WATERSHED
CONSULTING ASSOCIATES, LLC

December 27, 2013

Megan J. Moir
Stormwater Program Manager
Department of Public Works
P.O. Box 878
Burlington, VT 05402

RE: ***College St. Item 1: Task F Retrofit Design***

ATTACHMENTS:
A-1: Bank/Pine St. Retrofit Design Plan
A-2: College/Pine St. Retrofit Design Plan
A-3: Basis of Design Documentation
A-4: SWMM model output summaries

Dear Megan:

The College St. project team completed a final BMP screening which included three retrofit collections and a large infiltration practice on the ICV property. After further assessment, the final BMP list was prioritized into three implementation stages for the complete College St. Stormwater Retrofit Plan. Initial engineering design plans for the Stage 1 collections (Table 1) were included with this submittal. Stage 2 plans will be provided with the final deliverable. The third and final stage includes a full build-out of the watershed, for which a conceptual plan will also be provided with the final deliverable. Cost estimates for the Stage 3 BMP implementation are still to be determined.

Table 1: College St. Stormwater Retrofit Plan Implementation Stages

Retrofit Collection	BMP ID	Type	Greened Impervious (ac)	Total Cost Estimate
Stage 1				
Bank/Pine	BNK1-A	ROW Planter	0.25	$45,442.34
	BNK1-B, GG	Green Gutter	0.38	$46,200.00
	BNK1-B, ROW	ROW Planter		$22,282.42
	PS2-A, Peoples	Infiltration Basin	0.20	$94,128.22
		Total:	0.83	$178,380.05
College/Pine	CS1-A	ROW Planter	0.24	$21,879.93
	CS1-C	ROW Planter	0.26	$21,874.30
	PS1-F	ROW Planter	0.16	$17,312.59
	PS1-G	ROW Planter	0.09	$7,579.27
	PS1-H	ROW Planter	0.14	$26,219.17
		Total:	0.90	$94,865.25
		Stage 1 Implementation Total:	**1.72**	**$273,245.30**
Stage 2				
Hilton Parking Garage	BTV1-A	Roof Planter	0.05	$5,365.33
	BTV1-B	Roof Planter	0.05	$5,917.51
	BTV1-C	Bioretention	0.48	$63,688.46
ICV	CS4-A, ICV	Infiltration Basin	3.63	$165,182.49
		Stage 2 Implementation Total:	**4.20**	**$240,153.77**
		Stage 1 and 2 Implementation Total:	**5.92**	**$513,399.07**

INITIAL RETROFIT DESIGN:

The project team developed initial engineering plans (20%) for the Stage 1 collections including the Bank/Pine St. and College/ Pine St. BMPs, included as Attachments A-1 and A-2.

Initially, all materials collected as a part of the feasibility assessment screening phases were reviewed by the team and SMM, P.E. Additional survey needs regarding drainage paths, utility conflicts, and other constraints were identified. Based on the review, team members conducted additional site surveys at the retrofit locations using the total station instrument (Figure 1). Retrofit layout, sizing, elevation control, drainage flow paths, and other critical details needed to verify engineering feasibility were confirmed as a part of the plan preparation.

Figure 1: Team Member, SS, completing supplementation site survey at Bank/Pine St. Site (CR: DA, 11-13-13)

An refined H&H and water quality analysis was completed using the SWMM model to determine the volume captured, peak discharge reduction, and downstream impacts of the proposed systems for the WQ (0.9”), 1-yr (1.94”) and 10-yr (3.10”) 24-hr design storms. The 24-hr distributions were developed from local rainfall intensity duration curves (IDF) provided by the Northeast Regional Climate Center. The final basis for design of each retrofit practice was confirmed and documented for Stage 1 and 2 BMPs (A-3), including the volume capture for each design storm. Model output summaries are included in A-4.

COLLEGE ST. RETROFIT PLAN IMPACT:

Stages 1 and 2 implementation scenarios were modeled and compared to the existing condition model scenario (Table 2). Reductions in peak flow were assessed at the outfall, as well as the upstream junction (J4), above which all BMPs will be installed. J4 offers an assessment point that reflects the percent reduction as a result of BMP implementation. Additionally, water quality benefits were assessed in terms of TSS and Phosphorus reductions at the outfall. Changes in phosphorus loading between design storms were below the limits of the model output, therefore no change between the design storms was observed.

Stage 1 collections include two filtration planters in the ROW (i.e. Fig. 2) and a “green gutter” infiltration system along Bank St. which all drain to a large infiltration gallery in front of Peoples Bank, and four ROW planters along Pine St and at the College/Pine intersection. The collections would capture 100% of the WQ-storm from 0.90 ac impervious. Overall, the College St. watershed was estimated to experience a 19.4 % reduction of the WQ storm peak discharge at J4 and 11.4 % at the outfall (Table 2). The system was estimated to also provide volume and peak discharge reduction for the 1-yr and 10-yr design storms. TSS and P loading were estimated to reduce by 19.6% and 25.0% respectively during the WQ-storm.

Figure 2: Example ROW Planter similar to proposed College and Bank St BMPs

Table 2: Stage 1 BMP Implementation Impact

Stage 1	Percent Reduction (%) with BMPs		
	WQ (0.9")	1-Yr (1.94")	10-Yr (3.10")
H&H			
J4	19.4%	8.6%	5.5%
Outfall	11.4%	5.1%	3.3%
Water Quality at Outfall			
TSS (lbs)	19.6%	18.9%	18.3%
Phosphorus (lbs)	25.0%	25.0%	25.0%

Stage 2 collections were estimated to provide a more substantial benefit with the implementation of several additional planters and a large infiltration practice on the ICV property (Table 3). The additional planters would manage 0.57 ac impervious, while the main storm line would be routed through the ICV practice, therefore managing 3.63 ac of additional impervious surfaces. Stage 2 implementation was estimated to provide a 60.6% reduction in the WQ-storm peak discharge at the upstream Junction 4 (J4), and a 35.8% reduction at the outfall (Table 3). In the system, TSS and P loading was estimated to reduce by 46.8% and 50.0% respectively during the WQ-storm.

Table 3: Stage 2 BMP Implementation Impact

Stage 2	Percent Reduction (%) with BMPs		
	WQ (0.9")	1-Yr (1.94")	10-Yr (3.10")
H&H			
J4	60.6%	37.8%	25.2%
Outfall	35.8%	22.6%	14.6%
Water Quality at Outfall			
TSS (lbs)	46.8%	44.9%	42.7%
Phosphorus (lbs)	50.0%	50.0%	50.0%

Cost Estimates

The cost estimates were prepared based on the estimated BMP construction volume. An average base unit cost for urban bioretention systems of $5.30/ cft was used to estimate the base construction cost[1] after correction for inflation. For the bioretention BMPs and planters, the cost for plantings was estimated per BMP surface area using a local plantings estimate from a past project. An additional 30% Design and Permitting factor was added as recommended for typical urban stormwater retrofit projects. Furthermore, a 10% contingency factor was included to account for project complications and unforeseen conflicts.

[1] EPA. (2006). Urban Stormwater Preliminary Data Summary. Pg. 6-1.
http://water.epa.gov/scitech/wastetech/guide/stormwater/upload/2006_10_31_guide_stormwater_usw_d.pdf

NEXT STEPS:

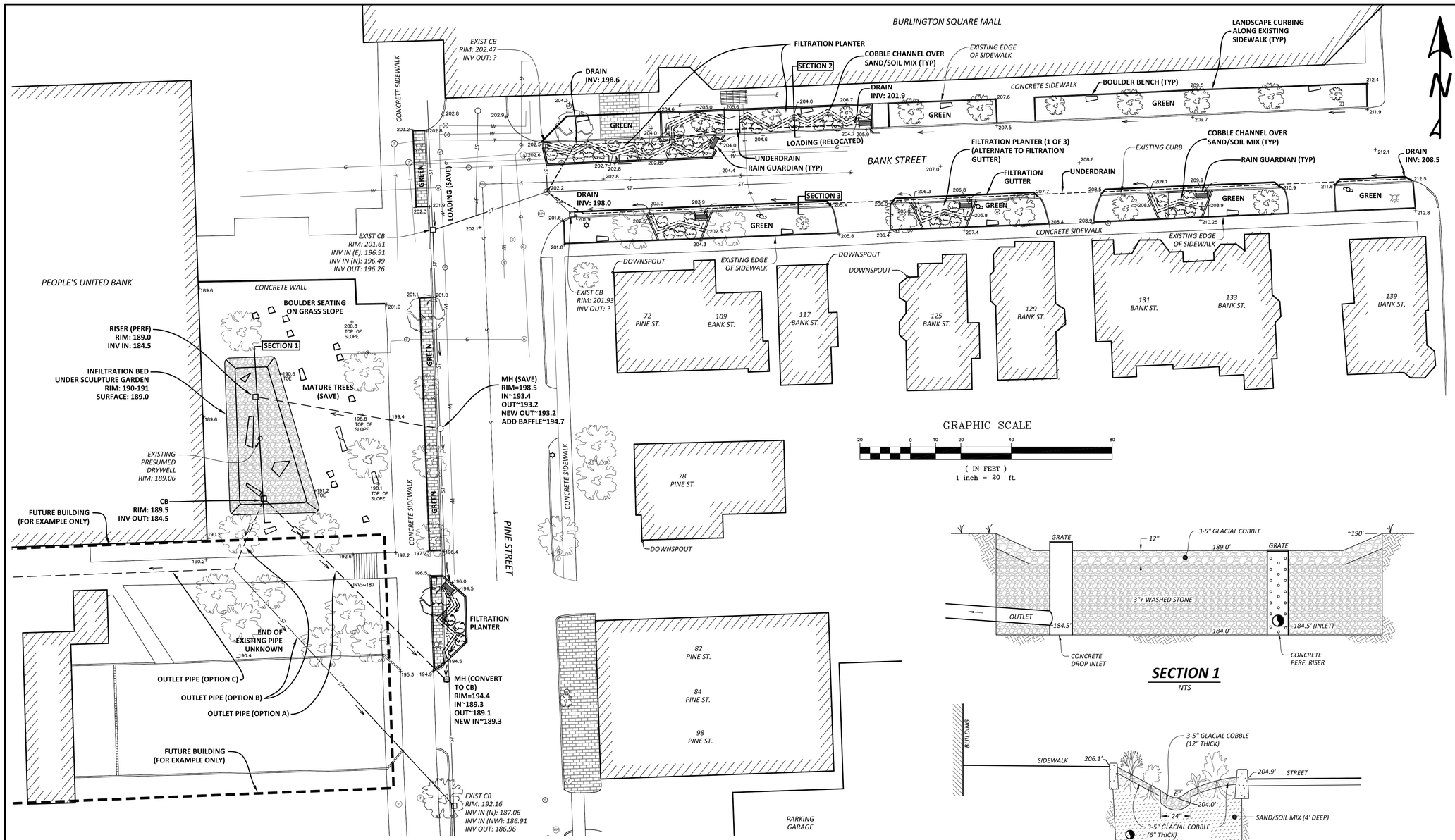
The final phase of the project will involve the initial engineering and preparation of design plans for the Stage 2 BMPs as well as an erosion mitigation plan for the alleyway between the Cherry St parking lot and Mall (Site # BTC2-A) and the upper portion of the walking path North of the Peoples Bank building. A final report will be prepared summarizing our methods and findings in a concise format for future reference and documentation. Additionally, a supplemental overall watershed concept plan will be prepared to vision the Stage 3 full BMP build-out scenario. Revised design plans for the Bank/Pine and College/Pine will be submitted if needed as per your comments.

Please let us know if you have any questions or comments.

Sincerely on behalf of the project team,

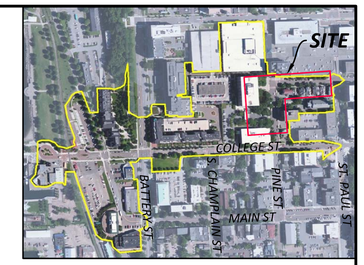
Andres Torizzo
WCA Principal

Joanie Stultz, E.I.
WCA Staff Engineer



GRAPHIC SCALE

(IN FEET)
1 inch = 20 ft.



SITE LOCATION

NTS

LEGEND

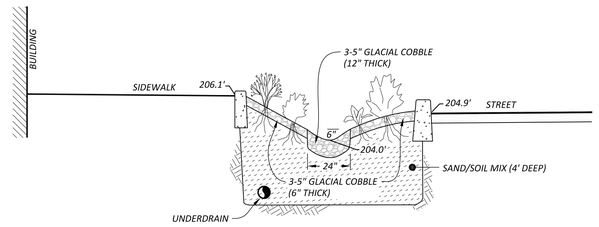
- SANITARTY SEWER
- WATER LINE
- UNDERGROUND TELEPHONE
- UNDERGROUND ELECTRIC
- GAS LINE
- STORM SEWER
- CATCH BASIN
- HYDRANT
- UTILITY POLE
- LIGHT POLE
- SPOT ELEVATION
- EXISTING TREE
- PROPOSED PLANTING

NOTES

1. AGE/QUALITY OF EXISTING STORM INFRASTRUCTURE HAS NOT BEEN COMPREHENSIVELY ASSESSED AND MUST BE VERIFIED.
2. EXISTING UTILITY INFORMATION BASED ON HISTORIC PLANS AND SITE SURVEY BY THIS OFFICE ON 11-13-13. LOCATIONS AND DEPTH OF UNDERGROUND UTILITIES TO BE FIELD CONFIRMED.
3. "GREEN": AREA TO BE AMENDED WITH LANDSCAPING FEATURES FOR SOIL STABILIZATION AND IMPROVED AESTHETICS.

SECTION 1

NTS



SECTION 2

NTS

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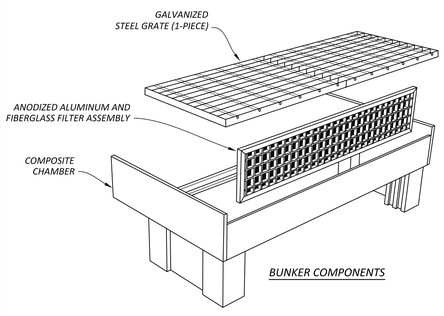
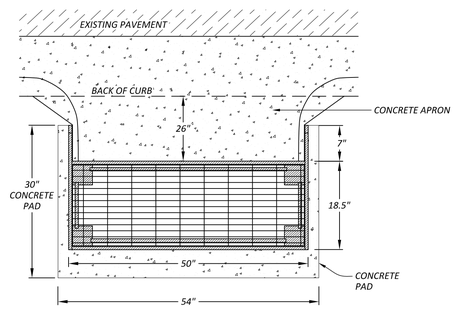
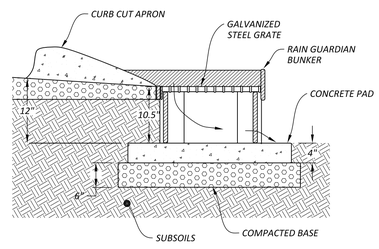


BUNKER COMPONENTS



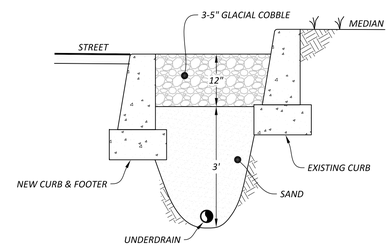
PLAN VIEW



SECTION VIEW

RAIN GUARDIAN DETAIL

NTS



SECTION 3

NTS

COLLEGE STREET STORM DRAIN SYSTEM

BURLINGTON, VERMONT

BANK STREET STORMWATER IMPROVEMENT PLAN

WATERSHED CONSULTING ASSOCIATES, LLC
Stormwater Management | Water Quality | Erosion Control
430 Shelburne Road P.O. Box 4413
Burlington, VT 05406
Mobile: 802.922.4671 | Main: 802.497.2367
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LAKESIDE ENVIRONMENTAL GROUP
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SMM ENVIRONMENTAL ENGINEERING
SCOTT MICHAEL MAPES
POST OFFICE BOX 5517
BURLINGTON, VERMONT
802-864-8100

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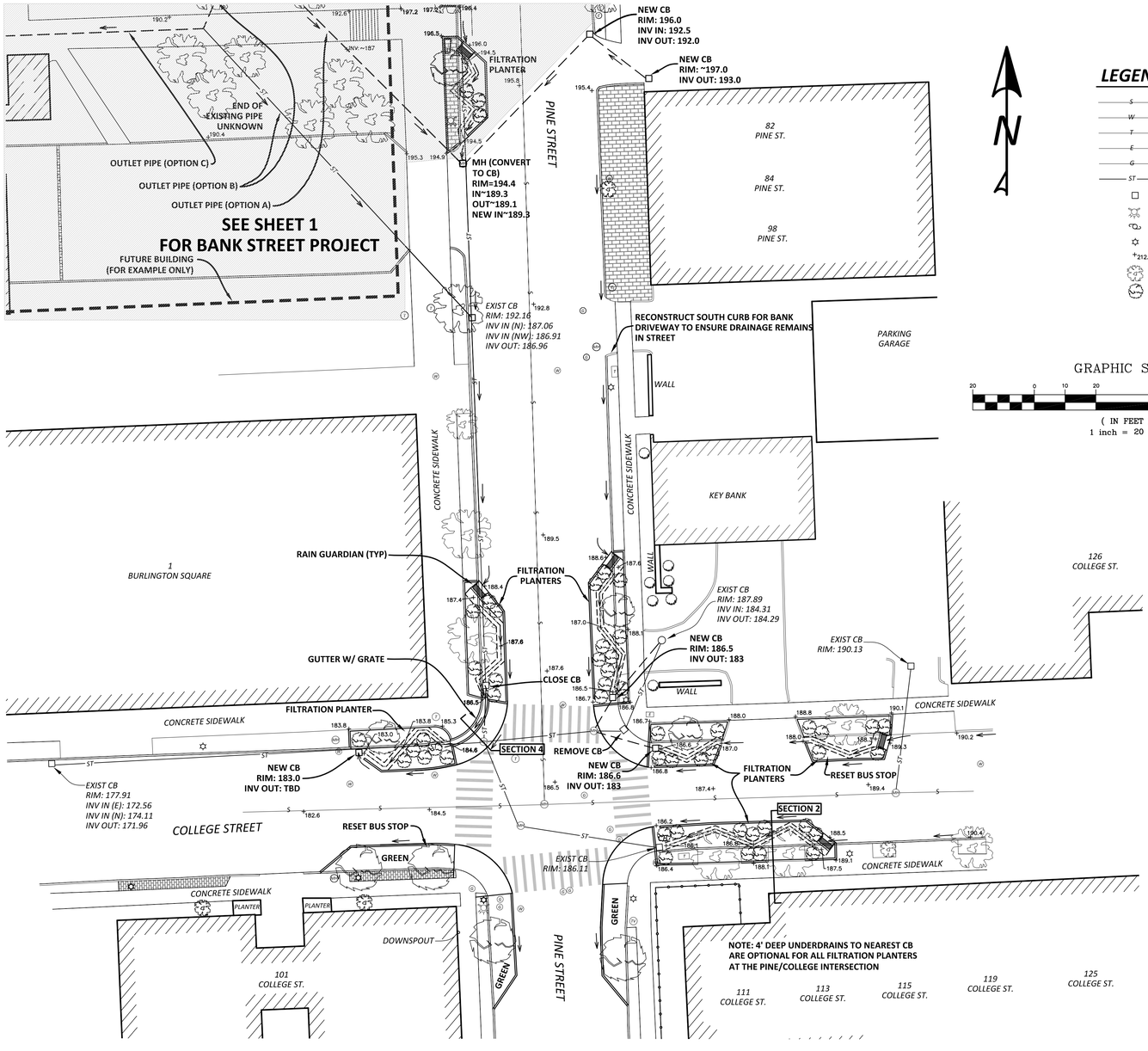

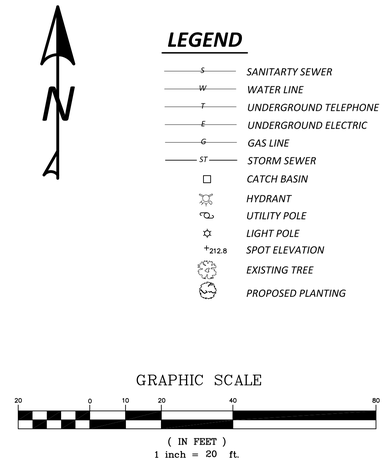

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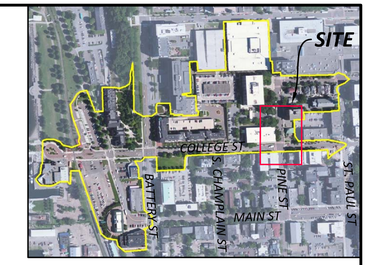

SITE LOCATION

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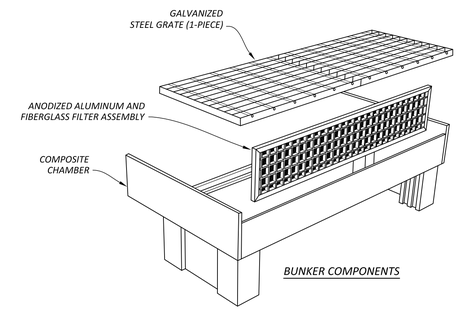

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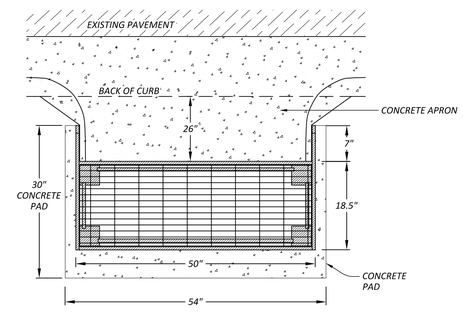
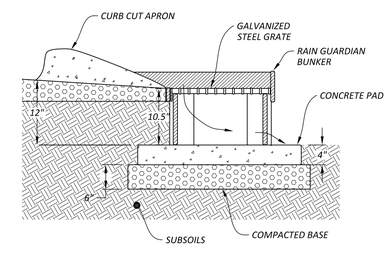


PLAN VIEW



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RAIN GUARDIAN DETAIL

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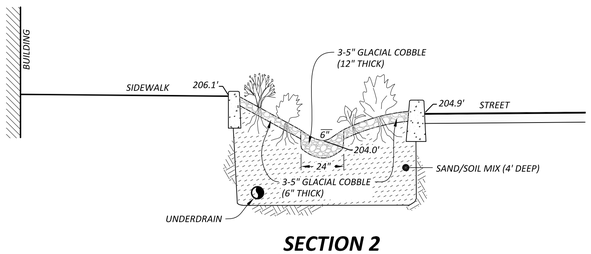

SECTION 2

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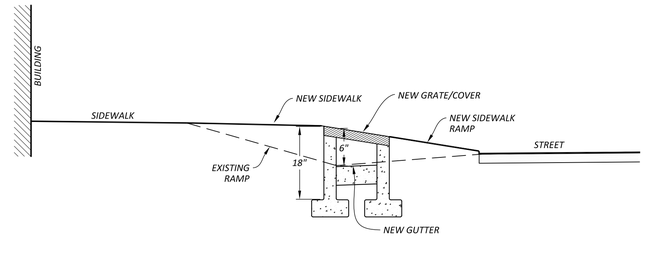

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COLLEGE/PINE ST. INTERSECTION STORMWATER IMPROVEMENT PLAN

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College St Stormwater Retrofits Plan
Task F Submittal
Basis of Design
Submitted 12-26-13

BMP ID: BNK1-A

Location: North side of Bank St

Description: Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.

BMP Surface Area	1454	sqft
Total Drainage Area	0.303	ac
Greened Impervious Area	0.253	ac

SWMM H&H Analysis	Volume (cft)		
	Design Storm		
	WQ (0.9")	1-Yr (1.94")	10-Yr (3.10")
Inflow Depth (in)	835.01	1828.79	2965.57
Infiltration Loss (in)	395.09	906.52	1228.89
Final Storage (in)	441.14	671.40	924.70
Surface Outflow (in)	0.00	249.66	810.78
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	100%	86%	73%
Peak Discharge Reduction (%)	100%	53%	10%

BMP ID: BNK1-B, Green Gutter

Location: South side of Bank St

Description: Gravel infiltration strip along curb with underdrain

BMP Surface Area	616	sqft
Total Drainage Area	0.473	ac
Greened Impervious Area	0.377	ac

SWMM H&H Analysis	Volume (cft)		
	Design Storm		
	WQ (0.9")	1-Yr (1.94")	10-Yr (3.10")
Inflow Depth (in)	1150.11	2518.37	4086.60
Infiltration Loss (in)	761.09	2013.00	3020.11
Final Storage (in)	373.27	438.72	506.58
Surface Outflow (in)	0.00	0.00	110.28
Drain Outflow (in)	14.54	66.66	449.62
Volume Capture (%)	99%	97%	86%
Peak Discharge Reduction (%)	72.7%	45.8%	30.2%

BMP ID: BNK1-B, ROW Planter		
Location: South side of Bank St		
Description:Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.		
BMP Surface Area	713	sqft
Total Drainage Area	0.473	ac
Greened Impervious Area	0.377	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1459.15	3195.84	5184.60
Infiltration Loss (in)	774.42	1260.40	1554.89
Final Storage (in)	631.41	836.23	1125.87
Surface Outflow (in)	53.32	1099.21	2505.04
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	96%	66%	52%
Peak Discharge Reduction (%)	72.7%	45.8%	30.2%

BMP ID: BTV1-A		
Location: City of Burlington Parking Garage Roof, West		
Description: Rooftop filtration planter with underdrain		
BMP Surface Area	133	sqft
Total Drainage Area	0.050	ac
Greened Impervious Area	0.050	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1710.02	3744.84	6076.57
Infiltration Loss (in)	613.23	952.57	1231.31
Final Storage (in)	1096.79	1810.61	2131.77
Surface Outflow (in)	0.00	982.87	2713.49
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	100%	74%	55%
Peak Discharge Reduction (%)	100.0%	0.0%	0.0%

BMP ID: BTV1-B		
Location: City of Burlington Parking Garage Roof, East		
Description: Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.		
BMP Surface Area	147	sqft
Total Drainage Area	0.048	ac
Greened Impervious Area	0.048	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1551.26	3397.01	5510.60
Infiltration Loss (in)	552.64	907.73	1180.41
Final Storage (in)	997.41	1726.99	2077.23
Surface Outflow (in)	0.00	729.58	2252.96
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	100%	79%	59%
Peak Discharge Reduction (%)	100.0%	0.0%	0.0%

BMP ID: BTV1-C		
Location: Hilton and City of Burington Parking Garage		
Description: Bioretention filter within the circular median and bioretention filter along sidewalk with inlet pretreatment device "Rain Guardian".		
BMP Surface Area	2038	sqft
Total Drainage Area	0.529	ac
Greened Impervious Area	0.476	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1221.62	2783.78	4710.74
Infiltration Loss (in)	649.59	1173.14	1445.82
Final Storage (in)	573.24	1256.76	1536.72
Surface Outflow (in)	0.00	353.88	1726.99
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	100%	87%	63%
Peak Discharge Reduction (%)	100%	50%	7%

BMP ID: CS1-A		
Location: College/Pine Intersection, NE corner		
Description: Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.		
BMP Surface Area	0	sqft
Total Drainage Area	0.271	ac
Greened Impervious Area	0.235	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1543.99	3383.68	5488.79
Infiltration Loss (in)	513.85	902.88	1174.35
Final Storage (in)	929.54	1250.70	1568.23
Surface Outflow (in)	100.59	1230.10	2747.42
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	93%	64%	50%
Peak Discharge Reduction (%)	57.1%	13.3%	7.7%

BMP ID: CS1-C		
Location: College/Pine Intersection, SE corner		
Description: Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.		
BMP Surface Area	700.05	sqft
Total Drainage Area	0.273	ac
Greened Impervious Area	0.258	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1726.99	3784.83	6142.02
Infiltration Loss (in)	557.48	951.36	1231.31
Final Storage (in)	967.11	1311.30	1631.25
Surface Outflow (in)	203.60	1522.17	3279.46
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	88%	60%	47%
Peak Discharge Reduction (%)	62.5%	11.8%	7.1%

BMP ID: PS1-F		
Location: College/Pine Intersection, NE corner		
Description: Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.		
BMP Surface Area	554.06	sqft
Total Drainage Area	0.194	ac
Greened Impervious Area	0.164	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1186.47	2597.15	4213.85
Infiltration Loss (in)	625.35	1131.93	1431.28
Final Storage (in)	559.91	759.87	1002.26
Surface Outflow (in)	0.00	705.34	1779.10
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	100%	73%	58%
Peak Discharge Reduction (%)	100.0%	10.0%	5.6%

BMP ID: PS1-G		
Location: Pine St, Across from Peoples Bank drive through station		
Description: Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.		
BMP Surface Area	242.56	sqft
Total Drainage Area	0.107	ac
Greened Impervious Area	0.095	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1667.60	3653.94	5928.72
Infiltration Loss (in)	842.29	1331.90	1630.03
Final Storage (in)	654.44	896.82	1196.17
Surface Outflow (in)	172.09	1425.22	3102.52
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	90%	61%	48%
Peak Discharge Reduction (%)	66.7%	16.7%	10.0%

BMP ID: PS1-H		
Location: College/Pine Intersection, NW corner		
Description: Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.		
BMP Surface Area	839.10	sqft
Total Drainage Area	0.161	ac
Greened Impervious Area	0.143	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	832.59	2095.41	3636.97
Infiltration Loss (in)	392.66	884.70	1201.01
Final Storage (in)	439.93	670.19	811.99
Surface Outflow (in)	0.00	541.73	1625.19
Drain Outflow (in)	0.00	0.00	0.00
Volume Capture (%)	100%	74%	55%
Peak Discharge Reduction (%)	100.0%	20.0%	8.0%

BMP ID: PS2-A, Peoples Infiltration		
Location: On East side of Peoples Bank, along Pine St.		
Description: Filtration planter placed in the ROW, with "Rain Guardian" inlet pretreatment device.		
BMP Surface Area	1729.99	sqft
Total Drainage Area	0.374	ac
Greened Impervious Area	0.198	ac

SWMM H&H Analysis	**Volume (cft)**		
	Design Storm		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Inflow Depth (in)	1316.15	3178.87	5680.27
Infiltration Loss (in)	1316.15	2846.80	3932.68
Final Storage (in)	0.00	0.00	0.00
Surface Outflow (in)	0.00	0.00	0.00
Drain Outflow (in)	0.00	330.85	1748.80
Volume Capture (%)	100%	90%	69%
Peak Discharge Reduction (%)	80.0%	56.1%	35.9%

BMP ID: CS4-A, ICV Infiltration Practice		
Location: College/Battery Intersection within Pomerleau green space		
Description: Underground infiltration gallery with park area above practice		
BMP Surface Area	9235.07	sqft
Total Drainage Area	4.358	ac
Greened Impervious Area	3.626	ac

SWMM H&H Analysis	**Design Storm**		
	WQ (0.9")	**1-Yr (1.94")**	**10-Yr (3.10")**
Maximum Total Inflow (CFS)	1.14	3.25	6.17
Maximum Outflow (CFS)	0	1.71	3.99
Flow Reduction (%)	100%	47%	35%
Percent Infiltration Loss (%)	100%	72%	54%
Peak Discharge Reduction (%)	63%	39%	25%