

Preliminary Stormwater Engineering Analysis
for
Thalia Plaza
4317 Virginia Beach Blvd. and
216 N. Fir Road

DSC File: TBD
JSE File: 0562001

GPIN: 14778571940000 and 14778570960000
City of Virginia Beach, Virginia

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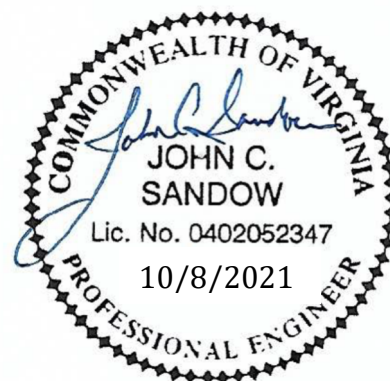


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Narrative

The intent of the project is to re-develop a single-family residential lot combined with a previously developed take-out pizza business as a single mixed-use project at southeast corner of Virginia Beach Boulevard and N. Fir Drive in Virginia Beach, Virginia. The project site includes 0.6 acres of previously developed land. The proposed building will have three-stories with a total floor area of 12,696 Gross Square Feet (GSF). Each floor will have approximately 4,232 GSF. The first floor will be used for retail space and the remaining two floors will be used for multi-family residential. This development requires parcel combination and a rezoning. The site is bounded by single-family residential homes to the south, public right-of-way to the west and north, and professional offices to the east. The proposed redevelopment will increase the impervious ground cover from 0.22 acres to 0.44 acres. Stormwater runoff from the existing site flows primarily by overland flow to the street gutters and then to curb inlets that feed a 42-inch diameter reinforced concrete pipe that flows into Thalia Creek. A portion of the old non-residential building site flows into a drop inlet located in the front yard of the property. Several other grate inlet structures were found by the surveyor inside a mature and wide hedge that follows the right-of-way line along the boulevard, but little or no flow appears to reach these. A significant portion of the site is located within a FEMA FIRM 100-year flood plain. The building pad is elevated to be approximately 2.4-feet above the FEMA base flood elevation.

The proposed drainage pattern is to route all roof drains and all of the parking lot (less and except the driveway) into a structural vault located along the right-of-way of N. Fir Drive. The proposed structure is approximately 7-feet deep with only about 2.5-feet of exposed wall at the sidewalk. The structure will be constructed of concrete and will have a top with an opening on the east side to receive surface flow from the parking lot. From the sidewalk level the stormwater vault is intended to function as a seat wall. This vault is intended to attenuate the peak runoff from the proposed re-development. Water quality will be addressed by the purchase of nutrient credits in the amount of 0.44-lbs.

The City models were found to have different invert elevations for the main storm drainage trunk line along Virginia Beach Boulevard compared to the field survey. The model was adjusted in the pre- and post-development scenarios to reflect the field survey results. However, this did create a sump condition in the overall continuity of said trunk line. This is expected to have caused a spike in HGL at the northeast corner of the property. This may also be affecting other HGLs of more modest deviations at other nodes.

Methodology

Overall

The intent of the analysis prepared by John Sandow Engineering, LLC (JSE) is to build upon the partial watershed models in PC-SWMM format files provided to JSE by the City of Virginia Beach to more precisely approximate the existing conditions and the impact of the proposed conditions based on the site design plans. All modeling prepared by JSE has been performed using PC-SWMM Version 5.1.

A series of adjustments have been made to the SWMM format files provided by the City for both the existing and proposed conditions in scenarios for the 2-, 10-, and 100-year storm events. All

these adjustments are related to the project site in one regard or another. No adjustments to tailwater conditions, rainfall, or outfalls from the City SWMM files have been deliberately made or were evident during comparative analysis of the revised models against the models provided by the City of Virginia Beach.

Storage Curves

Stage storage curve information for the new storage nodes was derived using contour data extracted from a combination of City DEM files and from the surveyed and proposed surface models in Civil 3D (CAD DWG) software.

The storage node for the on-site area was modified to include the new pond volume. The conceptual grading and pipe network is indicated on the maps herein.

Flooded Nodes in Models

None of the nodes in the City's model or in the files provided by JSE were found to be flooding in the PRE or POST development models.

Limits of Analysis

The limits of analysis for compliance with both Channel Protection and Flood Protection is junction 04540-170 – located near Thalia Creek. This is the nearest node in the model that captures all drainage from the proposed site development and is has a contributing drainage area large enough to serve as the point of Limits of Analysis. The entire downstream area is located inside of a mapped FEMA flood plain.

Water Quality Compliance

The Virginia Runoff Reduction Method (VRRM) Re-Development Compliance Spreadsheet - Version 3.0 was used to assess the level of water quality treatment required for compliance with applicable state and local regulations. For this analysis, the site area was 0.60 acres. The analysis determined that 0.44 lbs/year of remaining total phosphorus load reduction is required for this development.

Results

Select values from the adjusted pre-developed models and post-development models are summarized in the tables found at the end of the narrative section of this report.

Channel Protection

This project complies with 9VAC25-870-66,B,1,a by showing that runoff from the 2-year, 24-hour design storm results in a non-erosive velocity for pre- and post-developed conditions.

Flood Protection

This project does not strictly comply with Virginia Beach Public Works Design Standards Manual, June 2020 (PWDSM) section 8.3 by showing that the Post-Developed Max HGL does not increase during the 10-year, 24-hour design storm event. However, the discrepancy in trunk line inverts is expected to be a factor. Also, further detention within the site is not likely to have a significant impact on smoothing out some of the minor deviations (increases) in 100-year HGL around the site. The consultant respectfully requests consideration of the impact of the sump created in the

trunk line of the model by the apparent discrepancy between field surveyed inverts and those from the City GIS (in the City provided SWMM files).

Conclusion

This analysis of the modifications to the City SWMM models indicate that the proposed stormwater device and nutrient credits adequately address the applicable requirements with due consideration given to modeling fluctuation that is beyond the scope of this study.

Channel Protection (9VAC25-870-66, B, 1, a) - 2 YEAR

Q-PRE (cfs)	Q-POST (cfs)	V-PRE (fps)	V-POST (fps)	Erosive Velocity (fps)	Conduit ID	Description of Conduit
56.38	67.39	5.86	7	15	04520-460:04520-454	42" RCP on VB Blvd. at North Fir Ave.
26.81	30.79	3.79	4.36	15	04520-444:04520-442	36" RCP into Thalia Creek
29.68	36.65	4.2	5.18	15	04520-454:04520-456	36" RCP into Thalia Creek (2nd pipe)
0	3.59	0	1.24	3	O_04520-460:04540-170	Overland Flow Path to Thalia Creek from Site

Flood Protection (9VAC25-870-66, C, 2, b) - 10 YEAR

Q-PRE (cfs)	Q-POST (cfs)	Conduit ID	Description of Conduit
63.98	73.84	04520-460:04520-454	42" RCP on VB Blvd. at North Fir Ave.
30.21	33.84	04520-444:04520-442	36" RCP into Thalia Creek
33.98	40.19	04520-454:04520-456	36" RCP into Thalia Creek (2nd pipe)
12.44	68.37	O_04520-460:04540-170	Overland Flow Path to Thalia Creek from Site

Maximum HGL Elevation - 2-YEAR

PRE	POST	Storage Node	Description
7.42	7.79	04520-468	Curb Inlet on VB Blvd Near NE Property Corner
7.23	7.65	04520-460	Curb Inlet on VB Blvd Directly in front of Site
6.7	6.87	04520-454	Storm Manhole in the intersction of VB Blvd and North Fir Ave.
--	7.72	04520-464-B	Stormwater Management Vault On-Site

Maximum HGL Elevation - 10-YEAR

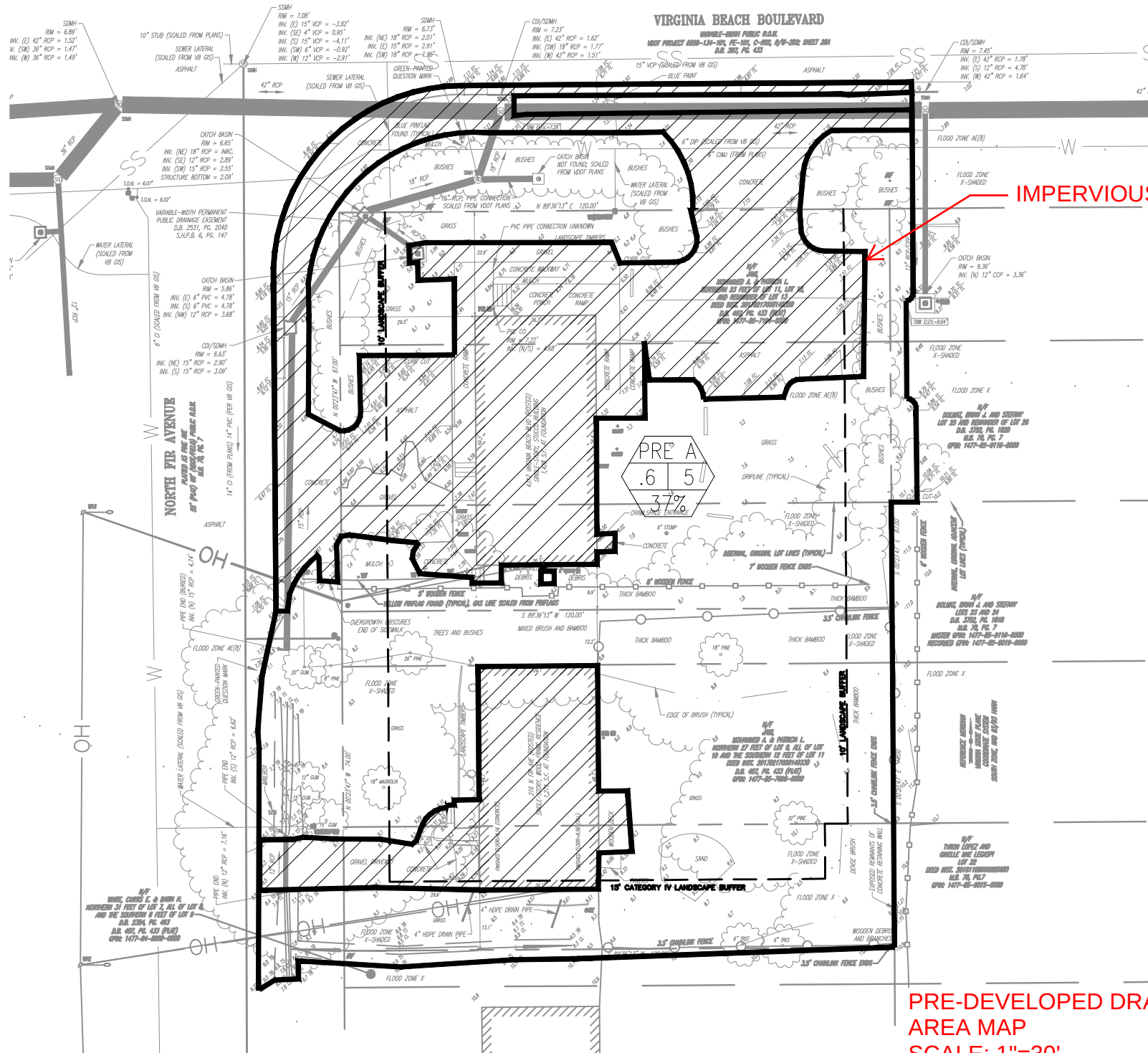
PRE	POST	Storage Node	Description	Flow Line Elev.
7.94	8.24	04520-468	Curb Inlet on VB Blvd Near NE Property Corner	6.95
7.8	8.16	04520-460	Curb Inlet on VB Blvd Directly in front of Site	6.73
7.2	7.27	04520-454	Storm Manhole in the intersction of VB Blvd and North Fir Ave.	6.99
--	8.72	04520-464-B	Stormwater Management Vault On-Site	9.3

Maximum HGL Elevation - 100-YEAR

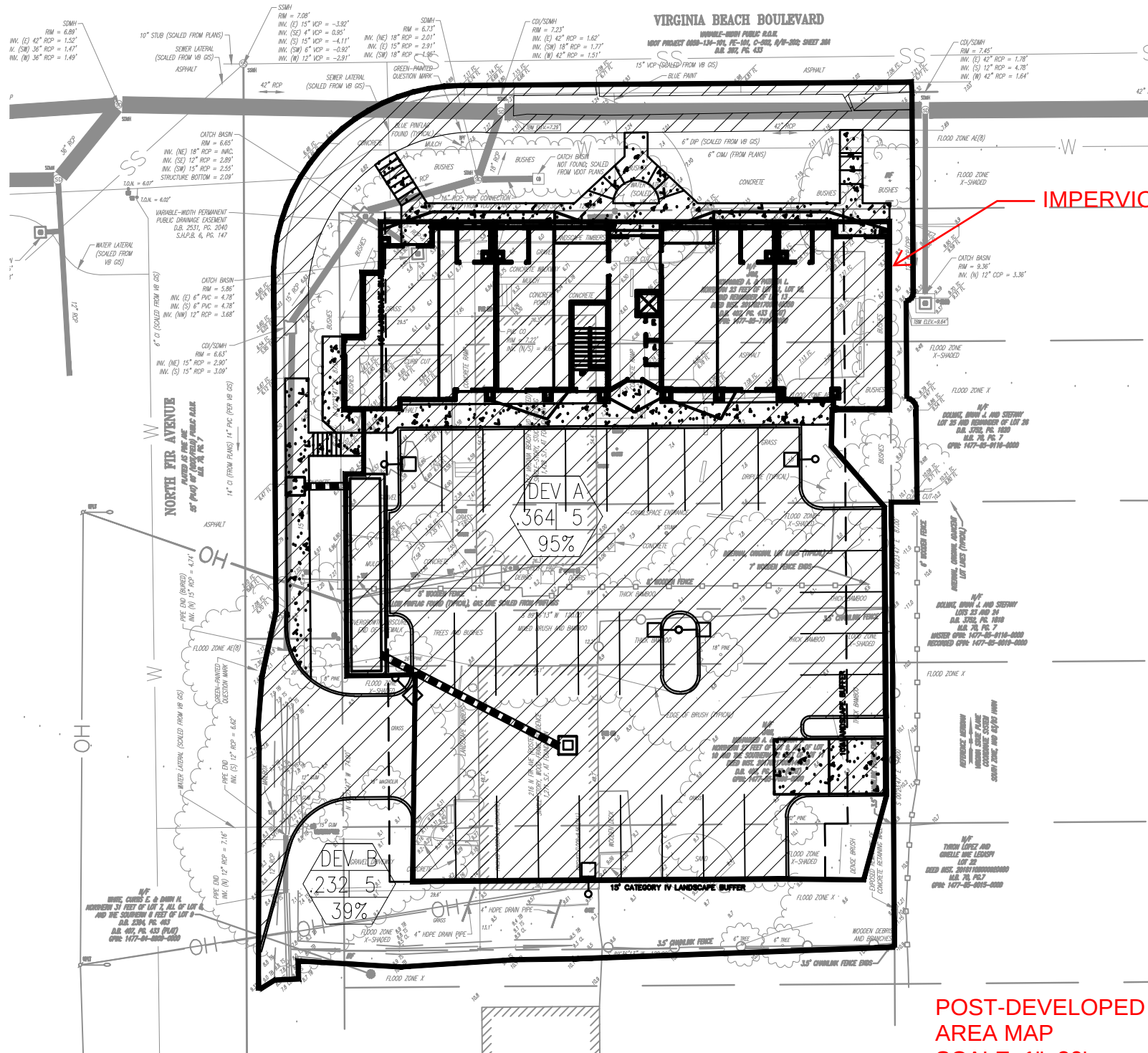
PRE	POST	Storage Node	Description
8.47	17.45	04520-468	Curb Inlet on VB Blvd Near NE Property Corner
8.41	8.44	04520-460	Curb Inlet on VB Blvd Directly in front of Site
7.86	7.86	04520-454	Storm Manhole in the intersction of VB Blvd and North Fir Ave.
--	9.16	04520-464-B	Stormwater Management Vault On-Site

Appendix A
Pre- and Post-Development
Drainage Area Maps





PRE-DEVELOPED DRAINAGE
AREA MAP
SCALE: 1"=30'

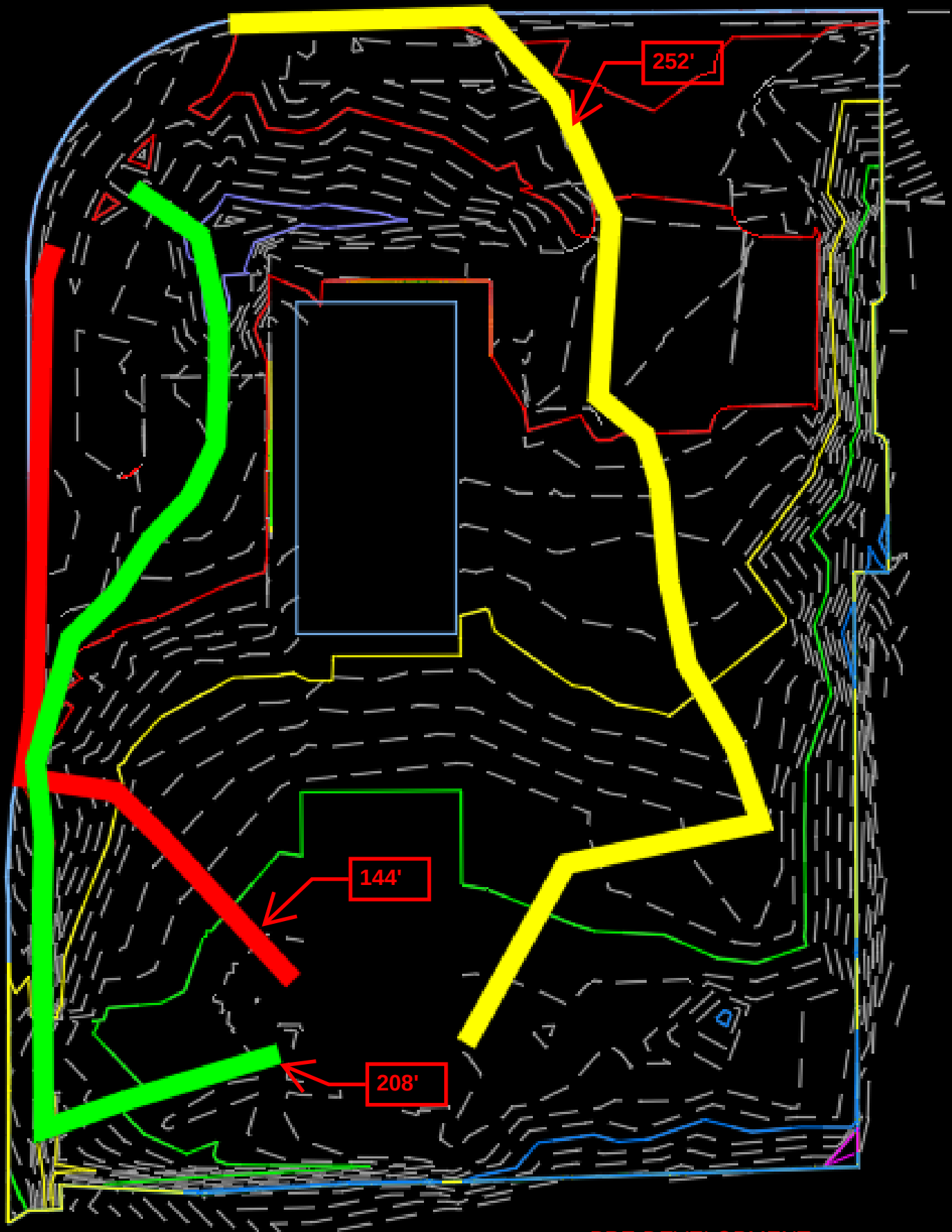


POST-DEVELOPED DRAINAGE
AREA MAP
SCALE: 1"=30'

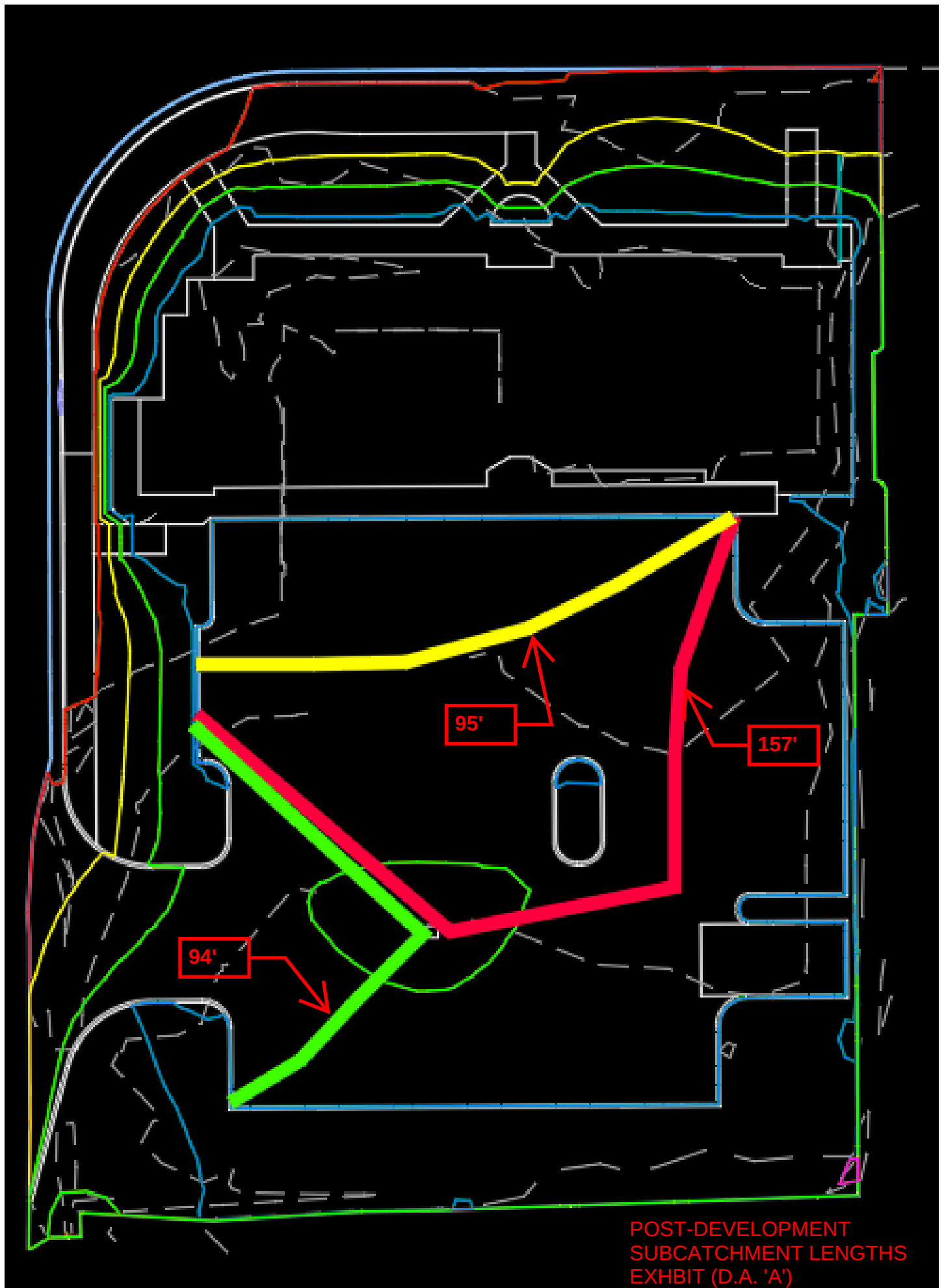
Appendix B

Subcatchment Length Maps and Calculations

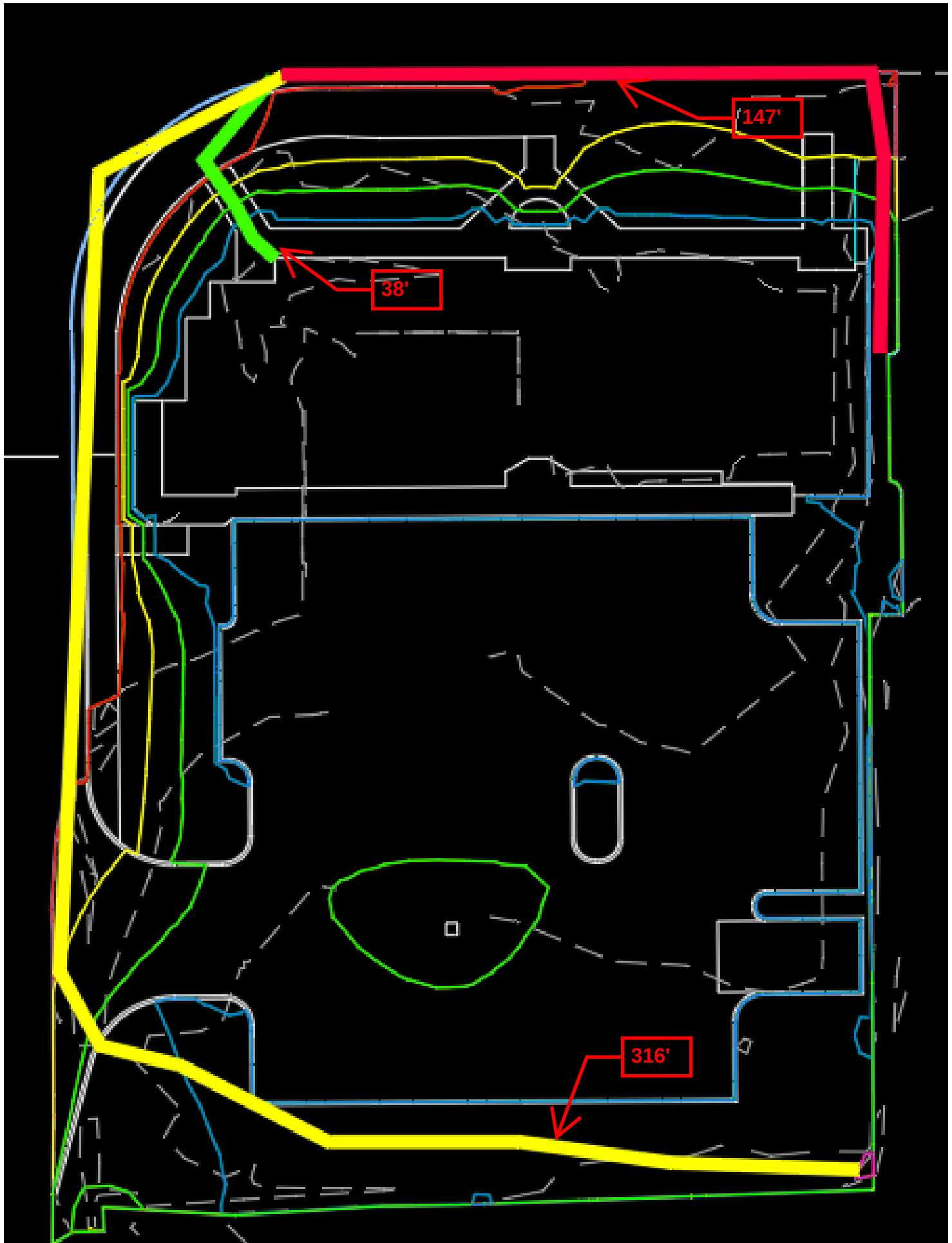




PRE-DEVELOPMENT
SUBCATCHMENT LENGTHS
EXHBIT



POST-DEVELOPMENT
SUBCATCHMENT LENGTHS
EXHIBIT (D.A. 'A')



POST-DEVELOPMENT
SUBCATCHMENT LENGTHS
EXHBIT (D.A. 'B')

Appendix C

VRRM Redevelopment Spreadsheet



Project Name:		Thalia Plaza		CLEAR ALL (Ctrl+Shift+R)		data input cells									
Date:		10/8/2021				constant values									
		Linear Development Project?		No											
Site Information						calculation cells									
						final results									
Post-Development Project (Treatment Volume and Loads)															
Enter Total Disturbed Area (acres) →										0.60		Check:			
												BMP Design Specifications List:		2013 Draft Stds & Specs	
Maximum reduction required:										10%		Linear project?		No	
The site's net increase in impervious cover (acres) is:										0.22		Land cover areas entered correctly?		✓	
Post-Development TP Load Reduction for Site (lb/yr):										0.44		Total disturbed area entered?		✓	
Pre-ReDevelopment Land Cover (acres)															
		A Soils		B Soils		C Soils		D Soils		Totals					
Forest/Open Space (acres) -- undisturbed forest/open space										0.00					
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed								0.38		0.38					
Impervious Cover (acres)								0.22		0.22					
										0.60					
Post-Development Land Cover (acres)															
		A Soils		B Soils		C Soils		D Soils		Totals					
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land										0.00					
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed								0.16		0.16					
Impervious Cover (acres)								0.44		0.44					
Area Check		OK.		OK.		OK.		OK.		0.60					
Constants															
Annual Rainfall (inches)		43		Runoff Coefficients (Rv)		A Soils		B Soils		C Soils		D Soils			
Target Rainfall Event (inches)		1.00		Forest/Open Space		0.02		0.03		0.04		0.05			
Total Phosphorus (TP) EMC (mg/L)		0.26		Managed Turf		0.15		0.20		0.22		0.25			
Total Nitrogen (TN) EMC (mg/L)		1.86		Impervious Cover		0.95		0.95		0.95		0.95			
Target TP Load (lb/acre/yr)		0.41													
Pj (unitless correction factor)		0.90													
LAND COVER SUMMARY -- PRE-REDEVELOPMENT															
LAND COVER SUMMARY -- POST DEVELOPMENT															
Land Cover Summary-Pre															
Land Cover Summary-Post (Final)															
Land Cover Summary-Post															
Land Cover Summary-Post															
Pre-ReDevelopment		Listed		Adjusted ¹		Post ReDev. & New Impervious				Post-ReDevelopment				Land Cover Summary-Post	
Forest/Open Space Cover (acres)		0.00		0.00		Forest/Open Space Cover (acres)		0.00		Forest/Open Space Cover (acres)		0.00			
Weighted Rv(forest)		0.00		0.00		Weighted Rv(forest)		0.00		Weighted Rv(forest)		0.00			
% Forest		0%		0%		% Forest		0%		% Forest		0%			
Managed Turf Cover (acres)		0.38		0.16		Managed Turf Cover (acres)		0.16		Managed Turf Cover (acres)		0.16			
Weighted Rv(turf)		0.25		0.25		Weighted Rv (turf)		0.25		Weighted Rv (turf)		0.25			
% Managed Turf		63%		42%		% Managed Turf		27%		% Managed Turf		42%			
Impervious Cover (acres)		0.22		0.22		Impervious Cover (acres)		0.44		ReDev. Impervious Cover (acres)		0.22		New Impervious Cover (acres) 0.22	
Rv(impervious)		0.95		0.95		Rv(impervious)		0.95		Rv(impervious)		0.95		Rv(impervious) 0.95	
% Impervious		37%		58%		% Impervious		73%		% Impervious		58%			
Total Site Area (acres)		0.60		0.38		Final Site Area (acres)		0.60		Total ReDev. Site Area (acres)		0.38			
Site Rv		0.51		0.66		Final Post Dev Site Rv		0.76		ReDev Site Rv		0.66			
Treatment Volume and Nutrient Load															
Treatment Volume and Nutrient Load															
Pre-ReDevelopment Treatment Volume (acre-ft)		0.0253		0.0208		Final Post-Development Treatment Volume (acre-ft)		0.0382		Post-ReDevelopment Treatment Volume (acre-ft)		0.0208		Post-Development Treatment Volume (acre-ft) 0.0174	
Pre-ReDevelopment Treatment Volume (cubic feet)		1,104		904		Final Post-Development Treatment Volume (cubic feet)		1,663		Post-ReDevelopment Treatment Volume (cubic feet)		904		Post-Development Treatment Volume (cubic feet) 759	
Pre-ReDevelopment TP Load (lb/yr)		0.69		0.57		Final Post-Development TP Load (lb/yr)		1.04		Post-ReDevelopment Load (TP) (lb/yr)*		0.57		Post-Development TP Load (lb/yr) 0.48	
Pre-ReDevelopment TP Load per acre (lb/acre/yr)		1.16		1.49		Final Post-Development TP Load per acre (lb/acre/yr)		1.74		Post-ReDevelopment TP Load per acre (lb/acre/yr)		1.49			
Baseline TP Load (lb/yr)				0.16						Max. Reduction Required (Below Pre-ReDevelopment Load)		10%			
0.41 lbs/acre/yr applied to pre-redevelopment area excluding pervious land proposed for new impervious cover															
Adjusted Land Cover Summary: Pre ReDevelopment land cover minus pervious land cover (forest/open space or managed turf) acreage proposed for new impervious cover.															
Adjusted total acreage is consistent with Post-ReDevelopment acreage (minus acreage of new impervious cover).															
Column I shows load reduction requirement for new impervious cover (based on new development load limit, 0.41 lbs/acre/year).															
TP Load Reduction Required for Redeveloped Area (lb/yr) 0.06															
TP Load Reduction Required for New Impervious Area (lb/yr) 0.39															
Post-Development Requirement for Site Area															
TP Load Reduction Required (lb/yr) 0.44															

Drainage Area A

Drainage Area A Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals	Land Cover Rv
Forest/Open Space (acres)					0.00	0.00
Managed Turf (acres)				0.16	0.16	0.25
Impervious Cover (acres)				0.44	0.44	0.95
Total				0.60		

CLEAR BMP AREAS

Total Phosphorus Available for Removal in D.A. A (lb/yr)	1.04
Post Development Treatment Volume in D.A. A (ft ³)	1,663

Stormwater Best Management Practices (RR = Runoff Reduction)

-Select from dropdown lists-

Practice	Runoff Reduction Credit (%)	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	Volume from Upstream Practice (ft ³)	Runoff Reduction (ft ³)	Remaining Runoff Volume (ft ³)	Total BMP Treatment Volume (ft ³)	Phosphorus Removal Efficiency (%)	Phosphorus Load from Upstream Practices (lb)	Untreated Phosphorus Load to Practice (lb)	Phosphorus Removed By Practice (lb)	Remaining Phosphorus Load (lb)	Downstream Practice to be Employed
1. Vegetated Roof (RR)													
1.a. Vegetated Roof #1 (Spec #5)	45				0	0	0	0		0.00	0.00	0.00	
1.b. Vegetated Roof #2 (Spec #5)	60				0	0	0	0		0.00	0.00	0.00	
2. Rooftop Disconnection (RR)													
2.a. Simple Disconnection to A/B Soils (Spec #1)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	
2.b. Simple Disconnection to C/D Soils (Spec #1)	25			0	0	0	0	0	0.00	0.00	0.00	0.00	
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	
2.d. To Dry Well or French Drain #1, Micro-Infiltration #1 (Spec #8)	50			0	0	0	0	25	0.00	0.00	0.00	0.00	
2.e. To Dry Well or French Drain #2, Micro-Infiltration #2 (Spec #8)	90			0	0	0	0	25	0.00	0.00	0.00	0.00	
2.f. To Rain Garden #1, Micro-Bioretenion #1 (Spec #9)	40			0	0	0	0	25	0.00	0.00	0.00	0.00	
2.g. To Rain Garden #2, Micro-Bioretenion #2 (Spec #9)	80			0	0	0	0	50	0.00	0.00	0.00	0.00	
2.h. To Rainwater Harvesting (Spec #6)	0			0	0	0	0	0	0.00	0.00	0.00	0.00	
2.i. To Stormwater Planter, Urban Bioretention (Spec #9, Appendix A)	40			0	0	0	0	25	0.00	0.00	0.00	0.00	
3. Permeable Pavement (RR)													
3.a. Permeable Pavement #1 (Spec #7)	45			0	0	0	0	25	0.00	0.00	0.00	0.00	
3.b. Permeable Pavement #2 (Spec #7)	75				0	0	0	25		0.00	0.00	0.00	
4. Grass Channel (RR)													
4.a. Grass Channel A/B Soils (Spec #3)	20			0	0	0	0	15	0.00	0.00	0.00	0.00	
4.b. Grass Channel C/D Soils (Spec #3)	10			0	0	0	0	15	0.00	0.00	0.00	0.00	
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	20			0	0	0	0	15	0.00	0.00	0.00	0.00	
5. Dry Swale (RR)													
5.a. Dry Swale #1 (Spec #10)	40			0	0	0	0	20	0.00	0.00	0.00	0.00	
5.b. Dry Swale #2 (Spec #10)	60			0	0	0	0	40	0.00	0.00	0.00	0.00	
6. Bioretention (RR)													
6.a. Bioretention #1 or Micro-Bioretenion #1 or Urban Bioretention (Spec #9)	40			0	0	0	0	25	0.00	0.00	0.00	0.00	
6.b. Bioretention #2 or Micro-Bioretenion #2 (Spec #9)	80			0	0	0	0	50	0.00	0.00	0.00	0.00	
7. Infiltration (RR)													
7.a. Infiltration #1 (Spec #8)	50			0	0	0	0	25	0.00	0.00	0.00	0.00	
7.b. Infiltration #2 (Spec #8)	90			0	0	0	0	25	0.00	0.00	0.00	0.00	
8. Extended Detention Pond (RR)													
8.a. ED #1 (Spec #15)	0			0	0	0	0	15	0.00	0.00	0.00	0.00	
8.b. ED #2 (Spec #15)	15			0	0	0	0	15	0.00	0.00	0.00	0.00	
9. Sheetflow to Filter/Open Space (RR)													
9.a. Sheetflow to Conservation Area, A/B Soils (Spec #2)	75			0	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area, C/D Soils (Spec #2)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	
9.c. Sheetflow to Vegetated Filter Strip, A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	

TOTAL IMPERVIOUS COVER TREATED (ac) 0.00 AREA CHECK: OK.
TOTAL MANAGED TURF AREA TREATED (ac) 0.00 AREA CHECK: OK.
TOTAL RUNOFF REDUCTION IN D.A. A (ft³) 0

Nitrogen Removal Efficiency (%)	Nitrogen Load from Upstream Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs)	Remaining Nitrogen Load (lbs)
1. Vegetated Roof (RR)				
0		0.00	0.00	0.00
0		0.00	0.00	0.00

2. Rooftop Disconnection (RR)				
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00

3. Permeable Pavement (RR)				
25	0.00	0.00	0.00	0.00
25		0.00	0.00	0.00

4. Grass Channel (RR)				
20	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00

5. Dry Swale (RR)				
25	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00

6. Bioretention (RR)				
40	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00

7. Infiltration (RR)				
15	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00

8. Extended Detention Pond (RR)				
10	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00

9. Sheetflow to Filter/Open Space (RR)				
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00

Site Results (Water Quality Compliance)

Area Checks	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	AREA CHECK
FOREST/OPEN SPACE (ac)	0.00	0.00	0.00	0.00	0.00	OK.
IMPERVIOUS COVER (ac)	0.44	0.00	0.00	0.00	0.00	OK.
IMPERVIOUS COVER TREATED (ac)	0.00	0.00	0.00	0.00	0.00	OK.
MANAGED TURF AREA (ac)	0.16	0.00	0.00	0.00	0.00	OK.
MANAGED TURF AREA TREATED (ac)	0.00	0.00	0.00	0.00	0.00	OK.
AREA CHECK	OK.	OK.	OK.	OK.	OK.	
Site Treatment Volume (ft ³)	1,663					
Runoff Reduction Volume and TP By Drainage Area						
	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	TOTAL
RUNOFF REDUCTION VOLUME ACHIEVED (ft ³)	0	0	0	0	0	0
TP LOAD AVAILABLE FOR REMOVAL (lb/yr)	1.04	0.00	0.00	0.00	0.00	1.04
TP LOAD REDUCTION ACHIEVED (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00
TP LOAD REMAINING (lb/yr)	1.04	0.00	0.00	0.00	0.00	1.04
NITROGEN LOAD REDUCTION ACHIEVED (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00
Total Phosphorus						
FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	1.04					
TP LOAD REDUCTION REQUIRED (lb/yr)	0.44					
TP LOAD REDUCTION ACHIEVED (lb/yr)	0.00					
TP LOAD REMAINING (lb/yr):	1.04					
REMAINING TP LOAD REDUCTION REQUIRED (lb/yr):	0.44					
Total Nitrogen (For Information Purposes)						
POST-DEVELOPMENT LOAD (lb/yr)	7.47					
NITROGEN LOAD REDUCTION ACHIEVED (lb/yr)	0.00					
REMAINING POST-DEVELOPMENT NITROGEN LOAD (lb/yr)	7.47					

Runoff Volume and Curve Number Calculations									
Enter design storm rainfall depths (in):									
		1-year storm		2-year storm		10-year storm			
		3.00		3.65		5.63			
Use NOAA Atlas 14 (http://hdsc.nws.noaa.gov/hdsc/pfds/)									
*Notes (see below): [1] The curve numbers and runoff volumes computed in this spreadsheet for each drainage area are limited in their applicability for determining and demonstrating compliance with water quantity requirements. See VRRM User's Guide and Documentation for additional information. [2] Runoff Volume (RV) for pre- and post-development drainage areas must be in volumetric units (e.g., acre-feet or cubic feet) when using the Energy Balance Equation. Runoff measured in watershed-inches and shown in the spreadsheet as RV(watershed-inch) can only be used in the Energy Balance Equation when the pre- and post-development drainage areas are equal. Otherwise RV(watershed-inch) must be multiplied by the drainage area. [3] Adjusted CNs are based on runoff reduction volumes as calculated in D.A. tabs. An alternative CN adjustment calculation for Vegetated Roofs is included in BMP specification No. 5.									
Drainage Area Curve Numbers and Runoff Depths* Curve numbers (CN, CNadj) and runoff depths (RV_{Developed}) are computed with and without reduction practices.									
Drainage Area A		A Soils	B Soils	C Soils	D Soils	Total Area (acres): 0.60			
Forest/Open Space -- undisturbed, protected forest/open space or reforested land	Area (acres)	0.00	0.00	0.00	0.00	Runoff Reduction			
	CN	30	55	70	77	Volume (ft ³): 0			
Managed Turf -- disturbed, graded for yards or other turf to be mowed/managed	Area (acres)	0.00	0.00	0.00	0.16				
	CN	39	61	74	80				
Impervious Cover	Area (acres)	0.00	0.00	0.00	0.44				
	CN	98	98	98	98				
		CN _(D.A. A)							
		93							
		1-year storm	2-year storm	10-year storm					
RV _{Developed} (watershed-inch) with no Runoff Reduction*		2.25	2.88	4.82					
RV _{Developed} (watershed-inch) with Runoff Reduction*		2.25	2.88	4.82					
Adjusted CN*		93	93	93					
*See Notes above									

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: 2013 Draft Stds & Specs

Site Summary

Project Title: Thalia Plaza

Date: 44477

Total Rainfall (in):	43
Total Disturbed Acreage:	0.60

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.38	0.38	63
Impervious Cover (acres)	0.00	0.00	0.00	0.22	0.22	37
					0.60	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.16	0.16	27
Impervious Cover (acres)	0.00	0.00	0.00	0.44	0.44	73
					0.60	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post- ReDevelopment	Post- Development (New Impervious)	Adjusted Pre- ReDevelopment
Site Rv	0.76	0.66	0.95	0.66
Treatment Volume (ft ³)	1,663	904	759	904
TP Load (lb/yr)	1.04	0.57	0.48	0.57

Pre- ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.49	1.74	1.49

Total TP Load Reduction Required (lb/yr)	0.44	0.06	0.39
--	------	------	------

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre- ReDevelopment
TN Load (lb/yr)	7.47	4.96

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	10%
--	-----

Total Runoff Volume Reduction (ft ³)	0
Total TP Load Reduction Achieved (lb/yr)	0.00
Total TN Load Reduction Achieved (lb/yr)	0.00
Remaining Post Development TP Load (lb/yr)	1.04
Remaining TP Load Reduction (lb/yr) Required	0.44

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres)	0.16	0.00	0.00	0.00	0.00	0.16
Impervious Cover (acres)	0.44	0.00	0.00	0.00	0.00	0.44
Total Area (acres)	0.60	0.00	0.00	0.00	0.00	0.60

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00
TN Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00

Runoff Volume and CN Calculations

	1-year storm	2-year storm	10-year storm
Target Rainfall Event (in)	3.00	3.65	5.63

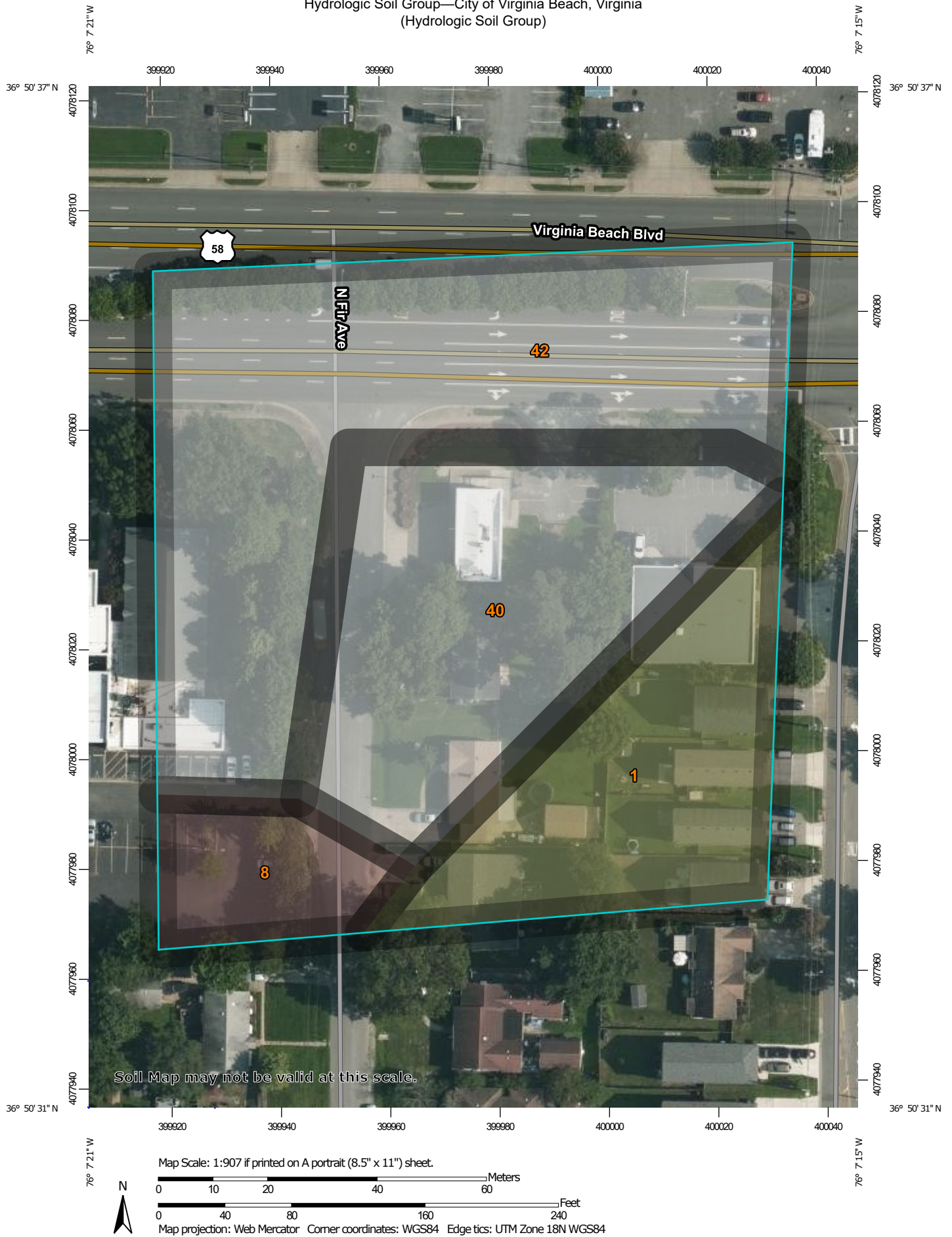
Drainage Areas	RV & CN	Drainage Area A	Drainage Area B	Drainage Area C	Drainage Area D	Drainage Area E
CN		93	0	0	0	0
RR (ft ³)		0	0	0	0	0
1-year return period	RV wo RR (ws-in)	2.25	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	2.25	0.00	0.00	0.00	0.00
	CN adjusted	93	0	0	0	0
2-year return period	RV wo RR (ws-in)	2.88	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	2.88	0.00	0.00	0.00	0.00
	CN adjusted	93	0	0	0	0
10-year return period	RV wo RR (ws-in)	4.82	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	4.82	0.00	0.00	0.00	0.00
	CN adjusted	93	0	0	0	0

Appendix D

Web Soil Survey Map and Data



Hydrologic Soil Group—City of Virginia Beach, Virginia
(Hydrologic Soil Group)



Hydrologic Soil Group—City of Virginia Beach, Virginia
(Hydrologic Soil Group)

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 1:15,800.

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:
 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: City of Virginia Beach, Virginia
 Survey Area Data: Version 14, Sep 17, 2021

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

Date(s) aerial images were photographed: Jul 1, 2018—Aug 1, 2018

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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Acredale silt loam	C/D	0.7	20.2%
8	Chapanoke silt loam	B/D	0.3	7.4%
40	Udorthents, loamy		1.0	29.1%
42	Urban land		1.5	43.3%
Totals for Area of Interest			3.4	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

Appendix E

NOAA Atlas 14





NOAA Atlas 14, Volume 2, Version 3
Location name: Virginia Beach, Virginia, USA*
Latitude: 36.843°, Longitude: -76.1218°
Elevation: m/ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.411 (0.375-0.453)	0.483 (0.439-0.533)	0.549 (0.499-0.605)	0.628 (0.568-0.692)	0.708 (0.639-0.779)	0.778 (0.700-0.858)	0.843 (0.754-0.928)	0.905 (0.805-0.997)	0.981 (0.865-1.08)	1.05 (0.921-1.17)
10-min	0.657 (0.600-0.724)	0.772 (0.702-0.852)	0.879 (0.799-0.970)	1.00 (0.908-1.11)	1.13 (1.02-1.24)	1.24 (1.11-1.37)	1.34 (1.20-1.47)	1.43 (1.28-1.58)	1.55 (1.37-1.72)	1.66 (1.45-1.84)
15-min	0.821 (0.749-0.905)	0.971 (0.883-1.07)	1.11 (1.01-1.23)	1.27 (1.15-1.40)	1.43 (1.29-1.57)	1.57 (1.41-1.73)	1.69 (1.51-1.86)	1.81 (1.61-2.00)	1.95 (1.72-2.16)	2.08 (1.82-2.31)
30-min	1.13 (1.03-1.24)	1.34 (1.22-1.48)	1.58 (1.44-1.74)	1.84 (1.66-2.03)	2.12 (1.91-2.33)	2.36 (2.13-2.60)	2.59 (2.32-2.85)	2.82 (2.51-3.11)	3.11 (2.74-3.44)	3.37 (2.95-3.73)
60-min	1.40 (1.28-1.55)	1.68 (1.53-1.86)	2.03 (1.84-2.23)	2.40 (2.17-2.64)	2.82 (2.54-3.10)	3.20 (2.88-3.53)	3.57 (3.19-3.93)	3.95 (3.52-4.36)	4.46 (3.93-4.93)	4.93 (4.31-5.45)
2-hr	1.67 (1.51-1.84)	2.00 (1.81-2.21)	2.46 (2.22-2.72)	2.96 (2.67-3.26)	3.55 (3.18-3.91)	4.10 (3.65-4.51)	4.64 (4.12-5.11)	5.23 (4.60-5.75)	6.02 (5.25-6.63)	6.75 (5.84-7.43)
3-hr	1.80 (1.63-2.00)	2.15 (1.94-2.40)	2.65 (2.39-2.96)	3.21 (2.88-3.57)	3.90 (3.47-4.32)	4.55 (4.03-5.03)	5.21 (4.59-5.76)	5.93 (5.17-6.54)	6.92 (5.98-7.63)	7.85 (6.72-8.68)
6-hr	2.19 (1.97-2.46)	2.63 (2.35-2.95)	3.24 (2.89-3.64)	3.93 (3.49-4.40)	4.78 (4.23-5.34)	5.61 (4.93-6.24)	6.44 (5.62-7.16)	7.37 (6.37-8.17)	8.66 (7.39-9.61)	9.89 (8.35-11.0)
12-hr	2.60 (2.32-2.93)	3.11 (2.77-3.51)	3.85 (3.42-4.34)	4.69 (4.15-5.28)	5.76 (5.07-6.47)	6.81 (5.93-7.62)	7.89 (6.82-8.82)	9.09 (7.77-10.2)	10.8 (9.11-12.1)	12.4 (10.3-13.9)
24-hr	3.00 (2.77-3.27)	3.65 (3.37-3.99)	4.72 (4.35-5.16)	5.63 (5.17-6.13)	6.97 (6.36-7.59)	8.14 (7.36-8.85)	9.43 (8.44-10.2)	10.9 (9.62-11.8)	13.0 (11.3-14.1)	14.8 (12.7-16.2)
2-day	3.45 (3.16-3.79)	4.18 (3.84-4.60)	5.37 (4.93-5.91)	6.41 (5.85-7.03)	7.96 (7.21-8.71)	9.31 (8.36-10.2)	10.8 (9.61-11.8)	12.5 (11.0-13.7)	15.0 (12.9-16.5)	17.2 (14.6-19.0)
3-day	3.64 (3.35-3.99)	4.41 (4.06-4.84)	5.65 (5.19-6.18)	6.70 (6.13-7.32)	8.26 (7.50-9.00)	9.59 (8.65-10.4)	11.1 (9.87-12.0)	12.7 (11.2-13.8)	15.1 (13.1-16.6)	17.3 (14.8-19.0)
4-day	3.84 (3.54-4.19)	4.65 (4.29-5.08)	5.93 (5.46-6.46)	7.00 (6.42-7.61)	8.56 (7.80-9.29)	9.87 (8.93-10.7)	11.3 (10.1-12.3)	12.9 (11.4-14.0)	15.2 (13.2-16.6)	17.3 (14.9-19.0)
7-day	4.49 (4.16-4.87)	5.42 (5.02-5.87)	6.82 (6.30-7.38)	7.97 (7.35-8.63)	9.65 (8.84-10.4)	11.1 (10.1-11.9)	12.6 (11.3-13.6)	14.2 (12.7-15.4)	16.6 (14.6-18.0)	18.5 (16.1-20.3)
10-day	5.07 (4.72-5.46)	6.08 (5.66-6.55)	7.53 (7.00-8.12)	8.74 (8.10-9.41)	10.5 (9.66-11.3)	11.9 (10.9-12.8)	13.4 (12.2-14.5)	15.1 (13.6-16.3)	17.4 (15.5-18.9)	19.4 (17.0-21.2)
20-day	6.84 (6.40-7.33)	8.15 (7.62-8.74)	9.90 (9.24-10.6)	11.3 (10.5-12.1)	13.4 (12.4-14.3)	15.0 (13.8-16.1)	16.7 (15.3-18.0)	18.6 (16.8-20.0)	21.1 (18.9-22.8)	23.2 (20.6-25.2)
30-day	8.45 (7.93-9.03)	10.0 (9.43-10.7)	12.0 (11.3-12.9)	13.7 (12.8-14.6)	15.9 (14.8-17.0)	17.6 (16.4-18.9)	19.5 (18.0-20.8)	21.3 (19.5-22.8)	23.8 (21.7-25.7)	25.8 (23.3-27.9)
45-day	10.5 (9.81-11.2)	12.4 (11.6-13.2)	14.7 (13.8-15.7)	16.6 (15.6-17.8)	19.3 (18.0-20.6)	21.5 (19.9-22.9)	23.7 (21.9-25.3)	26.0 (23.9-27.8)	29.2 (26.5-31.3)	31.7 (28.5-34.2)
60-day	12.4 (11.7-13.2)	14.7 (13.8-15.6)	17.2 (16.3-18.3)	19.3 (18.2-20.5)	22.1 (20.7-23.5)	24.3 (22.7-25.8)	26.4 (24.6-28.2)	28.6 (26.5-30.6)	31.6 (29.0-33.9)	33.8 (30.8-36.4)

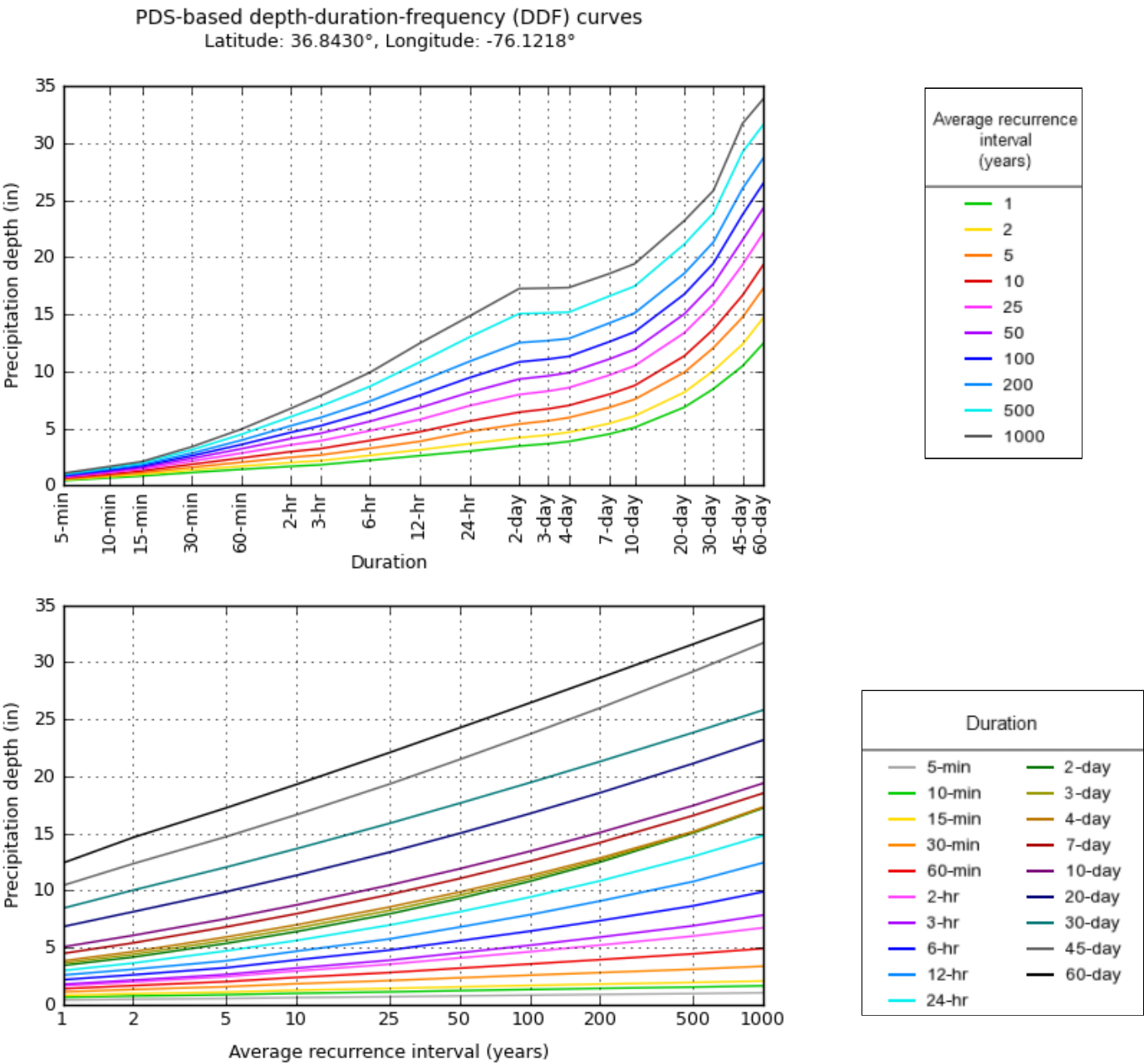
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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

Please refer to NOAA Atlas 14 document for more information.

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PF graphical



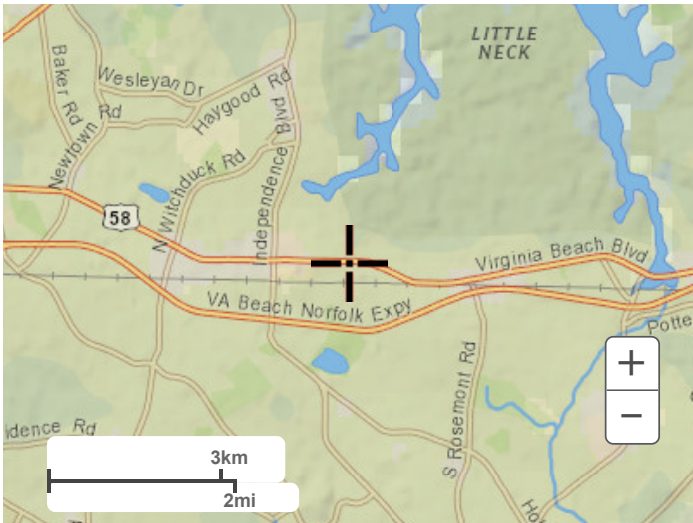
NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Fri Oct 8 18:10:13 2021

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Maps & aerials

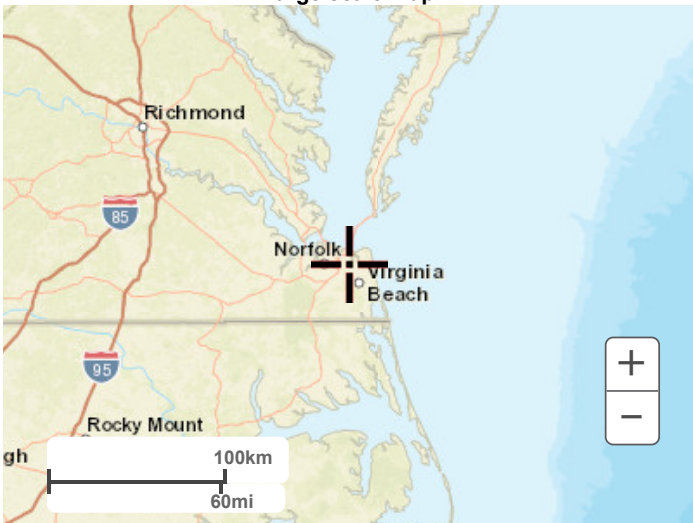
Small scale terrain



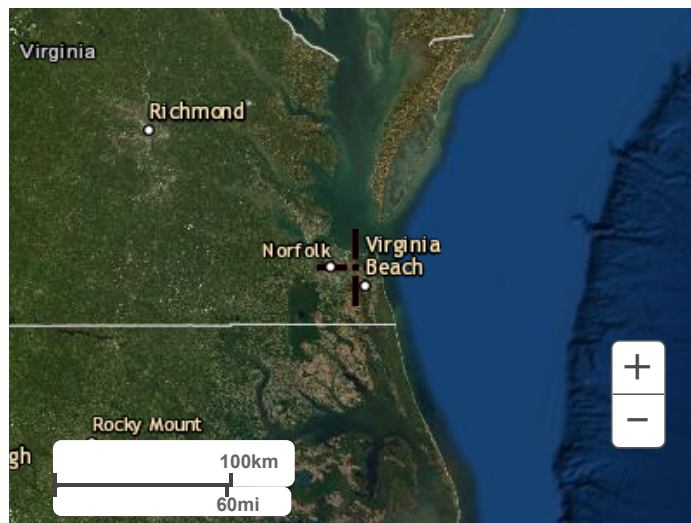
Large scale terrain



Large scale map



Large scale aerial



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[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

Appendix F

Nutrient Bank Availability Letter





Date: October 8, 2021

To: John Sandow, PE (VA, GA), LEED AP
John Sandow Engineering, LLC

From: Caitlan Parker
Credit Sales Manager
Resource Environmental Solutions

Subject: James River Watershed – Nutrient Credit Availability

Project Reference: 4317 Virginia Beach Boulevard; 0.44 Credits Requested; HUC 02080108

This letter is to confirm the availability of 0.44 authorized nutrient credits (“Nutrient Credits”) from one or more of Resource Environmental Solutions’ (“RES”) James Nutrient Bank facilities for use by permit applicants within the James River watershed, including HUC 02080108, to compensate for nutrient loadings in excess of state or local regulations, as per Virginia Code § 62.1-44.15:35 and § 62.1-44.19:14 and Virginia Administrative Code 9 VAC 25-820-10 et seq. These Nutrient Credits are generated and managed under the terms of the Banking Instruments known as the Miyagi Creek Nutrient Reduction Implementation Plan (NRIP).

Please feel free to contact me if you have any questions.

Sincerely,

A handwritten signature in black ink that reads "Caitlan B. Parker".

Caitlan B. Parker
Resource Environmental Solutions
cparker@res.us

10055 Red Run Blvd.
Suite 130
Owings Mills, MD
21117

412 N. 4th St.
Suite 300
Baton Rouge, LA
70802

701 E. Bay St.
Suite 306
Charleston, SC
29403

5020 Montrose Blvd.
Suite 650
Houston, TX
77006

1200 Camellia Blvd.
Suite 220
Lafayette, LA
70508

137½ East Main St.
Suite 210
Oak Hill, WV
25901

33 Terminal Way
Suite 431
Pittsburgh, PA
15219

302 Jefferson St.
Suite 110
Raleigh, NC
27605

1408 B Roseneath Rd
Richmond, VA
23230

Appendix G

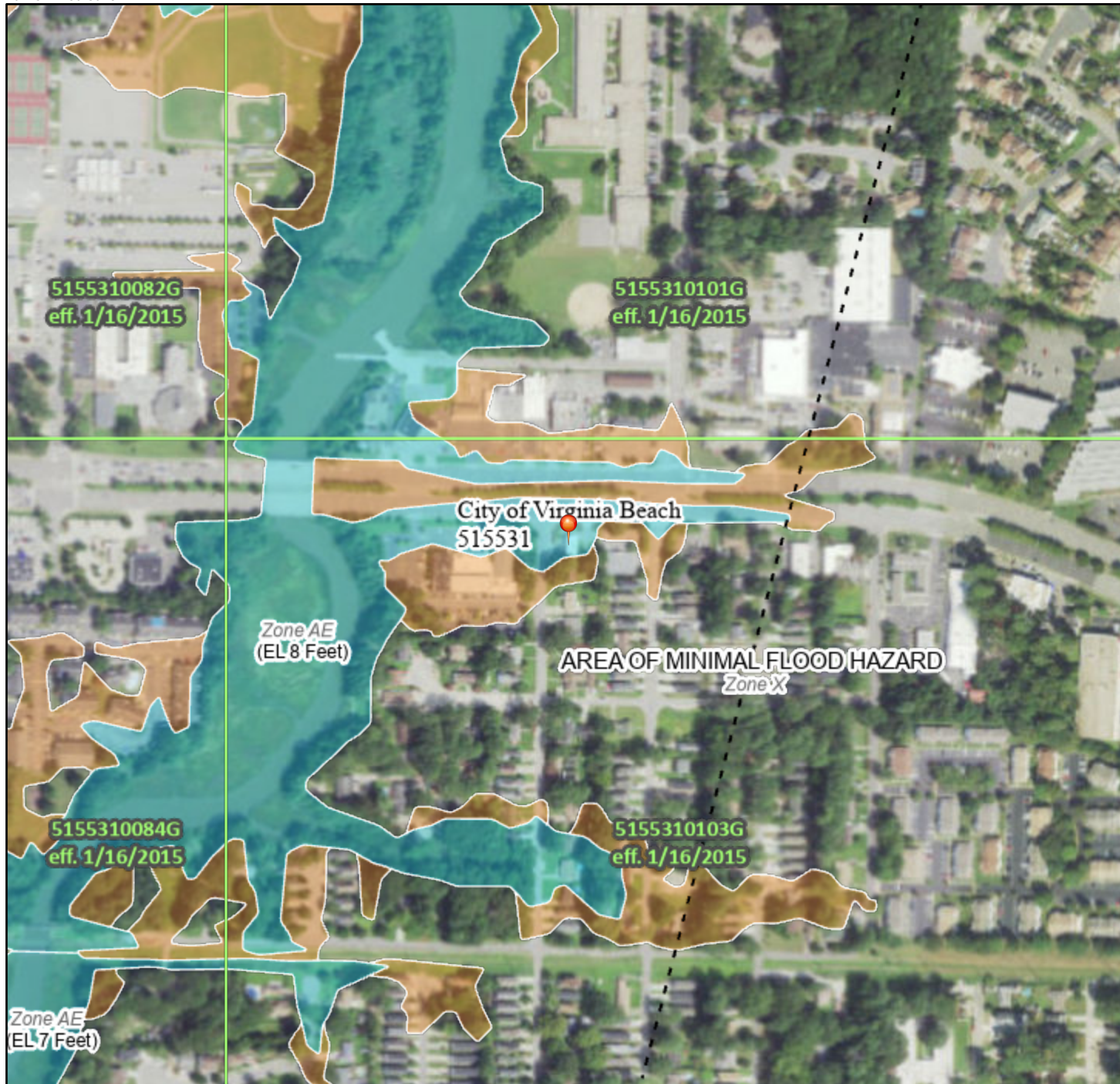
FEMA FIRMette



National Flood Hazard Layer FIRMette



76°7'37"W 36°50'49"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **10/8/2021 at 2:40 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.