

The Effect of a Flood Mitigation Structure Utilizing Filtrex[®] Land Improvement Systems on Flooding in The Town of Dewey Beach Bayard Avenue Watershed

*Todd A. Fritchman, Biologist,
Environmental Professional, Author*



Purpose



Bayard Avenue and its watershed had been subject to flooding from tide and heavy rain fall events for decades
October 2009 Nor'easter Flooding



Bayard Avenue and its watershed had been subject to flooding from tide and heavy rain fall events for decades
October 2009 Nor'easter Flooding



October 2009
Nor'easter Flooding



October 2009
Nor'easter Flooding



October 2009
Nor'easter Flooding

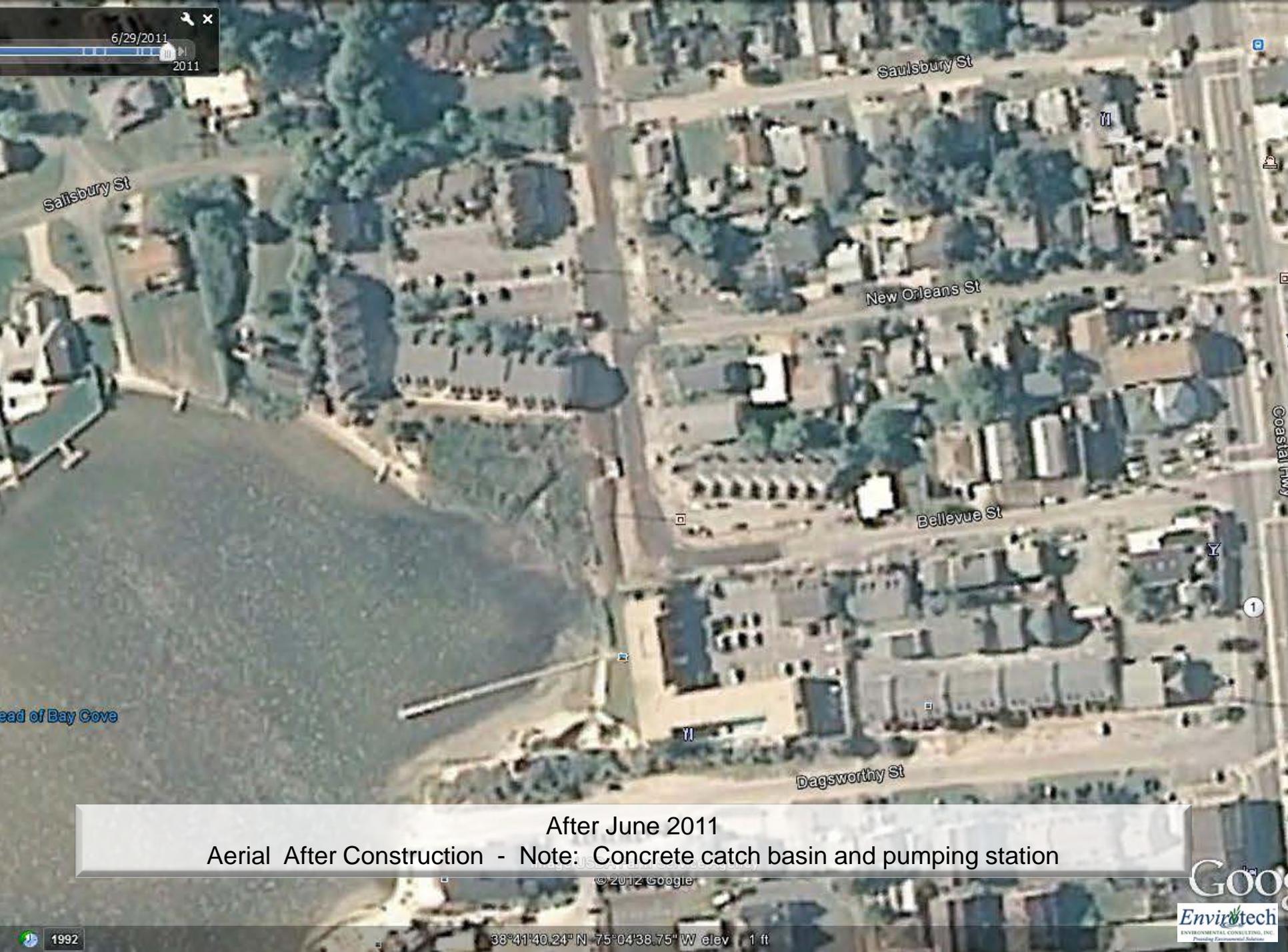


Before July 2010
Aerial Pre-Construction

Before Bayard Avenue Flood Mitigation Project

February 2010





6/29/2011

2011

Salisbury St

Salisbury St

New Orleans St

Bellevue St

Dagsworthy St

Coastal Hwy

Head of Bay Cove

After June 2011
Aerial After Construction - Note: Concrete catch basin and pumping station

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1992

38°41'40.24" N 75°04'38.75" W elev 1 ft



Completed Project After Two (2) Growing Season
September 2012

Introduction



The Town of Dewey Beach, Sussex County, Delaware experienced drainage problems within the drainage area along Bayard Avenue. These problems resulted in flooding of Bayard Avenue and associated parking areas and yards. The untreated stormwater generated by the impervious areas within the drainage area continued to pollution loadings and water quality impacts to Rehoboth Bay (the “Bay”). The Town of Dewey Beach (the “Town”) commissioned a committee (the Roads Committee) to identify and evaluate potential options of addressing flooding problems and water quality impacts along Bayard Avenue that result from stormwater runoff and tidal surges in 2009.

(Duffield Associates, Inc., August 2009)

Background Information



The Town of Dewey Beach (the “Town”) offered a Request for Proposal (RFP) regarding an analysis of possible conceptual alternative for addressing drainage, flooding and water quality problems within the drainage area along Bayard Avenue. The report is intended to be used to inform the Town’s Roads Committee and Council about the sources and extent of impairments, the range of options available to mitigate the issues, the preliminary engineer’s opinion of probable concept construction cost to mitigate the issues, and possible funding opportunities to help offset the cost to the Town for implementing a possible remedy

(Duffield Associates, Inc., August 2009)



Approximate Bayard Avenue Drainage Area / Watershed

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38°41'42.91" N 75°04'35.33" W elev 4 ft

I. Methods: Background Study

Bayard Avenue Flood and Water Quality Improvement Study

DRAFT

**BAYARD AVENUE FLOOD
AND
WATER QUALITY IMPROVEMENT STUDY**

August 2009

Prepared for:

The Town of Dewey Beach
105 Rodney Avenue
Dewey Beach, Delaware 19971

Prepared by:

Duffield Associates, Inc.
Consultants in the Geosciences
128 West Market Street
Georgetown, Delaware 19947

DRAFT

David L. Diefenthaler, P.E., LEED AP
Project Engineer

DRAFT

Nicholas A. DiPasquale
Project Manager

Project No. 7703.CB



DUFFIELD
ASSOCIATES

DRAFT

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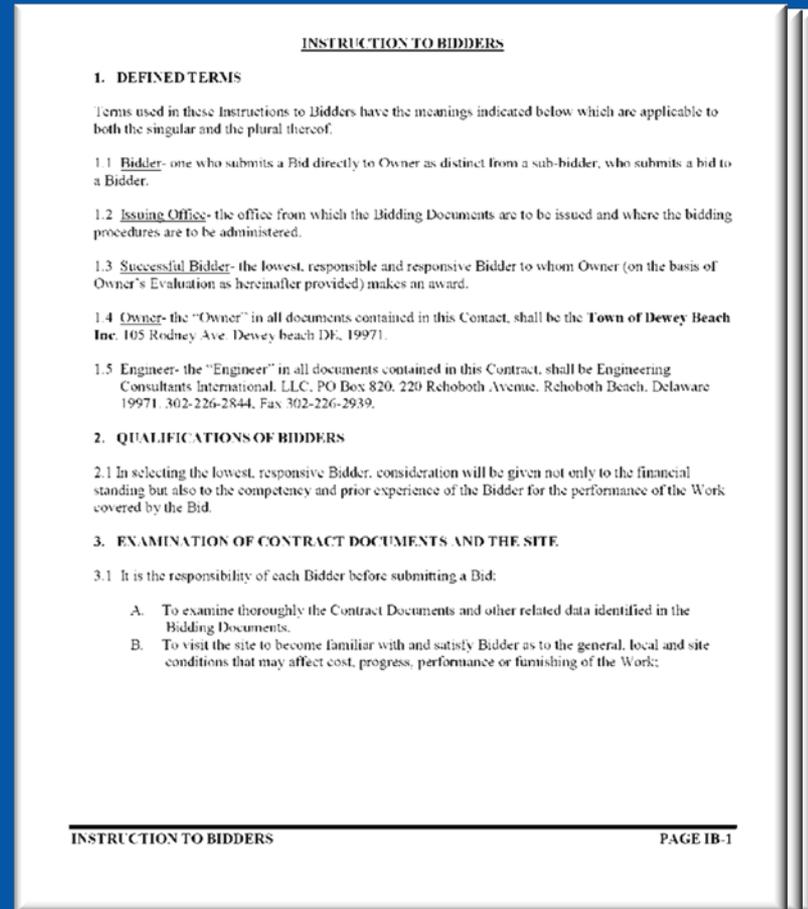
EXHIBITS

Exhibit 1	General Project Area Map
Exhibit 2	Aerial Photograph Study Area - 1937
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Exhibit 10	Tide Gauge Data
Exhibit 11	Probability Plot
Exhibit 12	Probability Map
Exhibit 13	Collection Areas

II. Methods: Bid Specifications

Project Bid Announcement(s) Town of Dewey Beach

- After study, the Town of Dewey Beach announces engineering specifications for Bayard Avenue Flood Mitigation Project.



INSTRUCTION TO BIDDERS

1. DEFINED TERMS

Terms used in these Instructions to Bidders have the meanings indicated below which are applicable to both the singular and the plural thereof.

- 1.1 **Bidder**- one who submits a Bid directly to Owner as distinct from a sub-bidder, who submits a bid to a Bidder.
- 1.2 **Issuing Office**- the office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.
- 1.3 **Successful Bidder**- the lowest, responsible and responsive Bidder to whom Owner (on the basis of Owner's Evaluation as hereinafter provided) makes an award.
- 1.4 **Owner**- the "Owner" in all documents contained in this Contract, shall be the **Town of Dewey Beach Inc.** 105 Rodney Ave. Dewey beach DE, 19971.
- 1.5 **Engineer**- the "Engineer" in all documents contained in this Contract, shall be Engineering Consultants International, LLC, PO Box 820, 220 Rehoboth Avenue, Rehoboth Beach, Delaware 19971, 302-226-2844, Fax 302-226-2939.

2. QUALIFICATIONS OF BIDDERS

2.1 In selecting the lowest, responsive Bidder, consideration will be given not only to the financial standing but also to the competency and prior experience of the Bidder for the performance of the Work covered by the Bid.

3. EXAMINATION OF CONTRACT DOCUMENTS AND THE SITE

- 3.1 It is the responsibility of each Bidder before submitting a Bid:
 - A. To examine thoroughly the Contract Documents and other related data identified in the Bidding Documents.
 - B. To visit the site to become familiar with and satisfy Bidder as to the general, local and site conditions that may affect cost, progress, performance or furnishing of the Work.

III. Methods: Project Partnering

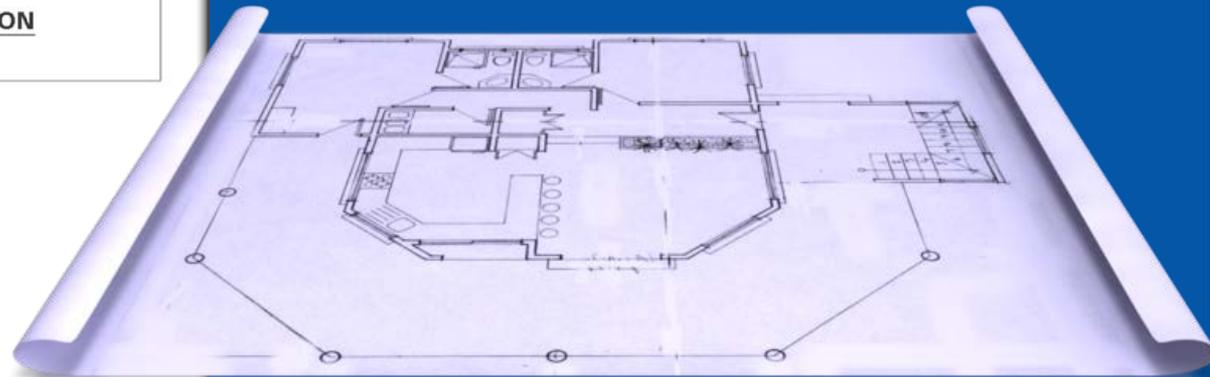
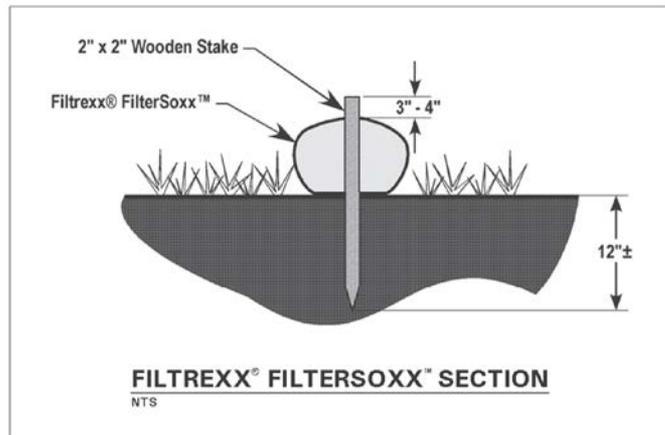
Project Partnering

- February 2009, Envirotech Environmental Consulting, Inc. (EECI) was retained in conjunction with ECI Engineering Planning Surveying (ECI) to create a Green Technology Best Management Practices (BMP) for low-impact development and coastal watershed management.
- ECI would design berm with clay core and other engineering including catch basins, outfall structure, pumps, etc.
- EECI would provide wetland delineation, jurisdictional determinations, permits, conservation landscape plan, and Filtrexx® low-impact land improvement system design, installation and maintenance.



III. Methods: Concept

Concept Design (EECI) - Filtrex® Bank Stabilization



III. Methods: Concept

Concept Design (EECI) - Filtrex® Bank Stabilization



LAND IMPROVEMENT SYSTEMS

Section 2: Storm Water Management - Post-Construction

SWPPP Cut Sheet: Filtrex® Bank Stabilization

*Streambank & Shoreline
Stabilization Technology*

PURPOSE & DESCRIPTION
The Filtrex® Bank stabilization vegetated soft armoring system is designed to **stabilize banks, and prevent erosion of waterway and shoreline banks.** The Bank stabilization system is composed of a heavy duty tubular mesh netting matrix used to contain and reinforce growing media and vegetation. The Bank stabilization technology provides structural protection, erosion control, vegetation growth, and vegetation reinforcement in one system. The Bank stabilization weight and anchoring system can withstand storm runoff velocities and hydraulic shear stresses similar to traditional soft armoring devices, while the injected GrowingMedia™ and optional drip tape irrigation system ensure establishment and sustainability of both seeded and live stake plantings. The Bank stabilization system will provide: structural stability/protection from toe-cutting and sloughing of waterway bank; structural stability/protection from mass wasting and sloughing of shoreline from wave action; control of erosion from overland runoff; wave action, and shear stress from concentrated flows; control of runoff velocity flowing to receiving water; dissipation of runoff energy flowing to receiving water; sustained vegetation health; sediment, soluble pollutant, and pathogen removal of runoff flowing to receiving water.

APPLICATION
The Bank stabilization armoring system is used where waterway and shoreline banks are eroding, are unstable, or cannot sustain vegetation. Bank stabilization is used to establish and reinforce

vegetation where flows and intense hydraulic pressures typically undermine vegetation. Applications include: creek, stream, riparian bank stabilization; pond, lake shoreline stabilization; sediments, storm water retention/detention pond bank stabilization; riparian, stream bank, tidal creek, salt marsh restoration, habitat/ecological restoration, aesthetic revitalization.

INSTALLATION

1. Filtrex® Bank stabilization shall meet Filtrex® Bank stabilization Specifications and use Filtrex® GrowingMedia™.
2. Contractor is required to be a Filtrex® Certified™ Installer as determined by Filtrex® International, LLC (440-926-2607; www.filtrex.com). Certification shall be considered current if appropriate identification is shown during time of bid or at time of application (list found at www.filtrex.com). Look for Filtrex® Certified™ Installer Seal.
3. Bank stabilization will be placed at locations indicated on plans as directed by the Engineer and will be fabricated on-site.
4. Bank stabilization shall be placed in a manner that protects the entire bank or shoreline from erosion and destabilization.
5. Bank stabilization must be installed and stabilized before concentrated flow is allowed to contact bank or slope area.
6. Sediment control devices (such as Filtrex® Sediment control) shall be installed if construction requires land disturbance or earth moving.

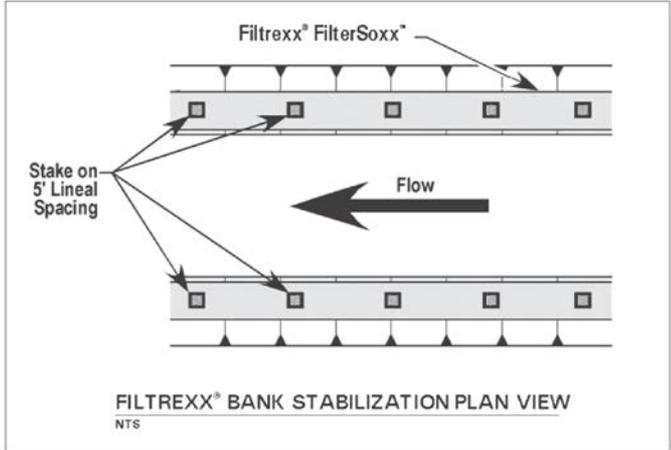
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Post-Construction | Section 2: Storm Water Management | 379



SWPPP Cut Sheet - 2.5. Filtrex® Bank Stabilization

Figure 52. Staking Details for Filtrex® Bank Stabilization



FILTREXX® BANK STABILIZATION PLAN VIEW
NTS

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Post-Construction | Section 2: Storm Water Management | 385



III. Methods: Concept

Concept Design (EECI) - Filtrex® Storm Water Blanket



Section 2: Storm Water Management - Post-Construction

SWPPP Cut Sheet: Filtrex® Storm Water Blanket

Runoff Reduction & Vegetation Technology

PURPOSE & DESCRIPTION
Filtrex® Storm water blankets are a **storm water runoff reduction and permanent vegetation establishment** practice used on post-construction soil surfaces. Storm water blankets are intended for application and use when:

- Land disturbing activities have ceased,
- permanent vegetation is required,
- reduction of pollutant loading in storm runoff is required,
- runoff volume reduction from contributing watershed is necessary,
- reduction in the size of storm water collection or bio-retention ponds, and rain gardens is necessary.

Storm water blankets are designed to act like a sponge for rain water and non-concentrated storm runoff. By holding large volumes of water at and across the land surface, Storm water blankets increase the infiltration and evapotranspiration of water from rainfall and storm runoff. These processes aid the cycling of water by recharging ground water and atmospheric water vapor. By increasing the land surface roughness, Storm water blankets slow the rate of sheet runoff, allowing it to more readily infiltrate the soil surface. Storm water blankets are also specifically designed to allow for permanent and sustained vegetation growth.

APPLICATION
Filtrex® Storm water blankets are surface applied at a depth of 2 in (50mm). Storm water blankets are used where reduction of storm water runoff and/or permanent vegetation is required or will improve the design and function of the landscape. Storm water blankets are generally applied after land disturbing activities have ceased and where sheet runoff may exist under storm conditions. Storm water blankets should NOT be used in areas of concentrated storm water flow. Storm water blankets should not be used on slopes greater than 2:1 without the use of additional stabilizers or support practices. Filtrex® Slope interruption may be seeded and used with Storm water blankets to slow runoff velocity and the potential for soil erosion.

Storm water blankets are designed to absorb water. For every 1% of organic matter, the Storm water blanket will hold approximately 5,500 gal (21 cubic m) of water per acre inch (103 cubic m) (Beedlove, 2006). Storm water blankets are typically 25% organic matter by wet weight and 50% organic matter by dry weight. Alternatively, Storm water blankets typically hold approximately 1.6 oz (45 g) of water per 3.6 oz (100 g) of Storm water blanket (dry weight); 1 gal (0.004 cubic m) of water per 20 lbs (9 kg) of Storm water blanket (dry wt) or per 30 lbs (14 kg) of Storm water blankets (wet wt). This equates to approximately 40 gal (0.15 cubic m) of water per cubic yard (0.76 cubic m) of Storm water blanket and

SWPPP Cut Sheet-2.1 Filtrex® Storm Water Blanket

Figure 1.1. Engineer Design Details for Storm Water Blanket.



**FILTREXX®
STORM WATER BLANKET**
NTS

DIRECTION OF FLOW

2" FILTREXX STORM WATER BLANKET

PERMANENT EROSION CONTROL SEEDING

CURB

NOTES

1. Stormwater blanket to meet Filtrex® installation specifications.
2. Stormwater blanket must use Filtrex® Certified GrowingMedia™.
3. Stormwater blanket must be installed by a Filtrex® Certified Installer.
4. Stormwater blanket shall be applied to 100% of bare soil or area specified where storm water reduction and permanent vegetation is required.
5. Stormwater blanket shall be installed at least 10 feet over the slope shoulder or into existing vegetation.
6. Stormwater blanket will be placed at locations indicated on plans as directed by the Engineer.
7. Land or soil surface shall be roughened prior to application of Stormwater blanket.
8. Stormwater blanket shall be applied at a minimum depth of 2 in. or at a rate of 270 cubic yards/acre.
9. Seeds shall be thoroughly mixed with the Filtrex® GrowingMedia™ prior to application or surface applied to Filtrex® GrowingMedia™ at the time of application.
10. Stormwater blanket shall not be installed in areas of concentrated stormwater flow, including channels and ditches.
11. Stormwater blanket installed on slopes greater than 2:1 shall be tracked. Installation on slopes greater than 2:1 shall be tracked and use other support practices, such as Filtrex® Lockdown™ Netting or Filtrex® Tackifying agents.



III. Methods: Concept

Concept Design (EECI) - Filtrexx® LockDown™ Netting

filtrexx®
LAND IMPROVEMENT SYSTEMS

Section 3: Support Practices™

Filtrexx® LockDown™ Netting

Slope Stabilization Technology

LOCKDOWN™ NETTING

Description
Filtrexx® LockDown™ Netting is a single net rolled erosion control product (RECP) that is designed to increase the slope stabilization and erosion control capabilities of Temporary seeding, Slope protection, and Storm water blankets.

LockDown™ Netting is typically stapled to the slope prior to application of these practices; however, where high wind velocity conditions are anticipated, LockDown™ Netting should be installed on top of these practices. LockDown™

Netting is available in three different materials, including biodegradable cotton, HDPE, and polypropylene. LockDown™ Netting is recommended for slopes between 3:1 and 2:1, and is required for slopes greater than 2:1. Slope protection should not be applied at slopes greater than 1:1 without additional support from erosion control arming devices or practices. For LockDown™ Netting Material Specifications see Table 1.2. See Figure 1.2 for examples of LockDown Netting™ installations. See Figure 1.2 for design details of LockDown™ Netting installed under Filtrexx® Slope protection and Figure 1.3 for design details of LockDown™ Netting installed on top of a Filtrexx® Slope protection.

Function

LockDown™ Netting is categorized as an erosion control net (ECN) (ECTC, 2004) and is used to increase soil surface roughness and stability of disturbed soils on hill slopes. The primary purpose of LockDown™ Netting is to provide a structural surface to increase the stability of the Temporary seeding, Slope protection, or Storm water blanket at the soil interface, particularly on steep grades.

LockDown™ Netting Application Method

LockDown™ Netting is not sufficient to be used alone as a form of slope stabilization or erosion control, and is to be used as a permanent stabilization practice. LockDown™ Netting is available in a variety of materials of differing tensile strength, functional longevity (2 mo. - 4 yrs), and degradability. Cotton LockDown™ Netting is 100% biodegradable. LockDown™ Netting is typically applied to bare hill slopes prior to application of Slope protection. During installation, LockDown™ Netting is installed horizontally down slope and anchored to the soil using 8 in (150-200mm) sod staples to be driven along the entire perimeter of the net with approximately one sod staple per square yard (0.8 square m) within the net perimeter. See Installation specifications for more details.

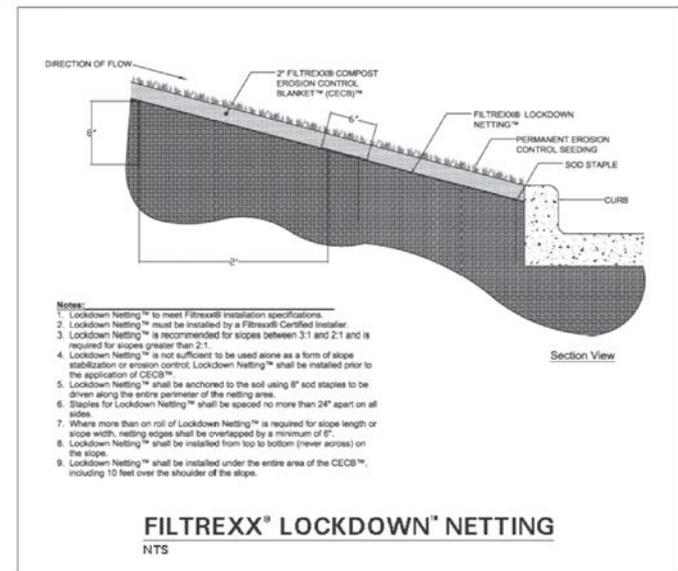
Performance

Research from the San Diego State University Soil Erosion Research Laboratory on LockDown™ Netting using ASTM D-6459 on 2:1 slopes

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www.filtrexx.com | Section 3: Support Practices™ | 289

Figure 2.1. Design Drawing Detail for LockDown™ Netting Installed Underneath Slope Protection.



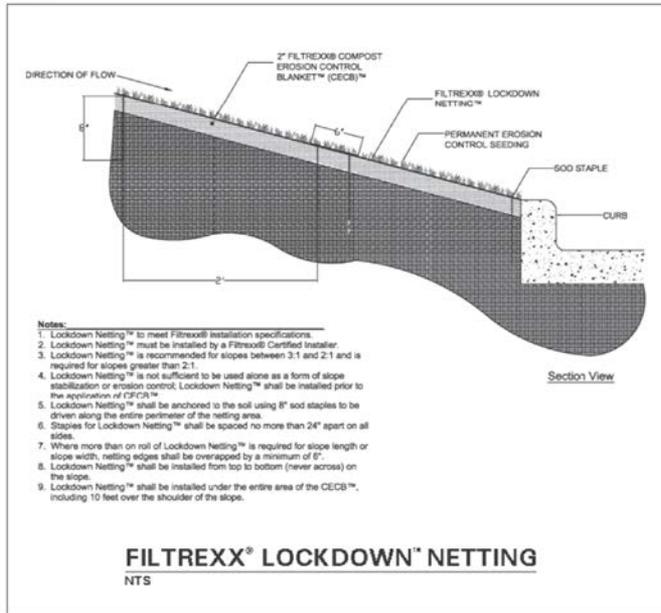
292 | Filtrexx® Low Impact Design Manual | Version 3.0

III. Methods: Concept

Concept Design (EECI) - Filtrexx® LockDown™ Netting

3.2 Filtrexx® LockDown™ Netting™

Figure 22. Design Drawing Detail for LockDown™ Netting Installed on Top of Slope Protection.



3.2 Filtrexx® LockDown™ Netting™

TABLES & FIGURES:

Table 2.1. Material Specifications for Filtrexx® LockDown™ Netting

Support Practice	LockDown™ Netting	LockDown™ Netting	LockDown™ Netting	Testing Lab
Purpose	Increase stabilization/erosion control/Slope protection	Increase stabilization/erosion control/Slope protection	Increase stabilization/erosion control/Slope protection	
Description	Improves performance and allowable slope steepness	Improves performance and allowable slope steepness	Improves performance and allowable slope steepness	
Material Description	5 mm multifilament polypropylene	5 mm monofilament HDPE	2 mm chain woven 20Z cotton	
Mesh Description	¾ in (19mm) openings	¾ in (19mm) openings	¾" x 1¼" (20mm) openings	
Color	Black	Green	White	
Tensile Strength (ASTM 5055-95)	22.8 lbs/ft ² (2.3 kg/cm ²)	1.2 lbs/ft ² (0.08 kg/cm ²)	Unknown/Low	Texas Transportation Institute TXA&M [®]
Elongation (% relative) (ASTM 5055-95)	46.5	ND	ND	Texas Transportation Institute TXA&M [®]
Functional Longevity	1 - 4 yr	6 mo - 3 yr	2 mo	Filtrexx® International Field Lab
Roll Size (w x l)	30 ft (9m) x 375 ft (114m)	30 ft (9m) x 375 ft (114m)	28 in (700mm) x 2300 ft (700m), 40 in (1016mm) x 2300 ft (700m), 56 in (1418mm) x 2300 ft (700m)	
Application Method	Stapled to soil/Slope protection applied on top	Stapled to soil/Slope protection applied on top	Stapled to soil/Slope protection applied on top	

ND: No Data Available



Filtrexx® Products on the site after installation in April 2011

IV. Wetland Delineations

Wetland Delineation(s)

Bayard Avenue Wetland Delineation

*Enviro*tech

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Providing Environmental Solutions

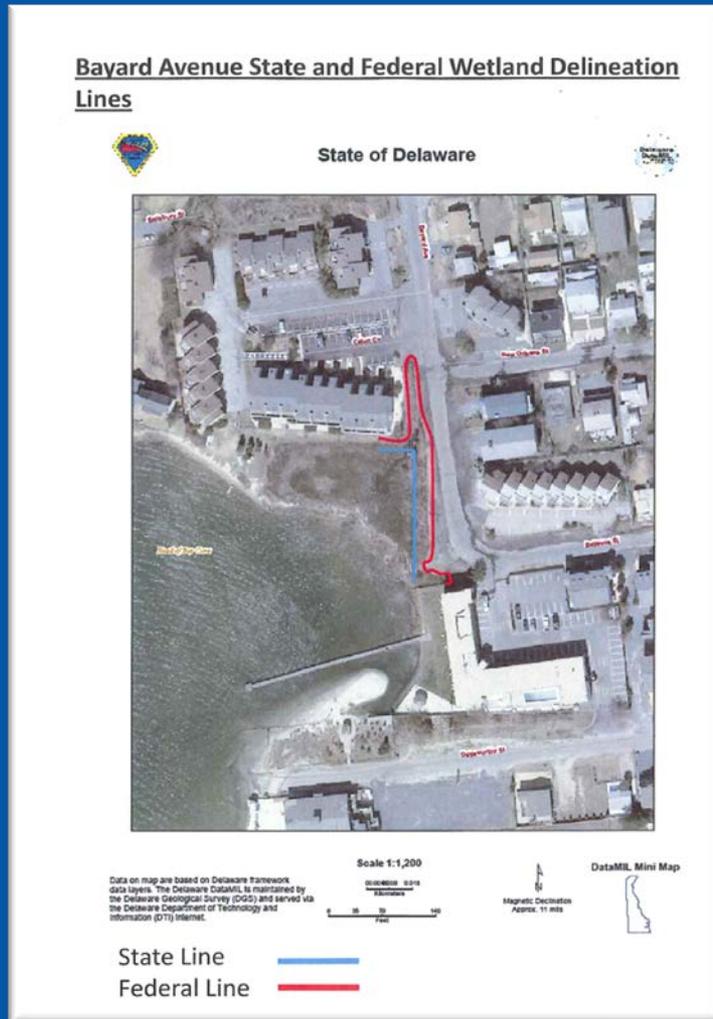
16394 Samuel Paynter Blvd, Suite 203
Milton, DE 19968
(302)645-6491, Fax (302)645-6495
www.envirotechcinc.com



*Enviro*tech
ENVIRONMENTAL CONSULTING, INC.
Providing Environmental Solutions

IV. Methods: Environmental Study

Wetland Delineation(s)



V. Methods: Site Preparation

Integrated Vegetation Management (IVM)

- Site was dominated by invasive *Phragmites australis*. The Town of Dewey Beach contracted Envirotech Environmental Consulting, Inc. (EECI) to treat and remove the phragmites before construction in July 2010.





ENVIRONMENTAL CONSULTING, INC.
Providing Environmental Solutions

**16394 Samuel Payner
 Boulevard, Suite 203
 Milton, DE 19968**

Reference Copy

Date	Contract #
7/9/2010	5356

Customer	Effective Dates		
Town of Dewey Beach 105 Rodney Avenue Dewey Beach, DE 19971			
	CREW		
	Date Given to Crew		
	Qty		Total
Accepted via check #5356 Paid in Full			
<p><i>Phragmites australis</i> eradication and Integrated Vegetation Management (IVM) Program during the 2010 growing season for the drainage ditch and swale located at Bayard Avenue and Rehoboth Bay in Dewey Beach, D.E.</p> <p>The purpose of this program include, but may not be limited to:</p> <ul style="list-style-type: none"> - in compliance with permit issued by DNREC wetland and Army Corp. of Engineers - control exotic invasive emergent vegetation - mitigate fire risk - improve aesthetics - meet regulatory policy <p><i>Phragmites australis</i> and IVM services include control/eradication of target species (<i>Phragmites australis</i> and any other exotic invasive species) with:</p> <ul style="list-style-type: none"> - herbicide application(s) to all target species (approx. late June once <i>Phragmites australis</i> reaches 36" in height and is susceptible to herbicide treatment) - Clear cutting and pruning approximately 14-20 days following application(s), or once chlorosis has taken place - Removing the cut vegetation and disposing of the organic material in a Town provided dumpster. - Spot treatment of any <i>Phragmites australis</i> and any other exotic invasive re-growth in the Fall 			
First Herbicide application to any/all <i>Phragmites australis</i>	1		
Clear Cutting of all treated <i>Phragmites</i> and treated vegetation once chlorosis has occurred (approximately 14-20 days after herbicide application). All clear cut vegetation will be dispose of in Town provided dumpster on site.	1		

PLACE IN YOUR NOTEBOOK FOR REFERENCE

Page 1

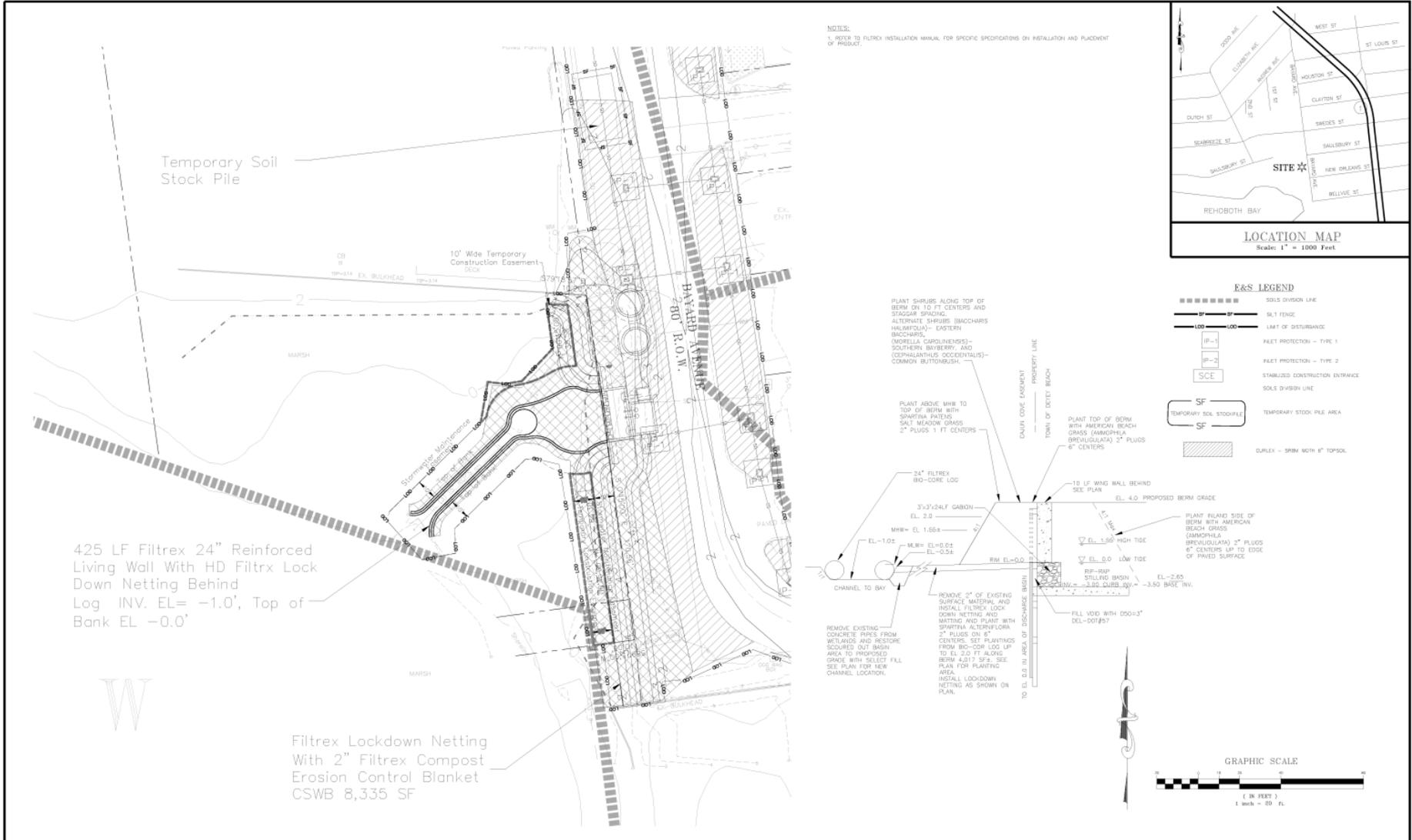
VI. Methods: Engineering

ECI Engineering Planning Surveying (ECI)

- ECI develops plan incorporating road grading, additional catch basins, a berm with an outfall structure/pumping station at the end of Bellvue and Bayard Avenues, and a drainage swale.
- The berm and drainage swale utilize Filtrexx® products and native vegetation.
- Top and slopes of the berm stabilized with stormwater erosion control blanket and native vegetation.
- Lock-Down Netting was to be used to further stabilize the berm slopes.



VI. Methods: Engineering



#	REVISION	DATE	CHKD.	PROJECT
1.	INCREASE SIZE OF 80'-LONG TO 24" ADDED SOILS DESCRIPTION	6/11/16	MC	
2.				
3.				
4.				
5.				

TOWN OF DEWEY BEACH
LEWES AND REHOBOTH HUNDRED
SUSSEX COUNTY, DELAWARE

EROSION AND SEDIMENT CONTROL PLAN

DESIGNED BY: ECI PREPARED BY: ECI
 DRAWN BY: VT DATE: 05-14-10

ENVIRONMENTAL CONSULTANTS INTERNATIONAL, LLC
 ENGINEERING, SURVEYING, PLANNING, AND MANAG
 330 REHOBOTH AVENUE • P.O. BOX 23
 REHOBOTH BEACH, DELAWARE 19971
 (302) 226-2844 • FAX (302) 226-293

Envirotech
 Pioneering Environmental Solutions

ENVIRONMENTAL CONSULTING, INC.
 SHEET ES-2

VII. Methods: Permitting

Permit Application

- Once engineered plans were developed, permits were obtained for construction.



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ENVIRONMENTAL CONSULTING, INC.
Providing Environmental Solutions

June 22, 2010

Ms. Laura Herr
DNREC
Wetlands and Subaqueous Lands Section
89 Kings Highway
Dover, DE 19901

RE: Bayard Avenue Flood and Water Quality Improvement Project Bayard Avenue, Dewey Beach, DE.

Dear Ms. Herr,

Please find enclosed a Wetlands and Subaqueous Lands Application for the **Bayard Avenue Flood and Water Quality Improvement Project**. The proposed project is located in the Town of Dewey Beach off of Bayard Avenue and immediately adjacent to the Rehoboth Bay. The project was presented at the March 25th, 2010 Joint Permit Processing meeting. The Tidal Wetland Map associated with the project is Map#18. The project purpose and need is as follows:

A living wall will be created over an existing bulkhead to reduce tidal storm flooding. The living wall will be covered with a filterxx erosion control blanket consisting of a planting media. The blanket will be planted with native beneficial vegetation. Outfall pipes which convey water from the flooded upland street will outfall into a dissipation area which will be stabilized with a filterxx erosion control blanket, lockdown netting and planted with native vegetation. The existing non functioning pipes located within the wetland will be removed and a stream channel will be created in their place.

211 square feet of uplands will be converted from uplands to wetlands.

Total impacts to state wetlands will include 2,425 square feet of wetlands with 135 cubic yards of clean fill for the creation of a stream channel, creation of a living wall and filling of an open un-vegetative basin to create vegetative wetlands.

Envirotech was requested by the Town of Dewey Beach to represent this application.

Wetlands and Subaqueous Lands Section

PERMIT APPLICATION FORM

For Subaqueous Lands, Wetlands, Marina and 401 Water
Quality Certification Projects

State of Delaware
Department of Natural Resources and Environmental
Control
Division of Water Resources
Wetlands and Subaqueous Lands Section



VIII. Methods: Construction Bids/Construction

Awarded to Mumford and Miller Concrete





Construction

03/17/2011



Construction



Construction

02/28/2011



Construction



Construction

03/09/2011



Construction

04/04/2011



Bay
Resort
MOTEL
SUITES

Construction



Berm constructed with stormwater erosion control blanket



Catch Basin and Pump Station



Stormwater Erosion Control Blanket



Construction



24" Blank Stabilization Sock and Drainage Swale



24" Blank Stabilization Sock and Drainage Swale



24" Blank Stabilization Sock and Drainage Swale



24" Blank Stabilization Sock and Drainage Swale

Methods: IX. Planting/Ecological Restoration



Installation of *Spartina patens* (Salt Meadow Hay) and *Ammophila breviligulata* (American Beach Grass) on berm slopes for permanent vegetative stabilization



Installed Stormwater Blanket with Underlayment Fabric Pre-Planting

04/01/2011



Top of slope planted with *Prunus maritima* (Beach Plum) and *Myrica cerifera* (Southern Bayberry) for permanent vegetative stabilization

04/17/2011



Installation of *Spartina patens* (Salt Meadow Hay) and *Ammophila breviligulata* (American Beach Grass) on berm slopes for permanent vegetative stabilization



Installation of *Spartina patens* (Salt Meadow Hay) and *Ammophila breviligulata* (American Beach Grass) on berm slopes for permanent vegetative stabilization



Top of slope planted with *Prunus maritima* (Beach Plum) and *Myrica cerifera* (Southern Bayberry) for permanent vegetative stabilization



Front slope planted with *Spartina patens* (Salt Meadow Hay) and *Spartina alterniflora* (Smooth Cordgrass) for permanent vegetative stabilization



Maintenance and Management
Integrated Vegetation Management (IVM)

07/28/2011

X. Maintenance and Management



Maintenance and Management
Integrated Vegetation Management (IVM)

XI. Results



Completed Project During the First Growing Season
May 2011



Completed Project During the First Growing Season
May 2011



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012



Completed Project After Two (2) Growing Seasons
September 2012

XII. Conclusions

The affect was 100% performance zero flooding within the watershed occurred from the point of construction completion withstood the impact of Hurricane Irene (August 27-31, 2011). However, on August 25, 2012, due to malfunction within a control panel the pumps failed to operate and flooding occurred.



After June 2011
Aerial After Construction - Note: Concrete catch basin and pumping station

References

Duffield Associates, Inc. (2009). Bayard Avenue Flood and Water Quality Improvement Study; Project No. 7703.CB

**State of Delaware, Department of Natural Resources and Environmental Control
Division of Water Subaqueous Lands Section**
Wetland Permit Application

Envirotech Environmental Consulting, Inc. (2010). Bayard Avenue Wetland Delineation

Filtrexx® Land Improvement Systems (2011). Design Manual
Section 2, Section 3

Other Filtrex® Projects

by





Bethany Woods – Living Shoreline and Embankment Stabilization
June 2009



Bethany Woods – Living Wall
July 2009





Bethany Woods – Living Wall
July 2009



Bethany Woods – Living Wall Week 2
August 2009

BETHANY WOODS



Bethany Woods – Living Wall Week 2
August 2009



Workman Farm – Filtrex® for Concentrated Animal Feeding Operation (CAFO)
March 20, 2012



Workman Farm – Filtrex® for Concentrated Animal Feeding Operation (CAFO)
March 20, 2012



Workman Farm – Filtrex[®] for Concentrated Animal Feeding Operation (CAFO)
March 20, 2012



City of Rehoboth – Rain Garden
May 10, 2012



City of Rehoboth – Rain Garden
May 10, 2012



City of Rehoboth – Rain Garden
May 10, 2012



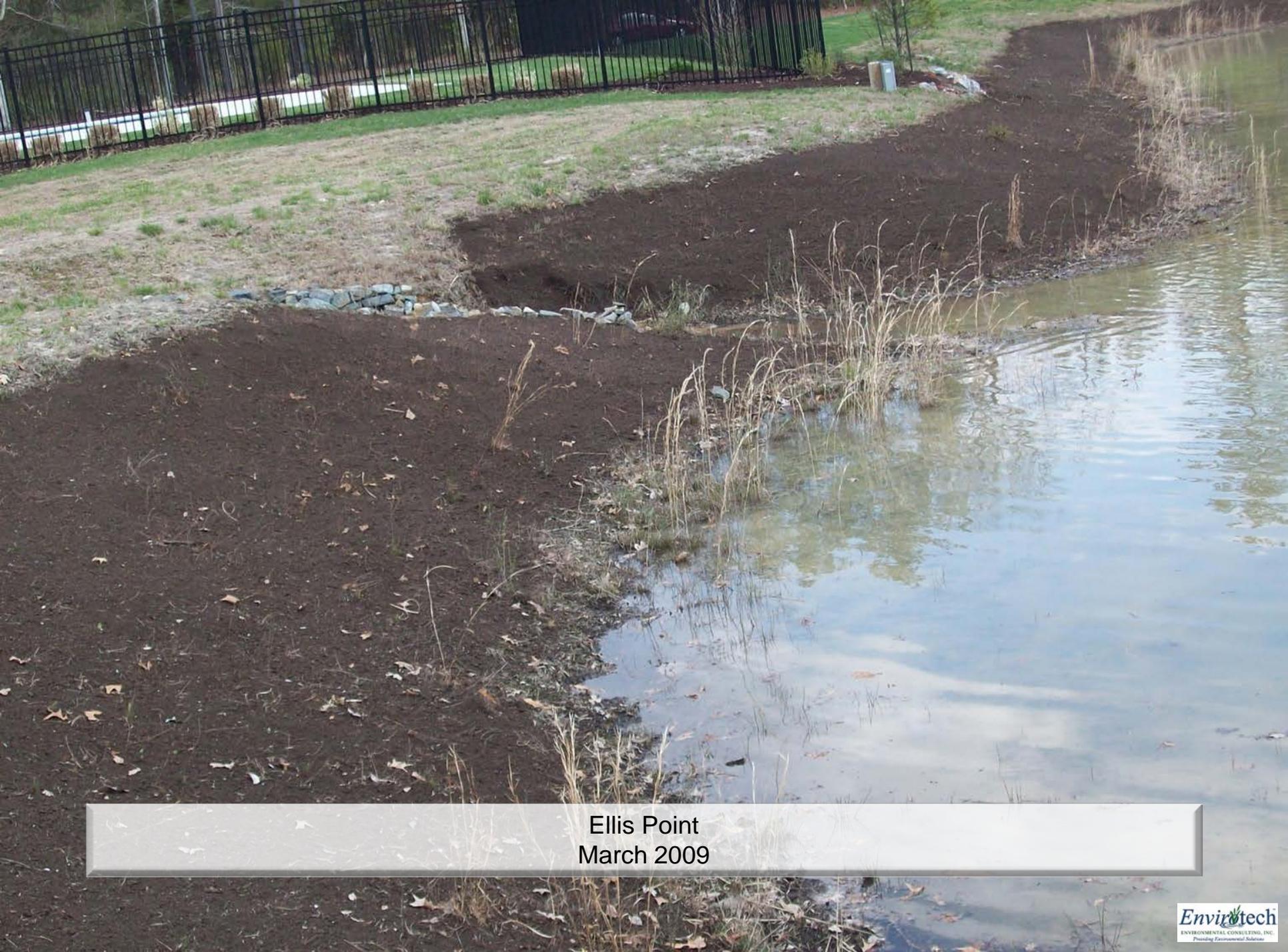
City of Rehoboth – Rain Garden
May 11, 2012



City of Rehoboth – Rain Garden
July 16, 2012



City of Rehoboth – Rain Garden
July 16, 2012



Ellis Point
March 2009



Ellis Point – Compost Erosion Control Blanket with Native Wildflower and Grass Mix
August 6, 2009



Montego Bay – Living Shoreline
September 2009



Cedar Street Georgetown, DE – Perimeter Control
October 2008



Rehoboth Beach Museum – Steep Slope Stabilization with LockDown Netting™ and Slope Interruption Soxx; April 2010



Rehoboth Beach Museum – Steep Slope Stabilization with Lock-Down Netting and Slope Interruption Soxx; April 2010



Rehoboth Beach Museum – Steep Slope Stabilization with Lock-Down Netting and Slope Interruption Sox; April 2010



ENVIRONMENTAL CONSULTING, INC.

Providing Environmental Solutions

16394 Samuel Paynter Boulevard

Milton, DE 19968

(302) 645-6491

(302) 645-6495 Fax

www.envirotechcinc.com