Resilient Stormwater and Tidal Flooding BMP in Norfolk, Virginia

COLLEGE OF ENGINEERING
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THE CITY OF NORFOLK

WETLANDS WATCH

- Background -

Climate change, land subsidence, sea level rise, and storm surges are causing increased inland and tidal flooding across coastal regions. The city of Norfolk, Virginia is projected to experience a 1.5-ft increase in sea level by the year 2050. Norfolk funds green infrastructure projects to address these issues, including in the St. Paul neighborhood to the west and northwest of the South Brambleton study area.
Circumventing existing development and infrastructure, some of which are highlighted below, can be a significant obstacle for these types of projects.

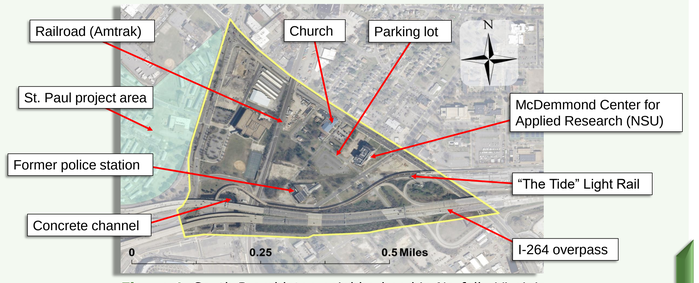

Figure 1. South Brambleton neighborhood in Norfolk, Virginia.

- Problem Statement -

The neighborhood of South Brambleton in Norfolk is currently under threat from both stormwater and tidal flooding. A plot of land in this area is being considered for redevelopment to address these challenges while providing community green space. This design must be resilient, capable of adapting to changing climatic and hydrologic conditions, while also preserving a historic police station located on-site (see figure 1).

- Goals & Objectives -

Goal:
Design a series of stormwater BMPs in South Brambleton that will reduce flooding and effluent sediment load, while also providing wildlife habitats and usable community green space.

Objectives:
- Provide storage and tidal buffer areas within our design
- Grade wetland areas to allow for upland retreat as water table rises
- Use natural methods of stormwater capture and uptake
- Design site microtopography to support native plant communities, providing habitat variation and improving biodiversity
- Incorporate community amenities

- Design Considerations -

Constraints
- Avoid altering existing infrastructure
- Reduce overall flooding on parking lot and adjacent railway
- Stay within a budget of $2 million
- Abide by relevant VA DEQ Stormwater Management Codes

Criteria
- Attenuate stormwater and storm surge peaks
- Reduce sediment load by 20%
- Reduce Nitrogen and Phosphorus load by 45% and 20%, respectively

Standards
- *ASCE 45-16:* Standard Guidelines for the Design of Urban Stormwater Systems
- *Virginia DEQ Stormwater Design Specifications*
  - no. 11: Wet Swales
  - no. 13: Constructed Wetlands
  - no. 14: Wet Ponds

- Final Design -

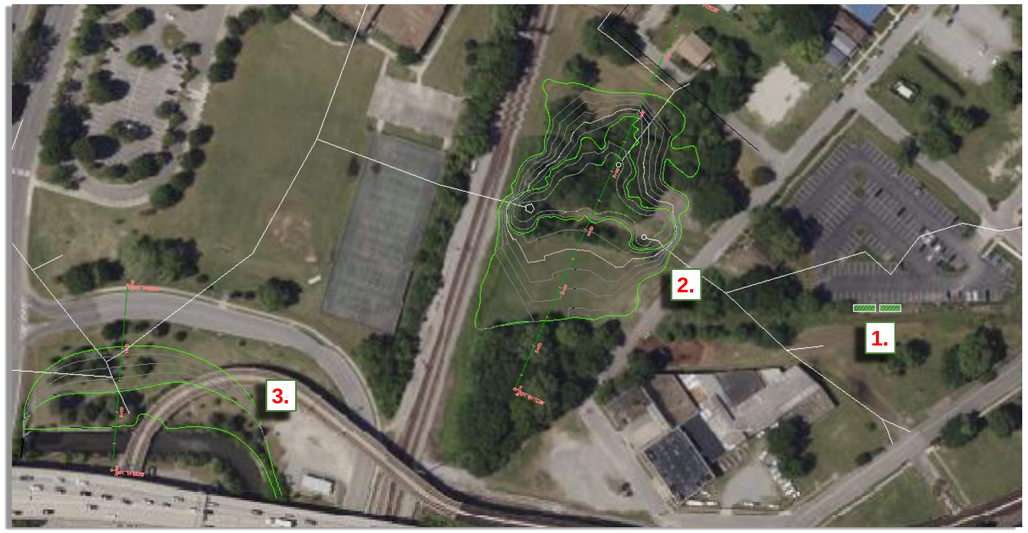

Figure 2. Civil3D marsh and wet pond schematic.

Design Components:
1. Filterra units to filter stormwater runoff from the parking lot before conveyance to pond
2. Wet pond with buffer zones for nutrient treatment
3. Riparian buffer area to act as a transitional tidal marsh

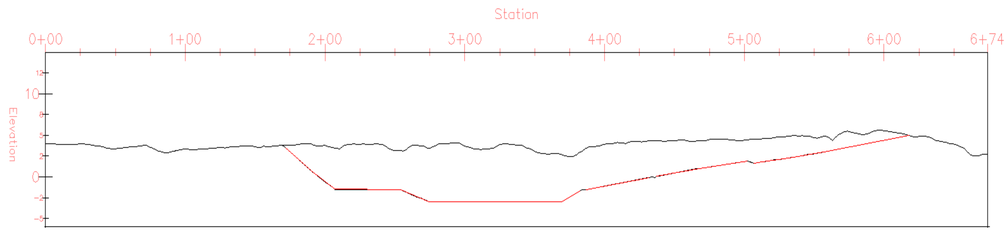

Figure 3. Civil3D wet pond cross section.

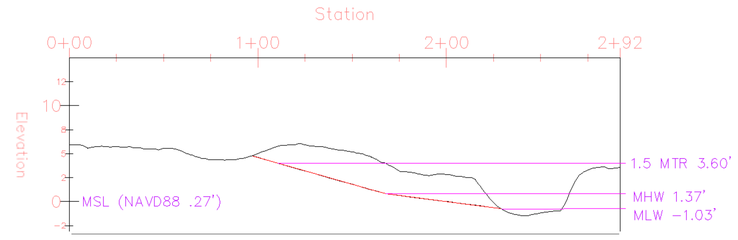

Figure 4. Civil3D riparian buffer area cross section.

Classification	Area (ft²)
Low Marsh	25,915
High Marsh	10,571
Salt Panne	8,512
Upland	37,830

Table 1: Planting areas for the riparian buffer area.

Classification	Area (ft²)	Storage Volume (m³)	Excavation Volume (m³)
Open Water	31,397	1,334	-
Emergent	18,666	450	-
Freshwater Marsh	22,226	10,604	-
Upland	59,502	-	-
Total	-	12,388	12,479

Table 2: Planting areas and storage volume for the wet pond.

- Economic Analysis -

MATERIALS & EQUIPMENT	Unit Cost	Unit	Quantity	Total Cost
Clearing Existing Vegetation	$3,500	/AC	1.84	$6,440
Excavation	$10	/CY	16,322	$163,220
Erosion & Sediment Control	$1,053.17	/200 FT	200	$1,053.17
Standpipe/ Riser	$501.80	/U	1	$501.80
Filterra Unit	$25,500	/U	2	$51,000
VEGETATION (Riparian Buffer Area)				
Low Marsh	$6.38	/SY	2,879 SY	$18,370.86
Salt Meadow	$4.41	/SY	1,175 SY	$5,179.79
Salt Panne	$5.97	/SY	946 SY	$5,646.29
VEGETATION (Wet pond)				
Emergent	$4.62	/SY	2,074 SY	$9,581.88
Peripheral	$1.28	/SY	2,470 SY	$3,161.03
Upland	$.87	/SY	6,611 SY	$5,751.86
MAINTENANCE	**Rate**	**Basis**		**Cost / year**
Landscaping	$27	/HR/person	2	$54
Plant Checkup (annual)	$27	/HR/person	4	$108
Culvert / Inlet Debris Removal	$27	/HR/person	4	$108
			TOTAL	$269,906.68

Table 3: Summary of Economic Analysis

-Planting Guide-

RIPARIAN BUFFER VEGETATION	Habitat Type
Juncus roemerianus	Low Marsh
Scirpus robustus	Low Marsh
Spartina alterniflora	Low Marsh
Spartina cynosuroides	Low Marsh
Atriplex patula	Salt Meadow
Distichlis spicata	Salt Meadow
Limonium spp.	Salt Meadow
Spartina patens	Salt Meadow
Symphyotrichum tenuifolium	Salt Meadow
Baccharis halimifolia	Salt Panne
Borrichia frutescens	Salt Panne
Hibiscus moscheutos	Salt Panne
Iva frutescens	Salt Panne
Kostelezkya virginica	Salt Panne
Panicum virgatum	Salt Panne
Salicornia spp.	Salt Panne
Solidago sempervirens	Salt Panne

Table 4: Riparian buffer area planting list

WET POND VEGETATION	Habitat Type
Cephalanthus occidentalis (shrub)	Emergent
Ilex glabra (shrub)	Emergent
Alnus serrulata (tree)	Emergent
Azalea viscosum (shrub)	Emergent
Rosa palustris (shrub)	Emergent
Nyssa biflora (Tree)	Emergent
Juncus spp. (sedge)	Emergent
Carex spp. (rush)	Emergent
Sambucus canadensis	Peripheral
Ilex verticillatta	Peripheral
Magnolia virginiana (tree)	Peripheral
Platanus occidentalis (tree)	Peripheral
Acer rubrum (tree)	Upland
Liquidambar styraciflua (tree)	Upland
Quercus nigra (tree)	Upland
Quercus phellos (tree)	Upland
Native Short Grass Seed mix	Upland

Table 5: Wet pond planting list

Nurseries
Environmental Concern Inc., MD
Pinelands Nursery, NJ
New Moon Nursery, NJ
American Native Plants Nursery, MD

Table 6: Nursery sources

-Future Work-

- Planting areas should be monitored on a yearly basis for the invasive species *Phragmites australis* and to avoid monoculture development to preserve vegetation biodiversity.
- Accumulated trash and debris should be removed from the wet pond area to ensure aesthetic integrity, so that the drop inlet which drains this area is not obstructed. Inspection should be conducted on a yearly basis.
- Standard maintenance procedures should be followed for the two Filterra Units installed in the parking lot.

-Acknowledgements-

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