Stormwater Treatment Structures
Endorsed by DNREC, Sediment & Stormwater Program
Effective Date: 12/12

Manufacturer/Distributor	Product	Stand-Alone for TSS	Pre-Treatment for TSS	Petroleum Hydrocarbons	Trash/Gross Pollutant Removal	Component in Treatment Train
Filtration Structures						
AquaShield, Inc.	Aqua-Filter		X	X		X
Gillespie & Son, Inc.	Pre-cast Modular Sand Filter	X		X		
National Concrete, Inc.	Pre-cast Modular Sand Filter	X		X		
Pipe & Precast Products, Inc.	Pre-cast Modular Sand Filter	X		X		
StormTreat Systems, Inc.	StormTreat		X	X		X
Stormwater 360	StormFilter	X		X		
Stormwater 360	StormGate		X	X		X
Hydrodynamic Separators						
Advanced Drainage Systems	ADS Water Quality Units		X	X		X
AquaShield, Inc.	Aqua-Swirl		X	X		X
BaySaver, Inc.	BaySaver		X	X		X
CDS Technologies	CDS Unit		X	X	X	X
H.I.L. Technology, Inc.	Downstream Defender		X	X	X	X
Rinker Materials Corp.	Stormceptor		X	X		X
Stormwater 360	Vortechs, VortSentry		X	X		X
Terre Hill Concrete Products	Terre-Kleen		X	X	X	X
Catch Basin Inserts						
AbTech	Ultra-Urban Filter				X	X
Best Management Practices, Inc.	Snout				X	X
Foss Environmental Services	StreamGuard Insert		X			X
Foss Environmental Services	StreamGuard Exert		X			X
Foss Environmental Services	SG Passive Skimmer			X		X
Hydro Compliance Management, Inc	Hydro-Kleen		X	X	X	X
Suntree Technologies, Inc.	Grate Inlet Skimmer Box Curb Inlet Basket		X	X	X	X
Other Systems						
ACF Environmental	Segregator Pipe	X	X	X	X	X
Cultec, Inc.	Separator Row	X	X	X	X	X
StormTech	Isolator Row Chambers	X	X	X	X	X
Suntree Technologies, Inc.	Nutrient Seperating Baffle Box		X	X	X	X

COUNTY OF PRINCE WILLIAM

5 County Complex Court, Suite 170
Prince William, Virginia 22192-5308
(703) 792-7070 Metro 631-1703 Fax (703) 792-6297

DEPARTMENT OF PUBLIC WORKS

Environmental Services Division

Thomas Bruun
Director

March 22, 2007

Mr. Brian Rustia
StormTech, LLC – Corporate Office
20 Beaver Road
Suite 104
Wethersfield, CT 06109

RE: Phosphorus Removal Efficiency for StormTech Chamber System with an Isolator Row and Filtering Mechanism

Dear Mr. Rustia:

This letter is in response to your email request to use the StormTech Chamber system as a structural Storm Water Management (SWM)/Best Management Practices (BMP) in Prince William County.

The County will allow the referenced BMP on a case by case basis, with a maximum phosphorus removal efficiency of 40%. In addition, other considerations for the County's approval include the following:

- Underground facilities shall not be used in residential developments, including condominiums and apartments.
- This system shall be privately maintained.
- Site conditions should be suitable for the proposed structural SWM/BMP.
- The system shall be designed to meet Prince William County SWM/BMP design requirements.
- Installation shall be in accordance with the manufacturer's specifications.
- Underground structures detaining flows but not providing in ground percolation, or not providing adequate drainage by gravity (in the form of outfall), or not documented to reduce pollution loads, are not permitted.

- Maintenance shall be in accordance with the manufacturer's guidelines and County requirements.

- All the design computations, specifications, construction details, and maintenance requirements shall be incorporated onto the plan sheets.

The County may revise the removal efficiency based on the review and evaluation of future monitoring data or where its use is considered unsuitable.

If you have any questions, please call Raj Bidari at 703-792-7078.

Sincerely,

Marc T. Aveni

Marc T. Aveni
Watershed Management Branch Chief

C: Rajendra P. Bidari, Engineer IV

RPB/mmp/Brian Rustia – Phosphorus Removal

Isolator Row Approvals

- Bartow County
- Cherokee County
- Cobb County
- Columbia County
- DeKalb County
- Fayette County
- Forsyth County
- Fulton County
- Rockdale County
- City of Villa Rica
- City of Warner Robins
- City of Woodstock
- City of Union City

City of Atlanta
City of Canton
City of Cartersville
City of Carrollton
City of Chattanooga
City of Chamblee
City of College Park
City of Cumming
City of Columbus
City of Dalton
City of Duluth
City of Dunwoody

City of Gainesville
City of Johns Creek
City of Kennesaw
City of LaFayette
City of Newnan
City of Norcross
City of Peachtree City
City of Rome
City of Roswell
City of Sandy Springs
City of Smyrna
City of Suwannee
City of Sugar Hill

Metropolitan
St. Louis Sewer
District

2350 Market Street
St. Louis, MO 63103-2555
(314) 768-6200

November 8, 2010

Tim Ritchie
StormTech/ADS
Storm Water Product Manager
13109 Padre Ave
Keller, TX. 76244

RE: ADS Isolator Row, St. Louis MSD Submission
Redevelopment Use Level (RUL) Approval within District

Dear Sir:

The Metropolitan St. Louis Sewer District (MSD) has reviewed your application regarding the ADS Isolator Row for use as a Best Management Practice for stormwater management. MSD is pleased to provide the Redevelopment Use Level (RUL) approval for use of the ADS Isolator Row as a stand-alone water quality BMP, subject to the following provisions:

- The ADS Isolator Row is only approved for use on redevelopment sites less than 5 acres. This approval is based compliance with requirements listed in MSD's Proprietary Water Quality Products and the MSD's Stormwater Management Program (Rev. Jan. 2009).
- The device shall be configured as an off-line BMP.
- The ADS Isolator Row must be sized to capture all floatable trash and free oil, and remove 80% of total suspended solids for the OK-110 particle size distribution. The Isolator Row will be installed with the ability to store 75% the water quality volume (WQ_v) within the unit. Procedures for calculating WQ_v are provided in Volume I of the Maryland Stormwater Design Manual 2000 (with modified precipitation depth P=1.14inches).
- Confined space entry shall not be a requirement for routine maintenance. No special tools or attachments should be required to provide routine maintenance with a vacuum pumping and hydro-flushing truck.
- Each Isolator Row shall have a 48" concrete manhole with a HS-20 rated cast iron frame and a minimum 30-inch diameter access lid.
- Project specific design calculations, material specifications, and maintenance plan furnished by ADS must be included within the project's "Stormwater Management Facilities Report" prepared by the consulting engineer.
- Material specifications and product details furnished by ADS must be included within the project's construction plans prepared by the consulting engineer.
- The initial installation of the ADS Isolator Row in The District shall include the following:

1) A manufacturer's or vendor's representative must be onsite during the proprietary BMP installation to ensure the product's installation requirements are met.
2) Shop drawings indicating elevations of flowlines, weirs, pipe inverts, etc. will be required prior to installation.
3) The manufacturer or vendor must arrange for an as-built survey and as-built drawings of the proprietary BMP to be performed by a Missouri-registered Professional Land Surveyor once the device has been installed, and prior to any testing or monitoring.
4) The manufacturer or vendor must perform quarterly inspections of the proprietary BMP during its' first year of operation, which will include visual inspections and quantitative analysis of the service's sediment removal efficiency, especially as compared to its design efficiency. MSD requests to be invited to these inspections to further enhance familiarity and understanding of the device.
5) Formal reports shall be submitted to MSD, including as-builts and at each quarterly inspection. The reports shall include summaries, quantitative analysis mentioned in item 4, photographs of the structure, inlet, internal conditions of the structure, the geotextile fabrics, and outfall conditions, etc. The reports shall also evaluate the performance of the owner's adherence to the approved maintenance program, and offer suggestions for any areas of improvement.

The ADS Isolator Row is not approved for General use or Highway use at this time.

MSD reserves the ability to withdraw or modify this approval based on subsequent information, including information indicating that this BMP does not satisfy MSD rules, requirements, or construction specifications. If you have any questions, please do not hesitate to contact me at (314) 768-2773.

Sincerely,

Jason T. Peterein, P.E.
Civil Engineer (BMP Committee Chairman)
Engineering Department / Planning Division
Metropolitan St. Louis Sewer District

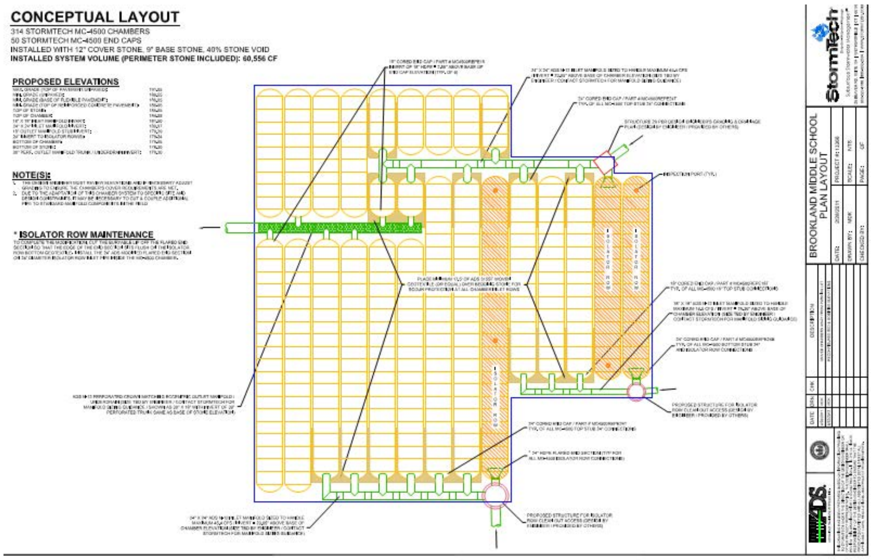
Brookland Middle School

Henrico County, VA

Brookland Middle School in Henrico County is growing! The school's enrollment has risen and as a result, the classroom trailers located behind the school are at capacity. Land is at a premium for this land locked school. Henrico Public Schools decided to upgrade and expand the school. The tennis courts, baseball field and other land intensive activities caused the engineer to specify going underground with its storm water management pond.

StormTech's MC4500 chamber were selected by the contactor for the durability (no corrosion concerns) as well as its high storage capacity of around 4.6 cubic feet per square foot of area. Three hundred and fourteen (314) MC 4500 chambers where installed in January 2013 and the total installed the system stores over 60,000 cubic feet of stormwater runoff. The system is currently located in a grassed area and can be utilized for future parking if needed.

The contractor also used a "[stone conveyor]" or "slinger" to place the stone over around and over the chambers. They choose this method because of the high efficiency of allowing over 175 tons of stone to be applied per hour. They were able to install the entire system in about a week and a half's time (10 days). The stone slinger saved approximately 20% of the installation costs compared to the conventional approach of using an excavator to dump stone on the system.



For Additional Info:

Brian Rustia
brustia@stormtech.com
(703)772-8696

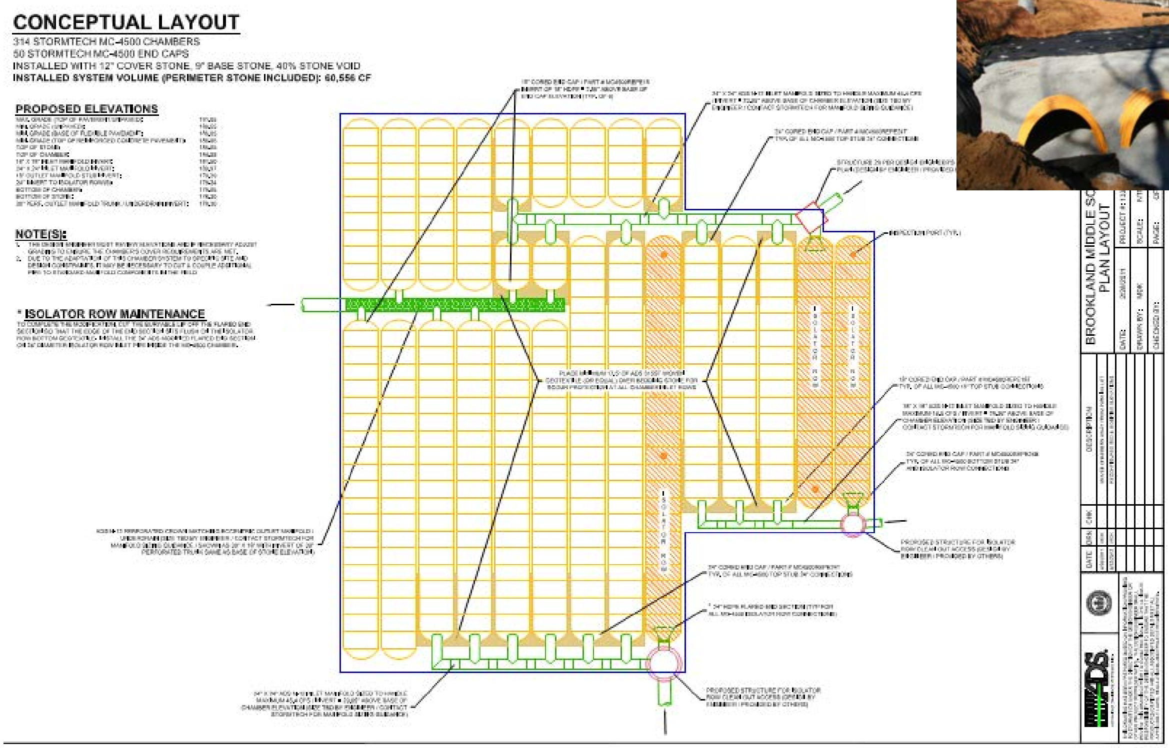
Oakton East Townhomes

Fairfax, VA

Oakton East is a new community of luxury townhomes located within five miles of Tyson's Corner, Fairfax Corner, and Vienna.

What makes this an interesting project for ADS is Fairfax County has their own MS4 program and thus have their own set of regulations that are separate and distinct from [Virginia's Stormwater Management Program](). And greatly oversimplifying Fairfax County's complex Public Facilities Manual, basically underground stormwater detention is prohibited and allowed all through an exception process.

Given the highly urbanized setting and the need to manage the 100 year storm, (186) MC-4500 chambers and (12) DC-780 chambers were installed to provide over 36,000 cf of storage. The deep bury chambers (DC) chambers provide for bury depths of up to 12 feet.



For Additional Info:

Brian Rustia
brustia@stormtech.com
(703)772-8696

Myers Estates

Charles County, MD

Got ESD? Charles County, Maryland does. When you think of environmental site design, or more commonly referred to as ESD, and residential development- you typically think of the issues of using Bioretention or rain gardens and the difficulty of fitting facilities on a site with multiple land owners (i.e., not crossing individual property lines).

A site in Charles County, Maryland, solved this by going underground and infiltrating it's stormwater in a common area that didn't encroach on individual land owners plots. Sixty (60) ADS' StormTech MC4500 chambers were used to provide "a peak" storage of approximately 11,500 cubic ft (86,000 gallons) of run-off from the various impervious areas around the residential site. The StormTech bed is designed (with pretreatment) to infiltrate all the water it receives and does so in a pretty tight footprint of 2,800 square feet.

Infiltration facilities for residential applications typically have a bad track record in that they can clog and not perform over a long period of time. This is not the case with the StormTech system. Given pretreatment in front of the bed and the pure void space (over 6,700 cubic feet) in the chamber cavity area- the system would need to see over 250 cubic yards of debris before the chamber cavity area would be totally filled. That's a lot of debris!

The underground area is located close to a traditional stormwater management pond but without the concerns of safety and fencing that such above ground facilities must provide for the good of public safety.

For Additional Info:

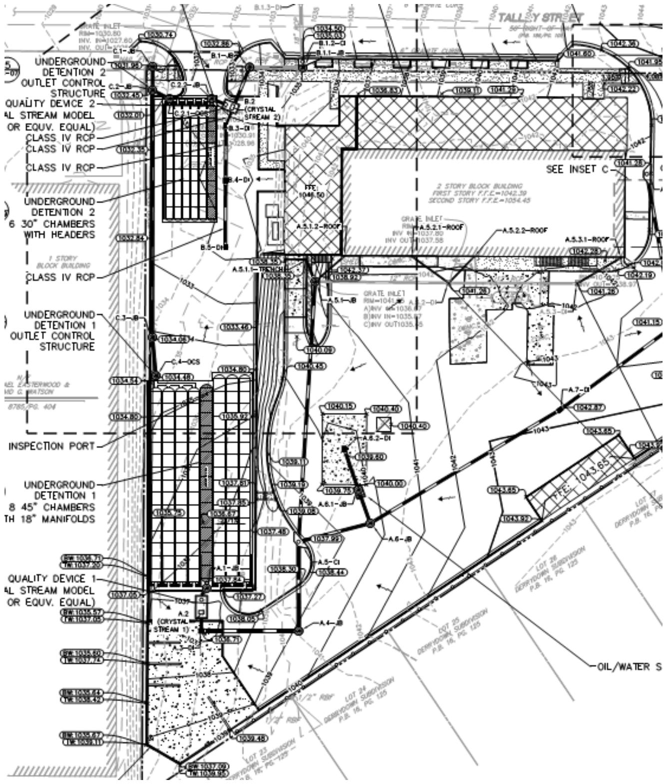
Brian Rustia

Brian.rustia@ads-pipe.com

(703)772-8696

Public Works Facility

Decatur, GA



SC 740's and MC 3500's

The City of Decatur, GA is a thriving business community with 19,000 residents, just east of Atlanta and is comprised of many neighborhood homes, schools and places of worship. The City has a traditional small-town atmosphere and all the benefits of living in a major metropolitan area.

Decatur's Environmental Sustainability Plan envisions creating a community where the environment and the City's natural resources are protected and enhanced. ADS's EPM team helped Kimley-Horn and Associates, Inc. overcome some challenging site issues in connection with the renovation for the new Public Works building. Based on the changing elevations and the limited site footprint, this project was brought in to compliance with the City's Environmental Sustainability Plan by using Stormtech chambers to provide retention under the parking lots. All StormTech chambers meet AASHTO LFRD Section 12.12 thus providing a factor of safety greater than 2.0.

What made this project interesting is due to the grades on this site, a shallow bed of SC740 chambers were used to provide to 4,766 cf of storage and our new 45inch tall MC3500 chambers were used to provide an additional 21,905 cf of storage.

This project also made use of the Stormtech Isolator Row thus enabling the project to meet the requirements of Decatur's Grow Greener theme. The Isolator Row System provides excellent TSS separation and extended maintenance intervals that protect the system to assure long term performance.

For Additional Info:

Ed Pisowicz
Ed.Pisowicz@ads-pipe.com
(404) 433-7452

PROJECT PROFILE

StormTech®
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Improved Parking Facilities for the South Carolina State Fairgrounds

PROJECT DETAILS

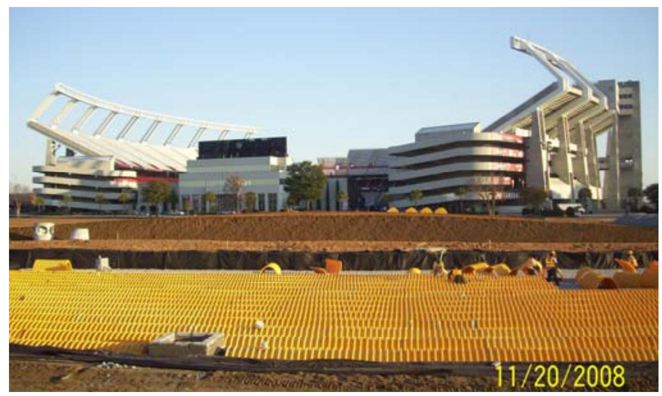
The ***South Carolina State Fairgrounds in Columbia, South Carolina*** is a very popular recreational venue in the Fall season, not just because of the exhibits and rides which provide entertainment to all ages. The Fairgrounds also offer an ideal location for SEC football fans to gather and celebrate before and after University of South Carolina Gamecock Football games. The Fairground is adjacent to Williams-Brice Stadium in Columbia. These grounds are not just used in the Fall, they are used throughout the year for a variety of trade shows, festivals, industry and community functions.

B.P Barber was chosen as the designer for the State Fairgrounds parking renovation project with Jim Futter, P.E. heading up the design team. A soil analysis confirmed the excellent infiltration capabilities of the soils on site. Due to the nature of the soils, B.P. Barber decided to take advantage of these infiltrative characteristics by specifying ***2,503 StormTech SC 740 Chambers for retention / detention systems.*** These StormTech Chambers were laid out into five separate beds throughout the Fairgrounds. Chambers were placed beneath the asphalt parking areas which would eventually serve as areas to house exhibits, set up areas for fair vendors, and tailgating / parking areas for the football fans.

U.S.Group, the installing contractor, ***was pleased with the speed and ease of the chamber installation.*** Pre-fabricated manifolds and basins allowed for a timely installation once the pits were excavated.

The design incorporated the ***patented Isolator System*** which provides excellent TSS separation and extended maintenance intervals that protect the system to assure performance. The Stormtech Chambers meet both the ***AASHTO LRFD Section 12.12 and ASTM F2418-05 Industry Standards*** thus providing 2 to 1 safety factors and superior structural integrity

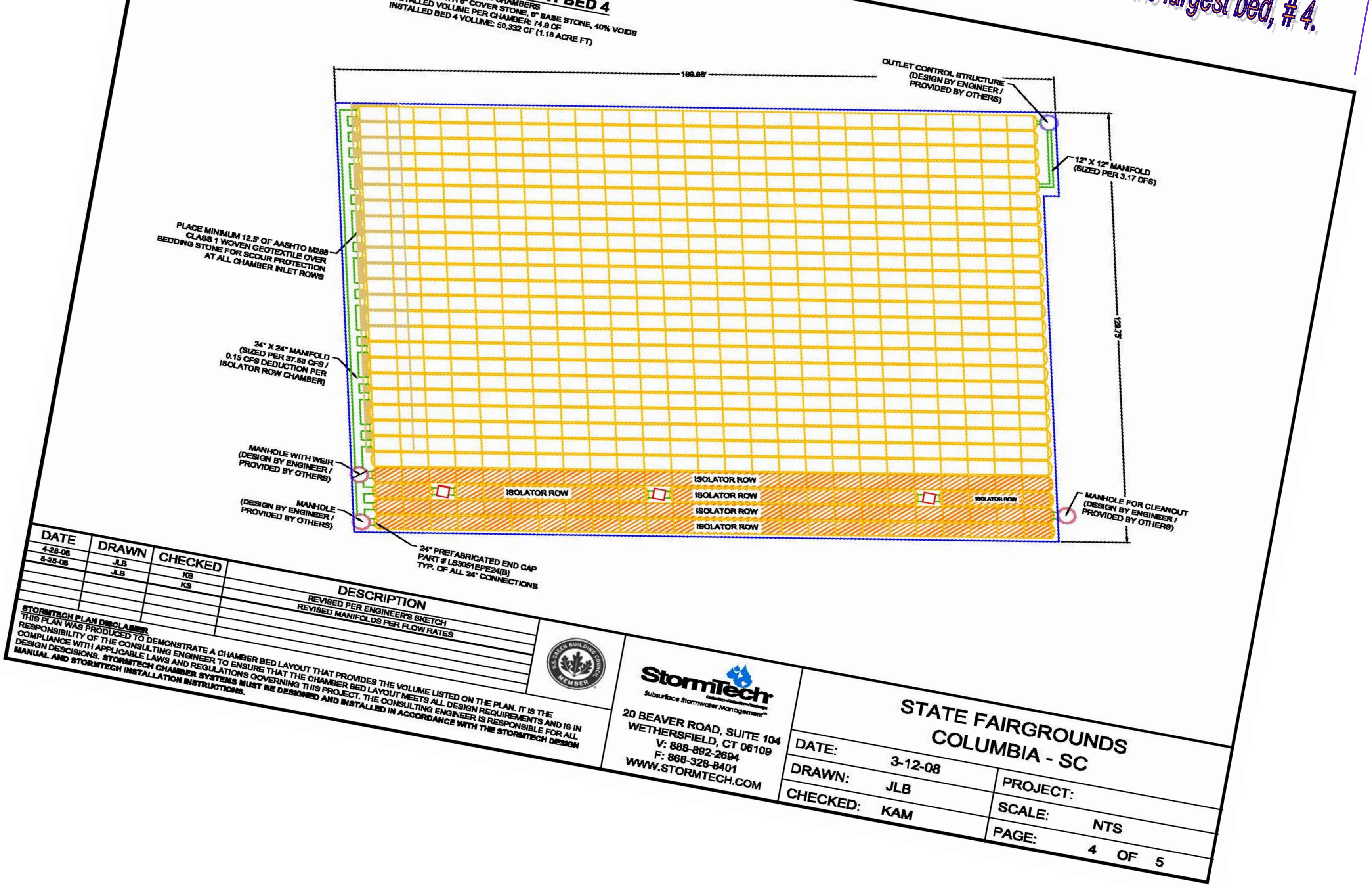
For additional details about this project or your specific application call 1-888-892-2694 for your local StormTech Regional Product Manager



20 Beaver Rd STE 104 / Wethersfield, CT 06109 / 888-892-2694 / 860-529-8188 Fax 860-257-2141
www.stormtech.com

South Carolina Fairgounds Parking Lot Improvements

Shown above are the 5 chamber beds under the parking lot. Below is a typical bed layout from the largest bed, # 4.



PROJECT PROFILE

StormTech®
Detention • Retention • Recharge
Subsurface Stormwater Management℠

WINTER GARDEN VILLAGE AT FOWLER GROVES

PROJECT DETAILS — OPEN AIR CENTER

This 1.15 million square foot open-air shopping center is located at the northeast quadrant of C.R. 535 in the City of Winter Garden. Winter Garden Village is anchored by Super Target, Lowes, Barnes & Noble and Beall's Department Store.

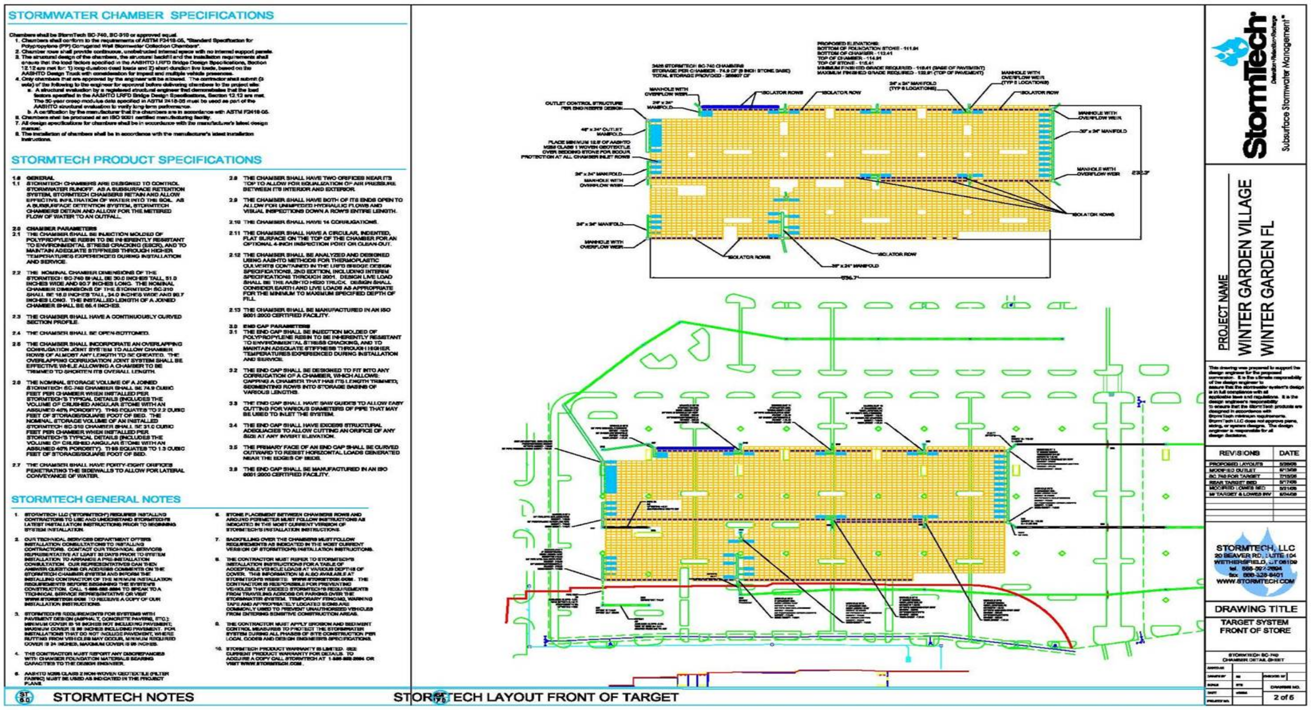
The StormTech underground stormwater detention system utilized 5,600 SC-740 chambers in 3 separate beds providing 420,000 cubic feet of storage capacity designed to meet regulatory requirements. Large StormTech chamber beds were placed beneath the parking lot in front of the Super Target , Lowes and adjacent to the Target . The design incorporated the ***patented Isolator System*** which provides excellent TSS separation and extended maintenance intervals that protect the system to assure performance. The Stormtech Chambers meet both the ***AASHTO LRFD Section 12.12 and ASTM F2418-05 Industry Standards*** thus providing safety factors and superior structural integrity.

The project was developed by The Sembler Company. Hardin Construction Company was the General Contractor for the project and the StormTech chamber system was installed by DeWitt Excavating, Inc. of Winter Garden, Florida. Lochrane Engineering of Orlando is the civil engineering design firm of record.

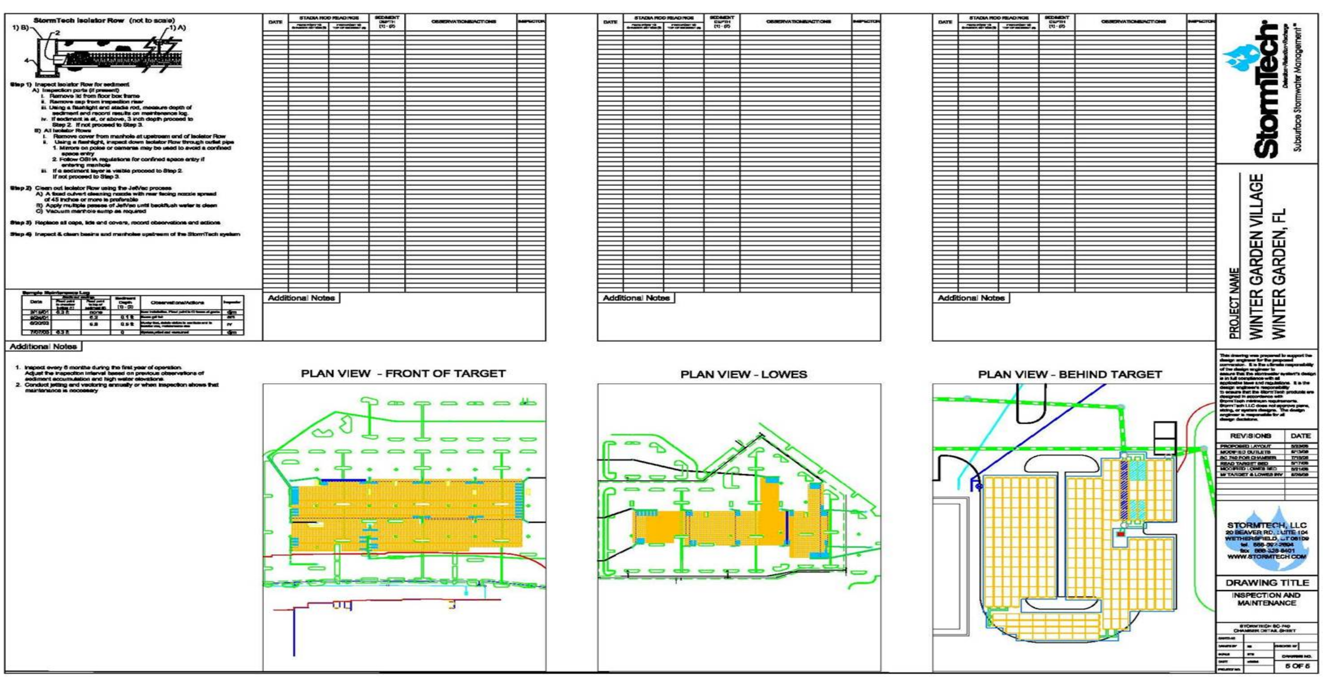
For additional product details contact StormTech @ 1-888-892-2694

PROJECT PROFILE

WINTER GARDEN VILLAGE AT FOWLER GROVES



The largest of the 3 beds. Layout of manifolds and Isolator Rows.



Step by step maintenance instructions and log for each chamber bed.

PROJECT CASE STUDY
Tram Depot, Edinburgh

microstrain
sustainable engineering solutions

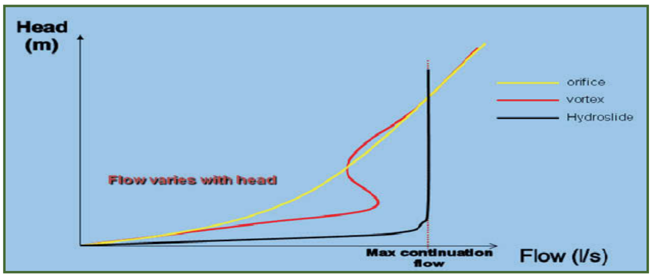
Project Summary

The attenuation system for the Edinburgh Tram Depot comprised of 525 StormTech SC740 chambers. The system was designed by Parsons Brinckerhoff, supplied by Microstrain and installed by Barr Construction.

StormTech was chosen as the preferred system for the project due to the following attributes;

- The design incorporated the patented Isolator Row which provides TSS separation that protects the system designed storage capacity, and assures optimum hydraulic performance.
- It was placed under traffic area, Stormtech can take HGV loading with 300mm cover. The parabolic arch with stone column ensures live and long term loading design standards are met.
- The speed and ease of installation.

A Hydroslide flow regulator supplied by Microstrain Ltd was used to control the 46 l/s discharge rate. The float activated mechanism which has been widely used by UK Water Authorities, is designed to maintain a constant discharge without the use of external energy sources. By utilising a Hydroslide unit as opposed to a head driven vortex unit, up to 30% in attenuated volume can be saved, thus the client saves on attenuation materials, construction costs and installation time.



By utilising a combination of the Hydroslide flow regulator and the StormTech attenuation system, Microstrain were able to save 22% in the attenuated volume for this project. A reduction of 351m3.

StormTech
Detention • Retention • Recharge

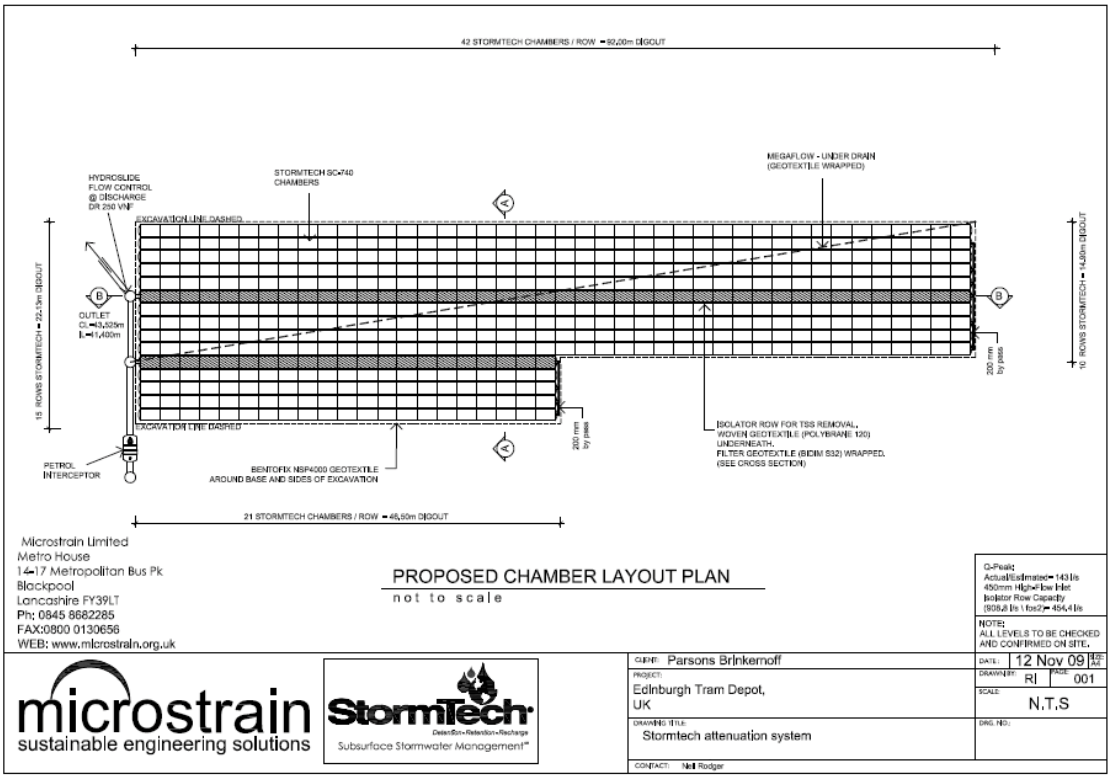
microstrain
sustainable engineering solutions

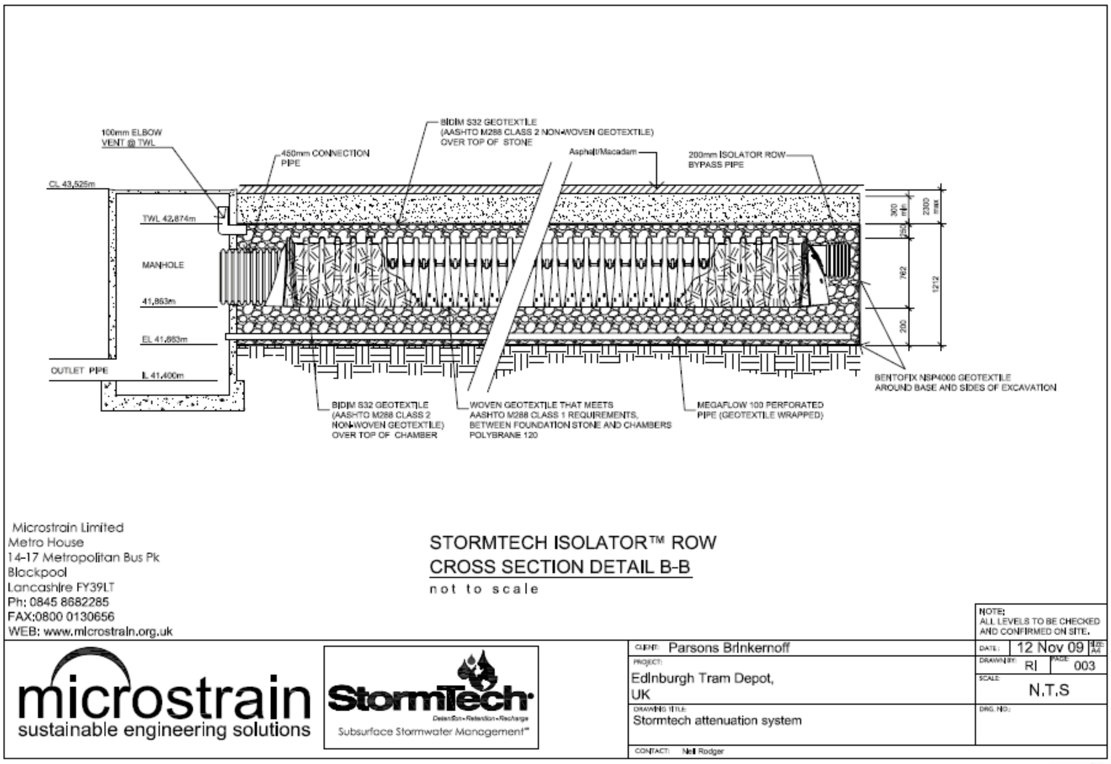
Phone: 0845 8682285
Email: info@microstrain.org.uk
Web: www.microstrain.org.uk

PROJECT CASE STUDY

Tram Depot, Edinburgh

Project Summary





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August 2013

CE NEWS

business and technology for civil engineers

Philadelphia's green infrastructure on the CSO front lines

StormTech Chambers designed to meet ASTM and AASHTO performance standards*

NOW INCLUDING RAI ROADS | BRIDGES | RAILWAYS

*See back cover to learn more

zweigwhite

Strategies for successful performance

Apply appropriate engineering principles in design of underground plastic stormwater collection structures.

By Bryan P. Strohman and Phillip A. Sharff

Use of underground stormwater collection systems has increased in recent years because of regulatory mandates to retain, recharge, and/or reuse stormwater onsite. Because of advantages in economics and constructability, the stormwater industry has seen significant growth in the number of available products manufactured from structural plastics. Many of these new, innovative designs offer benefits such as light weight, high corrosion resistance, large storage-to-footprint ratios, and moldability of efficient structural shapes.

However, recent catastrophic failures of some systems have raised concern about the long-term viability of these structures and focused attention on the engineering rigor behind the design of certain products (Figures 1 and 2). Successful structural performance of plastic stormwater collection structures requires understanding and applying engineering principles specific to the behavior of structural plastic materials. It is important for civil engineers to understand the types of plastic stormwater collection structures and strategies for successful performance, including the importance of material selection, structural design, qualification testing, and installation specifications.

Types of structures

Four types of structures currently are available within the plastic stormwater collection industry.

Open-bottom corrugated arched chambers (Figure 3) — Open-bottom corrugated arched chamber stormwater structures consist of arch units placed both in series and parallel, connected by a header pipe, and encapsulated in crushed stone. Both the arches and crushed stone are used to collect, recharge, and/or reuse stormwater. Relevant reference standards for plastic open-bottom corrugated arched chambers include ASTM F2418, ASTM F2787, and ASTM F2922.

Stackable cellular-type units (Figure 4) — Cellular-type units are comprised of a number of pre-assembled modular vertical columns (or cells). The units are manufactured in single-layer panels that comprise an array of interconnected vertical cells. The panels are stacked vertically and placed horizontally to create the stormwater collection system.

Stackable crate-type units (Figure 5) — Crate-type units are comprised of a number of individually assembled crates. Each crate is assembled by joining top, bottom, side, end, and interior plates. The number of interior plates commonly varies by loading (pedestrian, light traffic, and traffic loads). The crates are stacked vertically and placed horizontally to form a modular stormwater collection system.

Figure 1: Collapsed parking lot over failed retention system

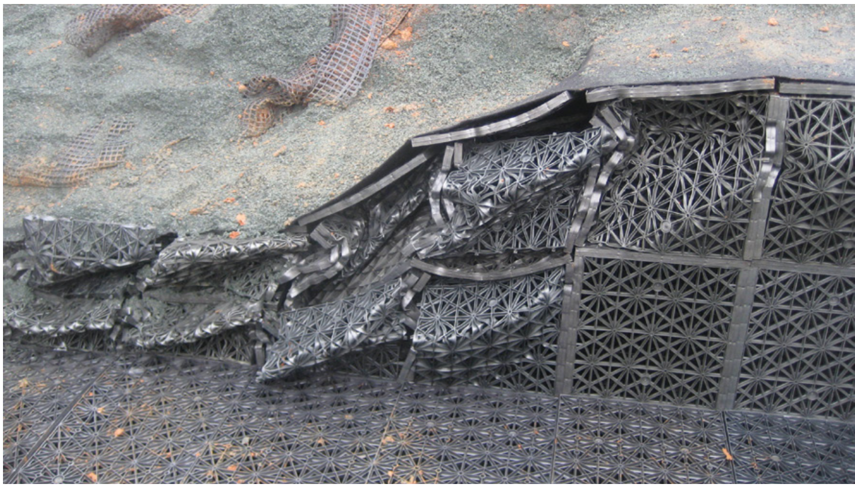

Figure 2: Collapse of a crate-type stormwater system

Figure 3: Open-bottom corrugated arched stormwater chambers

Corrugated and profile-wall pipe — Corrugated and profile-wall pipe stormwater structures are standard corrugated or profile-wall pipes, which in collection structures can be supplied with perforations to facilitate the percolation of water into the surrounding soil environment. Example reference standards for corrugated or profile-wall plastic pipe include ASTM F949, ASTM F2306, and ASTM F2881.

All stormwater collection structures are commonly embedded in a granular envelope to facilitate structural support and, when required, provide additional water storage capacity. Systems typically are wrapped in a geotextile filter fabric to prevent the migration of fine soils into the system. Structures used for detention/retention and reuse of water are encapsulated in a geomemembrane liner. The completed system usually includes maintenance ports or manholes, filtration system, and outlet pipe.

Strategies for success

Most plastic stormwater collection structures are pre-designed by the product manufacturer for "typical" site and installation conditions. However, successful structural performance of plastic stormwater collection structures requires the designer to consider unique site and installation conditions and to understand and apply engineering principles specific to the behavior of structural plastic materials. Components for a designer to evaluate prior to specifying a stormwater collection system for a specific site include material selection, structural design, qualification testing, and installation specifications.

Material selection — A designer needs to ensure that product materials meet applicable consensus standards, such as ASTM, or are otherwise qualified by extensive and properly conducted material and mechanical testing, including resistance to the effects of time and the environment. Common materials used in plastic stormwater collection structures include thermoplastics and fiber-reinforced thermoset plastics.

Thermoplastics are polymers that become moldable above a specific temperature, and then return to a solid state upon cooling. This property allows fabrication of efficient geometries for optimizing structural performance. Examples of thermoplastics used in stormwater systems include polyethylene and polypropylene. These materials exhibit

Figure 4: Stackable cellular-type stormwater units

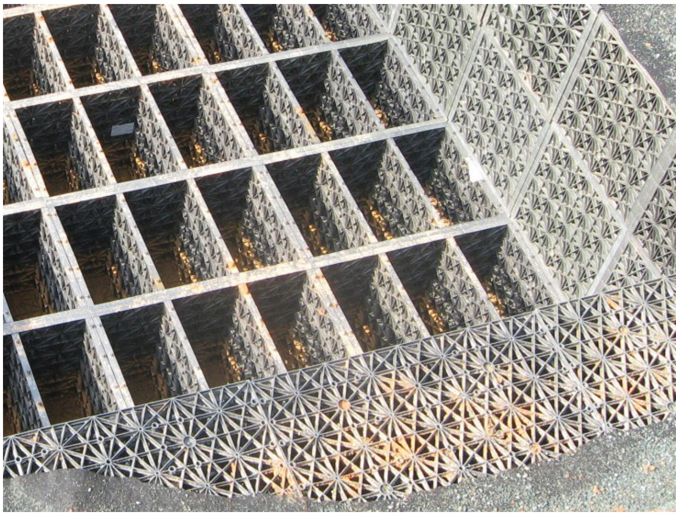

Figure 5: Stackable crate-type stormwater units

significant time-dependent deformation under sustained loads, a response known as "creep." When specifying thermoplastic systems, use accepted product standards and material cell classifications.

Thermosets are polymers that begin as malleable materials that are molded into a specific geometry and then cured. Curing is often achieved by the application of heat, radiation, or via a chemical reaction. After curing is complete, the thermoset cannot return to its malleable state. Typical thermoset resins include epoxy and polyesters. Soy-based epoxy resins also are being used in at least one stormwater product. Thermoset resins are usually combined with reinforcing fibers such as glass or natural fibers to enhance strength and stiffness. Fiber reinforcement also helps to control creep deformation. For thermosets, designers must rely on manufacturer's data for material, mechanical, and durability test results.

The use of recycled plastic materials for stormwater collection structures has increased in recent years. These materials present a special challenge in design because of unknown origin and quality control in processing, and variability in basic design properties. The stormwater industry is currently developing specifications for qualifying recycled materials. Designers should use caution when specifying products incorporating recycled materials.

Structural design — Designers of stormwater collection structures must address a number of specific design considerations including the following (Bass et al, 2010):

- Confirm that the system has been pre-designed to meet applicable design standards. Examples are ASTM F2787 for thermoplastic corrugated arched chambers and AASHTO LRFD Bridge Design Specifications for thermoplastic pipe. In the absence of accepted standards, the designer must proceed with caution and conduct a suitability review of the product. This will typically include review of the manufacturer's material and product tests, quality control program, structural calculations, and survey of the in-service performance history of the product.

- Apply the principles of soil-structure interaction similar to buried flexible pipe. This requires a thorough understanding of soil behavior and how the stormwater structure interacts with the soil envelope. Both the vertical and lateral soil loads on the structure should be considered (Sharff et al, 2011).

- Consider the effects of creep of the plastic materials (i.e., time-dependent reduction in load-carrying capacity under sustained loading conditions) and its impact on the creep stiffness, creep rupture, and ultimately the long-term capacity of the structure. Buried stormwater structures typically are designed using 50-year or longer properties. Creep is non-linear with time, so even short-period loads (for example a parked truck) need to be accounted for in the design by reducing the stiffness of the structure. Reference standards for creep testing of plastic stormwater structures include ASTM D2990, ASTM D6992, and ASTM D7361.
- For corrugated and profile wall structures, take advantage of post-buckling capacity of corrugated elements as detailed in the current AASHTO LRFD Bridge Design Specifications design requirements for thermoplastic pipe. This design approach is now also embodied in ASTM F2787.

- Live load design for these structures is usually based on an AASHTO design truck with 16 kip wheel load. Designers also need to consider the effects of eccentric loadings and the increase in lateral load due to vehicles where appropriate. As noted above, the time-dependent reduction in strength and stiffness must be accounted even for relatively short-duration sustained loads, such as parked trucks over the structure.

Qualification testing — It is essential that structures undergo both laboratory and field testing to qualify their performance. The project designer should verify that laboratory and field testing was performed and incorporated in the product design prior to specifying a stormwater collection system:

- Laboratory tests should address basic material and mechanical properties, as well as tests on the finished product to check strength and stiffness, including confirmation of time-dependent behavior. Tests should include verification of resistance to environmental attack such as oxidation and environmental stress cracking. Reference standards governing environmental resistance include ASTM D3895 and ASTM F2136.

- Because of the complexity in structural behavior of buried plastic structures, full-scale field qualification testing should be conducted to verify structural analysis. These include deep burial tests with consideration for time-dependent response, and shallow burial tests under design vehicle loads. For example, both ASTM F2418 for polypropylene arch-shaped chambers and ASTM F2922 for polyethylene arch-shaped chambers require the chamber manufacturer to "verify the installation requirements and design basis with full-scale installation qualification testing of representative chambers under design earth and live loads" in accordance with ASTM F2787. ASTM F2787 provides specific guidance for field qualification testing, including the need for a minimum three-month test under soil fill equivalent to the factored design load. Experience has shown that well-controlled field qualification testing on prototype structures is essential to verify the structural design and the specified installation requirements.

Installation specifications — Stormwater collection system manufacturers must provide detailed installation requirements to designers to ensure their structures are installed with soil materials and procedures that are consistent with the structural design intent and assumptions. Project designers should incorporate these requirements into the technical specifications for the project, adapting them where appropriate to the site-specific conditions. Prevailing installation standards, such as ASTM D2321 for thermoplastic pipe and ASTM

D3839 for fiberglass pipe, provide benchmark recommendations that can be adapted for plastic stormwater collection structures. Key specifications should include requirements for the following:

- assessing and preparing the soil subgrade and structure foundation
- selection, placement, and compaction of backfill materials
- limiting dimensions of the excavation and soil envelope
- materials and installation of geofabrics, geogrids, and geomembranes
- quality control measurements such as allowable deflection, distortion, and alignment
- minimum and maximum soil cover depths
- basis for determining limiting cover depths, including soil density assumption and design vehicle load

Onsite monitoring of the excavation, installation, and backfill of the system is as important as having detailed installation specifications. A design professional representing the owner should make frequent site visits, and in some cases provide full-time inspection, to monitor conformance to the installation specifications. Identifying non-conformances and taking corrective action during construction goes a long way to preclude costly failures.

Conclusions

Development and application of innovative designs using structural plastic materials provides substantial opportunity for owners and designers to minimize cost and maximize the service life of underground stormwater collection structures. However, successful structural performance of these structures relies on application of engineering principles specific to the behavior of structural plastics materials. Industry standards that embody these principles have been developed for many of the products currently available on the market.

Recent failures of structures using products that have not been vetted by comprehensive industry standards highlight the importance for due diligence on the part of the specifying engineer when selecting candidate systems. As a result, stakeholders in the stormwater industry must push for the development of viable standards that guide designers, installers, and owners or municipalities to the selection of systems that are proven to perform in the long term.

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- ASTM D3839 - Standard Guide for Underground Installation of Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Pipe.
- ASTM D3895 - Standard Test Method for Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry.
- ASTM D6992 - Standard Test Method for Accelerated Tensile Creep and Creep Rupture of Geosynthetic Materials Based on Time Temperature Superposition Using the Stepped Isothermal Method.
- ASTM D7361 - Standard Test Method for Accelerated Compressive Creep of Geosynthetic Materials Based on Time Temperature Superposition Using the Stepped Isothermal Method.
- ASTM F949 - Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings.
- ASTM F2136 - Standard Test Method for Notched, Constant Ligament Stress (NCLS) Test to Determine Slow Crack Growth Resistance of HDPE Resins or HDPE Corrugated Pipe.
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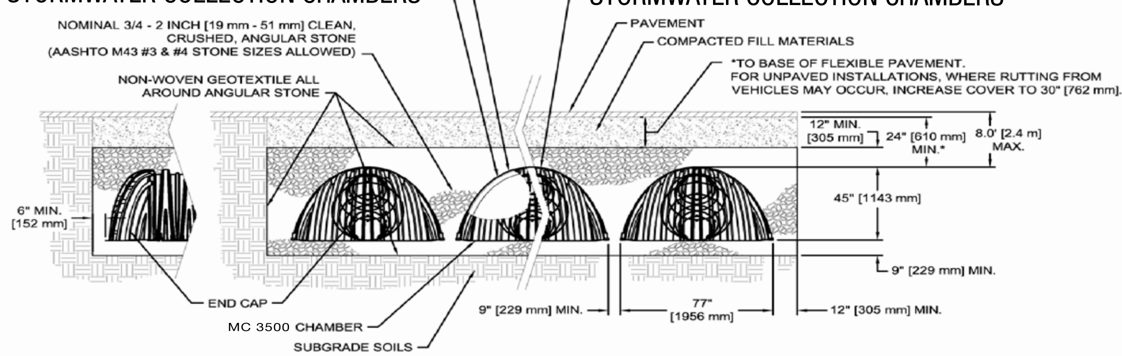
SUBSURFACE STORMWATER SYSTEMS ARE NOT ALL CREATED EQUAL

SPECIFYING INDUSTRY STANDARDS PROVIDES CONSULTING ENGINEERS WITH A DEFENSIBLE BASIS OF DESIGN

POLYPROPYLENE CHAMBERS MEET **ASTM F 2418** "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS"

POLYETHYLENE CHAMBERS MEET **ASTM F 2922** "STANDARD SPECIFICATION FOR POLYETHYLENE (PE) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS"

STORMTECH CHAMBERS CONFORM TO THE REQUIREMENTS OF **ASTM F 2787** "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS"



STORMTECH INSTALLED CHAMBERS PROVIDE THE LOAD FACTORS SPECIFIED IN THE **AASHTO LRFD** BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE PRESENCES. STORMTECH CHAMBERS ARE DESIGNED IN ACCORDANCE WITH **CSA B184** "POLYMERIC SUBSURFACE STORMWATER MANAGEMENT STRUCTURES."

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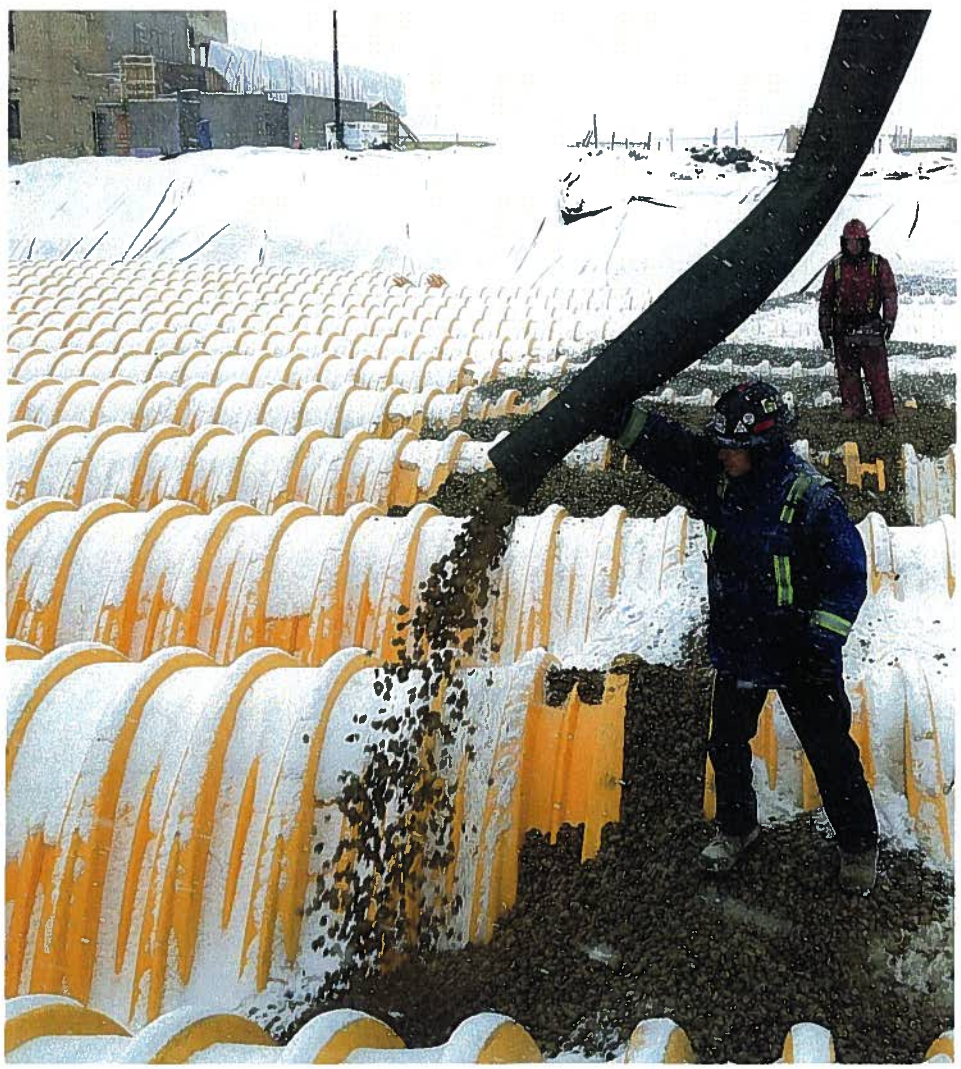
"...a highly cost-effective method for controlling storm water required for projects such as the Aurum Energy Park."

EMCO Waterworks

StormTech MC-4500 Chambers

One of the largest subsurface storm water management systems installed to date used more than 1,900 StormTech MC-4500 chambers to control runoff at the Aurum Energy Park industrial complex in Edmonton. Measuring 96m x 119m (315 x 390ft) it has a storage volume of some 10,000 cubic meters and was designed to meet with storm water requirements of the City of Edmonton. EMCO Waterworks managed the supply and scheduling of all StormTech products to the site for the project which was completed in December 2012. The 800-acre Aurum Energy Park is an industrial property development site.



The chambers from Advanced Drainage Systems, Inc. (ADS) are designed in accordance with CSA, AASHTO, and ASTM design standards, which qualifies the StormTech units to be used in commercial and municipal projects. The StormTech chambers are used as a retention system in order to hold the storm water long enough for it to dissipate through the outlet to prevent overloading the existing creek, and reducing erosion and flooding. The lightweight characteristics of the StormTech chambers not only made for efficient and economical transportation to site, but also allowed for each chamber to be lifted and maneuvered by two people without heavy equipment.

Manufactured using a high performance impact modified polypropylene (PP); the MC-4500 provides a 100-year service life. Able to handle large storm water flow volumes, it measures 1.5m (5ft) from the bottom to the top of the corrugation and has a base spread of more than 2.4m (8ft). The MC-4500 provides greater storage volume per square foot and is generally installed under parking lots such as the one at the Aurum development.

The system is constructed of 1,963 StormTech MC-4500 chambers with 212 end caps in a 2.13m (12.7ft) deep excavation. Clean, crushed angular stone was used to back fill the system from 0.20m (9 inches) below the chambers to 0.3m (12 inches) above the chamber. A well-graded aggregate was used as sub-base up to the bottom of the pavement section for the parking lot. The cover over the entire system was 2.13m (7ft).

Water is fed into the system from six catch basins, each connected underground to an inlet manifold constructed from 600mm (24-inch) diameter ADS N-12 corrugated HDPE pipe and a 121m (400ft) run of 150mm (6 inch) perforated N-12 pipe as an under-drain leading to the outlet control structure. ADS 315ST woven geotextile was placed over bedding stone for scour protection at all chamber inlet rows. This project utilized the patented Isolator Row, which is constructed with StormTech chambers and can remove a significant percentage of Total Suspended Solids (TSS) and other common stormwater pollutants based on design. The patented Isolator Row provides a proven method to protect the StormTech Chamber System from TSS while minimizing the maintenance intervals for the system.

"The practicality of a subsurface unit is being embraced more and more by engineers, urban planners and architects," observed Ewout Leeuwenburg, ADS Senior Vice President of International Operations. "With more than $250 billion in oil sands-related capital projects being developed in Fort McMurray and the Edmonton capital region, the demand for industrial land continues to grow and outstrip supply. The use of a StormTech system saves valuable space, reduces land use, provides a means to meet environmental regulations, and is a long-life, easy-to-install solution. The MC-4500 and our other StormTech products provide a highly cost-effective method for controlling storm water required for projects such as the Aurum Energy Park."

For further information contact your local EMCO Waterworks location.

EQUIPMENT REVIEW

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PRAIRIE FIRE GROUND THAWER

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