drains near OWTSs that do not meet the State's OWTS Rules.

Standard Met

There are no known illicit discharges at the site and none are proposed as part of this project.

5.10 Standard 10: Construction and Erosion Sedimentation Control

Erosion and sedimentation control practices must be utilized during the construction phase as well as during any land disturbing activities

Standard Met

Soil Erosion and Sedimentation Control Practices have been employed to avoid and minimize impacts to adjacent wetland resources. Detailed notes have been included in the plans to ensure effective implementation of erosion and sedimentation controls. The soil erosion and sedimentation control measures will be installed prior to the initiation of construction activities and maintained throughout construction. Silt fence and baled hay erosion checks are proposed within the site. Once established, these measures will be monitored daily until construction activities are complete. The baled hay and or silt sock will serve as the strict limits of disturbance for the project within or adjacent to regulated freshwater wetland areas. No alterations, including vegetative clearing or surface disturbance, will occur beyond this line. The limits of clearing, grading, and disturbance will be kept to a minimum within the proposed area of construction. All areas outside of these limits, as depicted on the project site plans, will be totally undisturbed, to remain in a completely natural condition.

5.11 Standard 11: Stormwater Management System Operation and Maintenance

The stormwater management system, including all structural stormwater controls and conveyances, must have an operation and maintenance plan to ensure that it continues to function as designed.

Standard Met

A long-term Stormwater Operation and Maintenance Plan has been prepared for the development in accordance with the Manual, and is provided in Appendix H.

VI. IMPACT AVOIDANCE AND MINIMIZATION

6.1 Project Description

The project proposes a 72-unit, residential development located at Scituate Avenue, Cranston, RI, A.P. 20/4, Lots 2113 and 2117. The owner/developer of the property is West Bay, LLC. The combined land area is 7.93 acres and lay within the A-20 and B-2 zoning districts as defined by the City of Cranston Zoning Ordinance. Lot 2113 is developed as single-family residential while Lot 2117 is undeveloped and can be characterized as primarily wooded with some wetlands and a river (less than 10-feet wide).

Generally, the project proposes sixty-three (72) residential units within two (2) detached structures and a club house. The project received Master Plan approval, March 4, 2014. The future residential structures will be serviced by municipal water and sewer services.

Existing and proposed drainage patterns have been evaluated and, due to a proposed infiltration basin, the results have shown no increase in post-development net runoff from the site. Proposed drainage conveyance is through ADS N-12 piping and is sized to accommodate 100-year storm events.

6.2 Project Narrative

6.2.1 Avoidance:

The applicant is proposing the developed portion of the 7.93-acre parcel to be located within the upland portion of the project site and have been positioned to reduce impacts to the on-site wetlands and river. To further prevent impacts, the development provides recharge volume through the use of a water quality structure (sand filter) and infiltration basin.

6.2.2 Minimization:

Per City requirement, the project site will accommodate a 81-unit development. To avoid impacts to the existing wetlands, the project has been reduced to 72-units. Therefore, the project proposes a reduced impervious condition and topographic change. The proposed limit of disturbance is outside of jurisdictional wetlands although runoff will be discharged to existing onsite wetlands. No increase in existing runoff is proposed and the scale of the project proposed is the minimal size to meet the objective.

The structures are positioned to allow for adequate setback to Scituate Avenue to lessen the impact on the view. Additionally, this location maximizes the separation between the proposed development and the wetlands and stream, utilizing the only upland area available to do so. No other location within the site would provide the applicant with the ability to achieve the project purpose, nor would any alternate designs, layouts or reductions in scale, while impacting less wetland. The applicant has minimized all impacts to the natural character of the wetlands and river, to the maximum extent possible, with the location, scale and design of this project.

6.2.3 Mitigation Measures:

Although no wetland proper, perimeter wetland, or riverbank wetland is proposed to be altered, runoff will discharge toward an existing wetland and river. Infiltration structures are proposed and will meter flow toward the environmental features by way of pipe outfall. Proposed peak runoff and total volume will mimic existing flows and no additional flow is proposed. Additionally, per state and local requirements, RIDEM Stormwater Design and Installation Standards Manual has been utilized to design for site recharge volumes, water quality control requirements, channel protection volume, and sand filter design.

Best Management Practices for soil erosion and sedimentation control is proposed for the project as well as stormwater collection and mitigation measures to further lessen the impact of the development. A sand filter will collect and discharge storm flow from one rooftop while isolator rows will provide necessary water quality measures and sediment control for the other rooftop and pavement surfaces.

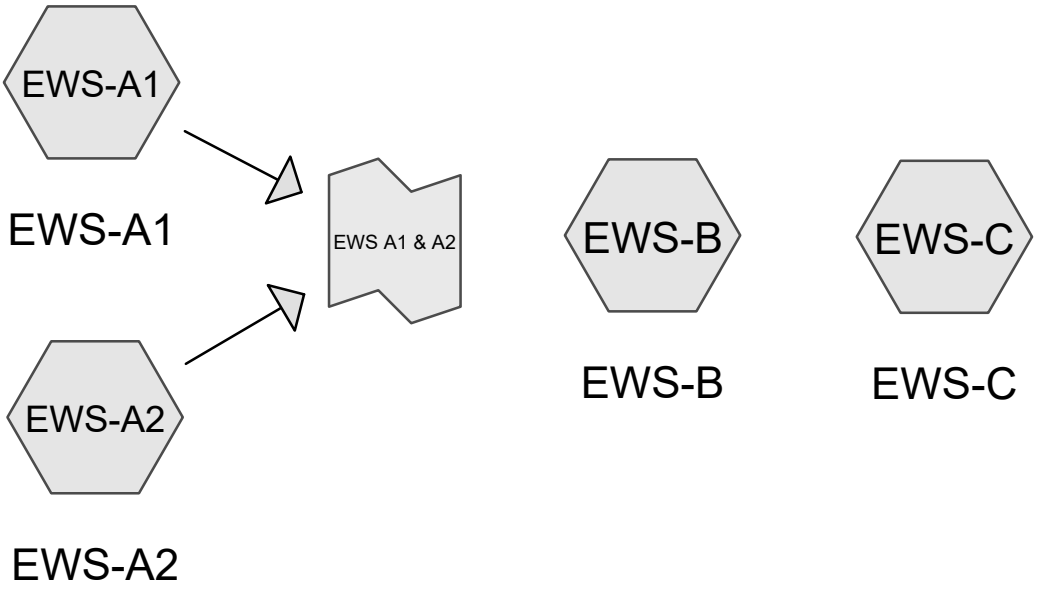
VII. CONCLUSIONS

The results of the drainage analyses indicate an overall decrease in post-development storm flow leaving the site for the 1-year, 2-year, 10-year, 25-year, and 100-year storm events. Additionally, Best Management Practices will be employed, utilizing the State of Rhode Island Stormwater Design and Installation Standards Manual, December, 2010 edition and the Rhode Island Soil and Erosion Sediment Control Handbook.

All catch basins and drainage manholes will incorporate a tee at the basin/manhole outlet for oil/water separation and a four (4) ft. sump for sediment control. Silt fence and/or hay bales will line the down gradient limit of disturbance. A crushed stone construction entrance pad shall be placed at the driveway entrance to mitigate any tracking of sediments onto Scituate Avenue. Rip-rap aprons will be placed at the inlets and outlets of all culverts. Any areas with slopes greater than 2:1 will receive a fiber mulch treatment. All sediment and erosion control measures will remain in place until all disturbed areas are stabilized. These measures shall be maintained during construction by the contractor until City acceptance. It is the responsibility of the contractor to maintain all components of the drainage system as well as all areas of disturbance. Any washouts or sediment build-ups will be attended to immediately.

Appendix A
Existing and Proposed Watershed Maps

Appendix B
Existing Watershed Calculations



Subcat Reach Pond Link

Drainage Diagram for 6856-2014-08-04-EWS
Prepared by Garofalo & Associates, Inc.

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EWS-A1: EWS-A1 Runoff Area=2.500 ac 10.00% Impervious Runoff Depth=0.31"
Flow Length=555' Tc=19.4 min CN=37/98 Runoff=0.55 cfs 0.064 af

Subcatchment EWS-A2: EWS-A2 Runoff Area=0.130 ac 30.77% Impervious Runoff Depth=1.20"
Flow Length=260' Slope=0.0200 '/' Tc=2.4 min CN=58/98 Runoff=0.16 cfs 0.013 af

Subcatchment EWS-B: EWS-B Runoff Area=3.520 ac 4.83% Impervious Runoff Depth=0.39"
Flow Length=545' Tc=34.0 min CN=54/98 Runoff=0.46 cfs 0.114 af

Subcatchment EWS-C: EWS-C Runoff Area=2.130 ac 0.00% Impervious Runoff Depth=0.41"
Flow Length=440' Tc=8.5 min CN=59/0 Runoff=0.51 cfs 0.073 af

Link EWS A1 & A2: Inflow=0.62 cfs 0.077 af
Primary=0.62 cfs 0.077 af

Total Runoff Area = 8.280 ac Runoff Volume = 0.264 af Average Runoff Depth = 0.38"
94.44% Pervious = 7.820 ac 5.56% Impervious = 0.460 ac

Summary for Subcatchment EWS-A1: EWS-A1

Runoff = 0.55 cfs @ 12.25 hrs, Volume= 0.064 af, Depth= 0.31"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

	Area (ac)	CN	Description
*	0.170	98	gravel road
*	0.080	98	Roofs
	1.740	30	Woods, Good, HSG A
	0.510	61	>75% Grass cover, Good, HSG B
	2.500	43	Weighted Average
	2.250	37	Pervious Area
	0.250	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	100	0.0200	0.12		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.30"
0.8	150	0.0400	3.22		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.3	40	0.2500	2.50		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
4.2	265	0.0450	1.06		**Shallow Concentrated Flow, D-E** Woodland Kv= 5.0 fps
19.4	555	Total			

Summary for Subcatchment EWS-A2: EWS-A2

Runoff = 0.16 cfs @ 12.05 hrs, Volume= 0.013 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

	Area (ac)	CN	Description
*	0.040	98	gravel road
	0.040	55	Woods, Good, HSG B
	0.050	61	>75% Grass cover, Good, HSG B
	0.130	71	Weighted Average
	0.090	58	Pervious Area
	0.040	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0200	1.40		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
1.2	160	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
2.4	260	Total			

Summary for Subcatchment EWS-B: EWS-B

Runoff = 0.46 cfs @ 12.61 hrs, Volume= 0.114 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

Area (ac)	CN	Description
3.150	55	Woods, Good, HSG B
0.170	98	Paved parking & roofs
0.200	30	Woods, Good, HSG A
3.520	56	Weighted Average
3.350	54	Pervious Area
0.170	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.2	75	0.0200	0.04		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.30"
2.4	200	0.0200	1.41		**Shallow Concentrated Flow, B-C** Nearly Bare & Untilled Kv= 10.0 fps
2.4	270	0.0700	1.85		**Shallow Concentrated Flow, C-D** Short Grass Pasture Kv= 7.0 fps
34.0	545	Total			

Summary for Subcatchment EWS-C: EWS-C

Runoff = 0.51 cfs @ 12.19 hrs, Volume= 0.073 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

Area (ac)	CN	Description
0.550	70	Woods, Good, HSG C
1.580	55	Woods, Good, HSG B
2.130	59	Weighted Average
2.130	59	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0400	1.84		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
7.6	340	0.0220	0.74		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
8.5	440	Total			

Summary for Link EWS A1 & A2:

Inflow Area = 2.630 ac, 11.03% Impervious, Inflow Depth = 0.35" for 2 YR event
Inflow = 0.62 cfs @ 12.25 hrs, Volume= 0.077 af
Primary = 0.62 cfs @ 12.25 hrs, Volume= 0.077 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EWS-A1: EWS-A1 Runoff Area=2.500 ac 10.00% Impervious Runoff Depth=0.57"
Flow Length=555' Tc=19.4 min CN=37/98 Runoff=0.83 cfs 0.120 af

Subcatchment EWS-A2: EWS-A2 Runoff Area=0.130 ac 30.77% Impervious Runoff Depth=2.21"
Flow Length=260' Slope=0.0200 '/' Tc=2.4 min CN=58/98 Runoff=0.32 cfs 0.024 af

Subcatchment EWS-B: EWS-B Runoff Area=3.520 ac 4.83% Impervious Runoff Depth=1.06"
Flow Length=545' Tc=34.0 min CN=54/98 Runoff=1.83 cfs 0.310 af

Subcatchment EWS-C: EWS-C Runoff Area=2.130 ac 0.00% Impervious Runoff Depth=1.18"
Flow Length=440' Tc=8.5 min CN=59/0 Runoff=2.30 cfs 0.209 af

Link EWS A1 & A2: Inflow=0.95 cfs 0.144 af
Primary=0.95 cfs 0.144 af

Total Runoff Area = 8.280 ac Runoff Volume = 0.662 af Average Runoff Depth = 0.96"
94.44% Pervious = 7.820 ac 5.56% Impervious = 0.460 ac

Summary for Subcatchment EWS-A1: EWS-A1

Runoff = 0.83 cfs @ 12.25 hrs, Volume= 0.120 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

	Area (ac)	CN	Description
*	0.170	98	gravel road
*	0.080	98	Roofs
	1.740	30	Woods, Good, HSG A
	0.510	61	>75% Grass cover, Good, HSG B
	2.500	43	Weighted Average
	2.250	37	Pervious Area
	0.250	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	100	0.0200	0.12		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.30"
0.8	150	0.0400	3.22		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.3	40	0.2500	2.50		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
4.2	265	0.0450	1.06		**Shallow Concentrated Flow, D-E** Woodland Kv= 5.0 fps
19.4	555	Total			

Summary for Subcatchment EWS-A2: EWS-A2

Runoff = 0.32 cfs @ 12.05 hrs, Volume= 0.024 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

	Area (ac)	CN	Description
*	0.040	98	gravel road
	0.040	55	Woods, Good, HSG B
	0.050	61	>75% Grass cover, Good, HSG B
	0.130	71	Weighted Average
	0.090	58	Pervious Area
	0.040	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0200	1.40		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
1.2	160	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
2.4	260	Total			

Summary for Subcatchment EWS-B: EWS-B

Runoff = 1.83 cfs @ 12.56 hrs, Volume= 0.310 af, Depth= 1.06"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

Area (ac)	CN	Description
3.150	55	Woods, Good, HSG B
0.170	98	Paved parking & roofs
0.200	30	Woods, Good, HSG A
3.520	56	Weighted Average
3.350	54	Pervious Area
0.170	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.2	75	0.0200	0.04		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.30"
2.4	200	0.0200	1.41		**Shallow Concentrated Flow, B-C** Nearly Bare & Untilled Kv= 10.0 fps
2.4	270	0.0700	1.85		**Shallow Concentrated Flow, C-D** Short Grass Pasture Kv= 7.0 fps
34.0	545	Total			

Summary for Subcatchment EWS-C: EWS-C

Runoff = 2.30 cfs @ 12.14 hrs, Volume= 0.209 af, Depth= 1.18"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

Area (ac)	CN	Description
0.550	70	Woods, Good, HSG C
1.580	55	Woods, Good, HSG B
2.130	59	Weighted Average
2.130	59	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0400	1.84		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
7.6	340	0.0220	0.74		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
8.5	440	Total			

Summary for Link EWS A1 & A2:

Inflow Area = 2.630 ac, 11.03% Impervious, Inflow Depth = 0.66" for 10 YR event
Inflow = 0.95 cfs @ 12.24 hrs, Volume= 0.144 af
Primary = 0.95 cfs @ 12.24 hrs, Volume= 0.144 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EWS-A1: EWS-A1 Runoff Area=2.500 ac 10.00% Impervious Runoff Depth=0.92"
Flow Length=555' Tc=19.4 min CN=37/98 Runoff=1.07 cfs 0.191 af

Subcatchment EWS-A2: EWS-A2 Runoff Area=0.130 ac 30.77% Impervious Runoff Depth=3.06"
Flow Length=260' Slope=0.0200 '/' Tc=2.4 min CN=58/98 Runoff=0.46 cfs 0.033 af

Subcatchment EWS-B: EWS-B Runoff Area=3.520 ac 4.83% Impervious Runoff Depth=1.71"
Flow Length=545' Tc=34.0 min CN=54/98 Runoff=3.29 cfs 0.501 af

Subcatchment EWS-C: EWS-C Runoff Area=2.130 ac 0.00% Impervious Runoff Depth=1.90"
Flow Length=440' Tc=8.5 min CN=59/0 Runoff=4.00 cfs 0.338 af

Link EWS A1 & A2: Inflow=1.24 cfs 0.224 af
Primary=1.24 cfs 0.224 af

Total Runoff Area = 8.280 ac Runoff Volume = 1.063 af Average Runoff Depth = 1.54"
94.44% Pervious = 7.820 ac 5.56% Impervious = 0.460 ac

Summary for Subcatchment EWS-A1: EWS-A1

Runoff = 1.07 cfs @ 12.27 hrs, Volume= 0.191 af, Depth= 0.92"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

	Area (ac)	CN	Description
*	0.170	98	gravel road
*	0.080	98	Roofs
	1.740	30	Woods, Good, HSG A
	0.510	61	>75% Grass cover, Good, HSG B
	2.500	43	Weighted Average
	2.250	37	Pervious Area
	0.250	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	100	0.0200	0.12		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.30"
0.8	150	0.0400	3.22		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.3	40	0.2500	2.50		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
4.2	265	0.0450	1.06		**Shallow Concentrated Flow, D-E** Woodland Kv= 5.0 fps
19.4	555	Total			

Summary for Subcatchment EWS-A2: EWS-A2

Runoff = 0.46 cfs @ 12.04 hrs, Volume= 0.033 af, Depth= 3.06"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

	Area (ac)	CN	Description
*	0.040	98	gravel road
	0.040	55	Woods, Good, HSG B
	0.050	61	>75% Grass cover, Good, HSG B
	0.130	71	Weighted Average
	0.090	58	Pervious Area
	0.040	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0200	1.40		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
1.2	160	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
2.4	260	Total			

Summary for Subcatchment EWS-B: EWS-B

Runoff = 3.29 cfs @ 12.53 hrs, Volume= 0.501 af, Depth= 1.71"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

Area (ac)	CN	Description
3.150	55	Woods, Good, HSG B
0.170	98	Paved parking & roofs
0.200	30	Woods, Good, HSG A
3.520	56	Weighted Average
3.350	54	Pervious Area
0.170	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.2	75	0.0200	0.04		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.30"
2.4	200	0.0200	1.41		**Shallow Concentrated Flow, B-C** Nearly Bare & Untilled Kv= 10.0 fps
2.4	270	0.0700	1.85		**Shallow Concentrated Flow, C-D** Short Grass Pasture Kv= 7.0 fps
34.0	545	Total			

Summary for Subcatchment EWS-C: EWS-C

Runoff = 4.00 cfs @ 12.13 hrs, Volume= 0.338 af, Depth= 1.90"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

Area (ac)	CN	Description
0.550	70	Woods, Good, HSG C
1.580	55	Woods, Good, HSG B
2.130	59	Weighted Average
2.130	59	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0400	1.84		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
7.6	340	0.0220	0.74		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
8.5	440	Total			

Summary for Link EWS A1 & A2:

Inflow Area = 2.630 ac, 11.03% Impervious, Inflow Depth = 1.02" for 25 YR event
Inflow = 1.24 cfs @ 12.26 hrs, Volume= 0.224 af
Primary = 1.24 cfs @ 12.26 hrs, Volume= 0.224 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EWS-A1: EWS-A1 Runoff Area=2.500 ac 10.00% Impervious Runoff Depth=1.98"
Flow Length=555' Tc=19.4 min CN=37/98 Runoff=2.85 cfs 0.412 af

Subcatchment EWS-A2: EWS-A2 Runoff Area=0.130 ac 30.77% Impervious Runoff Depth=5.12"
Flow Length=260' Slope=0.0200 '/' Tc=2.4 min CN=58/98 Runoff=0.79 cfs 0.055 af

Subcatchment EWS-B: EWS-B Runoff Area=3.520 ac 4.83% Impervious Runoff Depth=3.41"
Flow Length=545' Tc=34.0 min CN=54/98 Runoff=7.13 cfs 1.001 af

Subcatchment EWS-C: EWS-C Runoff Area=2.130 ac 0.00% Impervious Runoff Depth=3.75"
Flow Length=440' Tc=8.5 min CN=59/0 Runoff=8.28 cfs 0.665 af

Link EWS A1 & A2: Inflow=3.12 cfs 0.467 af
Primary=3.12 cfs 0.467 af

Total Runoff Area = 8.280 ac Runoff Volume = 2.133 af Average Runoff Depth = 3.09"
94.44% Pervious = 7.820 ac 5.56% Impervious = 0.460 ac

Summary for Subcatchment EWS-A1: EWS-A1

Runoff = 2.85 cfs @ 12.31 hrs, Volume= 0.412 af, Depth= 1.98"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

	Area (ac)	CN	Description
*	0.170	98	gravel road
*	0.080	98	Roofs
	1.740	30	Woods, Good, HSG A
	0.510	61	>75% Grass cover, Good, HSG B
	2.500	43	Weighted Average
	2.250	37	Pervious Area
	0.250	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	100	0.0200	0.12		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.30"
0.8	150	0.0400	3.22		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.3	40	0.2500	2.50		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
4.2	265	0.0450	1.06		**Shallow Concentrated Flow, D-E** Woodland Kv= 5.0 fps
19.4	555	Total			

Summary for Subcatchment EWS-A2: EWS-A2

Runoff = 0.79 cfs @ 12.04 hrs, Volume= 0.055 af, Depth= 5.12"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

	Area (ac)	CN	Description
*	0.040	98	gravel road
	0.040	55	Woods, Good, HSG B
	0.050	61	>75% Grass cover, Good, HSG B
	0.130	71	Weighted Average
	0.090	58	Pervious Area
	0.040	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0200	1.40		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
1.2	160	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
2.4	260	Total			

Summary for Subcatchment EWS-B: EWS-B

Runoff = 7.13 cfs @ 12.50 hrs, Volume= 1.001 af, Depth= 3.41"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

Area (ac)	CN	Description
3.150	55	Woods, Good, HSG B
0.170	98	Paved parking & roofs
0.200	30	Woods, Good, HSG A
3.520	56	Weighted Average
3.350	54	Pervious Area
0.170	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.2	75	0.0200	0.04		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.30"
2.4	200	0.0200	1.41		**Shallow Concentrated Flow, B-C** Nearly Bare & Untilled Kv= 10.0 fps
2.4	270	0.0700	1.85		**Shallow Concentrated Flow, C-D** Short Grass Pasture Kv= 7.0 fps
34.0	545	Total			

Summary for Subcatchment EWS-C: EWS-C

Runoff = 8.28 cfs @ 12.13 hrs, Volume= 0.665 af, Depth= 3.75"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

Area (ac)	CN	Description
0.550	70	Woods, Good, HSG C
1.580	55	Woods, Good, HSG B
2.130	59	Weighted Average
2.130	59	Pervious Area

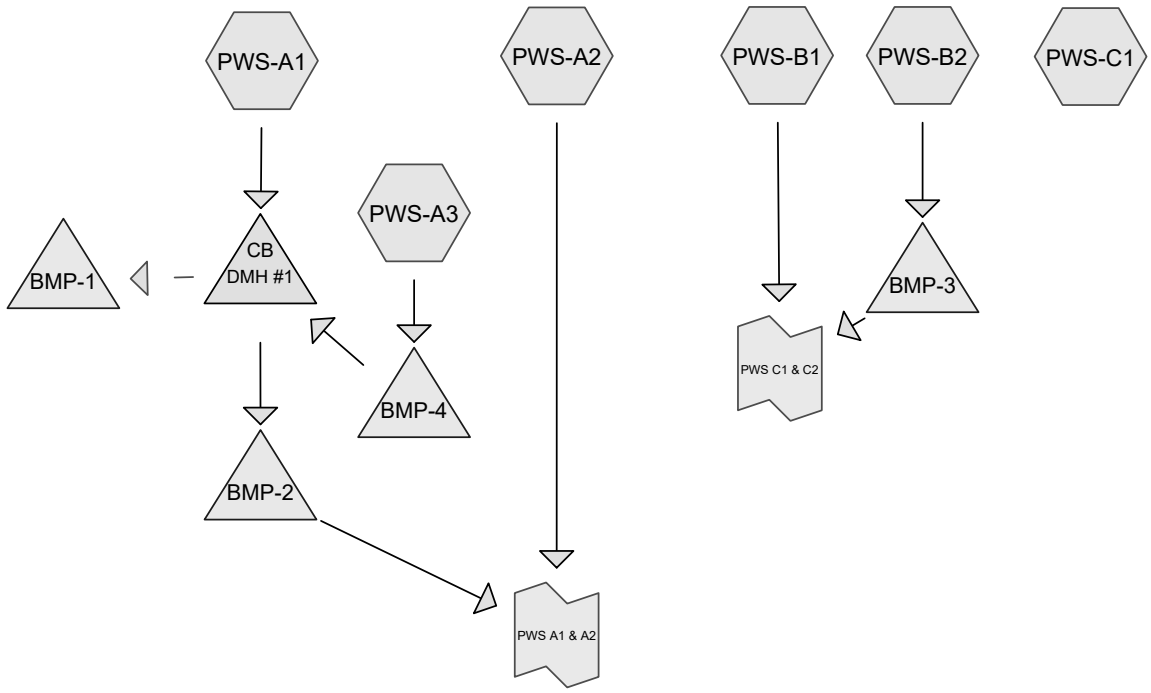
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0400	1.84		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
7.6	340	0.0220	0.74		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
8.5	440	Total			

Summary for Link EWS A1 & A2:

Inflow Area = 2.630 ac, 11.03% Impervious, Inflow Depth = 2.13" for 100 YR event
Inflow = 3.12 cfs @ 12.30 hrs, Volume= 0.467 af
Primary = 3.12 cfs @ 12.30 hrs, Volume= 0.467 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Appendix C
Proposed Watershed Calculations



Subcat Reach Pond Link

Drainage Diagram for 6856-2015-10-30-PWS-R7
Prepared by Garofalo & Associates, Inc.

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PWS-A1: Runoff Area=3.540 ac 62.71% Impervious Runoff Depth=1.97"
Tc=5.0 min CN=49/98 Runoff=7.16 cfs 0.581 af

Subcatchment PWS-A2: Runoff Area=0.300 ac 26.67% Impervious Runoff Depth=0.82"
Flow Length=70' Slope=0.0200 '/' Tc=7.3 min CN=39/98 Runoff=0.24 cfs 0.020 af

Subcatchment PWS-A3: Runoff Area=0.140 ac 100.00% Impervious Runoff Depth=3.07"
Flow Length=130' Tc=9.7 min CN=0/98 Runoff=0.39 cfs 0.036 af

Subcatchment PWS-B1: Runoff Area=2.250 ac 0.00% Impervious Runoff Depth=0.25"
Flow Length=720' Tc=45.5 min CN=54/0 Runoff=0.14 cfs 0.047 af

Subcatchment PWS-B2: Runoff Area=0.570 ac 87.72% Impervious Runoff Depth=2.75"
Tc=5.0 min CN=61/98 Runoff=1.64 cfs 0.131 af

Subcatchment PWS-C1: Runoff Area=1.610 ac 0.00% Impervious Runoff Depth=0.45"
Flow Length=380' Tc=29.1 min CN=60/0 Runoff=0.32 cfs 0.060 af

Pond BMP-1: Peak Elev=197.77' Storage=8,365 cf Inflow=6.98 cfs 0.448 af
Outflow=0.50 cfs 0.448 af

Pond BMP-2: Peak Elev=193.38' Storage=4,544 cf Inflow=5.02 cfs 0.134 af
Discarded=0.28 cfs 0.115 af Primary=0.09 cfs 0.019 af Outflow=0.37 cfs 0.134 af

Pond BMP-3: Peak Elev=210.31' Storage=1,664 cf Inflow=1.64 cfs 0.131 af
Discarded=0.31 cfs 0.131 af Primary=0.00 cfs 0.000 af Outflow=0.31 cfs 0.131 af

Pond BMP-4: Peak Elev=207.28' Storage=501 cf Inflow=0.39 cfs 0.036 af
Discarded=0.05 cfs 0.036 af Primary=0.00 cfs 0.000 af Outflow=0.05 cfs 0.036 af

Pond DMH #1: Peak Elev=197.61' Inflow=7.16 cfs 0.581 af
Primary=5.02 cfs 0.134 af Secondary=6.98 cfs 0.448 af Outflow=7.16 cfs 0.581 af

Link PWS A1 & A2: Inflow=0.24 cfs 0.040 af
Primary=0.24 cfs 0.040 af

Link PWS C1 & C2: Inflow=0.14 cfs 0.047 af
Primary=0.14 cfs 0.047 af

Total Runoff Area = 8.410 ac Runoff Volume = 0.876 af Average Runoff Depth = 1.25"
65.04% Pervious = 5.470 ac 34.96% Impervious = 2.940 ac

Summary for Subcatchment PWS-A1:

Runoff = 7.16 cfs @ 12.07 hrs, Volume= 0.581 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

	Area (ac)	CN	Description
*	2.220	98	roof and pavement
	0.620	61	>75% Grass cover, Good, HSG B
	0.700	39	>75% Grass cover, Good, HSG A
	3.540	80	Weighted Average
	1.320	49	Pervious Area
	2.220	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - H**

Summary for Subcatchment PWS-A2:

Runoff = 0.24 cfs @ 12.10 hrs, Volume= 0.020 af, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

	Area (ac)	CN	Description
	0.220	39	>75% Grass cover, Good, HSG A
	0.040	98	Paved roads w/curbs & sewers
*	0.030	98	Gravel Road "B"
*	0.010	98	Gravel Road "A"
	0.300	55	Weighted Average
	0.220	39	Pervious Area
	0.080	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	70	0.0200	0.16		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment PWS-A3:

Runoff = 0.39 cfs @ 12.13 hrs, Volume= 0.036 af, Depth= 3.07"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

Area (ac)	CN	Description
0.140	98	Paved roads w/curbs & sewers
0.140	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"
0.1	30	0.2200	7.55		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.7	130	Total			

Summary for Subcatchment PWS-B1:

Runoff = 0.14 cfs @ 12.94 hrs, Volume= 0.047 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

Area (ac)	CN	Description
1.720	55	Woods, Good, HSG B
0.220	39	>75% Grass cover, Good, HSG A
0.310	61	>75% Grass cover, Good, HSG B
2.250	54	Weighted Average
2.250	54	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.8	100	0.0200	0.05		**Sheet Flow, A -B** Woods: Dense underbrush n= 0.800 P2= 3.30"
2.4	220	0.0100	1.50		**Shallow Concentrated Flow, B - C** Grassed Waterway Kv= 15.0 fps
6.3	400	0.0450	1.06		**Shallow Concentrated Flow, C - D** Woodland Kv= 5.0 fps
45.5	720	Total			

Summary for Subcatchment PWS-B2:

Runoff = 1.64 cfs @ 12.07 hrs, Volume= 0.131 af, Depth= 2.75"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

	Area (ac)	CN	Description
*	0.500	98	roof
	0.070	61	>75% Grass cover, Good, HSG B
	0.570	93	Weighted Average
	0.070	61	Pervious Area
	0.500	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - B**

Summary for Subcatchment PWS-C1:

Runoff = 0.32 cfs @ 12.55 hrs, Volume= 0.060 af, Depth= 0.45"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YR Rainfall=3.30"

Area (ac)	CN	Description
1.030	55	Woods, Good, HSG B
0.580	70	Woods, Good, HSG C
1.610	60	Weighted Average
1.610	60	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0600	0.07		**Sheet Flow, A - B** Woods: Dense underbrush n= 0.800 P2= 3.30"
3.0	180	0.0400	1.00		**Shallow Concentrated Flow, B - C** Woodland Kv= 5.0 fps
2.4	100	0.0200	0.71		**Shallow Concentrated Flow, C - D** Woodland Kv= 5.0 fps
29.1	380	Total			

Summary for Pond BMP-1:

Inflow = 6.98 cfs @ 12.05 hrs, Volume= 0.448 af
Outflow = 0.50 cfs @ 12.16 hrs, Volume= 0.448 af, Atten= 93%, Lag= 6.9 min
Discarded = 0.50 cfs @ 12.16 hrs, Volume= 0.448 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 197.77' @ 12.16 hrs Surf.Area= 7,205 sf Storage= 8,365 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 236.8 min (1,002.8 - 765.9)

Volume	Invert	Avail.Storage	Storage Description
#1	197.20'	5,808 cf	**Surface Storage (Prismatic)** Listed below (Recalc)
#2	192.00'	1,003 cf	**Sand (Prismatic)** Listed below (Recalc) 3,040 cf Overall x 33.0% Voids
#3	194.00'	2,413 cf	**PRE-TREATMENT (Prismatic)** Listed below (Recalc)
#4	194.00'	3,316 cf	**WQ (Prismatic)** Listed below (Recalc)
		12,541 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
197.20	2,670	0	0
198.00	3,150	2,328	2,328
199.00	3,810	3,480	5,808

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	1,520	0	0
194.00	1,520	3,040	3,040

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	420	0	0
196.00	820	1,240	1,240
197.00	1,080	950	2,190
197.20	1,150	223	2,413

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	640	0	0
196.00	1,115	1,755	1,755
197.00	1,420	1,268	3,023
197.20	1,520	294	3,316

Device	Routing	Invert	Outlet Devices
#1	Discarded	192.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.50 cfs @ 12.16 hrs HW=197.76' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.50 cfs)

Summary for Pond BMP-2:

Inflow Area = 3.680 ac, 64.13% Impervious, Inflow Depth = 0.44" for 2 YR event
Inflow = 5.02 cfs @ 12.16 hrs, Volume= 0.134 af
Outflow = 0.37 cfs @ 13.01 hrs, Volume= 0.134 af, Atten= 93%, Lag= 51.1 min
Discarded = 0.28 cfs @ 13.01 hrs, Volume= 0.115 af
Primary = 0.09 cfs @ 13.01 hrs, Volume= 0.019 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 193.38' @ 13.01 hrs Surf.Area= 3,917 sf Storage= 4,544 cf

Plug-Flow detention time= 137.4 min calculated for 0.134 af (100% of inflow)
Center-of-Mass det. time= 137.9 min (882.6 - 744.7)

Volume	Invert	Avail.Storage	Storage Description
#1	192.00'	42,745 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	2,660	0	0
194.00	4,480	7,140	7,140
196.00	6,510	10,990	18,130
198.00	8,750	15,260	33,390
199.00	9,960	9,355	42,745

Device	Routing	Invert	Outlet Devices
#1	Primary	192.50'	**2.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	198.05'	**2.00' x 2.00' Horiz. Overflow Grate** Limited to weir flow C= 0.600
#3	Discarded	192.00'	**3.040 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.28 cfs @ 13.01 hrs HW=193.38' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=0.09 cfs @ 13.01 hrs HW=193.38' TW=0.00' (Dynamic Tailwater)
├**1=Orifice/Grate** (Orifice Controls 0.09 cfs @ 4.30 fps)
└**2=Overflow Grate** (Controls 0.00 cfs)

Summary for Pond BMP-3:

Inflow Area = 0.570 ac, 87.72% Impervious, Inflow Depth = 2.75" for 2 YR event
Inflow = 1.64 cfs @ 12.07 hrs, Volume= 0.131 af
Outflow = 0.31 cfs @ 12.51 hrs, Volume= 0.131 af, Atten= 81%, Lag= 26.4 min
Discarded = 0.31 cfs @ 12.51 hrs, Volume= 0.131 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 210.31' @ 12.51 hrs Surf.Area= 4,349 sf Storage= 1,664 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 46.5 min (804.7 - 758.2)

Volume	Invert	Avail.Storage	Storage Description
#1	210.00'	6,250 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
#2	208.00'	990 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 3,000 cf Overall x 33.0% Voids
		7,240 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
210.00	2,000	0	0
212.00	4,250	6,250	6,250

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
208.00	2,000	0	0
209.50	2,000	3,000	3,000

Device	Routing	Invert	Outlet Devices
#1	Discarded	208.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	210.50'	**8.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.31 cfs @ 12.51 hrs HW=210.31' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.31 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=208.00' TW=0.00' (Dynamic Tailwater)
└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond BMP-4:

Inflow Area = 0.140 ac,100.00% Impervious, Inflow Depth = 3.07" for 2 YR event
Inflow = 0.39 cfs @ 12.13 hrs, Volume= 0.036 af
Outflow = 0.05 cfs @ 11.70 hrs, Volume= 0.036 af, Atten= 88%, Lag= 0.0 min
Discarded = 0.05 cfs @ 11.70 hrs, Volume= 0.036 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 207.28' @ 12.84 hrs Surf.Area= 672 sf Storage= 501 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 68.5 min (827.7 - 759.2)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	380 cf	**Stone (Prismatic)** Listed below (Recalc) x 28 1,566 cf Overall - 413 cf Embedded = 1,153 cf x 33.0% Voids
#2	206.50'	413 cf	**28.9"W x 16.0"H x 7.12'L StormTech SC-310** x 28 Inside #1
		793 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	24	0	0
208.33	24	56	56

Device	Routing	Invert	Outlet Devices
#1	Discarded	206.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	207.50'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 11.70 hrs HW=206.03' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=206.00' TW=195.14' (Dynamic Tailwater)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Summary for Pond DMH #1:

Inflow Area = 3.680 ac, 64.13% Impervious, Inflow Depth = 1.90" for 2 YR event
Inflow = 7.16 cfs @ 12.07 hrs, Volume= 0.581 af
Outflow = 7.16 cfs @ 12.07 hrs, Volume= 0.581 af, Atten= 0%, Lag= 0.0 min
Primary = 5.02 cfs @ 12.16 hrs, Volume= 0.134 af
Secondary = 6.98 cfs @ 12.05 hrs, Volume= 0.448 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 197.61' @ 12.16 hrs
Flood Elev= 199.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	197.20'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Secondary	195.14'	**24.0" x 10.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 194.94' S= 0.0200 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=4.66 cfs @ 12.16 hrs HW=197.59' TW=192.31' (Dynamic Tailwater)
└**1=Sharp-Crested Rectangular Weir** (Weir Controls 4.66 cfs @ 2.03 fps)

Secondary OutFlow Max=0.00 cfs @ 12.05 hrs HW=197.12' TW=197.30' (Dynamic Tailwater)
└**2=Culvert** (Controls 0.00 cfs)

Summary for Link PWS A1 & A2:

Inflow Area = 3.980 ac, 61.31% Impervious, Inflow Depth = 0.12" for 2 YR event
Inflow = 0.24 cfs @ 12.10 hrs, Volume= 0.040 af
Primary = 0.24 cfs @ 12.10 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Summary for Link PWS C1 & C2:

Inflow Area = 2.820 ac, 17.73% Impervious, Inflow Depth = 0.20" for 2 YR event
Inflow = 0.14 cfs @ 12.94 hrs, Volume= 0.047 af
Primary = 0.14 cfs @ 12.94 hrs, Volume= 0.047 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PWS-A1: Runoff Area=3.540 ac 62.71% Impervious Runoff Depth=3.15"
Tc=5.0 min CN=49/98 Runoff=11.11 cfs 0.929 af

Subcatchment PWS-A2: Runoff Area=0.300 ac 26.67% Impervious Runoff Depth=1.38"
Flow Length=70' Slope=0.0200 '/' Tc=7.3 min CN=39/98 Runoff=0.36 cfs 0.034 af

Subcatchment PWS-A3: Runoff Area=0.140 ac 100.00% Impervious Runoff Depth=4.66"
Flow Length=130' Tc=9.7 min CN=0/98 Runoff=0.58 cfs 0.054 af

Subcatchment PWS-B1: Runoff Area=2.250 ac 0.00% Impervious Runoff Depth=0.87"
Flow Length=720' Tc=45.5 min CN=54/0 Runoff=0.82 cfs 0.164 af

Subcatchment PWS-B2: Runoff Area=0.570 ac 87.72% Impervious Runoff Depth=4.25"
Tc=5.0 min CN=61/98 Runoff=2.51 cfs 0.202 af

Subcatchment PWS-C1: Runoff Area=1.610 ac 0.00% Impervious Runoff Depth=1.24"
Flow Length=380' Tc=29.1 min CN=60/0 Runoff=1.19 cfs 0.167 af

Pond BMP-1: Peak Elev=197.93' Storage=8,848 cf Inflow=3.53 cfs 0.559 af
Outflow=0.51 cfs 0.559 af

Pond BMP-2: Peak Elev=195.11' Storage=12,736 cf Inflow=9.24 cfs 0.377 af
Discarded=0.39 cfs 0.286 af Primary=0.17 cfs 0.091 af Outflow=0.56 cfs 0.377 af

Pond BMP-3: Peak Elev=210.59' Storage=2,379 cf Inflow=2.51 cfs 0.202 af
Discarded=0.33 cfs 0.183 af Primary=0.76 cfs 0.019 af Outflow=1.09 cfs 0.202 af

Pond BMP-4: Peak Elev=207.74' Storage=661 cf Inflow=0.58 cfs 0.054 af
Discarded=0.05 cfs 0.048 af Primary=0.24 cfs 0.007 af Outflow=0.29 cfs 0.054 af

Pond DMH #1: Peak Elev=197.81' Inflow=11.11 cfs 0.936 af
Primary=9.24 cfs 0.377 af Secondary=3.53 cfs 0.559 af Outflow=11.11 cfs 0.936 af

Link PWS A1 & A2: Inflow=0.46 cfs 0.125 af
Primary=0.46 cfs 0.125 af

Link PWS C1 & C2: Inflow=0.96 cfs 0.183 af
Primary=0.96 cfs 0.183 af

Total Runoff Area = 8.410 ac Runoff Volume = 1.550 af Average Runoff Depth = 2.21"
65.04% Pervious = 5.470 ac 34.96% Impervious = 2.940 ac

Summary for Subcatchment PWS-A1:

Runoff = 11.11 cfs @ 12.07 hrs, Volume= 0.929 af, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

	Area (ac)	CN	Description
*	2.220	98	roof and pavement
	0.620	61	>75% Grass cover, Good, HSG B
	0.700	39	>75% Grass cover, Good, HSG A
	3.540	80	Weighted Average
	1.320	49	Pervious Area
	2.220	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - H**

Summary for Subcatchment PWS-A2:

Runoff = 0.36 cfs @ 12.10 hrs, Volume= 0.034 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

	Area (ac)	CN	Description
	0.220	39	>75% Grass cover, Good, HSG A
	0.040	98	Paved roads w/curbs & sewers
*	0.030	98	Gravel Road "B"
*	0.010	98	Gravel Road "A"
	0.300	55	Weighted Average
	0.220	39	Pervious Area
	0.080	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	70	0.0200	0.16		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment PWS-A3:

Runoff = 0.58 cfs @ 12.13 hrs, Volume= 0.054 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

Area (ac)	CN	Description
0.140	98	Paved roads w/curbs & sewers
0.140	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"
0.1	30	0.2200	7.55		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.7	130	Total			

Summary for Subcatchment PWS-B1:

Runoff = 0.82 cfs @ 12.75 hrs, Volume= 0.164 af, Depth= 0.87"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

Area (ac)	CN	Description
1.720	55	Woods, Good, HSG B
0.220	39	>75% Grass cover, Good, HSG A
0.310	61	>75% Grass cover, Good, HSG B
2.250	54	Weighted Average
2.250	54	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.8	100	0.0200	0.05		**Sheet Flow, A -B** Woods: Dense underbrush n= 0.800 P2= 3.30"
2.4	220	0.0100	1.50		**Shallow Concentrated Flow, B - C** Grassed Waterway Kv= 15.0 fps
6.3	400	0.0450	1.06		**Shallow Concentrated Flow, C - D** Woodland Kv= 5.0 fps
45.5	720	Total			

Summary for Subcatchment PWS-B2:

Runoff = 2.51 cfs @ 12.07 hrs, Volume= 0.202 af, Depth= 4.25"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

	Area (ac)	CN	Description
*	0.500	98	roof
	0.070	61	>75% Grass cover, Good, HSG B
	0.570	93	Weighted Average
	0.070	61	Pervious Area
	0.500	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - B**

Summary for Subcatchment PWS-C1:

Runoff = 1.19 cfs @ 12.46 hrs, Volume= 0.167 af, Depth= 1.24"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YR Rainfall=4.90"

Area (ac)	CN	Description
1.030	55	Woods, Good, HSG B
0.580	70	Woods, Good, HSG C
1.610	60	Weighted Average
1.610	60	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0600	0.07		**Sheet Flow, A - B** Woods: Dense underbrush n= 0.800 P2= 3.30"
3.0	180	0.0400	1.00		**Shallow Concentrated Flow, B - C** Woodland Kv= 5.0 fps
2.4	100	0.0200	0.71		**Shallow Concentrated Flow, C - D** Woodland Kv= 5.0 fps
29.1	380	Total			

Summary for Pond BMP-1:

Inflow = 3.53 cfs @ 12.05 hrs, Volume= 0.559 af
Outflow = 0.51 cfs @ 12.14 hrs, Volume= 0.559 af, Atten= 86%, Lag= 5.6 min
Discarded = 0.51 cfs @ 12.14 hrs, Volume= 0.559 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 197.93' @ 12.14 hrs Surf.Area= 7,299 sf Storage= 8,848 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 245.8 min (1,015.2 - 769.3)

Volume	Invert	Avail.Storage	Storage Description
#1	197.20'	5,808 cf	**Surface Storage (Prismatic)** Listed below (Recalc)
#2	192.00'	1,003 cf	**Sand (Prismatic)** Listed below (Recalc) 3,040 cf Overall x 33.0% Voids
#3	194.00'	2,413 cf	**PRE-TREATMENT (Prismatic)** Listed below (Recalc)
#4	194.00'	3,316 cf	**WQ (Prismatic)** Listed below (Recalc)
		12,541 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
197.20	2,670	0	0
198.00	3,150	2,328	2,328
199.00	3,810	3,480	5,808

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	1,520	0	0
194.00	1,520	3,040	3,040

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	420	0	0
196.00	820	1,240	1,240
197.00	1,080	950	2,190
197.20	1,150	223	2,413

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	640	0	0
196.00	1,115	1,755	1,755
197.00	1,420	1,268	3,023
197.20	1,520	294	3,316

Device	Routing	Invert	Outlet Devices
#1	Discarded	192.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.51 cfs @ 12.14 hrs HW=197.93' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.51 cfs)

Summary for Pond BMP-2:

Inflow Area = 3.680 ac, 64.13% Impervious, Inflow Depth = 1.23" for 10 YR event
Inflow = 9.24 cfs @ 12.10 hrs, Volume= 0.377 af
Outflow = 0.56 cfs @ 13.26 hrs, Volume= 0.377 af, Atten= 94%, Lag= 69.1 min
Discarded = 0.39 cfs @ 13.26 hrs, Volume= 0.286 af
Primary = 0.17 cfs @ 13.26 hrs, Volume= 0.091 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 195.11' @ 13.26 hrs Surf.Area= 5,606 sf Storage= 12,736 cf

Plug-Flow detention time= 259.4 min calculated for 0.377 af (100% of inflow)
Center-of-Mass det. time= 259.8 min (1,005.5 - 745.7)

Volume	Invert	Avail.Storage	Storage Description
#1	192.00'	42,745 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	2,660	0	0
194.00	4,480	7,140	7,140
196.00	6,510	10,990	18,130
198.00	8,750	15,260	33,390
199.00	9,960	9,355	42,745

Device	Routing	Invert	Outlet Devices
#1	Primary	192.50'	**2.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	198.05'	**2.00' x 2.00' Horiz. Overflow Grate** Limited to weir flow C= 0.600
#3	Discarded	192.00'	**3.040 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.39 cfs @ 13.26 hrs HW=195.11' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.39 cfs)

Primary OutFlow Max=0.17 cfs @ 13.26 hrs HW=195.11' TW=0.00' (Dynamic Tailwater)
├**1=Orifice/Grate** (Orifice Controls 0.17 cfs @ 7.65 fps)
└**2=Overflow Grate** (Controls 0.00 cfs)

Summary for Pond BMP-3:

Inflow Area = 0.570 ac, 87.72% Impervious, Inflow Depth = 4.25" for 10 YR event
Inflow = 2.51 cfs @ 12.07 hrs, Volume= 0.202 af
Outflow = 1.09 cfs @ 12.26 hrs, Volume= 0.202 af, Atten= 56%, Lag= 11.5 min
Discarded = 0.33 cfs @ 12.26 hrs, Volume= 0.183 af
Primary = 0.76 cfs @ 12.26 hrs, Volume= 0.019 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 210.59' @ 12.26 hrs Surf.Area= 4,669 sf Storage= 2,379 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 50.8 min (802.9 - 752.2)

Volume	Invert	Avail.Storage	Storage Description
#1	210.00'	6,250 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
#2	208.00'	990 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 3,000 cf Overall x 33.0% Voids
		7,240 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
210.00	2,000	0	0
212.00	4,250	6,250	6,250

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
208.00	2,000	0	0
209.50	2,000	3,000	3,000

Device	Routing	Invert	Outlet Devices
#1	Discarded	208.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	210.50'	**8.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.33 cfs @ 12.26 hrs HW=210.59' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.33 cfs)

Primary OutFlow Max=0.75 cfs @ 12.26 hrs HW=210.59' TW=0.00' (Dynamic Tailwater)
↑**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.75 cfs @ 1.00 fps)

Summary for Pond BMP-4:

Inflow Area = 0.140 ac,100.00% Impervious, Inflow Depth = 4.66" for 10 YR event
Inflow = 0.58 cfs @ 12.13 hrs, Volume= 0.054 af
Outflow = 0.29 cfs @ 12.36 hrs, Volume= 0.054 af, Atten= 51%, Lag= 13.9 min
Discarded = 0.05 cfs @ 11.35 hrs, Volume= 0.048 af
Primary = 0.24 cfs @ 12.36 hrs, Volume= 0.007 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 207.74' @ 12.36 hrs Surf.Area= 672 sf Storage= 661 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 78.4 min (830.2 - 751.8)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	380 cf	**Stone (Prismatic)** Listed below (Recalc) x 28 1,566 cf Overall - 413 cf Embedded = 1,153 cf x 33.0% Voids
#2	206.50'	413 cf	**28.9"W x 16.0"H x 7.12'L StormTech SC-310** x 28 Inside #1
		793 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	24	0	0
208.33	24	56	56

Device	Routing	Invert	Outlet Devices
#1	Discarded	206.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	207.50'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 11.35 hrs HW=206.03' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.23 cfs @ 12.36 hrs HW=207.73' TW=197.55' (Dynamic Tailwater)
↑**2=Orifice/Grate** (Orifice Controls 0.23 cfs @ 1.65 fps)

Summary for Pond DMH #1:

Inflow Area = 3.680 ac, 64.13% Impervious, Inflow Depth = 3.05" for 10 YR event
Inflow = 11.11 cfs @ 12.07 hrs, Volume= 0.936 af
Outflow = 11.11 cfs @ 12.07 hrs, Volume= 0.936 af, Atten= 0%, Lag= 0.0 min
Primary = 9.24 cfs @ 12.10 hrs, Volume= 0.377 af
Secondary = 3.53 cfs @ 12.05 hrs, Volume= 0.559 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 197.81' @ 12.10 hrs
Flood Elev= 199.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	197.20'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Secondary	195.14'	**24.0" x 10.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 194.94' S= 0.0200 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=9.10 cfs @ 12.10 hrs HW=197.81' TW=193.37' (Dynamic Tailwater)
└**1=Sharp-Crested Rectangular Weir** (Weir Controls 9.10 cfs @ 2.55 fps)

Secondary OutFlow Max=0.00 cfs @ 12.05 hrs HW=197.71' TW=197.79' (Dynamic Tailwater)
└**2=Culvert** (Controls 0.00 cfs)

Summary for Link PWS A1 & A2:

Inflow Area = 3.980 ac, 61.31% Impervious, Inflow Depth = 0.38" for 10 YR event
Inflow = 0.46 cfs @ 12.11 hrs, Volume= 0.125 af
Primary = 0.46 cfs @ 12.11 hrs, Volume= 0.125 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Summary for Link PWS C1 & C2:

Inflow Area = 2.820 ac, 17.73% Impervious, Inflow Depth = 0.78" for 10 YR event
Inflow = 0.96 cfs @ 12.34 hrs, Volume= 0.183 af
Primary = 0.96 cfs @ 12.34 hrs, Volume= 0.183 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PWS-A1: Runoff Area=3.540 ac 62.71% Impervious Runoff Depth=4.09"
Tc=5.0 min CN=49/98 Runoff=14.63 cfs 1.208 af

Subcatchment PWS-A2: Runoff Area=0.300 ac 26.67% Impervious Runoff Depth=1.91"
Flow Length=70' Slope=0.0200 '/' Tc=7.3 min CN=39/98 Runoff=0.46 cfs 0.048 af

Subcatchment PWS-A3: Runoff Area=0.140 ac 100.00% Impervious Runoff Depth=5.86"
Flow Length=130' Tc=9.7 min CN=0/98 Runoff=0.73 cfs 0.068 af

Subcatchment PWS-B1: Runoff Area=2.250 ac 0.00% Impervious Runoff Depth=1.50"
Flow Length=720' Tc=45.5 min CN=54/0 Runoff=1.60 cfs 0.281 af

Subcatchment PWS-B2: Runoff Area=0.570 ac 87.72% Impervious Runoff Depth=5.40"
Tc=5.0 min CN=61/98 Runoff=3.17 cfs 0.256 af

Subcatchment PWS-C1: Runoff Area=1.610 ac 0.00% Impervious Runoff Depth=1.99"
Flow Length=380' Tc=29.1 min CN=60/0 Runoff=2.03 cfs 0.267 af

Pond BMP-1: Peak Elev=198.09' Storage=9,352 cf Inflow=4.32 cfs 0.628 af
Outflow=0.51 cfs 0.628 af

Pond BMP-2: Peak Elev=196.25' Storage=19,797 cf Inflow=12.66 cfs 0.594 af
Discarded=0.48 cfs 0.440 af Primary=0.20 cfs 0.155 af Outflow=0.68 cfs 0.595 af

Pond BMP-3: Peak Elev=210.68' Storage=2,605 cf Inflow=3.17 cfs 0.256 af
Discarded=0.34 cfs 0.210 af Primary=1.95 cfs 0.046 af Outflow=2.29 cfs 0.256 af

Pond BMP-4: Peak Elev=207.86' Storage=689 cf Inflow=0.73 cfs 0.068 af
Discarded=0.05 cfs 0.054 af Primary=0.51 cfs 0.015 af Outflow=0.56 cfs 0.068 af

Pond DMH #1: Peak Elev=197.96' Inflow=14.63 cfs 1.222 af
Primary=12.66 cfs 0.594 af Secondary=4.32 cfs 0.628 af Outflow=14.63 cfs 1.222 af

Link PWS A1 & A2: Inflow=0.60 cfs 0.202 af
Primary=0.60 cfs 0.202 af

Link PWS C1 & C2: Inflow=2.24 cfs 0.327 af
Primary=2.24 cfs 0.327 af

Total Runoff Area = 8.410 ac Runoff Volume = 2.127 af Average Runoff Depth = 3.04"
65.04% Pervious = 5.470 ac 34.96% Impervious = 2.940 ac

Summary for Subcatchment PWS-A1:

Runoff = 14.63 cfs @ 12.07 hrs, Volume= 1.208 af, Depth= 4.09"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

	Area (ac)	CN	Description
*	2.220	98	roof and pavement
	0.620	61	>75% Grass cover, Good, HSG B
	0.700	39	>75% Grass cover, Good, HSG A
	3.540	80	Weighted Average
	1.320	49	Pervious Area
	2.220	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - H**

Summary for Subcatchment PWS-A2:

Runoff = 0.46 cfs @ 12.11 hrs, Volume= 0.048 af, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

	Area (ac)	CN	Description
	0.220	39	>75% Grass cover, Good, HSG A
	0.040	98	Paved roads w/curbs & sewers
*	0.030	98	Gravel Road "B"
*	0.010	98	Gravel Road "A"
	0.300	55	Weighted Average
	0.220	39	Pervious Area
	0.080	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	70	0.0200	0.16		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment PWS-A3:

Runoff = 0.73 cfs @ 12.13 hrs, Volume= 0.068 af, Depth= 5.86"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

Area (ac)	CN	Description
0.140	98	Paved roads w/curbs & sewers
0.140	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"
0.1	30	0.2200	7.55		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.7	130	Total			

Summary for Subcatchment PWS-B1:

Runoff = 1.60 cfs @ 12.71 hrs, Volume= 0.281 af, Depth= 1.50"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

Area (ac)	CN	Description
1.720	55	Woods, Good, HSG B
0.220	39	>75% Grass cover, Good, HSG A
0.310	61	>75% Grass cover, Good, HSG B
2.250	54	Weighted Average
2.250	54	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.8	100	0.0200	0.05		**Sheet Flow, A -B** Woods: Dense underbrush n= 0.800 P2= 3.30"
2.4	220	0.0100	1.50		**Shallow Concentrated Flow, B - C** Grassed Waterway Kv= 15.0 fps
6.3	400	0.0450	1.06		**Shallow Concentrated Flow, C - D** Woodland Kv= 5.0 fps
45.5	720	Total			

Summary for Subcatchment PWS-B2:

Runoff = 3.17 cfs @ 12.07 hrs, Volume= 0.256 af, Depth= 5.40"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

	Area (ac)	CN	Description
*	0.500	98	roof
	0.070	61	>75% Grass cover, Good, HSG B
	0.570	93	Weighted Average
	0.070	61	Pervious Area
	0.500	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - B**

Summary for Subcatchment PWS-C1:

Runoff = 2.03 cfs @ 12.44 hrs, Volume= 0.267 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YR Rainfall=6.10"

Area (ac)	CN	Description
1.030	55	Woods, Good, HSG B
0.580	70	Woods, Good, HSG C
1.610	60	Weighted Average
1.610	60	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0600	0.07		**Sheet Flow, A - B** Woods: Dense underbrush n= 0.800 P2= 3.30"
3.0	180	0.0400	1.00		**Shallow Concentrated Flow, B - C** Woodland Kv= 5.0 fps
2.4	100	0.0200	0.71		**Shallow Concentrated Flow, C - D** Woodland Kv= 5.0 fps
29.1	380	Total			

Summary for Pond BMP-1:

Inflow = 4.32 cfs @ 12.04 hrs, Volume= 0.628 af
Outflow = 0.51 cfs @ 12.14 hrs, Volume= 0.628 af, Atten= 88%, Lag= 5.9 min
Discarded = 0.51 cfs @ 12.14 hrs, Volume= 0.628 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 198.09' @ 12.14 hrs Surf.Area= 7,400 sf Storage= 9,352 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 252.3 min (1,021.9 - 769.6)

Volume	Invert	Avail.Storage	Storage Description
#1	197.20'	5,808 cf	**Surface Storage (Prismatic)** Listed below (Recalc)
#2	192.00'	1,003 cf	**Sand (Prismatic)** Listed below (Recalc) 3,040 cf Overall x 33.0% Voids
#3	194.00'	2,413 cf	**PRE-TREATMENT (Prismatic)** Listed below (Recalc)
#4	194.00'	3,316 cf	**WQ (Prismatic)** Listed below (Recalc)
		12,541 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
197.20	2,670	0	0
198.00	3,150	2,328	2,328
199.00	3,810	3,480	5,808

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	1,520	0	0
194.00	1,520	3,040	3,040

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	420	0	0
196.00	820	1,240	1,240
197.00	1,080	950	2,190
197.20	1,150	223	2,413

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	640	0	0
196.00	1,115	1,755	1,755
197.00	1,420	1,268	3,023
197.20	1,520	294	3,316

Device	Routing	Invert	Outlet Devices
#1	Discarded	192.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.51 cfs @ 12.14 hrs HW=198.09' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.51 cfs)

Summary for Pond BMP-2:

Inflow Area = 3.680 ac, 64.13% Impervious, Inflow Depth = 1.94" for 25 YR event
Inflow = 12.66 cfs @ 12.10 hrs, Volume= 0.594 af
Outflow = 0.68 cfs @ 13.51 hrs, Volume= 0.595 af, Atten= 95%, Lag= 84.7 min
Discarded = 0.48 cfs @ 13.51 hrs, Volume= 0.440 af
Primary = 0.20 cfs @ 13.51 hrs, Volume= 0.155 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 196.25' @ 13.51 hrs Surf.Area= 6,791 sf Storage= 19,797 cf

Plug-Flow detention time= 336.3 min calculated for 0.594 af (100% of inflow)
Center-of-Mass det. time= 336.9 min (1,085.4 - 748.5)

Volume	Invert	Avail.Storage	Storage Description
#1	192.00'	42,745 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	2,660	0	0
194.00	4,480	7,140	7,140
196.00	6,510	10,990	18,130
198.00	8,750	15,260	33,390
199.00	9,960	9,355	42,745

Device	Routing	Invert	Outlet Devices
#1	Primary	192.50'	**2.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	198.05'	**2.00' x 2.00' Horiz. Overflow Grate** Limited to weir flow C= 0.600
#3	Discarded	192.00'	**3.040 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.48 cfs @ 13.51 hrs HW=196.25' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.48 cfs)

Primary OutFlow Max=0.20 cfs @ 13.51 hrs HW=196.25' TW=0.00' (Dynamic Tailwater)
├**1=Orifice/Grate** (Orifice Controls 0.20 cfs @ 9.22 fps)
└**2=Overflow Grate** (Controls 0.00 cfs)

Summary for Pond BMP-3:

Inflow Area = 0.570 ac, 87.72% Impervious, Inflow Depth = 5.40" for 25 YR event
Inflow = 3.17 cfs @ 12.07 hrs, Volume= 0.256 af
Outflow = 2.29 cfs @ 12.16 hrs, Volume= 0.256 af, Atten= 28%, Lag= 5.5 min
Discarded = 0.34 cfs @ 12.16 hrs, Volume= 0.210 af
Primary = 1.95 cfs @ 12.16 hrs, Volume= 0.046 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 210.68' @ 12.16 hrs Surf.Area= 4,763 sf Storage= 2,605 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 47.9 min (797.3 - 749.4)

Volume	Invert	Avail.Storage	Storage Description
#1	210.00'	6,250 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
#2	208.00'	990 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 3,000 cf Overall x 33.0% Voids
		7,240 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
210.00	2,000	0	0
212.00	4,250	6,250	6,250

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
208.00	2,000	0	0
209.50	2,000	3,000	3,000

Device	Routing	Invert	Outlet Devices
#1	Discarded	208.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	210.50'	**8.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.33 cfs @ 12.16 hrs HW=210.67' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.33 cfs)

Primary OutFlow Max=1.87 cfs @ 12.16 hrs HW=210.67' TW=0.00' (Dynamic Tailwater)
2=Sharp-Crested Rectangular Weir (Weir Controls 1.87 cfs @ 1.36 fps)

Summary for Pond BMP-4:

Inflow Area = 0.140 ac,100.00% Impervious, Inflow Depth = 5.86" for 25 YR event
Inflow = 0.73 cfs @ 12.13 hrs, Volume= 0.068 af
Outflow = 0.56 cfs @ 12.23 hrs, Volume= 0.068 af, Atten= 23%, Lag= 5.9 min
Discarded = 0.05 cfs @ 10.85 hrs, Volume= 0.054 af
Primary = 0.51 cfs @ 12.23 hrs, Volume= 0.015 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 207.86' @ 12.23 hrs Surf.Area= 672 sf Storage= 689 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 73.0 min (821.3 - 748.3)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	380 cf	**Stone (Prismatic)** Listed below (Recalc) x 28 1,566 cf Overall - 413 cf Embedded = 1,153 cf x 33.0% Voids
#2	206.50'	413 cf	**28.9"W x 16.0"H x 7.12'L StormTech SC-310** x 28 Inside #1
		793 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	24	0	0
208.33	24	56	56

Device	Routing	Invert	Outlet Devices
#1	Discarded	206.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	207.50'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 10.85 hrs HW=206.03' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.50 cfs @ 12.23 hrs HW=207.85' TW=197.73' (Dynamic Tailwater)
2=Orifice/Grate (Orifice Controls 0.50 cfs @ 2.02 fps)

Summary for Pond DMH #1:

Inflow Area = 3.680 ac, 64.13% Impervious, Inflow Depth = 3.99" for 25 YR event
Inflow = 14.63 cfs @ 12.07 hrs, Volume= 1.222 af
Outflow = 14.63 cfs @ 12.07 hrs, Volume= 1.222 af, Atten= 0%, Lag= 0.0 min
Primary = 12.66 cfs @ 12.10 hrs, Volume= 0.594 af
Secondary = 4.32 cfs @ 12.04 hrs, Volume= 0.628 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 197.96' @ 12.10 hrs
Flood Elev= 199.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	197.20'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Secondary	195.14'	**24.0" x 10.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 194.94' S= 0.0200 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=12.55 cfs @ 12.10 hrs HW=197.96' TW=194.18' (Dynamic Tailwater)
└**1=Sharp-Crested Rectangular Weir** (Weir Controls 12.55 cfs @ 2.84 fps)

Secondary OutFlow Max=0.00 cfs @ 12.04 hrs HW=197.81' TW=197.91' (Dynamic Tailwater)
└**2=Culvert** (Controls 0.00 cfs)

Summary for Link PWS A1 & A2:

Inflow Area = 3.980 ac, 61.31% Impervious, Inflow Depth = 0.61" for 25 YR event
Inflow = 0.60 cfs @ 12.11 hrs, Volume= 0.202 af
Primary = 0.60 cfs @ 12.11 hrs, Volume= 0.202 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Summary for Link PWS C1 & C2:

Inflow Area = 2.820 ac, 17.73% Impervious, Inflow Depth = 1.39" for 25 YR event
Inflow = 2.24 cfs @ 12.17 hrs, Volume= 0.327 af
Primary = 2.24 cfs @ 12.17 hrs, Volume= 0.327 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PWS-A1: Runoff Area=3.540 ac 62.71% Impervious Runoff Depth=6.26"
Tc=5.0 min CN=49/98 Runoff=22.75 cfs 1.848 af

Subcatchment PWS-A2: Runoff Area=0.300 ac 26.67% Impervious Runoff Depth=3.33"
Flow Length=70' Slope=0.0200 '/' Tc=7.3 min CN=39/98 Runoff=0.89 cfs 0.083 af

Subcatchment PWS-A3: Runoff Area=0.140 ac 100.00% Impervious Runoff Depth=8.46"
Flow Length=130' Tc=9.7 min CN=0/98 Runoff=1.04 cfs 0.099 af

Subcatchment PWS-B1: Runoff Area=2.250 ac 0.00% Impervious Runoff Depth=3.15"
Flow Length=720' Tc=45.5 min CN=54/0 Runoff=3.68 cfs 0.592 af

Subcatchment PWS-B2: Runoff Area=0.570 ac 87.72% Impervious Runoff Depth=7.91"
Tc=5.0 min CN=61/98 Runoff=4.62 cfs 0.376 af

Subcatchment PWS-C1: Runoff Area=1.610 ac 0.00% Impervious Runoff Depth=3.87"
Flow Length=380' Tc=29.1 min CN=60/0 Runoff=4.13 cfs 0.519 af

Pond BMP-1: Peak Elev=198.44' Storage=10,528 cf Inflow=5.78 cfs 0.767 af
Outflow=0.53 cfs 0.767 af

Pond BMP-2: Peak Elev=198.10' Storage=34,290 cf Inflow=20.31 cfs 1.116 af
Discarded=0.62 cfs 0.806 af Primary=0.56 cfs 0.310 af Outflow=1.18 cfs 1.116 af

Pond BMP-3: Peak Elev=210.78' Storage=2,898 cf Inflow=4.62 cfs 0.376 af
Discarded=0.34 cfs 0.264 af Primary=3.89 cfs 0.112 af Outflow=4.23 cfs 0.376 af

Pond BMP-4: Peak Elev=208.01' Storage=723 cf Inflow=1.04 cfs 0.099 af
Discarded=0.05 cfs 0.064 af Primary=0.98 cfs 0.034 af Outflow=1.03 cfs 0.099 af

Pond DMH #1: Peak Elev=198.25' Inflow=23.30 cfs 1.883 af
Primary=20.31 cfs 1.116 af Secondary=5.78 cfs 0.767 af Outflow=23.30 cfs 1.883 af

Link PWS A1 & A2: Inflow=1.08 cfs 0.393 af
Primary=1.08 cfs 0.393 af

Link PWS C1 & C2: Inflow=4.71 cfs 0.704 af
Primary=4.71 cfs 0.704 af

Total Runoff Area = 8.410 ac Runoff Volume = 3.516 af Average Runoff Depth = 5.02"
65.04% Pervious = 5.470 ac 34.96% Impervious = 2.940 ac

Summary for Subcatchment PWS-A1:

Runoff = 22.75 cfs @ 12.07 hrs, Volume= 1.848 af, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

	Area (ac)	CN	Description
*	2.220	98	roof and pavement
	0.620	61	>75% Grass cover, Good, HSG B
	0.700	39	>75% Grass cover, Good, HSG A
	3.540	80	Weighted Average
	1.320	49	Pervious Area
	2.220	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - H**

Summary for Subcatchment PWS-A2:

Runoff = 0.89 cfs @ 12.11 hrs, Volume= 0.083 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

	Area (ac)	CN	Description
	0.220	39	>75% Grass cover, Good, HSG A
	0.040	98	Paved roads w/curbs & sewers
*	0.030	98	Gravel Road "B"
*	0.010	98	Gravel Road "A"
	0.300	55	Weighted Average
	0.220	39	Pervious Area
	0.080	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	70	0.0200	0.16		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment PWS-A3:

Runoff = 1.04 cfs @ 12.13 hrs, Volume= 0.099 af, Depth= 8.46"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

Area (ac)	CN	Description
0.140	98	Paved roads w/curbs & sewers
0.140	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"
0.1	30	0.2200	7.55		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.7	130	Total			

Summary for Subcatchment PWS-B1:

Runoff = 3.68 cfs @ 12.67 hrs, Volume= 0.592 af, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

Area (ac)	CN	Description
1.720	55	Woods, Good, HSG B
0.220	39	>75% Grass cover, Good, HSG A
0.310	61	>75% Grass cover, Good, HSG B
2.250	54	Weighted Average
2.250	54	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.8	100	0.0200	0.05		**Sheet Flow, A -B** Woods: Dense underbrush n= 0.800 P2= 3.30"
2.4	220	0.0100	1.50		**Shallow Concentrated Flow, B - C** Grassed Waterway Kv= 15.0 fps
6.3	400	0.0450	1.06		**Shallow Concentrated Flow, C - D** Woodland Kv= 5.0 fps
45.5	720	Total			

Summary for Subcatchment PWS-B2:

Runoff = 4.62 cfs @ 12.07 hrs, Volume= 0.376 af, Depth= 7.91"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

	Area (ac)	CN	Description
*	0.500	98	roof
	0.070	61	>75% Grass cover, Good, HSG B
	0.570	93	Weighted Average
	0.070	61	Pervious Area
	0.500	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - B**

Summary for Subcatchment PWS-C1:

Runoff = 4.13 cfs @ 12.42 hrs, Volume= 0.519 af, Depth= 3.87"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

Area (ac)	CN	Description
1.030	55	Woods, Good, HSG B
0.580	70	Woods, Good, HSG C
1.610	60	Weighted Average
1.610	60	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0600	0.07		**Sheet Flow, A - B** Woods: Dense underbrush n= 0.800 P2= 3.30"
3.0	180	0.0400	1.00		**Shallow Concentrated Flow, B - C** Woodland Kv= 5.0 fps
2.4	100	0.0200	0.71		**Shallow Concentrated Flow, C - D** Woodland Kv= 5.0 fps
29.1	380	Total			

Summary for Pond BMP-1:

Inflow = 5.78 cfs @ 12.04 hrs, Volume= 0.767 af
Outflow = 0.53 cfs @ 12.15 hrs, Volume= 0.767 af, Atten= 91%, Lag= 6.7 min
Discarded = 0.53 cfs @ 12.15 hrs, Volume= 0.767 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 198.44' @ 12.15 hrs Surf.Area= 7,634 sf Storage= 10,528 cf

Plug-Flow detention time= 263.5 min calculated for 0.766 af (100% of inflow)
Center-of-Mass det. time= 264.1 min (1,020.9 - 756.9)

Volume	Invert	Avail.Storage	Storage Description
#1	197.20'	5,808 cf	**Surface Storage (Prismatic)** Listed below (Recalc)
#2	192.00'	1,003 cf	**Sand (Prismatic)** Listed below (Recalc) 3,040 cf Overall x 33.0% Voids
#3	194.00'	2,413 cf	**PRE-TREATMENT (Prismatic)** Listed below (Recalc)
#4	194.00'	3,316 cf	**WQ (Prismatic)** Listed below (Recalc)
		12,541 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
197.20	2,670	0	0
198.00	3,150	2,328	2,328
199.00	3,810	3,480	5,808

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	1,520	0	0
194.00	1,520	3,040	3,040

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	420	0	0
196.00	820	1,240	1,240
197.00	1,080	950	2,190
197.20	1,150	223	2,413

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	640	0	0
196.00	1,115	1,755	1,755
197.00	1,420	1,268	3,023
197.20	1,520	294	3,316

Device	Routing	Invert	Outlet Devices
#1	Discarded	192.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.53 cfs @ 12.15 hrs HW=198.44' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.53 cfs)

Summary for Pond BMP-2:

Inflow Area = 3.680 ac, 64.13% Impervious, Inflow Depth = 3.64" for 100 YR event
Inflow = 20.31 cfs @ 12.10 hrs, Volume= 1.116 af
Outflow = 1.18 cfs @ 13.46 hrs, Volume= 1.116 af, Atten= 94%, Lag= 81.3 min
Discarded = 0.62 cfs @ 13.46 hrs, Volume= 0.806 af
Primary = 0.56 cfs @ 13.46 hrs, Volume= 0.310 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 198.10' @ 13.46 hrs Surf.Area= 8,874 sf Storage= 34,290 cf

Plug-Flow detention time= 457.7 min calculated for 1.114 af (100% of inflow)
Center-of-Mass det. time= 458.5 min (1,218.3 - 759.8)

Volume	Invert	Avail.Storage	Storage Description
#1	192.00'	42,745 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	2,660	0	0
194.00	4,480	7,140	7,140
196.00	6,510	10,990	18,130
198.00	8,750	15,260	33,390
199.00	9,960	9,355	42,745

Device	Routing	Invert	Outlet Devices
#1	Primary	192.50'	**2.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	198.05'	**2.00' x 2.00' Horiz. Overflow Grate** Limited to weir flow C= 0.600
#3	Discarded	192.00'	**3.040 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.62 cfs @ 13.46 hrs HW=198.10' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.62 cfs)

Primary OutFlow Max=0.55 cfs @ 13.46 hrs HW=198.10' TW=0.00' (Dynamic Tailwater)
├**1=Orifice/Grate** (Orifice Controls 0.25 cfs @ 11.31 fps)
└**2=Overflow Grate** (Weir Controls 0.30 cfs @ 0.74 fps)

Summary for Pond BMP-3:

Inflow Area = 0.570 ac, 87.72% Impervious, Inflow Depth = 7.91" for 100 YR event
Inflow = 4.62 cfs @ 12.07 hrs, Volume= 0.376 af
Outflow = 4.23 cfs @ 12.11 hrs, Volume= 0.376 af, Atten= 9%, Lag= 2.4 min
Discarded = 0.34 cfs @ 12.11 hrs, Volume= 0.264 af
Primary = 3.89 cfs @ 12.11 hrs, Volume= 0.112 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 210.78' @ 12.11 hrs Surf.Area= 4,880 sf Storage= 2,898 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 45.9 min (791.3 - 745.4)

Volume	Invert	Avail.Storage	Storage Description
#1	210.00'	6,250 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
#2	208.00'	990 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 3,000 cf Overall x 33.0% Voids
		7,240 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
210.00	2,000	0	0
212.00	4,250	6,250	6,250

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
208.00	2,000	0	0
209.50	2,000	3,000	3,000

Device	Routing	Invert	Outlet Devices
#1	Discarded	208.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	210.50'	**8.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.34 cfs @ 12.11 hrs HW=210.78' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.34 cfs)

Primary OutFlow Max=3.79 cfs @ 12.11 hrs HW=210.78' TW=0.00' (Dynamic Tailwater)
↑**2=Sharp-Crested Rectangular Weir** (Weir Controls 3.79 cfs @ 1.72 fps)

Summary for Pond BMP-4:

Inflow Area = 0.140 ac,100.00% Impervious, Inflow Depth = 8.46" for 100 YR event
Inflow = 1.04 cfs @ 12.13 hrs, Volume= 0.099 af
Outflow = 1.03 cfs @ 12.15 hrs, Volume= 0.099 af, Atten= 1%, Lag= 1.2 min
Discarded = 0.05 cfs @ 9.80 hrs, Volume= 0.064 af
Primary = 0.98 cfs @ 12.15 hrs, Volume= 0.034 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 208.01' @ 12.15 hrs Surf.Area= 672 sf Storage= 723 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 65.1 min (808.7 - 743.6)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	380 cf	**Stone (Prismatic)** Listed below (Recalc) x 28 1,566 cf Overall - 413 cf Embedded = 1,153 cf x 33.0% Voids
#2	206.50'	413 cf	**28.9"W x 16.0"H x 7.12'L StormTech SC-310** x 28 Inside #1
		793 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	24	0	0
208.33	24	56	56

Device	Routing	Invert	Outlet Devices
#1	Discarded	206.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	207.50'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 9.80 hrs HW=206.03' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.98 cfs @ 12.15 hrs HW=208.01' TW=198.13' (Dynamic Tailwater)
↑**2=Orifice/Grate** (Orifice Controls 0.98 cfs @ 2.43 fps)

Summary for Pond DMH #1:

Inflow Area = 3.680 ac, 64.13% Impervious, Inflow Depth = 6.14" for 100 YR event
Inflow = 23.30 cfs @ 12.08 hrs, Volume= 1.883 af
Outflow = 23.30 cfs @ 12.08 hrs, Volume= 1.883 af, Atten= 0%, Lag= 0.0 min
Primary = 20.31 cfs @ 12.10 hrs, Volume= 1.116 af
Secondary = 5.78 cfs @ 12.04 hrs, Volume= 0.767 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 198.25' @ 12.10 hrs
Flood Elev= 199.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	197.20'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Secondary	195.14'	**24.0" x 10.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 194.94' S= 0.0200 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=20.25 cfs @ 12.10 hrs HW=198.25' TW=195.72' (Dynamic Tailwater)
└**1=Sharp-Crested Rectangular Weir** (Weir Controls 20.25 cfs @ 3.34 fps)

Secondary OutFlow Max=0.00 cfs @ 12.04 hrs HW=198.08' TW=198.18' (Dynamic Tailwater)
└**2=Culvert** (Controls 0.00 cfs)

Summary for Link PWS A1 & A2:

Inflow Area = 3.980 ac, 61.31% Impervious, Inflow Depth = 1.19" for 100 YR event
Inflow = 1.08 cfs @ 12.11 hrs, Volume= 0.393 af
Primary = 1.08 cfs @ 12.11 hrs, Volume= 0.393 af, Atten= 0%, Lag= 0.0 min

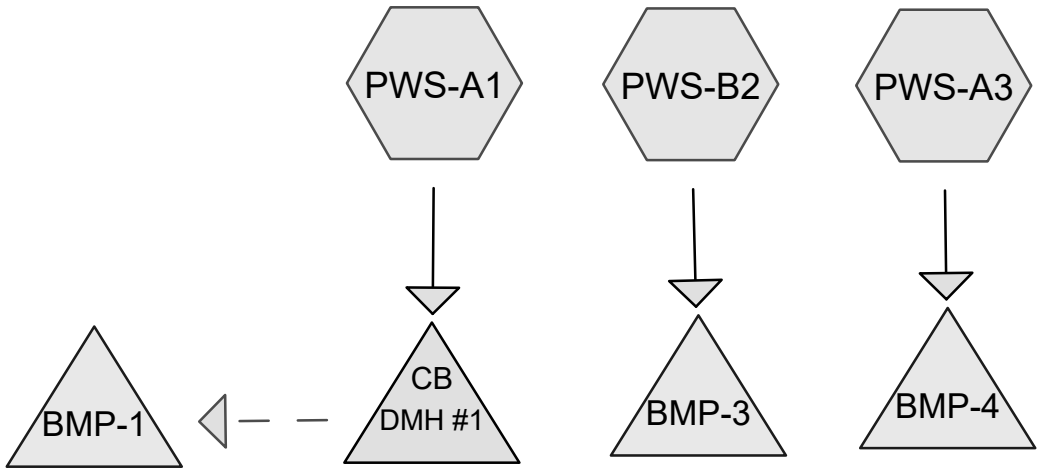
Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Summary for Link PWS C1 & C2:

Inflow Area = 2.820 ac, 17.73% Impervious, Inflow Depth = 3.00" for 100 YR event
Inflow = 4.71 cfs @ 12.12 hrs, Volume= 0.704 af
Primary = 4.71 cfs @ 12.12 hrs, Volume= 0.704 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Appendix D
Proposed Off-line Water Quality Calculations



Subcat Reach Pond Link

Drainage Diagram for 6856-2015-10-30-PWS-R7-WQ
Prepared by Garofalo & Associates, Inc.

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points x 3
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PWS-A1: Runoff Area=3.550 ac 59.44% Impervious Runoff Depth=0.59"
Tc=5.0 min CN=51/98 Runoff=2.32 cfs 0.173 af

Subcatchment PWS-A3: Runoff Area=0.140 ac 100.00% Impervious Runoff Depth=0.99"
Flow Length=130' Tc=9.7 min CN=0/98 Runoff=0.13 cfs 0.011 af

Subcatchment PWS-B2: Runoff Area=0.570 ac 87.72% Impervious Runoff Depth=0.86"
Tc=5.0 min CN=61/98 Runoff=0.55 cfs 0.041 af

Pond BMP-1: Peak Elev=195.50' Storage=3,078 cf Inflow=2.32 cfs 0.173 af
Outflow=0.22 cfs 0.173 af

Pond BMP-3: Peak Elev=208.52' Storage=343 cf Inflow=0.55 cfs 0.041 af
Discarded=0.14 cfs 0.041 af Primary=0.00 cfs 0.000 af Outflow=0.14 cfs 0.041 af

Pond BMP-4: Peak Elev=206.34' Storage=76 cf Inflow=0.13 cfs 0.011 af
Discarded=0.05 cfs 0.012 af Primary=0.00 cfs 0.000 af Outflow=0.05 cfs 0.012 af

Pond DMH #1: Peak Elev=195.82' Inflow=2.32 cfs 0.173 af
Primary=0.00 cfs 0.000 af Secondary=2.32 cfs 0.173 af Outflow=2.32 cfs 0.173 af

Total Runoff Area = 4.260 ac Runoff Volume = 0.226 af Average Runoff Depth = 0.64"
35.45% Pervious = 1.510 ac 64.55% Impervious = 2.750 ac

Summary for Subcatchment PWS-A1:

Runoff = 2.32 cfs @ 12.07 hrs, Volume= 0.173 af, Depth= 0.59"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 1.2 Rainfall=1.20"

Area (ac)	CN	Description
* 2.110	98	roof and pavement
0.770	61	>75% Grass cover, Good, HSG B
0.670	39	>75% Grass cover, Good, HSG A
3.550	79	Weighted Average
1.440	51	Pervious Area
2.110	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - H**

Summary for Subcatchment PWS-A3:

Runoff = 0.13 cfs @ 12.13 hrs, Volume= 0.011 af, Depth= 0.99"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 1.2 Rainfall=1.20"

Area (ac)	CN	Description
0.140	98	Paved roads w/curbs & sewers
0.140	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.30"
0.1	30	0.2200	7.55		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.7	130	Total			

Summary for Subcatchment PWS-B2:

Runoff = 0.55 cfs @ 12.07 hrs, Volume= 0.041 af, Depth= 0.86"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 1.2 Rainfall=1.20"

	Area (ac)	CN	Description
*	0.500	98	roof
	0.070	61	>75% Grass cover, Good, HSG B
	0.570	93	Weighted Average
	0.070	61	Pervious Area
	0.500	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, A - B**

Summary for Pond BMP-1:

Inflow = 2.32 cfs @ 12.07 hrs, Volume= 0.173 af
Outflow = 0.22 cfs @ 12.88 hrs, Volume= 0.173 af, Atten= 90%, Lag= 48.3 min
Discarded = 0.22 cfs @ 12.88 hrs, Volume= 0.173 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 195.50' @ 12.88 hrs Surf.Area= 3,234 sf Storage= 3,078 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 125.8 min (906.9 - 781.1)

Volume	Invert	Avail.Storage	Storage Description
#1	197.20'	5,808 cf	**Surface Storage (Prismatic)** Listed below (Recalc)
#2	192.00'	1,003 cf	**Sand (Prismatic)** Listed below (Recalc) 3,040 cf Overall x 33.0% Voids
#3	194.00'	2,413 cf	**PRE-TREATMENT (Prismatic)** Listed below (Recalc)
#4	194.00'	3,316 cf	**WQ (Prismatic)** Listed below (Recalc)
		12,541 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
197.20	2,670	0	0
198.00	3,150	2,328	2,328
199.00	3,810	3,480	5,808

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
192.00	1,520	0	0
194.00	1,520	3,040	3,040

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	420	0	0
196.00	820	1,240	1,240
197.00	1,080	950	2,190
197.20	1,150	223	2,413

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
194.00	640	0	0
196.00	1,115	1,755	1,755
197.00	1,420	1,268	3,023
197.20	1,520	294	3,316

Device	Routing	Invert	Outlet Devices
#1	Discarded	192.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.22 cfs @ 12.88 hrs HW=195.50' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.22 cfs)

Summary for Pond BMP-3:

Inflow Area = 0.570 ac, 87.72% Impervious, Inflow Depth = 0.86" for 1.2 event
Inflow = 0.55 cfs @ 12.07 hrs, Volume= 0.041 af
Outflow = 0.14 cfs @ 11.95 hrs, Volume= 0.041 af, Atten= 74%, Lag= 0.0 min
Discarded = 0.14 cfs @ 11.95 hrs, Volume= 0.041 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 208.52' @ 12.44 hrs Surf.Area= 2,000 sf Storage= 343 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 11.8 min (792.9 - 781.1)

Volume	Invert	Avail.Storage	Storage Description
#1	210.00'	6,250 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
#2	208.00'	990 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc) 3,000 cf Overall x 33.0% Voids
		7,240 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
210.00	2,000	0	0
212.00	4,250	6,250	6,250

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
208.00	2,000	0	0
209.50	2,000	3,000	3,000

Device	Routing	Invert	Outlet Devices
#1	Discarded	208.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	210.50'	**8.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.14 cfs @ 11.95 hrs HW=208.06' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=208.00' (Free Discharge)
2=Sharp-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Pond BMP-4:

Inflow Area = 0.140 ac,100.00% Impervious, Inflow Depth = 0.99" for 1.2 event
Inflow = 0.13 cfs @ 12.13 hrs, Volume= 0.011 af
Outflow = 0.05 cfs @ 12.05 hrs, Volume= 0.012 af, Atten= 65%, Lag= 0.0 min
Discarded = 0.05 cfs @ 12.05 hrs, Volume= 0.012 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 206.34' @ 12.46 hrs Surf.Area= 672 sf Storage= 76 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 7.4 min (792.8 - 785.4)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	380 cf	**Stone (Prismatic)** Listed below (Recalc) x 28 1,566 cf Overall - 413 cf Embedded = 1,153 cf x 33.0% Voids
#2	206.50'	413 cf	**28.9"W x 16.0"H x 7.12'L StormTech SC-310** x 28 Inside #1
		793 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	24	0	0
208.33	24	56	56

Device	Routing	Invert	Outlet Devices
#1	Discarded	206.00'	**3.040 in/hr Exfiltration over Surface area**
#2	Primary	207.50'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 12.05 hrs HW=206.05' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=206.00' (Free Discharge)
2=Orifice/Grate (Controls 0.00 cfs)

Summary for Pond DMH #1:

Inflow Area = 3.550 ac, 59.44% Impervious, Inflow Depth = 0.59" for 1.2 event
Inflow = 2.32 cfs @ 12.07 hrs, Volume= 0.173 af
Outflow = 2.32 cfs @ 12.07 hrs, Volume= 0.173 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 2.32 cfs @ 12.07 hrs, Volume= 0.173 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs / 3

Peak Elev= 195.82' @ 12.07 hrs
Flood Elev= 199.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	197.20'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Secondary	195.14'	**24.0" x 10.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 194.94' S= 0.0200 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=195.14' (Free Discharge)
└**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=2.24 cfs @ 12.07 hrs HW=195.80' TW=194.54' (Dynamic Tailwater)
└**2=Culvert** (Barrel Controls 2.24 cfs @ 3.66 fps)

Appendix E
Stormwater Management Standards / Calculations

Champlin Hills A.P. 20/4, Lot 2117 Scituate Avenue
Cranston, RI

Stormwater Management Standards - Calculations

revised: November 2, 2015

Base Data:

	Total Area:		Imperious (I):		
PWS-A1	3.54	ac.	2.22	ac.	(0.78 ac. roof and 1.40 ac. pavement)
PWS-B2	0.57	ac.	0.50	ac.	
PWS-A3	0.14	ac.	0.14	ac.	

1-yr peak discharge:	PWS-A1	5.83	cfs		
1-yr peak discharge:	PWS-B2	1.31	cfs		
1-yr peak discharge:	PWS-A3	0.32	cfs		
1-yr runoff volume:	PWS-A1	0.461	ac-ft	20,081	ft^3
1-yr runoff volume:	PWS-B2	0.103	ac-ft	4,487	ft^3
1-yr runoff volume:	PWS-A3	0.029	ac-ft	1,263	ft^4
10-yr, peak discharge:	PWS-A1	11.11	cfs		
10-yr, peak discharge:	PWS-B2	2.41	cfs		
10-yr, peak discharge:	PWS-A3	0.58	cfs		
100-yr, peak discharge:	PWS-A1	22.75	cfs		
100-yr, peak discharge:	PWS-B2	4.30	cfs		
100-yr, peak discharge:	PWS-A3	1.04	cfs		

Recharge Volume: Section 3.3.2

Watershed: PWS-A1

Re_v=	(1")(F)(I)/12			
	1.01 ac-ft			"A" soils
	1.1 ac-ft			"B" soils
F	0.47			Aggregate Factor (Table 3-4)
I	**2.22** ac.			Total Impervious Area (acres)
Re_v=	**0.09** ac-ft	**3,785**	ft^3	
Re_a=	**1.04** ac.		[(F)(I)]	Recharge area requiring treatment
WQ_v=	**0.19** ac-ft	**8,059**	ft^5	[(1")(I)/1 Water Quality - Entire Site

Watershed: PWS-B2

Re_v=	(1")(F)(I)/12			
F	0.35 ac-ft			"B" soils
I	**0.50** ac.			Total Impervious Area (acres)
Re_v=	**0.01** ac-ft	**635**	ft^3	
Re_a=	**0.18** ac.		[(F)(I)]	Recharge area requiring treatment
WQ_v=	**0.04** ac-ft	**1,815**	ft^5	[(1")(I)/1 Water Quality

Watershed: PWS-A3

Re_v=	(1")(F)(I)/12			
F	0.00 ac-ft			"B" soils
I	**0.15** ac.			Total Impervious Area (acres)
Re_v=	**0.00** ac-ft	**0**	ft^3	
Re_a=	**0.00** ac.		[(F)(I)]	Recharge area requiring treatment
WQ_v=	**0.01** ac-ft	**545**	ft^5	[(1")(I)/1 Water Quality

Water Quality Volume: Section 3.3.3

BMP-1

WQ_v= (1")(I)/12 (Water Quality Volume, use 75% for treatment (Section 5.5.4))

WQ_v= **8,058.60** ft^3 **6,044** ft^3 (75% Water Quality Volume)

2,015 ft^3 (25% Pre-treatment)

BMP-3

WQ_v= (1")(I)/12 (Water Quality Volume, use 75% for treatment (Section 5.5.4))

WQ_v= **1,815.00** ft^3 **1,361** ft^3 (75% Water Quality Volume)

454 ft^3 (not required for exclusive roof runoff)

BMP-4

WQ_v= (1")(I)/12 (Water Quality Volume, use 75% for treatment (Section 5.5.4))

WQ_v= **508.20** ft^3 **127** ft^3 (not required for exclusive roof runoff)

Bioretention Sizing (Minimum Filter Bottom Area): Section 5.5.4

Sand Filter **BMP-1**

$A_f = (WQ_v)(d_f)/[(k)(h_f+d_f)(t_f)]$

d_f	2.0	ft	(filter bed depth)
k	3.5	ft/day	(coefficient of permeability)(use Sand, Section 5.5.4)
h_f	1.50	ft	(avg ht of water above surface)
t_f	2.0	days	(design filter bed drain time)
A_f =	**657.84**	**sf**	

Sand Filter **BMP-3**

$A_f = (WQ_v)(d_f)/[(k)(h_f+d_f)(t_f)]$

d_f	1.5	ft	(filter bed depth)
k	3.5	ft/day	(coefficient of permeability)(use Sand, Section 5.5.4)
h_f	0.25	ft	(avg ht of water above surface)
t_f	2.0	days	(design filter bed drain time)
A_f =	**222.24**	**sf**	

Channel Protection Volume: Section 3.3.4

PWS-A1

$V_s = CP_v$= (0.65)(V_r)

V_r volume from 1-yr, 24 hour, Type III storm (ft^3)

Watershed: PWS-A1

V_r 20,081 ft^3

CP_v= **13,053** ft^3

Provided Filter Parameters:

BMP #1

WQ Volume	**6,733**	**cf**	Total Storage Provided (below Weir Elev=197.20, from HydroCAD)
Pre-Tratememt	**2,413**	**cf**	Total Storage Provided (below Weir Elev=197.20, from HydroCAD)
Bottom Area	**1,520**	**sf**	(Bottom Area of Sand, refer to Plans)

BMP #3

WQ Volume	**2,131**	**cf**	Total Storage Provided (below Weir Elev=210.5, from HydroCAD)
Pre-Tratememt	**0**	**cf**	Not required for exclusive roof runoff
Bottom Area	**2,000**	**sf**	(Bottom Area at surface, refer to Plans)

BMP #4

WQ Volume	**590**	**cf**	Total Storage Provided (below Weir Elev=207.5, from HydroCAD)
Pre-Tratememt	**0**	**cf**	Not required for exclusive roof runoff

Appendix F
RIDEM Stormwater Management Checklist

APPENDIX A: STORMWATER MANAGEMENT CHECKLIST

The first thing that applicants and designers must do before beginning a project is to make sure they are familiar with the 11 minimum standards listed in Manual Chapter Three, as projects must meet all 11 standards. Next, designers should review the available LID site planning and design strategies and BMPs in Manual Chapters Four through Seven to determine which would work best at their site. This checklist serves as a guide for engineers and designers to refer to during all stages of a project to ensure that they are meeting all applicable requirements. In addition, designers must include a completed checklist with their final stormwater management plan.

A.1 CHECKLIST FOR STORMWATER MANAGEMENT PLAN PREPARATION AND REVIEW

A.1.1 General Information

- [X] Applicant name, mailing address, and telephone number
- [X] Contact information for the licensed professional(s) responsible for site plans and stormwater management plan
- [X] Common address and legal description of project site
- [X] Vicinity map
- [X] Existing zoning and land use at the project site
- [X] Proposed land use – indicate if land use meets definition of a LUHPPL (see Manual Table 3-2)
- [X] General Project Narrative
- [X] Project type (new development or redevelopment)

A.1.2 Existing and Proposed Mapping and Plans

- [X] Existing and proposed mapping and plans (scale not greater than 1" = 40') with North arrow that illustrate at a minimum:
  - [X] Existing and proposed site topography (2-foot contours required). 10-foot contours accepted for off-site areas.
  - [X] Existing and proposed drainage area delineations and drainage flow paths, mapped according to the DEM *Guidance for Preparation of Drainage Area Maps* (included in Appendix K). Drainage area boundaries need to be complete; include off-site areas in both mapping and analyses, as applicable.
  - [X] Perennial and intermittent streams, in addition to areas subject to storm flowage (ASSFs)

☒ Mapping of predominant soils from USDA soil surveys, especially hydric soil groups as well as location of site-specific borings and/or test pits (on drainage area maps only – not site plans)

☒ Boundaries of existing predominant vegetation and proposed limits of clearing

☒ Location and field-verified boundaries of resource protection areas such as freshwater and coastal wetlands, lakes, ponds, coastal shoreline features and required setbacks (e.g., buffers, water supply wells, septic systems)

☒ Location of floodplain and, if applicable, floodway limits and relationship of site to upstream and downstream properties and drainages

☒ Location of existing and proposed roads, buildings, and other structures including limits of disturbance

☒ Existing and proposed utilities (e.g., water, sewer, gas, electric) and easements

☒ Location of existing and proposed conveyance systems such as grass channels, swales, and storm drains

☒ Location and dimensions of channel modifications, such as bridge or culvert crossings

☒ Location, size, and limits of proposed LID planning and site design techniques (type of practice, depth, area). LID techniques should be labeled clearly on the plan and a key should be provided that corresponds to a tabular description.

☒ Location, size, and limits of disturbance of proposed stormwater treatment practices (type of practice, depth, area). Stormwater treatment practices (BMPs) should be labeled with numbers that correspond to the table in Section A.1.5.

☒ Soils information from test pits or borings at the location of proposed stormwater management facilities, including but not limited to soil descriptions, depth to seasonal high groundwater, depth to bedrock, and estimated hydraulic conductivity. Soils information will be based on site test pits or borings logged by a DEM-licensed Class IV soil evaluator or RI-registered PE.

☒ 8.5 x 11 inch copy of site plan for public notice, as applicable.

A.1.3 Minimum Stormwater Management Standards

☒ **Minimum Standard 1: LID Site Planning and Design Strategies**

Document specific LID site planning and design strategies and associated methods that were employed for the project in the following table:

LID Site Planning and Design Checklist

The applicant must document specific LID site planning and design strategies applied for the project (see Manual Chapter Four and the *RI Community LID Guidance Manual* for more details regarding each strategy). If a particular strategy was not used, a justification and description of proposed alternatives must be provided. If a strategy is not applicable (N/A), applicants must describe why a certain method is not applicable at their site. For example, preserving wetland buffers may be not applicable for sites located outside any jurisdictional wetland buffers. In communities where conservation development or other low-impact development site planning and design processes exist, following the local community conservation development option may help a project achieve this standard.

1. Strategies to Avoid the Impacts

A. Preservation of Undisturbed Areas

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Limits of disturbance clearly marked on all construction plans.
- ☒ Mapped soils by Hydrologic Soil Group (HSG).
- ☒ Building envelopes avoid steep slopes, forest stands, riparian corridors, HSG D soils, and floodplains.
- ☒ New lots, to the extent practicable, have been kept out of freshwater and coastal wetland jurisdictional areas.
- ☒ Important natural areas (i.e., undisturbed forest, riparian corridors, and wetlands) identified and protected with permanent conservation easement.
- ☐ Percent of natural open space calculation is provided.
- ☐ Other (describe):

Explain constraints when a strategy is applied and/or proposed alternatives in space below:

B. Preservation of Buffers and Floodplains

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following:

- ☒ Applicable vegetated buffers of coastal and freshwater wetlands and perennial and intermittent streams have been preserved, where possible.
- ☒ Limits of disturbance included on all construction plans that protect applicable buffers
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

LID Site Planning and Design Checklist

C. Minimized Clearing and Grading

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Site fingerprinting to extent needed for building footprints, construction access and safety (i.e., clearing and grading limited to 15 feet beyond building pad or 5 feet beyond road bed/shoulder).
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

D. Locating Sites in Less Sensitive Areas

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ A site design process, such as conservation development, used to avoid or minimize impacts to sensitive resources such as floodplains, steep slopes, erodible soils, wetlands, hydric soils, surface waters, and their riparian buffers.
- ☒ Development located in areas with least hydrologic value (e.g., soil groups A and B)
- ☒ Development on steep slopes, grading and flattening of ridges has been avoided to the maximum extent practicable.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

E. Compact Development

☒ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ A site design technique (e.g., conservation development) used to concentrate development to preserve as much undisturbed open space as practicable and reduce impervious cover.
- ☐ Reduced setbacks, frontages, and right- of- way widths have been used where practicable.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

LID Site Planning and Design Checklist

F. Work with the Natural Landscape Conditions, Hydrology, and Soils

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Stormwater management system mimics pre-development hydrology to retain and attenuate runoff in upland areas (e.g., cuts and fills limited and BMPs distributed throughout site; trees used for interception and uptake).
- ☒ The post-development time of concentration (t_c) should approximate pre-development t_c.
- ☒ Flow velocity in graded areas as low as practicable to avoid soil erosion (i.e., slope grade minimized). Velocities shall not exceed velocities in Appendix B, Table B-2.
- ☐ Plans show measures to prevent soil compaction in areas designated as Qualified Pervious Areas (QPAs) for better infiltration.
- ☒ Site designed to locate buildings, roadways and parking to minimize grading (cut and fill quantities)
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

2. Strategies to Reduce the Impacts

Reduce Impervious Cover

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Reduced roadway widths
- ☒ Reduce driveway areas
- ☐ Reduced building footprint
- ☒ Reduced sidewalk area
- ☒ Reduced cul-de-sacs
- ☐ Reduced parking lot area
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

3. Strategies to Manage the Impacts

A. Disconnecting Impervious Area

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Impervious surfaces have been disconnected to QPAs to the extent possible.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

LID Site Planning and Design Checklist

B. Mitigation of Runoff at the point of generation

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Roof runoff has been directed to a QPA, such as a yard or vegetated area.
- ☐ Roof runoff has been directed to a lower impact practice such as a rain barrel or cistern.
- ☐ A green roof has been designed to reduce runoff.
- ☐ Small-scale BMPs applied at source.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

C. Stream/Wetland Restoration

☒ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Historic drainage patterns have been restored by removing closed drainage systems and/or restoring degraded stream channels and/or wetlands.
- ☐ Removal of invasive species.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

Not required.

D. Reforestation

☒ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Low maintenance, native vegetation has been proposed.
- ☐ Trees are proposed to be planted or conserved to reduce runoff volume, increase nutrient uptake, and provide shading and habitat.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

Not required.

E. Source Control

☒ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Source control techniques such as street sweeping or pet waste management have been proposed.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

Not requried.

☒ **Minimum Standard 2: Groundwater Recharge**

Demonstrate that groundwater recharge criteria for the site have been met. Include:

☒ The required recharge volume (Re_v) in acre-feet (See Manual Section 3.3.2)

☒ LID Stormwater Credit from Checklist Section A.1.4 to be applied to recharge requirement, if applicable, with the following calculations (See Manual Section 4.6.1):

- the recharge area (Re_a) in acres for the site
- the site impervious area draining to QPAs
- the new Re_v requirement

☒ Specific BMPs from Checklist Section A.1.5 that will be used to meet the recharge requirement. *Note: Only BMPs listed in Manual Table 3-5, List of BMPs Acceptable for Recharge may be used to meet the recharge requirement.*

☒ **Minimum Standard 3: Water Quality**

Demonstrate that the water quality criteria for the site have been met. Include:

☒ Required water quality volume (WQ_v) in acre-feet or ft^3 (see Manual Section 3.3.3).

☒ LID Stormwater Credit from Checklist Section A.1.4 to be applied to water quality requirement, if applicable, with the following calculations (see Manual Section 4.6.1):

- the new impervious area (in acres) for the site
- the new WQ_v in acre-feet or ft^3

☒ Specific BMPs from Checklist Section A.1.5 that will be used to meet water quality volume requirement. *Note: Only BMPs listed in Manual Table 3-6, Acceptable BMPs for Water Quality Treatment may be used to meet the water quality requirement.*

☒ Specify any additional pollutant-specific requirements and/or pollutant removal efficiencies applicable to the site as the result of SAMP, TMDL, or other watershed-specific requirements.

☒ **Minimum Standard 4: Conveyance and Natural Channel Protection**

Demonstrate that the conveyance and natural channel protection criteria for the site have been met. Include:

☐ Justification for channel protection criterion waiver, if applicable (see Manual Section 3.3.4).

☒ Required channel protection volume (CP_v) (see Manual Section 3.3.4).

☒ Specific BMPs from Checklist Section A.1.5 that will be used to meet the channel protection requirement. Hydrologic and hydraulic site evaluation as described in Manual Section 3.3.4 should be included in Checklist Section A.1.5 for each channel protection BMP.

☒ **Minimum Standard 5: Overbank Flood Protection**

Demonstrate that the overbank flood protection criteria for the site have been met. Include:

☒ Justification for overbank flood protection criterion waiver, if applicable (see Manual Section 3.3.5).

☒ Pre- and post-development peak discharge rates.

☒ Specific BMPs from Checklist Section A.1.5 that will be used to meet the overbank flood protection requirement. Hydrologic and hydraulic site evaluation as described in Manual Section 3.3.4 should be included in Checklist Section A.1.5 for each overbank flood protection BMP.

☐ **Minimum Standard 6: Redevelopment and Infill Projects**

Demonstrate that criteria for redevelopment and/or infill projects have been met, if applicable. Include:

☐ Description of site that meets redevelopment/infill definition.

☐ Approved off-site location within watershed where stormwater management requirements will be met, if applicable (see Manual Section 3.2.6).

☒ Not Applicable.

☒ **Minimum Standard 7: Pollution Prevention**

Demonstrate that the project meets the criteria for pollution prevention. Include:

☒ Stormwater pollution prevention plan

☐ **Minimum Standard 8: LUHPPLs**

Demonstrate that the project meets the criteria for LUHPPLs, if applicable. Include:

☐ Description of any land use activities considered stormwater LUHPPL (see Manual Table 3-2).

☐ Specific BMPs listed in Checklist Section A.1.5 that receive stormwater from LUHPPL drainage areas. These BMP types must be listed in Manual Table 3-3, "Acceptable BMPs for Use at LUHPPLs."

☐ Additional BMPs, if any, that meet RIPDES MSGP requirements.

☒ Not Applicable.

☒ **Minimum Standard 9: Illicit Discharges**

Applicant asserts that no illicit discharges exist or are proposed to the stormwater management system in accordance with State regulations.

☒ **Minimum Standard 10: Construction Erosion and Sedimentation Control**

Demonstrate that ESC practices will be used during the construction phase and land disturbing activities. Include:

☒ Description of temporary sediment trapping and conveyance practices, including sizing calculations and method of temporary and permanent stabilization (see Manual Section 3.2.9 and *the Rhode Island Soil Erosion and Sediment Control Handbook*).

☒ Description of sequence of construction. Activities should be phased to avoid compacting soil during construction, particularly in the location of infiltrating stormwater practices and qualifying pervious areas for stormwater credits.

☒ Location of construction staging and material stockpiling areas.

☒ **Minimum Standard 11: Stormwater Management System Operation and Maintenance**

Provide a stormwater management system operation and maintenance plan that at a minimum includes:

☒ Name, address, and phone number of responsible parties for maintenance

☒ Description of annual maintenance tasks

☒ Description of applicable easements

☒ Description of funding source

☒ Minimum vegetative cover requirements

☒ Access and safety issues

A.1.4 LID Stormwater Credit

Description of stormwater credit, if applicable. Label qualifying pervious areas (QPAs) on the site map, and document that all stormwater credit requirements listed in Section 4.6 are met. For each QPA, note the impervious area (in acres) that drains to it, and place a check in the appropriate box to demonstrate that it meets the following criteria:

	QPA 1	QPA 2	QPA 3	QPA 4
Impervious Area Draining to QPA (acres)				
QPA Criteria	**Criterion Met?**			
Construction vehicles shall not be allowed to drive over the QPA during construction. If the area becomes compacted, soil must be suitably amended, tilled, and revegetated once construction is complete to restore infiltration capacity.				
QPA infiltration area is at least 10ft from building foundation.				

	QPA 1	QPA 2	QPA 3	QPA 4
Contributing impervious area does not exceed 1,000 ft^2.				
Length of QPA in feet is equal to or greater than the contributing rooftop area in ft^2 divided by 13.3. The maximum contributing flow path from non-rooftop impervious areas is 75ft.				
QPA does not overlap any other QPA.				
Lot is greater than 6,000 ft^2.				
The slope of the QPA is less than or equal to 5.0%.				
Disconnected downspouts draining to QPA are at least 10 feet away from the nearest impervious surface.				
Runoff from rooftops without gutters / downspouts that drains to QPA flows away from the structure as low-velocity sheet flow.				
QPA is located on Hydrologic Soil Group (HSG) A or B soils.				
Depth to groundwater within QPA is 18 inches or greater (has been confirmed by evaluation by a DEM-licensed Class IV soil evaluator or RI-registered PE).				
Runoff is directed over soft shoulders, through curb cuts or level spreaders to QPA.				
Measures are employed at discharge point to prevent erosion and promote sheet flow.				
The flow path through the QPA complies with the setback requirements for structural infiltration BMPs.				
Rooftop runoff draining to QPA from LUHPPLs does not commingle with runoff from any paved surface or areas that may generate higher pollutant loads				
Inspection and maintenance of the QPA is included in the site Operation and Maintenance Plan (Minimum Standard 11).				
The QPA is owned or controlled by the property owner				
There is no history of groundwater seepage and / or basement flooding on the property				

A.1.5 Best Management Practices

Provide detailed information for all structural stormwater best management practices (BMPs) to be implemented. *Note: If a BMP cannot meet the required design criteria in Manual Chapters Five, Six, and Seven, a different BMP should be considered*.

Fill in the following table to document which proposed practices meet which requirement(s). Number each BMP and label them accordingly on the site map:

BMP No.	**Type of BMP**	**Check the function provided by the BMP**				
		Pretreatment	Re_v	WQ_v	CP_v	Q_p
1	Sand Filter	Sediment Forebay (25% WQ Volume)		X		
2	Infiltration Basin	N/A	X		X	
3	Sand Filter	N/A		X		
4	Infiltration Chambers	N/A		X		

In addition, for all structural components of stormwater system (e.g., storm drains, open channels, swales, stormwater BMPs, etc.) provide the following, if applicable:

☒ Hydrologic and hydraulic analysis, including:

- Study design/analysis points. The existing and proposed condition analyses need to compare the same overall area; thus, common study points are needed for both existing and proposed conditions.

- Existing condition analysis for drainage area boundaries, curve numbers, times of concentration, runoff rates, volumes, velocities, and water surface elevations showing methodologies used and supporting calculations.
- Proposed condition analysis for drainage area boundaries, curve numbers, times of concentration, runoff rates, volumes, velocities, water surface elevations, and routing showing the methodologies used and supporting calculations.
- Downstream Analysis, where required (see Manual Section 3.3.6).
- Final sizing calculations for structural stormwater BMPs including, contributing drainage area, storage, and outlet configuration.
- Stage-discharge or outlet rating curves and inflow and outflow hydrographs for storage facilities (e.g., detention, retention, or infiltration facilities).
- Dam breach analysis, where necessary, for earthen embankments over six (6) feet in height, or a capacity of 15 acre-feet or more, and that is a significant or high hazard dam.

☒ Drainage Area Maps prepared in accordance with DEM's *Guidance for Preparation of Drainage Area Maps* (included in Appendix K).

☒ Representative cross-section and profile drawings, notes and details of structural stormwater management practices and conveyances (i.e., storm drains, open channels, swales, etc.), which include:

- Locations, cross sections, and profiles of all streams and drainage swales and their method of stabilization.
- Existing and proposed structural elevations (e.g., invert of pipes, manholes, etc.).
- Design water surface elevations.
- Structural details of outlet structures, embankments, spillways, stilling basins, grade control structures, conveyance channels, etc.
- Logs of borings and/or test pit investigations along with supporting soils/geotechnical report.

☒ Planting plans for structural stormwater BMPs, including:

- Species, size, planting methods, and maintenance requirements of proposed planting.

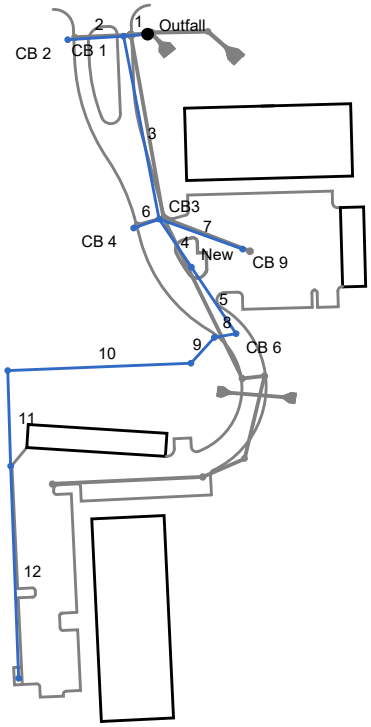
☒ Structural calculations, where necessary.

☒ Applicable construction specifications.

☒ Identification of all anticipated applicable local and State permits.

☒ Identification of all anticipated legal agreements related to stormwater (e.g., off-site easements, deed restrictions, and covenants).

Appendix G
Conveyance



Project File: 6856-2014-10-06-conveyance-R-6.stm	Number of lines: 12	Date: 10/6/2015

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	25.000	0.13	2.49	0.98	0.13	2.02	5.0	10.7	6.0	12.06	27.14	4.32	24	1.44	195.14	195.50	197.05	197.01	199.00	201.90	
2	1	58.000	0.47	0.47	0.45	0.21	0.21	5.0	5.0	7.2	1.52	9.13	2.31	15	2.00	196.25	197.41	197.53	197.90	201.90	201.90	
3	1	193.000	0.10	1.89	0.98	0.10	1.68	5.0	9.8	6.2	10.32	22.56	4.44	24	0.99	195.50	197.42	197.53	198.56	201.90	204.10	
4	3	60.000	0.00	0.95	0.00	0.00	0.93	0.0	9.2	6.3	5.82	27.39	3.85	24	1.47	197.42	198.30	198.56	199.15	204.10	205.00	
5	4	83.000	0.05	0.95	0.98	0.05	0.93	5.0	8.5	6.4	5.95	27.20	4.61	24	1.45	198.30	199.50	199.15	200.36	205.00	206.30	
6	3	28.000	0.33	0.33	0.45	0.15	0.15	5.0	5.0	7.2	1.07	5.04	4.16	12	2.00	198.42	198.98	198.73	199.42	204.10	204.10	
7	3	92.000	0.51	0.51	0.98	0.50	0.50	5.0	5.0	7.2	3.60	7.43	4.17	18	0.50	197.92	198.38	198.66	199.12	204.10	203.00	
8	5	23.000	0.05	0.90	0.98	0.05	0.88	5.0	8.4	6.4	5.66	10.50	5.48	18	1.00	200.00	200.23	200.78	201.16	206.30	206.30	
9	8	36.000	0.14	0.85	0.98	0.14	0.83	5.0	8.2	6.5	5.38	18.27	4.13	18	3.03	200.23	201.32	201.53	202.21	206.30	209.80	
10	9	190.000	0.21	0.71	0.98	0.21	0.70	5.0	7.0	6.7	4.67	14.87	4.50	18	2.01	201.32	205.13	202.21	205.95	209.80	212.00	
11	10	99.000	0.25	0.50	0.98	0.25	0.49	5.0	6.6	6.8	3.33	4.35	5.61	12	1.49	205.63	207.11	206.29	207.88	212.00	211.80	
12	11	220.000	0.25	0.25	0.98	0.25	0.25	5.0	5.0	7.2	1.76	3.56	3.29	12	1.00	207.11	209.31	207.88	209.87	211.80	211.80	

Project File: 6856-2014-10-06-conveyance-R-6.stm

Number of lines: 12

Run Date: 10/6/2015

NOTES:Intensity = 100.29 / (Inlet time + 18.20) ^ 0.84; Return period =Yrs. 100 ; c = cir e = ellip b = box

Appendix H
Stormwater Operations & Maintenance Plan

STORMWATER MANAGEMENT SYSTEM OPERATION AND MAINTENANCE PLAN

for:

CHAMPLIN HILLS

ASSESSORS PLAT 20/4, LOTS 2113 and 2117
SCITUATE AVENUE
CRANSTON, RHODE ISLAND

***Owner/Applicant*:**

West Bay, LLC
1414 Atwood Avenue
Cranston, Rhode Island 02919

Prepared by:

Garofalo & Associates, Inc.
85 Corliss Street, Providence, RI 02940
Tel.: (401).273.6000; Fax: (401).273.1000

MAY, 2014
Revised February 2, 2016

The owner shall designate a qualified professional entity or individual to perform all monitoring & maintenance of the stormwater management system. The name, address and telephone number of the entity or individual shall be provided to the RIDEM & the local D.P.W. office.

Land Use & Site Area:

The existing 6.71 acre parcel is located at 280 Scituate Avenue, Smithfield, RI, A.P. 20/4, Lots 2113 and 2117. Presently, the property is undeveloped and can be characterized as wooded with wetlands and a stream (< 10' wide). The front portion of the property slopes toward Scituate Avenue while portions of the site slope toward the East and into an existing Area Subject to Storm Flow (ASSF) and South to an existing river. Grades generally range from approximately 2% to 10% with small portions exceeding 15%. The total land area of the subject lot (Lot 2117) is approximately 6.57 acres. The site is bordered by existing multi-family developments along Scituate Avenue on its southern, eastern, and western boundaries, and by Scituate Avenue to the north. There is also an existing single family residence directly abutting the site to the northwest.

The proposal is for multi-family residential development. Specifically, the proposal includes two 3-story structures with sixty-three (63) total dwelling units, access roadway and parking, utilities, and associative mitigating drainage structures. The majority of site runoff will be directed to a new infiltration basin, which will infiltrate stormwater runoff from up to and including the 100-year design storm. Water quality treatment and pretreatment will be provided using a Sand Filter.

General:

Stormwater Management structures, facilities and permanent BMP's must be inspected in accordance with this document. All documentation on scheduled inspections, times of inspections, maintenance completed, remedial actions taken to make repairs, and any modifications or reconstruction of the stormwater management system shall be submitted to the RIDEM and the local DPW within (30) days of the inspection.

Disposal of the accumulated sediment must be in accordance with all applicable local, state, and federal guidelines and regulations. If any drainage structure or outfall indicates the presence of petroleum it shall be removed and disposed of immediately in accordance with all l applicable local, state and federal regulations.

Emergency Contacts:

West Bay, LLC
1414 Atwood Avenue
Cranston, Rhode Island 02919
(401) 273-6800

Pavement Sweeping:

1. Parking lots, roads and all access ways and gutters must be swept clean of all sediment and debris on a bi-annual basis in spring and fall, or as needed.

Drain Manholes:

1. All drain manholes must be inspected and maintained on a bi-annual basis in March and October of each year. Drain manholes must be inspected to ensure frames and covers are not damaged, inlet and outlet pipes are flowing freely and there are no blockages within the manhole, and brick course is intact

2. Drain manholes are to be cleaned out during bi-annual inspections in March and October of each year immediately clean the drain manhole if one foot or more of sediment has accumulated within the drain manhole.
3. If inspection indicates the presence of petroleum, it shall be removed immediately and disposed of off-site in accordance with all applicable local, state and federal regulations.

Catchbasins:

1. Maintenance of all catch basins and oil/water separator catch basins on-site will occur as sediment and debris reaches a depth of one and a half (1-1/2) ft. within the sump. Check for structural integrity & repair immediately as required.
2. All debris, sediment, and/or grease shall be removed from the oil/water separator catch basins and disposed of off-site in accordance with state and federal guidelines.

Sand Filter:

1. Long-term maintenance of the basin (sand filter) is the responsibility of the owner. Maintenance shall be performed at a minimum yearly basis. Maintenance shall include mowing of the basin once per growing season (preferably after august 15th), and/or maintaining a grass height of 2"-10", whichever comes first; removing accumulated sediment from the bottom of the basin using shovels and wheelbarrows (at a maximum interval of 10 years).
2. Sediment shall be cleaned out of the sediment forebay when it accumulates to a depth of more than 1/2 the design depth. Vegetation within the sediment forebay shall be limited to a height 10 inches. The sediment chamber outlet devices shall be cleaned/repaired when drawdown times exceed 36 hours. Trash and debris shall be removed as necessary.
3. Silt/sediment shall be removed from the filter bed when the accumulation exceeds one inch. When the filtering capacity of the filter diminished substantially (i.e., when water ponds on the surface of the filter bed for more than 48 hours), the top few inches of discolored material shall be removed and shall be replaced with fresh material. The removed sediments shall be disposed in an acceptable manner at an approved and permitted location.

Infiltration Basin:

1. The Infiltration Basin must be inspected annually and after every rain event greater that a 10-year, 24-hour, Type III event to ensure that the design infiltration rate is being met. Any accumulated sediment within the Basin system shall be removed bi-annually.
2. The system must be monitored for a 72-hour period after every rain storm event of two inches (2") or more. If any infiltration system fails to drain in a 72-hour period the Owner shall retain a qualified professional engineer to assess whether the infiltration system has failed and recommend any corrective action that is required. The corrective action determined shall be immediately implemented to restore the function of the systems to original design conditions.
3. Maintenance of Infiltration Basin shall occur on a yearly basis.
4. Sediments shall be removed and disposed of off-site.
5. Long-term maintenance of infiltration system is the responsibility of Owner or as specified in City permits and approvals. Maintenance shall be performed at a minimum yearly basis. Maintenance shall include mowing of the pond once per growing season (preferably after august

15th), and/or maintaining a grass height of 2"-10", whichever comes first; removing accumulated sediment from the bottom of the basin using shovels and wheelbarrows (at a maximum interval of 10 years), or a depth of 0.17 inches.

6. Check low-flow pipe for clogging and flush as necessary by removing the screw-on pvc cap.
7. If inspection indicates the presence of petroleum, it shall be removed immediately and disposed of off-site in accordance with all applicable local, state and federal regulations.

Underground Infiltration Systems:

1. Maintenance of StormTech infiltration system shall occur on a yearly basis and in accordance with manufacturer's requirements (Stormtech 1-888-892-2694).
2. Sediments shall be removed with use of vacuum truck by way of inspection ports. Sediments shall be removed and disposed of off-site.
3. Maintenance of infiltration system is responsibility of Home Owners or as specified in City permits and approvals.
4. The system must be monitored for a 72-hour period after every rain storm event of two inches (2") or more. If any infiltration system fails to drain in a 72-hour period the Owner shall retain a qualified professional engineer to assess whether the infiltration system has failed and recommend any corrective action that is required. The corrective action determined shall be immediately implemented to restore the function of the systems to original design conditions.

Pollution Prevention:

Solid Waste Containment:

Solid waste storage and removal shall be the responsibility of the owner.

Snow Disposal and Deicing:

1. Snow removal shall happen in conformance with RIDEM requirements. No snow shall be placed within regulated wetlands.
2. No storage or deicing materials shall be allowed at the site or at individual properties within the Champlin Hills development area. Application of deicing materials shall be in conformance with the applicable RIDEM requirements.
3. During winter conditions salt and sand use site-wide shall be applied to the minimum extent possible to maintain safe conditions.

Good Housekeeping Operations:

Good housekeeping and material management reduce the risk of accidental exposure of materials and substances to stormwater runoff.

1. All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers and under a roof or other weather proof enclosure.
2. Products shall be kept in their original containers with the original manufacturer's label.
3. Substances should not be mixed with one another, unless recommended by the manufacturer.
4. Whenever possible, all of a product will be used up before disposing of a container.

5. Petroleum Products:

   All on-site vehicles and parking areas shall be regularly monitored for leaks and spills. Spills encountered during monitoring must be cleaned immediately.

6. Fertilizers:
   1. Fertilizers shall only be used in the minimum amounts as recommended by the manufacturer.
   2. The contents of any un-used fertilizer shall be transferred to a clearly labeled, weather proof sealable plastic bin, to avoid spillage.

7. Paints, Solvents:
   1. All paints and solvents shall be stored in original manufacturer's containers and in a weather proof covered location.
   2. The use of paints and solvents shall, whenever possible, be limited to service or storage bays. Where not possible, the work area shall be protected with impermeable drop clothes or tarps.

STORMWATER MANAGEMENT
SYSTEM OPERATION AND MAINTENANCE PLAN

APPENDIX - A

BMP INSPECTIONS
CHECKLISTS

Infiltration System Operation, Maintenance, and Management Inspection Checklist

Project:

Location:

Site Status:

Date:

Time:

Inspector:

MAINTENANCE ITEM	SATISFACTORY / UNSATISFACTORY	COMMENTS
1. Debris Cleanout (Annual)		
Trench/chamber or basin surface clear of debris		
Inflow pipes clear of debris		
Overflow spillway clear of debris		
Inlet area clear of debris		
2. Sediment Traps or Forebays (Annual)		
Obviously trapping sediment		
Greater than 50% of storage volume remaining		
3. Dewatering (Annual)		
Trench/chamber or basin dewaters between storms		
4. Sediment Cleanout of Trench/Chamber or Basin (Annual)		

MAINTENANCE ITEM	SATISFACTORY / UNSATISFACTORY	COMMENTS
No evidence of sedimentation in trench/chamber or basin		
Sediment accumulation doesn't yet require cleanout		
5. Inlets (Annual)		
Good condition		
No evidence of erosion		
6. Outlet/Overflow Spillway (Annual)		
Good condition, no need for repair		
No evidence of erosion		
7. Aggregate Repairs (Annual)		
Surface of aggregate clean		
Top layer of stone does not need replacement		
Trench/Chamber or basin does not need rehabilitation		

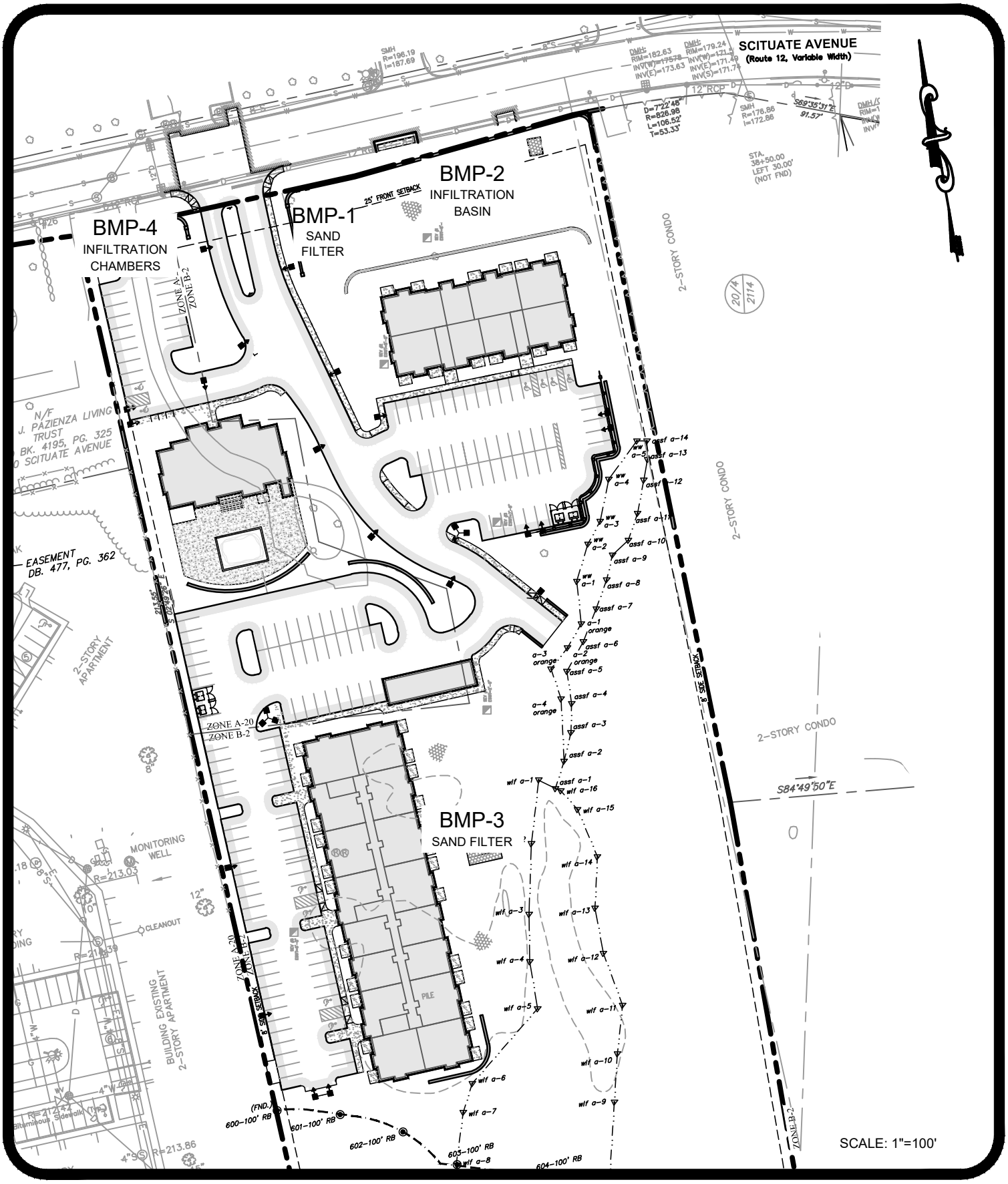
Comments:

Actions to be Taken:

STORMWATER MANAGEMENT
SYSTEM OPERATION AND MAINTENANCE PLAN

APPENDIX - B

BMP Map



GAROFALO

GAROFALO & ASSOCIATES, INC.
85 CORLISS STREET \ P.O. BOX 6145
PROVIDENCE, RHODE ISLAND 02940

CHAMPLIN HILLS
SCITUATE AVENUE
CRANSTON, RHODE ISLAND
BMP LAYOUT MAP

Appendix I
Flood Study Analysis

Flood Study Analysis

Backup Data

ASSESSORS PLAT 20/4, LOT 2117
SCITUATE AVENUE
CRANSTON, RHODE ISLAND

***Owner/Applicant*:**

West Bay, LLC
1414 Atwood Avenue
Cranston, Rhode Island 02919

Prepared by:

Garofalo & Associates, Inc.
85 Corliss Street, Providence, RI 02940
Tel.: (401).273.6000; Fax: (401).273.1000

SEPTEMBER, 2014
(revised 10/6/2015)

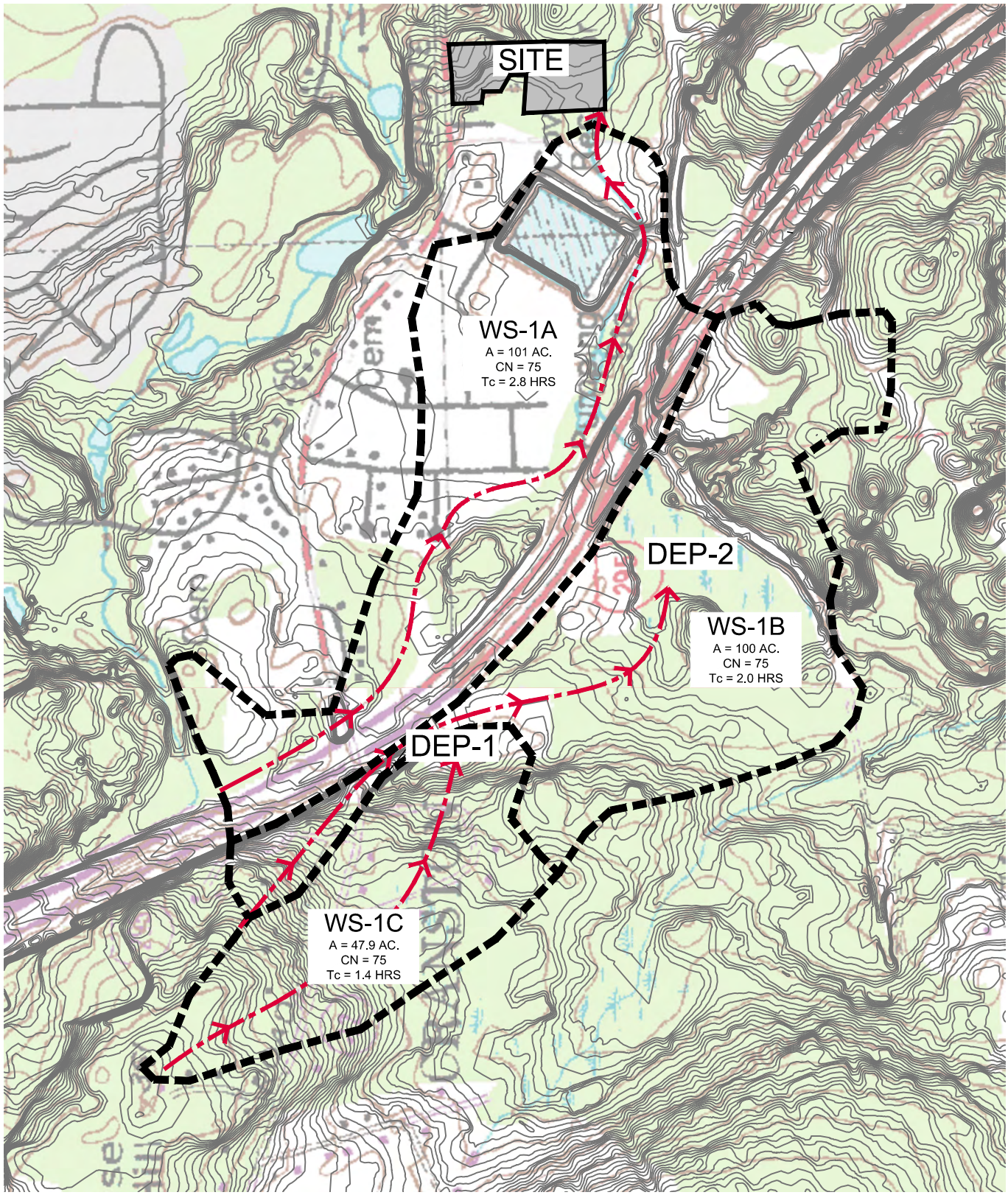


IMAGE: USGS
TOPOGRAPHY: RIGIS

SCALE 1"=800'

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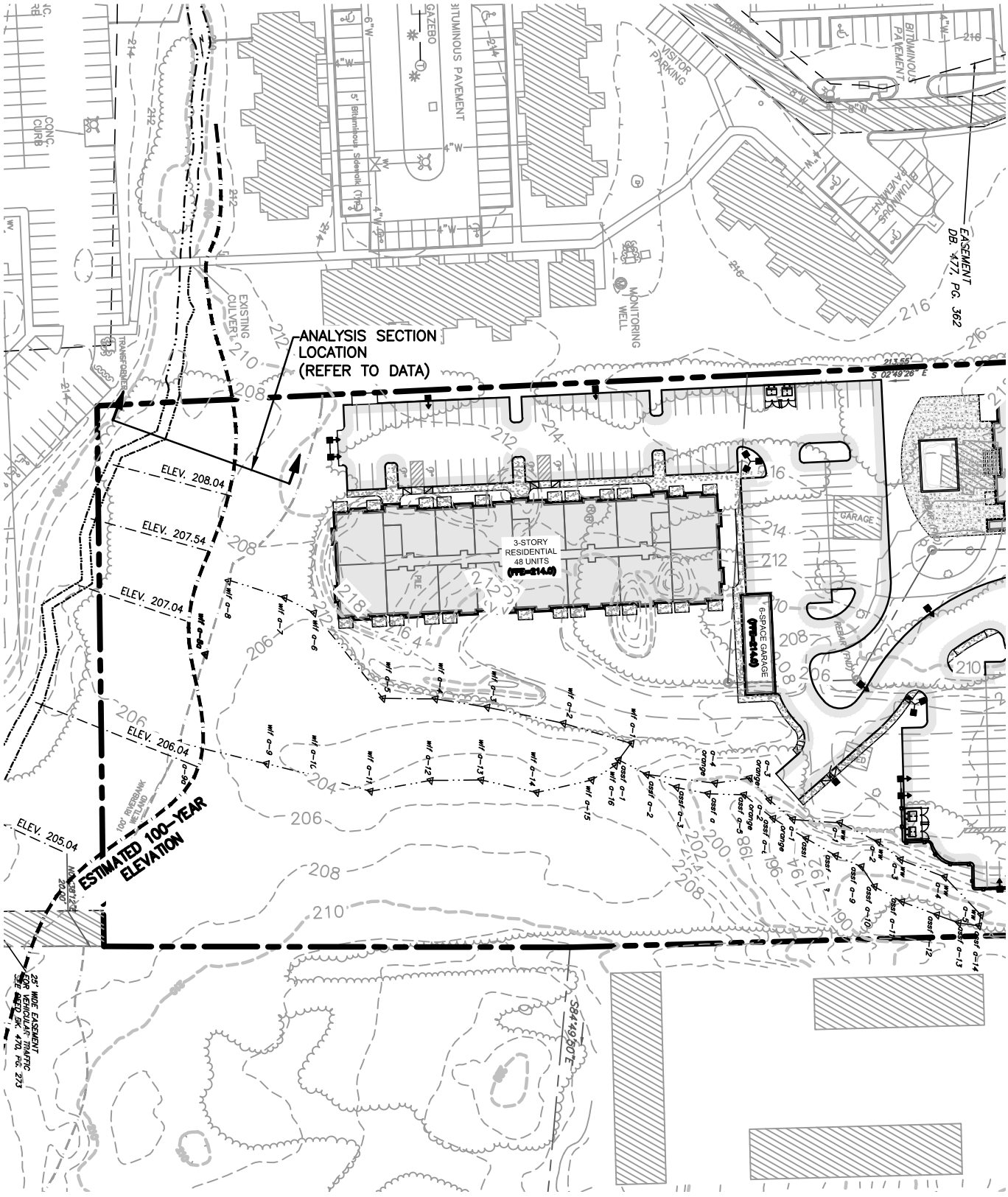
GAROFALO & ASSOCIATES , INC.
CIVIL & STRUCTURAL ENGINEERS\SURVEYORS
LAND PLANNERS\ENVIRONMENTAL SCIENTISTS
85 CORLISS STREET, P.O. BOX 6145
PROVIDENCE, RHODE ISLAND 02940
401-273-6000

CHAMPLIN HILLS
FLOOD STUDY
SCITUATE AVENUE
Cranston, Rhode Island

WATERSHED MAP
September, 2014



SCALE 1"=100'

GAROFALO
GAROFALO & ASSOCIATES , INC.
CIVIL & STRUCTURAL ENGINEERS\SURVEYORS
LAND PLANNERS\ENVIRONMENTAL SCIENTISTS
85 CORLISS STREET, P.O. BOX 6145
PROVIDENCE, RHODE ISLAND 02940
401-273-6000

CHAMPLIN HILLS
FLOOD STUDY
SCITUATE AVENUE
Cranston, Rhode Island

100-year FLOODPLAIN
September, 2014
(REVISED 10/6/2015)

Area (ac)	CN	Description
47.900	75	1/4 acre lots, 38% imp, HSG B
29.698		Pervious Area
18.202		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.8	100	0.0200	0.05		**Sheet Flow, A - B** Woods: Dense underbrush n= 0.800 P2= 3.30"
45.0	2,700	0.0400	1.00		**Shallow Concentrated Flow, B - C** Woodland Kv= 5.0 fps
81.8	2,800	Total			

Summary for Reach U-S: un-named stream

Inflow Area = 248.900 ac, 38.00% Impervious, Inflow Depth > 4.61" for 100 YR event
Inflow = 240.35 cfs @ 14.54 hrs, Volume= 95.717 af
Outflow = 240.29 cfs @ 14.55 hrs, Volume= 95.675 af, Atten= 0%, Lag= 0.4 min

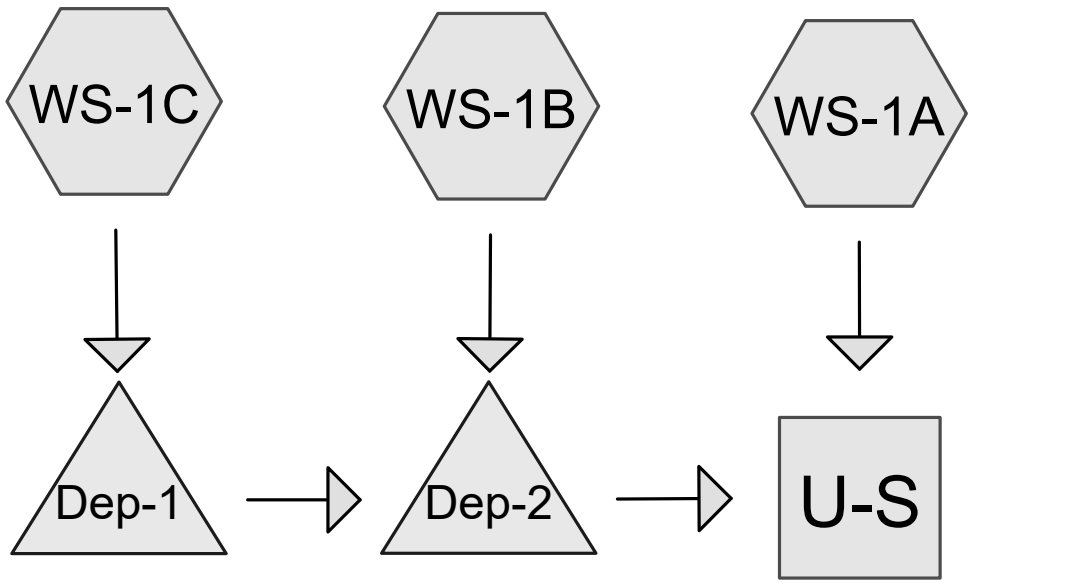
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Max. Velocity= 4.14 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.32 fps, Avg. Travel Time= 0.7 min

Peak Storage= 5,799 cf @ 14.54 hrs, Average Depth at Peak Storage= 1.04'
Bank-Full Depth= 2.50', Capacity at Bank-Full= 1,928.70 cfs

Custom cross-section, Length= 100.0' Slope= 0.0100 '/'
Constant n= 0.025 Earth, clean & winding
Inlet Invert= 208.00', Outlet Invert= 207.00'

‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
0.00	210.00	0.00
9.00	209.00	1.00
16.00	208.00	2.00
25.00	207.50	2.50
34.00	207.50	2.50
36.00	208.00	2.00
105.00	208.00	2.00
130.00	210.00	0.00



un-named stream

Subcat Reach Pond Link

Drainage Diagram for 6856-2014-09-03-FEMA
Prepared by {enter your company name here}, Printed 2/20/2015
HydroCAD® 8.50 s/n 005506 © 2007 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
248.900	75	1/4 acre lots, 38% imp, HSG B (WS-1A,WS-1B,WS-1C)

Soil Listing (all nodes)

Area (acres)	Soil Goup	Subcatchment Numbers
0.000	HSG A	
248.900	HSG B	WS-1A, WS-1B, WS-1C
0.000	HSG C	
0.000	HSG D	
0.000	Other	

Summary for Subcatchment WS-1A:

Runoff = 131.65 cfs @ 14.20 hrs, Volume= 45.985 af, Depth> 5.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

Area (ac)	CN	Description
101.000	75	1/4 acre lots, 38% imp, HSG B
62.620		Pervious Area
38.380		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.8	100	0.0200	0.05		**Sheet Flow, A - B** Woods: Dense underbrush n= 0.800 P2= 3.30"
133.4	4,900	0.0150	0.61		**Shallow Concentrated Flow, B - C** Woodland Kv= 5.0 fps
170.2	5,000	Total			

Summary for Subcatchment WS-1B:

Runoff = 165.81 cfs @ 13.60 hrs, Volume= 46.116 af, Depth> 5.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

Area (ac)	CN	Description
100.000	75	1/4 acre lots, 38% imp, HSG B
62.000		Pervious Area
38.000		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.8	100	0.0200	0.05		**Sheet Flow, A - B** Woods: Dense underbrush n= 0.800 P2= 3.30"
84.4	3,100	0.0150	0.61		**Shallow Concentrated Flow, B - C** Woodland Kv= 5.0 fps
121.2	3,200	Total			

Summary for Subcatchment WS-1C:

Runoff = 102.87 cfs @ 13.08 hrs, Volume= 22.295 af, Depth> 5.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YR Rainfall=8.70"

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	9.0	0	0.00
0.50	7.3	89.1	725	8.09
1.50	106.0	108.7	10,600	619.64
2.50	225.3	130.3	22,525	1,928.70

Summary for Pond Dep-1:

Inflow Area = 47.900 ac, 38.00% Impervious, Inflow Depth > 5.59" for 100 YR event
Inflow = 102.87 cfs @ 13.08 hrs, Volume= 22.295 af
Outflow = 84.74 cfs @ 13.48 hrs, Volume= 15.274 af, Atten= 18%, Lag= 23.9 min
Primary = 84.74 cfs @ 13.48 hrs, Volume= 15.274 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 245.75' @ 13.48 hrs Surf.Area= 87,836 sf Storage= 361,799 cf

Plug-Flow detention time= 163.4 min calculated for 15.274 af (69% of inflow)
Center-of-Mass det. time= 74.0 min (945.1 - 871.1)

Volume	Invert	Avail.Storage	Storage Description
#1	240.00'	384,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
240.00	38,000	0	0
246.00	90,000	384,000	384,000

Device	Routing	Invert	Outlet Devices
#1	Primary	245.00'	**40.0' long x 4.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=84.56 cfs @ 13.48 hrs HW=245.75' (Free Discharge)
1=Sharp-Crested Rectangular Weir (Weir Controls 84.56 cfs @ 2.83 fps)

Summary for Pond Dep-2:

Inflow Area = 147.900 ac, 38.00% Impervious, Inflow Depth > 4.98" for 100 YR event
Inflow = 249.13 cfs @ 13.52 hrs, Volume= 61.390 af
Outflow = 116.42 cfs @ 14.86 hrs, Volume= 49.731 af, Atten= 53%, Lag= 80.1 min
Primary = 116.42 cfs @ 14.86 hrs, Volume= 49.731 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 227.98' @ 14.86 hrs Surf.Area= 13.609 ac Storage= 25.695 af

Plug-Flow detention time= 180.8 min calculated for 49.731 af (81% of inflow)
Center-of-Mass det. time= 114.7 min (1,027.6 - 912.8)

Volume	Invert	Avail.Storage	Storage Description
#1	226.00'	25.920 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
226.00	12.300	0.000	0.000
228.00	13.620	25.920	25.920

Device	Routing	Invert	Outlet Devices
#1	Primary	226.50'	**20.0' long x 2.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=116.41 cfs @ 14.86 hrs HW=227.98' (Free Discharge)
↑—**1=Sharp-Crested Rectangular Weir** (Weir Controls 116.41 cfs @ 3.98 fps)

Appendix J
Supporting Documentation

PAUL B. ALDINGER & ASSOCIATES, INC.
Consulting in Geotechnical Engineering & Groundwater Hydrology
860A Waterman Avenue, Suite 9, East Providence, R.I. 02914 (401) 435-5570

October 17, 2014

Mr. Richard Bourbonnais II, P.E.
Garofalo and Associates, Inc.
85 Corliss St.
P.O. Box 6145
Providence, RI 02940

Re: Infiltration Testing
AP 20/4, Lot 2113
Cranston, RI
PBA 14031

Dear Mr. Bourbonnais:

As you requested, an engineer from Paul B. Aldinger & Associates, Inc. (PBA) conducted an infiltration test on October 8, 2014 at parcel AP 20/4, Lot 2113 located just east of 306 Scituate Avenue in Cranston, RI. The purpose of the test was to determine the soil infiltration rate of the underlying soil to assist in your design of the stormwater infiltration system for a new development at the site.

The Rhode Island Stormwater Design and Installation Standards Manual (2010) (Section H.1.3) lists the double ring infiltrometer test as one of the acceptable methods to determine the saturated hydraulic conductivity of a soil. As a result, PBA conducted a double ring infiltrometer test at the site in accordance with ASTM D 3385, *Standard Test Method for Infiltration Rate of Soils in Field using Double Ring Infiltrometer*. This test consists of conducting a constant head permeability test within a double ring infiltrometer. The use of the double rings reduces the potential for side seepage and allows for better measurement of vertical flow within the inner ring.

The infiltration test was conducted within the footprint of the proposed infiltration system at a depth of approximately 4 feet below grade following excavation with a backhoe which you provided. Photos 1 and 2 included with this letter show the setup of the test. The test was conducted for 6-hours until a relatively stabilized rate was achieved. During this time, the water level within the double rings (approximately 3.75 inches) was kept constant while the change in volume of the water was recorded within two pvc mariotte tubes. The results of the test are provided in Table 1 attached with this letter.

Based on the results, it appeared that the infiltration rate had achieved a relatively constant rate during the final hour which resulted in an infiltration rate of 6.07 in/hour. It is our understanding that based on the RI Stormwater Manual that a factor of safety of 2 is then applied to the field derived infiltration rate yielding 3.04 in/hour for the system design rate.

We appreciate the opportunity to have been of service to you and we trust that the information contained in this letter is adequate for your needs at this time. Please contact the undersigned if there are questions on these recommendations or if you need additional information.

Very truly yours,

Jody S. Richards, P.E.
Senior Geotechnical Engineer

Paul B. Aldinger, Ph.D., P.E.
President and Chief Engineer

PAUL B. ALDINGER
NO. 3449
REGISTERED
PROFESSIONAL ENGINEER

Enclosures:
Photos 1 and 2 Infiltration Test Setup
Table 1: Infiltration Test

TABLE 1: INFILTRATION TEST - CRANSTON, RI
Conducted by: J. Richards, P.E.

Vol. Inner Ring 113 in2
Vol. Outer Ring 339 in2

Vol. Liguid Container 12.56 in2/in
12.56 in2/in

Weather: Sunny, 70's
Depth of water in ring: 3.75 in

Water Flow maintained using Mariotte Tube
Ring Peneteration: 3 inches

Trial No.	Start/End	Date	Time	Elapsed time	TIME INTERVAL	Flow Readings & Infiltration Rate															
						Inner Ring reading (in)	flow (in3)	Inner in/hr		Time	Time Interval	Annular reading (in)	flow (in3)	Annular in/hr		Time	Time Interval	Annular reading (in)	flow (in3)	Annular in/hr	
	S	10/8/2014	9:00			55.5				9:00		32.5				13:16		33.5			Refill
	E	10/8/2014	9:15		15	40	194.68	6.89		9:05	5	16	207.24	7.34		13:22	6	16	219.8	6.48	
	S	10/8/2014	9:15			55.5			Refill	9:15		33			Refil	13:25		33.5			Refill
	E	10/8/2014	9:30		15	36.5	238.64	8.45		9:21	6	16	213.52	6.30		13:31	6	17	207.24	6.11	
	S	10/8/2014	9:30			55.5			Refill	9:38		33			Refil	13:36		33.5			Refill
	E	10/8/2014	9:45		15	41	182.12	6.45		9:45	7	24	113.04	2.86		13:43	7	16.5	213.52	5.40	
	S	10/8/2014	9:50			56.5			Refil	9:48		33			Refil	13:46		33			Refil
	E	10/8/2014	10:05		15	40.5	200.96	7.11		9:59	11	16	213.52	3.44		13:53	7	15.5	219.8	5.56	
	S	10/8/2014	10:06			56.5			Refil	10:06		33			Refil	13:54		33.5			Refil
	E	10/8/2014	10:21		15	44	157	5.56		10:20	14	16.5	207.24	2.62		14:00	6	16	219.8	6.48	
	S	10/8/2014	10:23			56.5			Refil	10:22		33			Refill	14:02		33.5			Refill
	E	10/8/2014	10:41		18	42	182.12	5.37		10:30	8	15.5	219.8	4.86		14:10	8	17	207.24	4.58	
	S	10/8/2014	10:45			56.5			Refill	10:35		33			Refill	14:14		33.5			Refill
	E	10/8/2014	11:03		18	41	194.68	5.74		10:44	9	16	213.52	4.20		14:21	7	16	219.8	5.56	
	S	10/8/2014	11:08			56.5			Refill	10:46		33			Refill	14:23		33.5			Refill
	E	10/8/2014	11:23		15	44	157	5.56		10:55	9	16	213.52	4.20		14:30	7	15.25	229.22	5.80	
	S	10/8/2014	11:24			56.5			Refill	10:56		33			Refill	14:38		33.5			Refill
	E	10/8/2014	11:50		16	41	194.68	6.46		11:03	7	16	213.52	5.40		14:44	6	17	207.24	6.11	
	S	10/8/2014	11:53			56.5			Refill	11:06		33			Refill	14:46		33			Refill
	E	10/8/2014	12:10		17	41	194.68	6.08		11:13	7	16	213.52	5.40		14:53	6	17.5	194.68	5.74	
	S	10/8/2014	12:13			56.5			Refill	11:15		33.5			Refil	14:54		33.5			Refill
	E	10/8/2014	12:32		19	41	194.68	5.44		11:20	5	17.75	197.82	7.00		15:00	5	20	169.56	6.00	
	S	10/8/2014	12:37			56.5			Refill	11:23		33.5			Refil						
	E	10/8/2014	12:56		19	40.25	204.1	5.70		11:32	9	16.25	216.66	4.26							
	S	10/8/2014	13:03			56.5			Refill	11:38		33.5			Refil						
	E	10/8/2014	13:14		11	46.5	125.6	6.06		11:42	4	17	207.24	9.17							
	S	10/8/2014	13:17			56.5			Refill	11:43		33.5			Refil						
	E	10/8/2014	13:32		15	43.25	166.42	5.89		11:51	8	16.25	216.66	4.79							
	S	10/8/2014	13:35			56.5			Refill	11:54		33.5			Refil						
	E	10/8/2014	13:52		16	41.375	189.97	6.30		12:03	9	16	219.8	4.32							
	S	10/8/2014	13:56			56.5			Refill	12:05		33.5			Refil						
	E	10/8/2014	14:11		15	42.5	175.84	6.22		12:13	8	16.75	210.38	4.65							
	S	10/8/2014	14:17			56.5			Refill	12:17		34			Refil						
	E	10/8/2014	14:26		10	47.5	113.04	6.00		12:29	12	15.5	232.36	3.43							
	S	10/8/2014	14:28			56.5			Refill	12:34		33.5			Refil						
	E	10/8/2014	14:42		14	44	157	5.95		12:44	10	16.25	216.66	3.83							
	S	10/8/2014	14:43			56.5			Refill	12:47		33.5			Refil						
	E	10/8/2014	15:00		17	41	194.68	6.08		12:53	6	17	207.24	6.11							
										12:55		33.5			Refil						
						Avg last Hour		6.07		13:01	6	16.5	213.52	6.30							
										13:04		33.5			Refil						
										13:13	9	16	219.8	4.32							

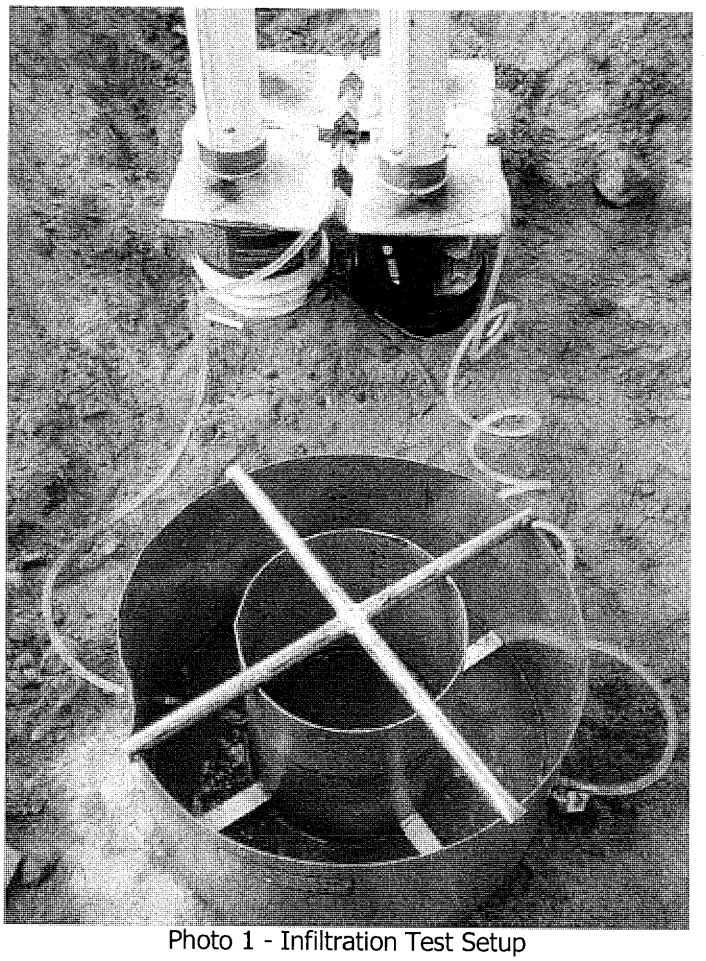


Photo 1 - Infiltration Test Setup

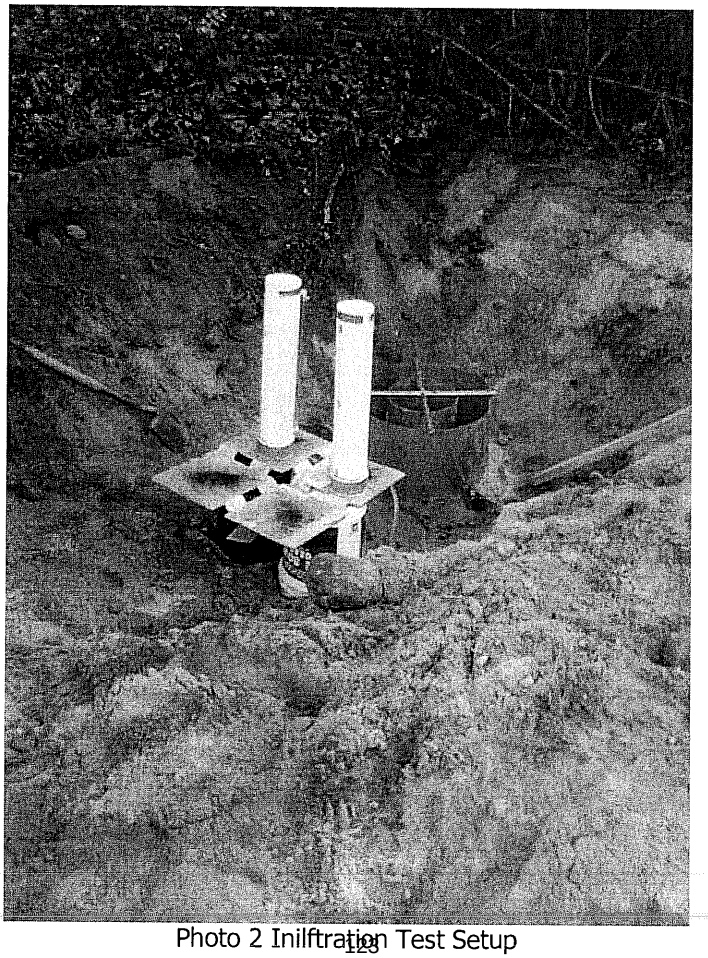


Photo 2 Inilftration Test Setup

Hydrologic Soil Group—State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
Survey Area Data: Version 12, Dec 18, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 21, 2013—Sep 7, 2013

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties (RI600)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
CeC	Canton and Charlton fine sandy loams, very rocky, 3 to 15 percent slopes	B	0.1	1.5%
EfB	Enfield silt loam, 3 to 8 percent slopes	B	2.8	29.4%
HnC	Hinckley-Enfield complex, rolling	A	0.1	1.4%
NaB	Narragansett silt loam, 3 to 8 percent slopes	B	1.8	18.3%
NbC	Narragansett very stony silt loam, 8 to 15 percent slopes	B	0.2	1.9%
Rc	Raypol silt loam	C	0.2	1.7%
Tb	Tisbury silt loam	B	2.4	24.4%
UD	Udorthents-Urban land complex	A	2.1	21.4%
Totals for Area of Interest			**9.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

MAP SCALE 1" = 500'

250 0 500 1000

FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0313G

FIRM

FLOOD INSURANCE RATE MAP

PROVIDENCE COUNTY, RHODE ISLAND
(ALL JURISDICTIONS)

PANEL 313 OF 451

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CRANSTON, CITY OF	445396	0313	G

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

MAP NUMBER
44007C0313G

EFFECTIVE DATE
MARCH 2, 2009

Federal Emergency Management Agency

Wetland Edge Delineation Data Form (UPLAND)

Applicant: Carpionato Group
Wetland No. A
Project: Champlin Hills
Flag No. Sequence: A-11
City/Town: Cranston
Date: 4/12/14

Vegetation: List the three dominant species in each vegetative strata along with their NWI status:

Tree	Indicator Status	Herbs	Indicator Status
1. Acer rubrum	Fac	1.	
2. Juniperus Virginiana	Fac U	2. None	
3.		3. Visible	
Saplings/Shrubs		**Woody Vines**	
1. Acer rubrum -	Fac	1.	
2.		2. None	
3.		3.	

List other vegetative species noted which may have affected determination of the wetland edge: _____

Soil: SCS Soil Survey Mapping Unit: Tisbury Silt loam (TtB)
On Hydric Soils List? (Y/N) No

Soil Profile (Note wetland flag no. nearest soil test pit): A-11

Horizon	Depth	Matrix Color	Mottling Description	Depth to Saturation	Depth to Free Water
Ap	0-8"	10YR 3/2	None	0	0
Bw	8-16"	5YR 2.5/2	None	0	0

Other indicators exhibiting an absence of wetland hydrology (e.g. absence of water marks, lack of redoximorphic features, lack of oxidized rhizospheres, etc.):

Landscape position: 10' upslope from Flag A-11
Altered/atypical situation? (describe)

Comments: Sparse Tree + Shrub cover

Wetland Edge Delineation Data Form ~~(UPLAND)~~ Wetland

Applicant: Carpionato Group Wetland No. A

Project: Champlin Hills Flag No. Sequence: A-11

City/Town: Cranston Date: 4/12/14

Vegetation: List the three dominant species in each vegetative strata along with their NWI status:

Tree	Indicator Status	Herbs	Indicator Status
1. Acer rubrum	Fac	1.	
2.		2. None	
3.		3. Visible	

Saplings/Shrubs	Woody Vines
1. Vaccinium corymbosum Facw-	1.
2.	2. Not present
3.	3.

List other vegetative species noted which may have affected determination of the wetland edge: _____.

Soil: SCS Soil Survey Mapping Unit: Tisbury Silt Loam (Tb)
On Hydric Soils List? (Y/~~N~~) No

Soil Profile (Note wetland flag no. nearest soil test pit): A-11

Horizon	Depth	Matrix Color	Mottling Description	Depth to Saturation	Depth to Free Water
Ap	0-8"	5YR 2.5/2	Few	8"	10"
Bw	8-16"	5YR 2.5/2	Many Yellow		10"

Other indicators of wetland hydrology (e.g. water marks, drainage patterns, root rhizospheres, etc.):

Landscape position: At edge Standing water
Altered/atypical situation? (describe)

Comments:

WTWEDF.MST - Rev April 7, 1994

Wetland Edge Delineation Data Form (UPLAND)

Applicant: Carpionato Group Wetland No. A

Project: Champlin Hills Flag No. Sequence: A-5

City/Town: Cranston Date: 4/12/14

Vegetation: List the three dominant species in each vegetative strata along with their NWI status:

Tree	Indicator Status	Herbs	Indicator Status
1. Acer rubrum	Fac	1.	
2. Juniperus	Fac U	2. None	
3. Virginiana		3. visible	

Saplings/Shrubs	Woody Vines
1. Vaccinium corymbosum FacW+	1.
2. Salix bebbiana FacW	2. None visible
3.	3.

List other vegetative species noted which may have affected determination of the wetland edge: _____.

Soil: SCS Soil Survey Mapping Unit: Urdothents

On Hydric Soils List? (Y/N) ~~Y~~

Soil Profile (Note wetland flag no. nearest soil test pit): A-5

Horizon	Depth	Matrix Color	Mottling Description	Depth to Saturation	Depth to Free Water
Ap	0-10"	Urdothent			

Other indicators exhibiting an absence of wetland hydrology (e.g. absence of water marks, lack of redoximorphic features, lack of oxidized rhizospheres, etc.):

Landscape position: Spoil piles

Altered/atypical situation? (describe)

Comments: Area of past fill deposition

No soil profile

Wetland Edge Delineation Data Form (WETLAND)

Applicant: Carpionato Group Wetland No. A

Project: Champlin Hills Flag No. Sequence: A-5

City/Town: Cranston Date: 4/12/14

Vegetation: List the three dominant species in each vegetative strata along with their NWI status:

Tree	Indicator Status	Herbs	Indicator Status
1. Acer rubrum	fac	1.	
2. Prunus seedling	FacU	2. None	
3.		3. visible	
Saplings/Shrubs		**Woody Vines**	
1. Salix bebbiana	FacW	1. Vitis	
2.		2.	
3.		3.	

List other vegetative species noted which may have affected determination of the wetland edge: _____

Soil: SCS Soil Survey Mapping Unit: Tisbury Silt loam (Tb)
On Hydric Soils List? (Y/N) No

Soil Profile (Note wetland flag no. nearest soil test pit): A-5

Horizon	Depth	Matrix Color	Mottling Description	Depth to Saturation	Depth to Free Water
Ap	0-8"	5YR 2.5/2	Few	8"	10"
Bw	8-16"	5YR 2.5/4	Many Yellow		10"

Other hydrological indicators (e.g. water marks, drainage patterns, root rhizospheres, etc.; see Appendix 4(A)(4) of the Rules): _____

Landscape position:
Altered/atypical situation? (describe) At edge of Urdotheca pits

Comments: _____

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
Department of Environmental Management
Office of Water Resources

Site Evaluation Form
Part A - Soil Profile Description

Application Number: —

Property Owner: West Bay, LLC
Property Location: Assessors Map 20/4, Lot 2117, Scituate Avenue, Cranston
Date of Test Hole: March 20, 2014
Soil Evaluator: Steven Hersey License Number: D4026
Weather: Ptly cldy 45-50° [illegible] 12" DBS Shaded: Yes ☒ No ☐ Time: 9am-11am

TH 1 Horizon	Depth	Horizon Boundaries Dist	Topo	Soil Colors Matrix	Re-Dox Features	Re-Dox Description Ab.	S.	Con.	Texture	Structure	Consistence	Soil Category
Ap	0-6"	CL	W	2.5Y 3/3	Few Dist mottles				SL TFSiL	mgr	VFr	
Bw1 Bw2	6-14" 14"-54"	CL Ab	W W	2.5Y 4/4 2.5Y 5/4	Com. Dist 10YR 5/8, 5Y 4/2 @ 18"-54" ±				GrSL, TFSiL GrSL w/pockets of FSiL	mgr mgr	VFr VFr-Fr	
2C1	54"-65"	CL	W	2.5Y 7/3	—		—		FS	MGR-OSG	VFR-L	
2C2	65"-75"	CL	W	2.5Y 7/2	—		—		FS	mGR-OSG	VFR-FR	
2C3	75-83"	CL	W	5Y 5/3	Very Prom Conc @ 78" 10YR 4/6				VFS, VFLS TFSiL	Platy	Fr (Firm in place)	
2C4	83-132"			2.5Y 7/2					FS	MGr-OSG	VFr	

TH 2 Horizon	Depth	Horizon Boundaries Dist	Topo	Soil Colors Matrix	Re-Dox Features	Re-Dox Description Ab.	S.	Con.	Texture	Structure	Consistence	Soil Category
Ap	0-5"	Ab	W	10YR 3/3	—		—		FSL-SiL	mgr	VFr	
Bw	5"-30"±	CL	Irr	2.5Y 5/4	—		—		GrSL	Mgr	VFr	
2C1	30"-76"	CL	W	2.5Y 7/3	Few pockets SiL 5Y 6/1 @ 74"± Many Dist Conc. 10YR 5/8 @ 74"-79"±				FS-S w/pockets of SiL @ 74"±	OSG Fgr	L-VFr	
2C2	76"-132"			2.5Y 7/2					FS-S	mgr-OSG	VFr-L	

Horizon Slumped +/- 12"

Soil Class: "D" Glacial Ice Contact Deposit
Total Depth of each Test Hole: 1 11', 2 11'
Depth to Groundwater Seepage: 1 none @ 11', 2 none @ 11'
Depth to Impervious or Limiting Layer: —
Estimated Seasonal High Water Table: 1 6'0", 2 6'0"
Comments: Pipes installed
Sev 1 top of pipe 4" above OG
" 2 " " " 5" " "

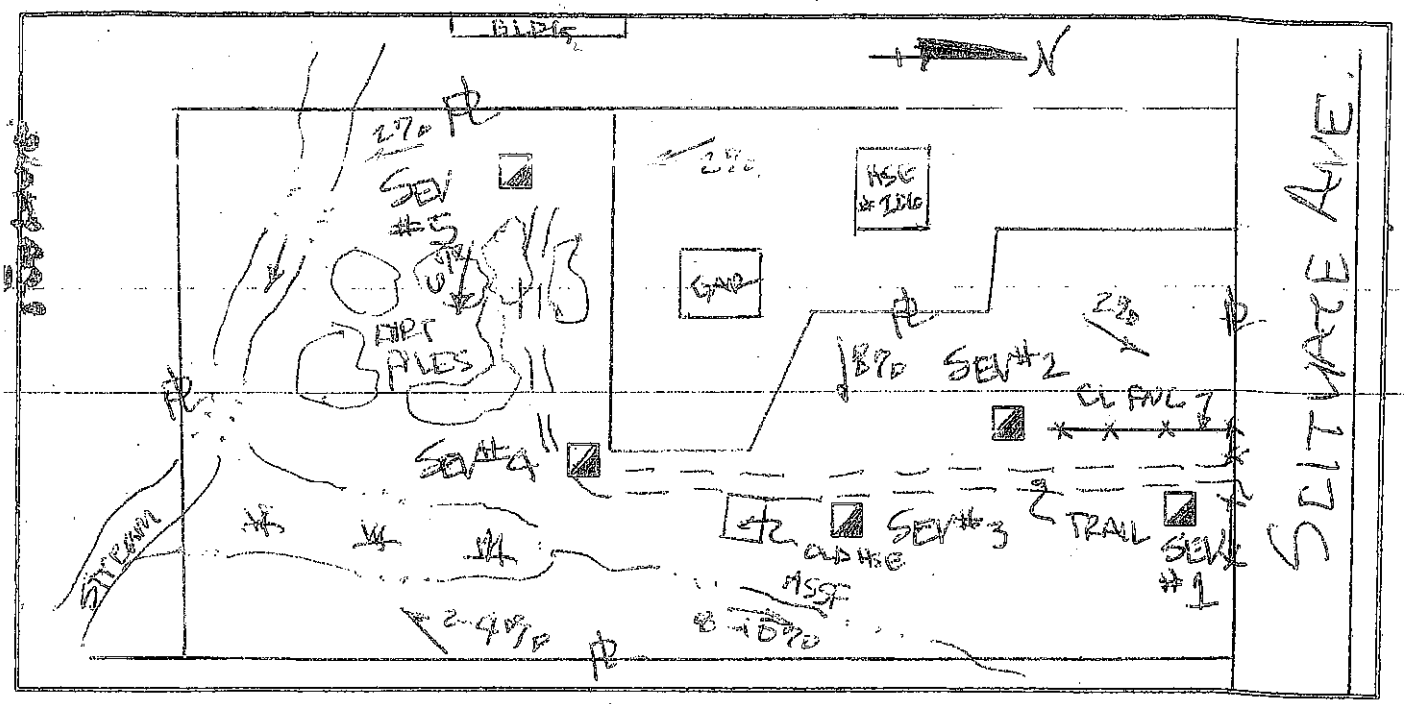
Part B

Site Evaluation - to be completed by Class II or III Designer or Soil Evaluator

Please use the area below to locate:

1. Test holes
2. Approximate direction of due north
3. Offsets from test holes to fixed points such as street, utility pole, or other permanent, marked object

Key:
- Approximate location of test holes
- x% Estimated gradient and direction of slope
- N Approximate direction of due north



1. Relief and Slope: Various - See Sketch
2. Presence of any watercourse, wetlands or surface water bodies, within 200 feet of test holes: YES☐ NO☐ If yes, locate on above sketch.
3. Presence of existing or proposed private drinking water wells within 200 feet of test holes: YES☐ NO☐ If yes, locate on above sketch.
4. Public drinking water wells within 500 feet of test holes: YES☐ NO☐ If yes, locate on above sketch.
5. Is site within the watershed of a public drinking water reservoir or other critical area defined in SD 19.00? YES☐ NO☐
6. Has soil been excavated from or fill deposited on site? YES☐ NO☐ If yes, locate on above sketch.
7. Site's potential for flooding or ponding: NONE☐ SLIGHT☐ MODERATE☐ SEVERE☐
8. Landscape position: bank slope
9. Vegetation: Mostly deciduous trees & Shrub
10. Indicate approximate location of property lines and roadways.
11. Additional comments, site constraints or additional information regarding site:

Certification

The undersigned hereby certifies that all information on this application and accompanying forms, submittals and sketches are true and accurate and that I have been authorized by the owner(s) to conduct these necessary field investigations and submit this request.

Part A prepared by: [signature] Date (Part B prepared by: [signature] Date 6

Signature License # Signature License #

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Decision: Approved ☐ Disclaimed ☐

Comments:

Signature Authorized Agent Date

revised 5/8/01

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
Department of Environmental Management
Office of Water Resources

Site Evaluation Form
Part A - Soil Profile Description

Application Number: —

Property Owner: West Bay, LLC
Property Location: Assessors Map 20/4, Lot 2117, Scituate Avenue, Cranston
Date of Test Hole: March 20, 2014
Soil Evaluator: Steven Henry License Number: D4D216
Weather: Partly cldy 45-50°D Ground Surface Shaded: Yes ☒ No ☐ Time: 10am - 1pm
12 hrs ±

TH 3 Horizon	Depth	Horizon Boundaries Dist	Topo	Soil Colors Matrix	Re-Dox Features	Re-Dox Description Ab. S. Con.	Texture	Structure	Consistence	Soil Category
	Top	±		Subsoil		Stripped				
C1	0-36"	Ab	W	2.5Y 5/4			Gr LS	ØSG	L	
C2	36"-74"	CL	W	2.5Y 7/3		Darker/Denser	S-FS	ØSG	L	
C3	74"-120"			2.5Y 6/3		Band of 2.5Y 6/2 @ 72-76" Thk	S	ØSG	L	
				No obvious redox - soils @ 72-76" appear dense in place						
TH 4 Horizon	Depth	Horizon Boundaries Dist	Topo	Soil Colors Matrix	Re-Dox Features	Re-Dox Description Ab. S. Con.	Texture	Structure	Consistence	Soil Category
Ap	0-4"	Ab	W	10YR 3/1		A bit lean may have been disturbed from adjacent Ballast	SiL	Mgr	L-VFr	
Bw	4"-14"	CL	W	10YR 5/4			SL TrSiL	Mgr	VFr-Fr	
2C1	14"-4'	CL	W	2.5Y 5/4		narrow line of cond @ 7.5YR 5/8 24"	Gr S-LS	ØSG	L	
2C2	4'-7'±	CL	W	** 7.5YR 5/2			Gr LS very wet	ØSG wet	L-Fr Appeared cemented from in place	
2C3	7'±-10'			**	many pockets of cond 10YR 5/8 throughout		S,FS	wet	VFr	
				**	DIFFICULT TO COLOR, ETC DUE TO HEAVY FLOW					

Soil Class: "D" Glacial Ice Contact Deposit Total Depth of each Test Hole: 3 & 4, 10'
Depth to Groundwater Seepage: 3 10½", 4 40" Heavy Depth to Impervious or Limiting Layer: —
Estimated Seasonal High Water Table: (3) 70", 4 24" Comments: Pipes installed
3 Top of pipe 4" above ground
4 " " " 8" " "

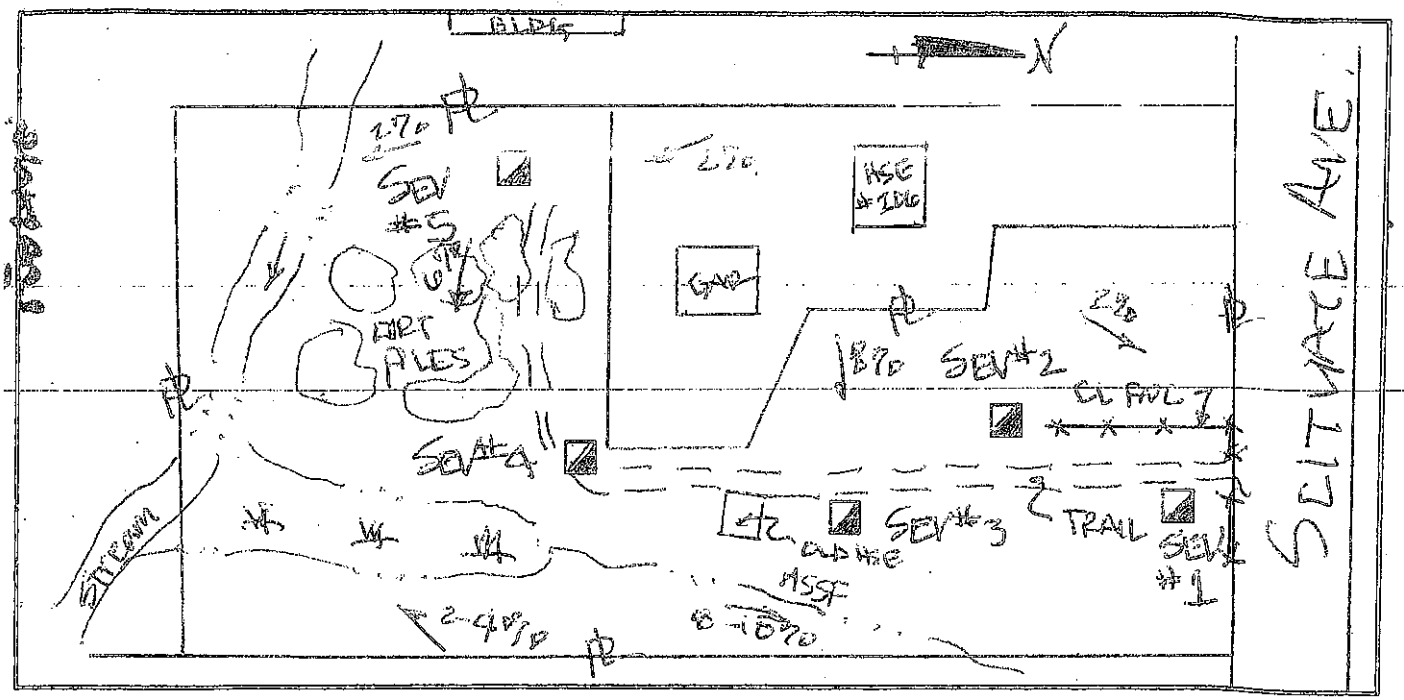
Part B

Site Evaluation - to be completed by Class II or III Designer or Soil Evaluator

Please use the area below to locate:

1. Test holes
2. Approximate direction of due north
3. Offsets from test holes to fixed points such as street, utility pole, or other permanent, marked object

Key:
- Approximate location of test holes
- x% → Estimated gradient and direction of slope
- N → Approximate direction of due north



1. Relief and Slope: Various - See sketch
2. Presence of any watercourse, wetlands or surface water bodies, within 200 feet of test holes: YES☐ NO☐ If yes, locate on above sketch.
3. Presence of existing or proposed private drinking water wells within 200 feet of test holes: YES☐ NO☐ If yes, locate on above sketch.
4. Public drinking water wells within 500 feet of test holes: YES☐ NO☐ If yes, locate on above sketch.
5. Is site within the watershed of a public drinking water reservoir or other critical area defined in SD 19.00? YES☐ NO☐
6. Has soil been excavated from or fill deposited on site? YES☐ NO☐ If yes, locate on above sketch.
7. Site's potential for flooding or ponding: NONE☐ SLIGHT☐ MODERATE☐ SEVERE☐
8. Landscape position: Backslope.
9. Vegetation: Mostly deciduous trees & Scrub
10. Indicate approximate location of property lines and roadways.
11. Additional comments, site constraints or additional information regarding site:

Certification

The undersigned hereby certifies that all information on this application and accompanying forms, submittals and sketches are true and accurate and that I have been authorized by the owner(s) to conduct these necessary field investigations and submit this request.

Part A prepared by: [signature] Date 4/2/20 Part B prepared by: [signature] Date 4/2/20

Signature License # Signature License #

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Decision: Approved ☐ Disclaimed ☐

Comments:

Signature Authorized Agent Date

revised 5/8/01

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
Department of Environmental Management
Office of Water Resources

Site Evaluation Form
Part A - Soil Profile Description

Application Number: —

Property Owner: West Bay, LLC
Property Location: Assessors Map 20/4, Lot 217, Scituate Avenue, Cranston
Date of Test Hole: March 20, 2014
Soil Evaluator: Steven Henry License Number: D4026
Weather: partly cloudy 45°-50° Recent Precipitation: 12 hrs ± Shaded: Yes ☒ No ☐ Time: 10am - 1pm

TH 5

Horizon	Depth	Horizon Boundaries: Dist	Horizon Boundaries: Topo	Soil Colors: Matrix	Soil Colors: Re-Dox Features	Re-Dox Description: Ab. S. Con.	Texture	Structure	Consistence	Soil Category
Ap	0-6"	Ab	S	10YR 3/3			SiL-FSL	Fgr	VFr	
Bw1	6-16"	CL	W	2.5Y 5/4			SL-T SiL	F-mgr Wbk	Fr	
Bw2	16"-28"	CL	W	2.5Y 5/4			SL-T SiL	mgr-Wbk	VFr	
2C1	28"-60"	CL	W	2.5Y 6/4			GrS-CS	Sg	L	
2C2	60"-10'			2.5Y 6/3	Few Faint & Dist Cmc 10YR 5/6 @ 74"		VGr CS Cobbly	Sg	L	

TH ____

Horizon	Depth	Horizon Boundaries: Dist	Horizon Boundaries: Topo	Soil Colors: Matrix	Soil Colors: Re-Dox Features	Re-Dox Description: Ab. S. Con.	Texture	Structure	Consistence	Soil Category

Soil Class: "D" Glacial Ice Contact Deposit
Depth to Groundwater Seepage: 5 @ 74"
Estimated Seasonal High Water Table: 5 60"
Total Depth of each Test Hole: 5 10'
Depth to Impervious or Limiting Layer: —
Comments: Pipes installed SCH "S" Top of Pipe 1'4" above Gr

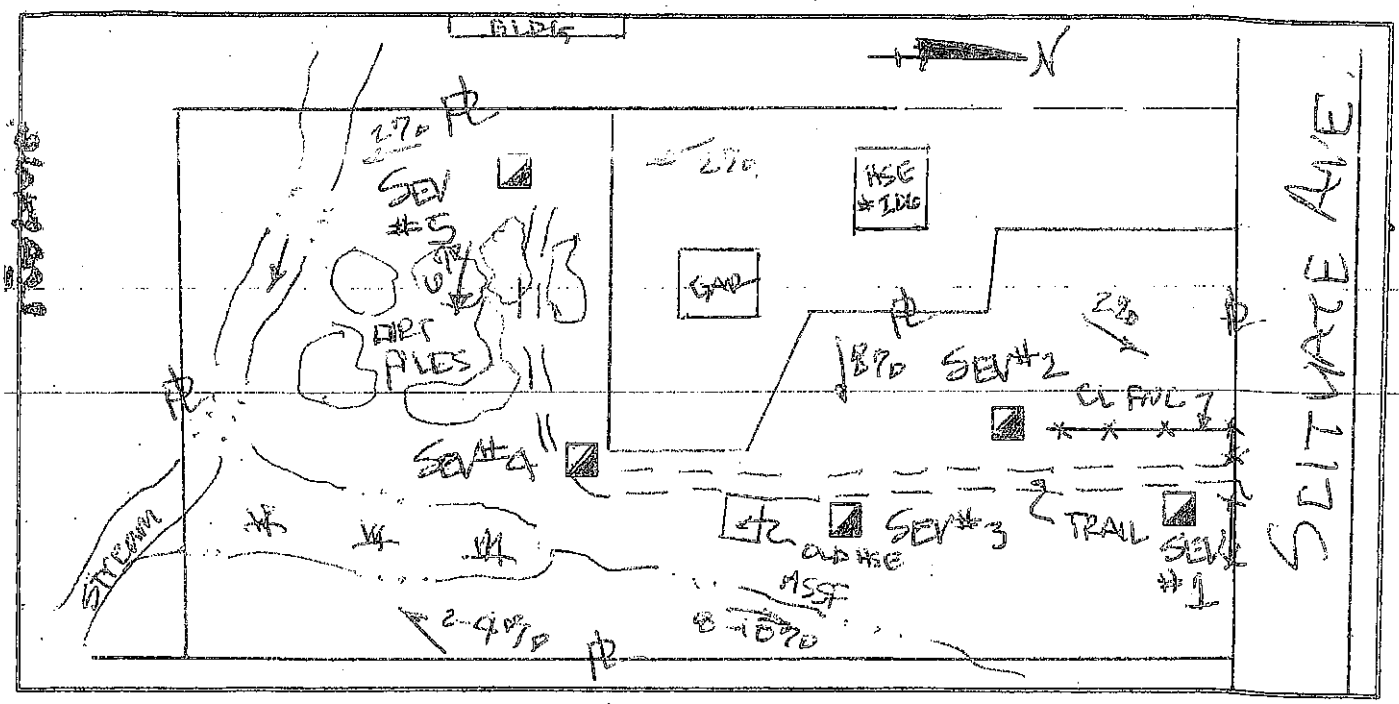
Part B

Site Evaluation - to be completed by Class II or III Designer or Soil Evaluator

Please use the area below to locate:

1. Test holes
2. Approximate direction of due north
3. Offsets from test holes to fixed points such as street, utility pole, or other permanent, marked object

Key:
- Approximate location of test holes
- x% → Estimated gradient and direction of slope
- N → Approximate direction of due north



1. Relief and Slope: Various - See Sketch
2. Presence of any watercourse, wetlands or surface water bodies, within 200 feet of test holes: YES☑ NO☐ If yes, locate on above sketch.
3. Presence of existing or proposed private drinking water wells within 200 feet of test holes: YES☐ NO☑ If yes, locate on above sketch.
4. Public drinking water wells within 500 feet of test holes: YES☐ NO☑ If yes, locate on above sketch.
5. Is site within the watershed of a public drinking water reservoir or other critical area defined in SD 19.00? YES☐ NO☑
6. Has soil been excavated from or fill deposited on site? YES☑ NO☐ If yes, locate on above sketch.
7. Site's potential for flooding or ponding: NONE☐ SLIGHT☑ MODERATE☐ SEVERE☐
8. Landscape position: back slope.
9. Vegetation: Mostly deciduous trees & Scrub
10. Indicate approximate location of property lines and roadways.
11. Additional comments, site constraints or additional information regarding site: _____

Certification

The undersigned hereby certifies that all information on this application and accompanying forms, submittals and sketches are true and accurate and that I have been authorized by the owner(s) to conduct these necessary field investigations and submit this request.

Part A prepared by: _____ Part B prepared by: _____ Date

Signature License # Signature License #

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Decision: Approved ☐ Disclaimed ☐

Comments: _____

Signature Authorized Agent Date

revised 5/8/01

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
6.0000	***R***	**Recharge (infiltration) rate (feet/day)**
0.270	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
1337.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
76.500	**x**	**1/2 length of basin (x direction, in feet)**
29.500	**y**	**1/2 width of basin (y direction, in feet)**
0.960	**t**	**duration of infiltration period (days)**
10.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

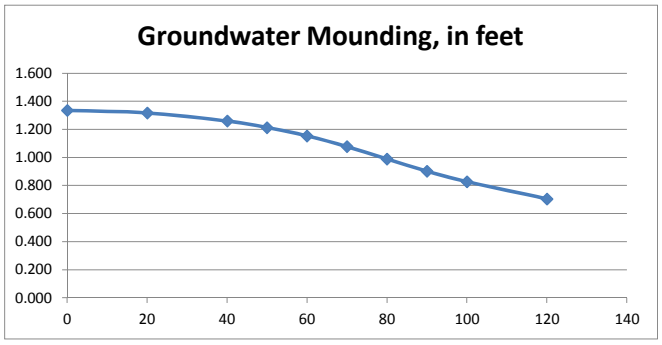
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

11.336	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
1.336	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
1.336	**0**
1.318	**20**
1.260	**40**
1.214	**50**
1.154	**60**
1.078	**70**
0.989	**80**
0.903	**90**
0.828	**100**
0.706	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

SPECIFIC YIELD --

COMPILATION OF SPECIFIC YIELDS

FOR VARIOUS MATERIALS

By A. I. Johnson

PREPARED IN COOPERATION WITH THE CALIFORNIA DEPARTMENT OF WATER RESOURCES

U.S. Geological Survey Open-File Report

Denver, Colorado
1963
Revised 1966

Table 28.--Compilation of specific yield for various materials

[All values rounded off to nearest whole percentage]

Material	Valley fill, Calif. (Eckis, 1934)	Mokelumne Area, Calif. (Piper and others, 1939)	Santa Ynez River Basin, Calif. (Upson and Thomasson, 1951)	Sacramento Valley, Calif. (Poland and others, 1949)	Smith River Plain, Calif. (Back, 1957)	Ventura County, Calif. (Calif. Water Resources Board, 1956)	Santa Margarita Valley, Calif. (Calif. Dept. Public Works, 1956)	Tia Juana Basin, Calif. (Calif. Water Rights Board, 1957)	San Luis Obispo County, Calif. (Calif. Water Resources Board, 1958)	San Joaquin Valley, Calif. (Davis and others, 1959)	Eureka area, Calif. (Evenson, 1959)	Santa Ynez Basin, Calif. (Wilson, 1959)	Rechna Doab, Pakistan (Kazmi, 1961)	Napa-Sonoma Valleys, Calif. (Kunkel and Upson, 1960)	Humboldt River Valley, Nev. (Cohen, 1963)	Unconsolidated Alluvium (Preuss and Todd, 1963)	Little Bighorn River Valley, Mont. (Moulder and others, 1960)	Average specific yield
Clay	1	4	2	3	1	0	1	1	3	3	3	5	3	3	0.5	--	--	2
Silt	10	4	12	3	--	3	10	10	5	5	10	5	5	5	19	4	17	8
Sandy clay	10	4	12	3	5	5	5	5	5	5	10	--	--	10	----	--	--	7
Fine sand	21	26	12	10	10	25	28	25	25	10	20	20	27	20	26	23	32	21
Medium sand	31	26	30	20	15	25	28	30	25	25	20	30	28	20	28	28	32	26
Coarse sand	31	35	35	20	25	25	28	32	25	25	20	30	23	20	27	28	32	27
Gravelly sand	31	35	35	20	25	21	22	28	21	25	20	--	23	20	----	22	32	25
Fine gravel	27	35	35	25	25	21	22	26	21	25	25	25	26	25	19	17	25	25
Medium gravel	21	--	--	25	25	21	22	23	21	25	25	25	26	25	----	13	25	23
Coarse gravel	14	--	--	25	25	21	22	18	21	25	25	25	26	25	----	12	--	22

Civil Engineering Reference Manual

for the PE Exam

Eighth Edition

Michael R. Lindeburg, PE

Professional Publications, Inc. • Belmont, CA

well is drilled into an unconfined aquifer, the water level in the well will correspond to the water table. Such a well is known as a *gravity well.*

An aquifer that is bounded on all extents is known as a *confined aquifer.* The water in confined aquifers may be under pressure. If a well is drilled into such an aquifer, the water in the well will rise to a height corresponding to the hydrostatic pressure. The *piezometric height* of the rise is

$$H = \frac{p}{\rho g} \quad \text{[SI]} \qquad 21.1(a)$$

$$H = \frac{p}{\gamma} = \frac{p}{\rho} \times \frac{g_c}{g} \quad \text{[U.S.]} \qquad 21.1(b)$$

If the confining pressure is high enough, the water will be expelled from the surface, and the source is known as an *artesian well.*

2. AQUIFER CHARACTERISTICS

Soil moisture content (*water content*), w, can be determined by oven drying a sample of soil and measuring the change in mass.[1] The water content is the ratio of the mass of water to the mass of solids, expressed as a percentage. The water content can also be determined with a *tensiometer*, which measures the vapor pressure of the moisture in the soil.

$$w = \frac{m_w}{m_s} = \frac{m_t - m_s}{m_s} \qquad 21.2$$

The *porosity*, n, of the aquifer is the percentage of void volume to total volume.[2]

$$n = \frac{V_v}{V_t} = \frac{V_t - V_s}{V_t} \qquad 21.3$$

The *void ratio*, e, is

$$e = \frac{V_v}{V_s} = \frac{V_t - V_s}{V_s} \qquad 21.4$$

Void ratio and porosity are related.

$$e = \frac{n}{1-n} \qquad 21.5$$

Some pores and voids are dead ends or are too small to contribute to seepage. Only the *effective porosity*, n_e, 95 to 98% of the total porosity, contributes to groundwater flow.

The *hydraulic gradient*, i, is the change in hydraulic head over a particular distance. The hydraulic head at a point is determined as the piezometric head at observation wells.

$$i = \frac{\Delta H}{L} \qquad 21.6$$

[1]It is common in civil engineering to use the term "weight" in place of mass. For example, the *water content* would be defined as the ratio of the weight of water to the weight of solids, expressed as a percentage.

[2]The symbol θ is sometimes used for porosity.

3. PERMEABILITY

The flow of a liquid through a permeable medium is affected by both the fluid and the medium. The effects of the medium (independent of the fluid properties) are characterized by the *intrinsic permeability* (*specific permeability*), k. Intrinsic permeability has dimensions of length squared. The *darcy* has been widely accepted as the unit of intrinsic permeability. One darcy is 0.987×10^{-8} cm^2.

For studies involving the flow of water through an aquifer, effects of intrinsic permeability and the water are combined into the *hydraulic conductivity*, also known as the *coefficient of permeability* or simply the *permeability*, K. Hydraulic conductivity can be determined from a number of water-related tests.[3] It has units of length divided by time (i.e., of velocity).

$$K = \frac{k\gamma}{\mu} \qquad 21.7$$

For many years in the United States, hydraulic conductivity was specified in *Meinzer units* (gallons per day per square foot). To avoid confusion related to multiple definitions and ambiguities in these definitions, hydraulic conductivity is now often specified in units of ft/day (m/day).

The coefficient of permeability is proportional to the square of the mean particle diameter.

$$K = CD^2_{\text{mean}} \qquad 21.8$$

Hazen's empirical formula can be used to calculate an approximate coefficient of permeability for clean, uniform sands. D_{10} is the *effective* size in mm (i.e., the size for which 10% of the distribution is finer).

$$K_{\text{cm/s}} \approx C(D_{10,\text{mm}})^2 \quad [0.1 \text{ mm} \le D_{10,\text{mm}} \le 3.0 \text{ mm}] \qquad 21.9$$

The coefficient C is 40 to 80 for very fine sand (poorly sorted) or fine sand with appreciable fines; 80 to 120 for medium sand (well sorted) or coarse sand (poorly sorted); and 120 to 150 for coarse sand (well sorted and clean).

Table 21.1 *Typical Permeabilities*

material	k (darcys)	K (gal/day-ft^2)
gravel	10^3–10^5	10^4–10^6
gravel/sand	10^3	10^4
clean sand	10^2	10^3
sandstone	10	10^2
dense shale or limestone	10^{-1}	1.0
granite or quartzite	10^{-3}	10^{-2}
clay	10^{-3}	10^{-2}

(Multiply gal/day-ft^2 by 0.1337 to obtain ft^3/day-ft^2.)
(Multiply cm^2 by 0.987×10^{-8} to obtain darcys.)

[3]Permeability can be determined from constant-head permeability tests (sands), falling-head permeability tests (fine sands and silts), consolidation tests (clays), and field tests of wells (in situ gravels and sands).