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REPORT

June 30, 2022

CITY OF
Chelsea
MASSACHUSETTS

Mill Creek Water Quality Improvement Project

Volume II of III: Identification of Pilot BMPs and Draft Design

View of Mill Creek from 88 Clinton Street, Chelsea, MA – future location of City park.

This project was funded by the Fiscal Year 2022 Coastal Pollutant Remediation (CPR) Grant Program awarded by the Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs Office of Coastal Zone Management.

MEMORANDUM

TO: Karl Allen, City of Chelsea Housing & Community Development

FROM: Timothy P. Corrigan, P.E. Project Manager/Team Leader

DATE: June 30, 2022

SUBJECT: Task 3 Draft Design Memorandum

Coastal Zone Management Coastal Pollution Remediation Grant Program

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This memorandum describes contents and rationale behind selected stormwater best management practices (BMPs) 50% Draft Design performed under the City of Chelsea Coastal Zone Management Coastal Pollution Remediation Grant Program (the Grant Program).

Background:

Mill Creek falls within the Mystic River watershed and serves as a boundary between the cities of Chelsea and Revere. The creek is a tidally influenced tributary to the Chelsea River and, ultimately, to the Mystic River and Boston Harbor. Ecologically, the Creek functions as Chelsea's largest and most biodiverse salt marsh, however, the marsh remains in only a small fraction of its historical area, which was largely developed in the mid-1900s.Water quality in Mill Creek has suffered as a result, and the area around the creek is prone to flooding. The remaining twenty acres of salt marsh habitat faces significant water quality impairments from surrounding land uses, as well as from erosion: Mill Creek is identified as a category 5 impaired waterbody on the 303(d) list, as noted on the 2016 Integrated List of Waters, and was given a water quality grade of 'F' by the EPA in 2020.

The City of Chelsea, through the Department of Housing & Community Development, endeavored through the Grant Program to identify and develop an actionable plan to address sources of contamination, including fecal coliform and other pollutants related to dense land use and former industrial activity. The proposed effort sought to identify pollutant sources and runoff pathways, prioritize structural and non-structural best management practices, and develop a 50% draft design for up to two proposed stormwater best management practice (BMP) measures, including preliminary cost estimates and permitting considerations. The overall goal of this project is to move toward improving water quality in Mill Creek by gaining a clearer understanding of the sources that contribute bacteria and other contaminants to the waterbody and to strategically plan BMPs to address the identified issues. Program task 1 "Non-Point Source Pollutant Assessment" and program Task 2 "Identify Areas for Pilot BMPs Prioritizing Bacteria Remediation" are reported under a separate Memorandum. This memorandum summarizes work performed under Task 3 "Water Quality BMP Draft Designs".

Site Selection for Design Development:

The project team chose to pursue a location for BMP draft design in the City of Chelsea where sub watersheds have the highest concentration of historic pollutant loading based on available wet-weather outfall sampling (data aggregated and analyzed under Tasks 1 and Task 2 of the Grant Program). Outfalls at Guam Road, Crescent Avenue, and Washburn Street screened as the three highest priority sub watersheds. Several BMPs were considered based on their opportunity to address contaminants of concern, feasibility to acquire land rights, permitting risks, perceived constructability risks, and cost/value, and subsequently the most fit sites were chosen for draft design. The following summary of opportunity sites were screened in the three high priority sub watersheds:

- *The Crescent Avenue Outfall* has had substantial BMP development already performed through work by other programs, as evidenced by rain gardens and infiltration planter beds in and around the Mace Housing Authority Property. Given that some of the optimal sites in the sub watershed were already developed, paired with the existing vehicle turning constraints in the Crescent/Clinton intersection and some of the permitting risks associated with the MWRA sewer interceptor, this sub watershed was not chosen for draft design advancement as part of this program

- *The Guam Road Outfall* discharges to the upper reaches of Mill Creek behind a Chelsea Housing Authority facility and collects from Prattville area in the northern part of the City of Chelsea. A substantial land feature in the Prattville area is Voke Park, a rich community park facility with a baseball field, a tennis court, basketball courts, a playground, and a splash pad. The facilities at this site have been upgraded in the past decades except for the parking lot off of Annese Road. The team observed that the Annese Road parking lot to Voke Park offered good opportunity with it's substantial land area, control and ownership by City Hall, and access to substantial collection areas subject to pollutant loading. The Chelsea Housing Authority facility also appeared a good site for BMP opportunity, however the site's scale, late-lifecycle condition (needs significant improvements), and property's ownership/management outside of City Hall jurisdiction made it screen slightly less favorably than the Voke Park lot. The Voke Park Parking Lot was selected as the first site for draft BMP design development.

- *The Washburn Street Outfall* is a limited catchment area off Clinton Street. The general area was a considered a high-opportunity area for it's comparatively small sub watershed, comparatively high concentration pollutant loading, and it's opportunity for synergy with other City initiatives. The City of Chelsea and their neighborhood partners are trying to activate the waterfront for the community, and the section of Mill Creek from Broadway to Mace Housing Authority is the current high priority and target. A creekfront boardwalk is being planned with a prospective new park site at 88 Clinton Street (land acquire this quarter) to Broadway (which is subject to a roadway reconstruction focusing on multi-modal community connectivity). These pieces make water quality in this district of especially high near-term priority. This catchment area, unfortunately, was recently subject to road and sidewalk reconstruction in all areas upgradient of Clinton Street. Clinton Street, at the base of Washburn, also happens to be an area that received high volume flow from the hillside and offers opportunity for BMP development. Clinton Street, near the base of Washburn Road, was selected as the second site for draft BMP design development.

Conceptual Design Development and Intent:

The Voke Park Parking Lot site was subject to an on-site inspection and the available historical records in the area were reviewed. It was found that the site has a 36" reinforced concrete drain in the rear running the length of the ballfield, and a 12" reinforced concrete drain running in the access easement which gathers flow from the parking lot and Annese Road upgradient. A catch basin exists under an apartment complex dumpster in the access road. It was observed that all existing catch basins in the area did not contain basic stormwater BMPs such as hoods (to screen floatables) and deep sumps (to settle sediment). The space seemed subject to water quality risk via pet waste in the grass strip abutting the sidewalk, vehicle fluid leaks in the parking lot and roadway gutter, de-icing chemicals from snow removal staged in the lot, and leachate from the dumpster to the proximate parking lot. Utility records and observations from site suggested no substantial utility obstructions within the property lot which would impact usable space. Site elevation of approximately 14.0' (NAVD 88) suggested the possibility that a groundwater table low-enough to support infiltration might be found. Review of MassDEP's Reported Release database suggested no known hazardous materials releases or activity and use limitations assigned to the site. Gas stations on Washington Avenue were flagged to have a history of contaminated materials releases, but the extent of impact laterally from these sites was unclear. The site was determined clear of the 100-year floodplain, state-agency jurisdictions, and relevant riverfront and wetlands buffers. The site pavement condition was evaluated as poor, so repair or surfaces at the end of the project could be a meaningful co-benefit. The grass strip in it's western extent appeared sufficiently wide to support a raingarden bioswale. The sidewalk area abutting the grass strip offered no suitable trees to impart shade and provide for canopy, so area plantings offered opportunity for coordination with City initiatives around urban heat island mitigation effect and tree canopy improvements. The site was a meaningful pilot for the broader portfolio of municipal parking lots, all of which should be eligible for consideration of adaptation with stormwater BMPs. The site was selected to develop design for a bioswale rain garden, possible water quality units, and subsurface infiltration features.

The Clinton Street area tributary to the Washburn Road outfall was similarly reviewed on site and considered with available records. The area receives hill runoff from Washburn Road upgradient. The gutter appears to puddle for a stretch on each side of the Tibetan Club parking lot. A single catch basin exists in this space and is unlikely to have capacity to manage heavy flows. The basin does not have BMPs such as hoods (to screen floatables) or deep sumps (to settle sediment). The site seems at risk of water quality issues resulting from roadway runoffs conveyed at velocity from the hillside. The gutter is subject to vehicle parking and driveway aprons to break-up the opportunity-space for BMPs. The gutter is outside of the 100 year floodplain and 25-foot riverfront buffer. The roadway and sidewalk is generally mid-lifecycle and improvements would result in a material surface condition betterment at conclusion. Review of MassDEP's Reported Release database suggested no known hazardous materials releases or activity and use limitations assigned to the site or any of the proximate properties. The sidewalk appeared wide-enough to support infiltration tree pits and/or right of way infiltration swales. The site offered opportunity to improve street tree canopy and pilot infiltration tree pits. The space offered co-benefits for it's proximity to proposed new park at 88 Clinton Street and the opportunity to use proximate stormwater tree pit BMPs as an educational tool for new park users.

The design concepts selected to advance to engineered draft design are presented in **Attachment 1, "Conceptual Design Board".** This presentation was prepared ahead of public meeting and solicited for feedback from the public. This concept informed areas where a licensed land surveyor was employed to develop base map and where an excavation contractor and licensed soil evaluator were employed to perform test pits and soil analysis.

Subsurface Exploration:

The City of Chelsea employed excavation contractor Tufts, Inc. to perform a subsurface investigation consisting of a series of test pits at Voke Park and Clinton Street. Excavations were observed by a Weston & Sampson Engineer / Soil Evaluator who logged the encountered soil conditions. In total, four test pits were excavated, in locations approximately as shown in Attachment 1. Logs from performed test pits are provided as Attachment 2, "Test Pit Logs". Key observations from test pitting included:

- *Test Pit #1* in the middle of the Voke Park Parking Lot returned urban fill to approximately 4 feet below grade, overlying silty clay. Perched groundwater was observed above the clay layer, and visual / olfactory evidence of petroleum was encountered. The clay and high groundwater will make it very difficult to infiltrate at the site and impossible to design infiltration to typical design standards, which generally seek to have structures 4-feet or more above seasonal high groundwater. The petroleum contamination will make displacing volumes of soil expensive for the proposed infiltration structure excavation and subsequent off-site disposal. Based on the subsurface investigation and encountered field conditions, this location is considered not feasible / cost effective for siting of a subsurface infiltration system.
- *Test Pit #2* was pursued to explore opportunities for water quality features nearer to surface grade. The site yielded a concrete pad approximately 2-feet below grade with topsoil overlay. The concrete pad may be former site lot cover or floor slab, or may be part of site capping prior to re-use. The concrete likely overlays the same petroleum contamination as observed in the adjacent test pit 1 location, and the concrete pad was not demolished to further exploration. Conditions observed suggest this would be a difficult location for earthwork and swale construction, and similar to the adjacent Test Pit #1 location, would prove a poor site for infiltration.
- *Test Pits #3 and #4* in Clinton Street generally presented ash fill in upper strata with visual presentation similar to deposits of City-fire ash. Experience with similar material has generally indicated high concentration of metals and Polycyclic Aromatic Hydrocarbons (PAHs). At around 5' underlying sandy clay was encountered. The excavation also encountered a drain line in close proximity to Test Pit #3 (note that the location of this drain was known) and an unknown concrete structure (possible old foundation) at location Test Pit #4. Ash fill at Clinton Street will make excavation and disposal of surplus material comparatively more expensive than typical cost. Fill materials, while capable of infiltration in limited capacity, do not support reliable performance-based design and underlying clay will have limited capacity. Additionally, it is possible that contamination related to the ash material may be mobilized by infiltration through this material and subsequently impact groundwater in the area.

The conclusion from test pitting and subsurface analysis is that the Voke Park and Clinton Street Sites could support water-quality oriented BMP measures, such as vegetated pits and swale features with the understanding that infiltration capacity will be limited and excavation costs will be comparatively higher than areas without hazardous materials. The space can also support grey-infrastructure improvements to catchment and treatment in with provision to separate and/or screen sediment and floatables. The project team determined to change approach away from infiltration and toward water-quality oriented design at each site. This generally allowed for shallower construction features and reduced excavation volume.

Hazardous Materials and Massachusetts Contingency Plan (MCP) Implications:

A detailed tabulation and geographic presentation of area release tracking numbers (RTNs) and activity and use limitations (AULs) is provided in Attachment 3, "MassDEP Reported Releases".

Based on visual and olfactory evidence from test pit soil investigation, contaminated soil and groundwater is likely to be encountered while performing work at the Voke Park Parking Lot site. The Clinton Street site will likely encounter contaminated soils. Each site is likely to result in exceedances of reportable concentrations in soil (RCS-1) should analytical samples of soil and / or groundwater be collected, which would then require reporting and management of the release through the Massachusetts Contingency Plan (MCP). The City requested that Weston & Sampson defer engaging laboratory analysis as part of this project so that the City may confirm timing and approach to project delivery before entering MCP reporting obligations. Groundwater handling at the Voke Park site could require a remediation general permit and subsequent treatment should construction operations require removal of pumped water and discharge to surface water / storm sewer infrastructure.

It is this team's opinion that existing contamination should not prevent the City from pursuing betterment in these valuable public spaces, but that it should drive more care in selecting the timing and approach to delivery. Performance of improvements in these areas might offer best-value if coordinated with broader improvements in each area, such as during a broader utility and roadway infrastructure maintenance program in Clinton Street, or during a broader parking lot reconstruction. The design included herein pursued relocation of stormwater BMPs to a location as far from known petroleum contamination as could be supported in site bounds. It is recommended that sampling be performed at the specific location of proposed features during final design to confirm if contamination extents reach the proposed adjusted location of work.

Property Survey and Assessment of Utility Infrastructure:

A licensed project land surveyor was employed to perform instrument survey of the Voke Park Parking Lot area. Base map for the Clinton Street project area was developed based on City-wide LiDAR survey secured by the Department of Public Works. Weston & Sampson performed stormwater manhole and catch basin inspection to determine pipe geometry, size, and depth to invert proximate proposed work areas. City GIS was reviewed to inform general nature of municipal utility infrastructure and attributes. Mark outs provided by Digsafe ahead of test pitting furthered understanding of subsurface utilities. Historical Aerials available online and Sanborn Insurance Maps from 1955 were reviewed to research historic land uses that might have contributed to below grade conditions observed.

Property survey revealed that the concept of a vegetated swale at the Voke Park Parking lot was not practical due to the comparatively narrow available space to house the swale. The narrow strip could not provide for conveyance of gutter flow down the street to the bottom of a theoretical swale with 3:1 side slopes. The swale could not get deep enough in the space provided to receive the pipe and convey flow via gravity. Remedy would require a significant take from the parking lot and excavation to lower grades, and resetting of bounding curbs, which would impact viability of the lot and make the project not financially feasible due to expense associated with contaminated materials handling and disposal.

Design Rationale:

Taking into account site existing conditions factors and treatment for contaminants of concern, 50% draft design intent for each site are as follows:

- Voke Park Parking Lot – Install water quality units to treat street runoff that collects in the general vicinity of the Voke Park Parking Lot. This includes runoff captured by the catch basins in the north and south gutter of Annese Road proximate the parking lot and runoff captured by the catch basin in the center of the parking lot. This technology choice will give opportunity to minimize risk of hazardous materials generation by locating structures offset from known contaminations and minimizing overall excavation volume. The project will serve as a pilot of water quality unit application (in various configurations) for training and assessment by City DPW staff. The project will also seek to install shade trees in the grass strip for synergy with their urban heat and tree canopy initiative and add pet waste bag dispensers and receptacles in the streetside area. Together, these measures should seek to reduce contaminant loading associated with pet waste, vehicle fluid leaks in the parking lot and roadway gutter, and de-icing chemicals from snow removal staged in the lot.

- Clinton Street – Install a stormwater infiltration tree pit and hydrodynamic separator water quality unit in-place of the existing catch basin. A tree pit will support limited infiltration and tree canopy consistent with the City's broader urban heat island mitigation program. Tree pits will reduce loading on proximate catchment site. Water quality unit used in place of a catch basin without a deep sump or hood will have significant improvement in reduction of contaminants in this high volume collection site.

50% draft design is provided attached to this memorandum as Attachment 4, "Draft BMP Design".

Product Selection, Performance, and Sizing:

The project team recommends specification be keyed around the Stormceptor hydrodynamic separator units by Contech, or approved equal, due to their suitability in site conditions and documented performance, which has received regulatory support. These proprietary self-contained units resemble typical manhole structures with deep sumps and have internal components that provide for stormwater quality treatment. Many urban sites are unable to support "green infrastructure" stormwater best management practices as a retrofit solution due to lack of space, poor soil conditions, or challenges related to existing site grades. Green infrastructure (GI) solutions typically consist of bioretention areas, water quality swales, infiltration basins and other similar practices. The subject site exhibits all of the characteristics that make GI practices infeasible. Since stormwater is already collected by a localized system of catch basins and underground pipe, the installation of Stormceptor units appears to be feasible. These units can be designed to provide treatment for the 1-inch 24-hour storm, consistent with the requirements of the Massachusetts Stormwater Handbook. The Stormceptor was previously tested and approved under the former MA STEP program, with potential Total Suspended Solids (TSS) removal efficiency of up to 80%. Additionally, the units are capable of trapping oils, floatables and deicing byproducts. Product literature is provided as Attachment 5, "Contech Stormceptor Product Literature".

The net catchment area for the two catch basins contributing to the hydrodynamic separator #1 is estimated just under a half-acre, largely comprised of impervious roadway. Using a 1-inch Type III distribution, 5-minute time of concentration, with 100% impervious, TR-55 stormwater modeling software yields an approximate peak flow of approximately 200 gpm. Sizing criteria in page #13 of the

Technology Assessment in Attachment 5 suggest that the Stormceptor model STC 900 may be sufficient for this scenario. Estimated catchment for hydrodynamic separator #2 and #3 are respectively approximately 0.2 and 0.3 acres. This team estimates that the 450i model may be suitable to treat typical the noted 1-inch 24-hour storm. During final design catchment are should confirmed with abutting premise inspection and estimated sizing should be confirmed with the manufacturer.

The City of Chelsea has tried several stormwater infiltration tree pits and prefers StormTree for it's open-structure design which allows for expansive root growth outside of the envelope of the structure. Given mixed media granular urban fill, the infiltration tree pit can not be designed to specific performance standards. The system selected for Clinton Street will support catchment from gutters adjacent and overflow to proximate drain manholes ahead of discharge. A standard specification for StormTree Catch Basin Series is provided as **Attachment 6, "StormTree Standard Specification".**

Permit Assessment:
MassGIS environmental resource, water supply, and floodplain resource areas were reviewed and are aggregated for presentation in **Attachment 7, "Environmental Resource Maps"**.

This information suggests that the Voke Park site is outside of the floodplain and clear of wetlands, riverfront buffer, and other relevant resource areas triggering permit. Weston & Sampson reviewed for proximate MWRA, MassDOT, and DCR jurisdictions and did not see any relevant to this site. The site is outside of Chapter 91 jurisdiction. While outside of sites with RTN and AUL, apparent contamination will trigger obligation for utility related abatement measure (URAM) during construction.

The Clinton Street site appears to be within the 100-foot wetlands buffer and will require Notice of Intent (NOI) to the City of Chelsea Conservation Commission. The site is outside of the 25-foot riverfront buffer and floodplain as well as Chapter 91 jurisdiction. While outside of the sites with RTN and AUL, apparent contamination will trigger obligation for utility related abatement measure (URAM) during construction. Weston & Sampson reviewed for proximate MWRA, MassDOT, and DCR jurisdictions and did not see any relevant to this site.

Estimated Cost:
Cost for the draft BMP program at Voke Park Parking Lot and Clinton Street was estimated in **Attachment 8, "Draft Design Estimate"**. The estimated project construction cost is $195,000. In addition to construction cost, eventual budgetary program costs to-deliver the program will include final design and permitting, construction administration and resident representation, construction contingency, uniformed officers for traffic control, and escalation to period of construction. Costs reflect the current market cost for June 2022 and current-period ENR construction cost index is noted in the estimate. Costs reflect limited escalation potential, as typical for comparatively small scale construction programs.

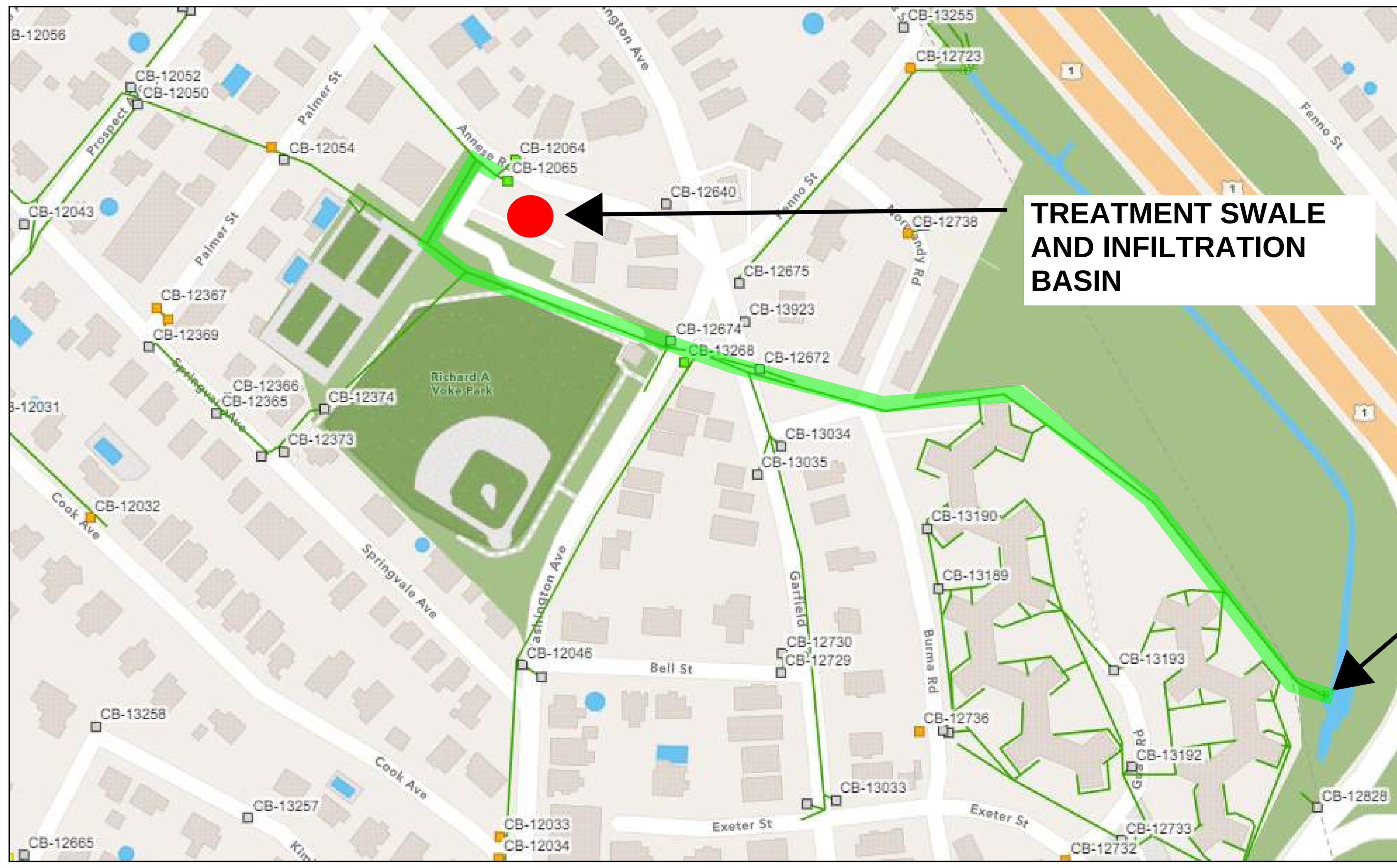
Attachments:

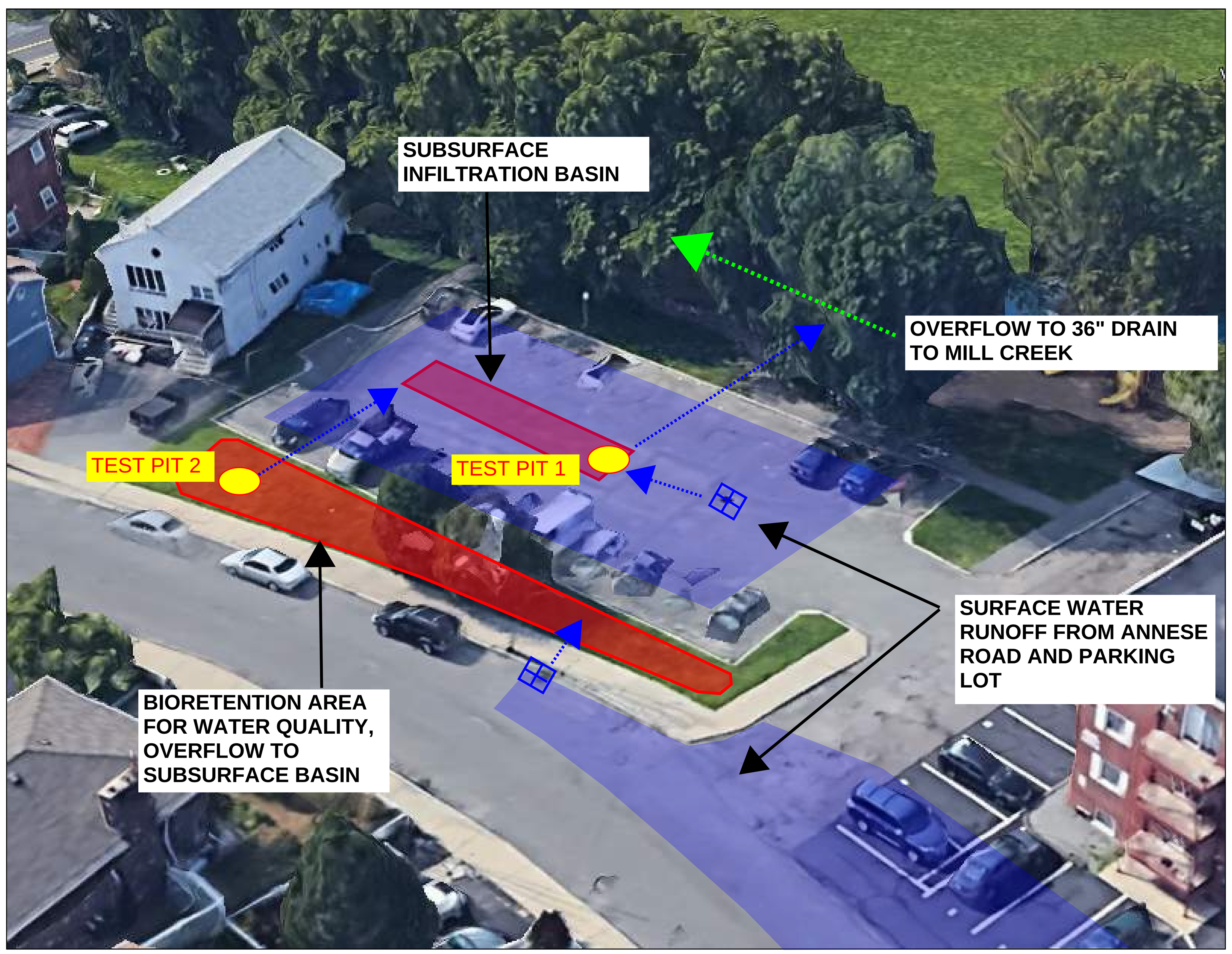
- Attachment 1 - Conceptual Design Boards
- Attachment 2 - Test Pit Logs
- Attachment 3 – Reported Releases
- Attachment 4 – Draft BMP Design
- Attachment 5 - Contech Stormceptor Product literature
- Attachment 6 - Stormtree Product Literature
- Attachment 7 – Environmental Resources Maps
- Attachment 8 – Draft Design Estimate

ATTACHMENT 1

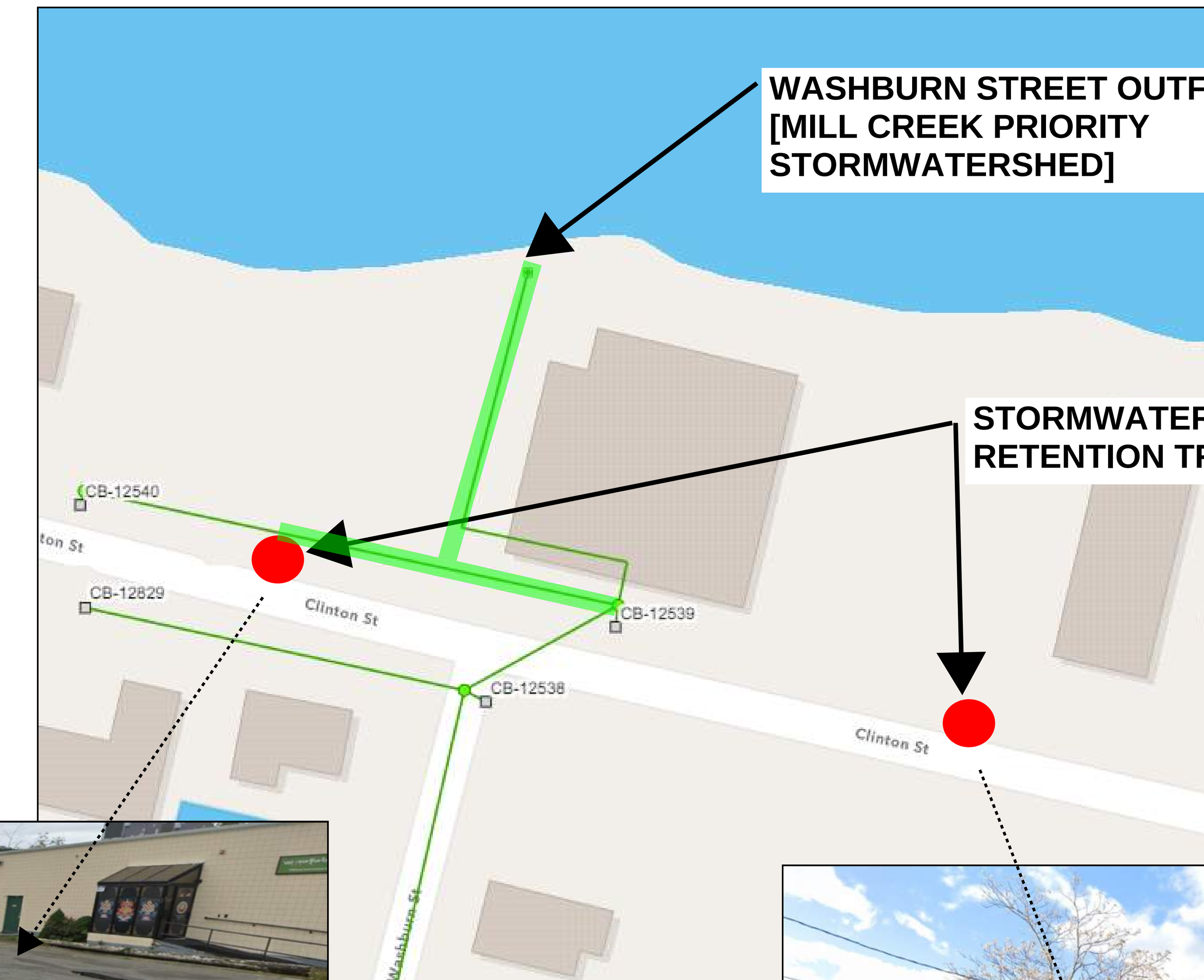
CITY OF CHELSEA, MA
CONCEPT FOR STORMWATER BMP 2023

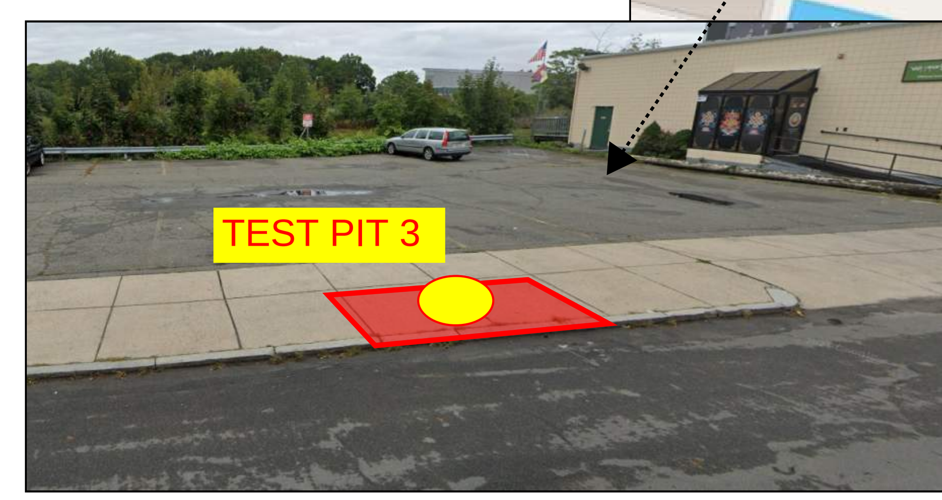
VOKE PARK PARKING LOT

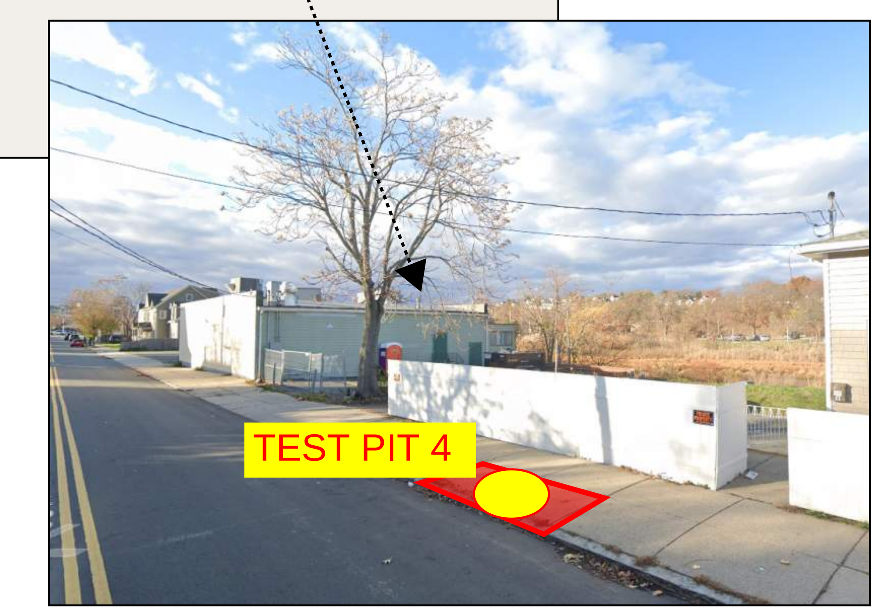




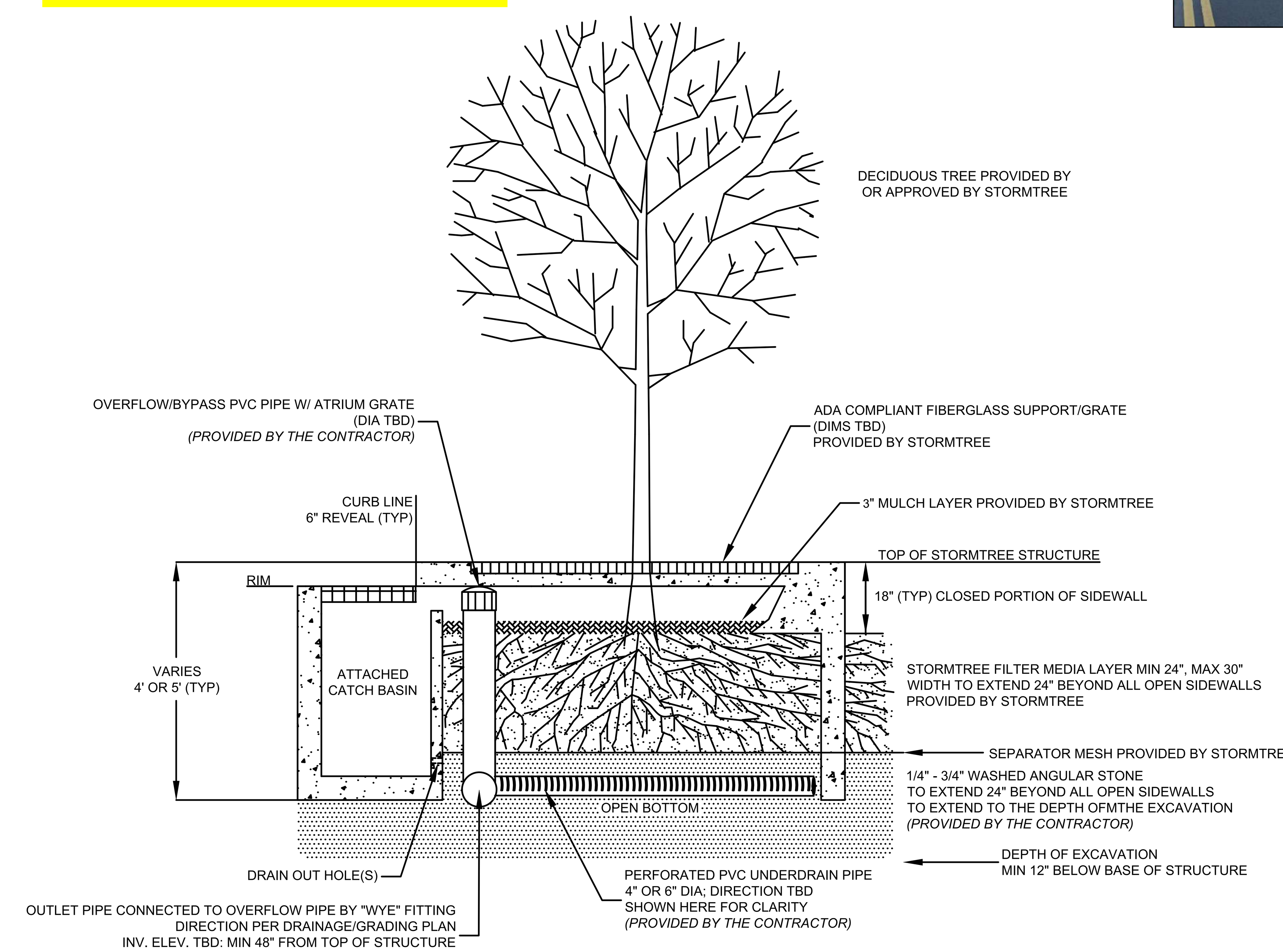
CLINTON STREET





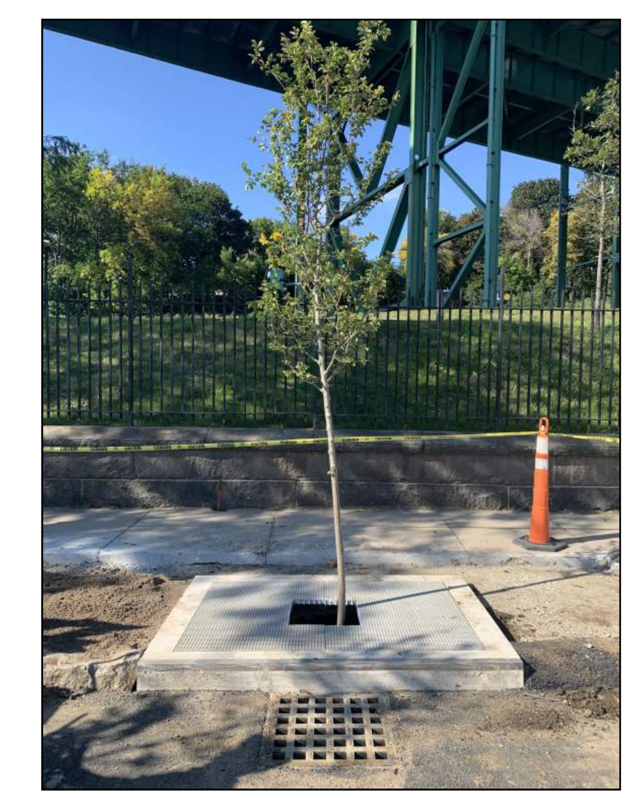


TEST PIT LOCATIONS FOR 6/17/22 - IN ORDER OF PRIORITY



SECTION A-A
NOT TO SCALE

STORM-TREE BRAND STORMWATER RETENTION TREE PITS



LOWER BROADWAY, CHELSEA, MA

SOUTH PORTLAND, ME

ATTACHMENT 2

TEST PIT LOG

PROJECT NAME/NO.	Chelsea Mill Creek CZM / ENG22-0200		
LOCATION	Chelsea, MA		
CLIENT	City of Chelsea		
CONTRACTOR	Tufts	FOREMAN:	
OBSERVED BY	LK	DATE	6/17/22
CHECKED BY	LK	DATE	6/22/22

TEST PIT NUMBER
Clinton-TP-01

GROUND SURFACE ELEVATION: ~

DEPTH TO GROUNDWATER: N/A

DEPTH BELOW GROUND SURFACE (ft.)	SOIL DESCRIPTION	STRATUM DESCRIPTION
Surface	0-0.5' : Concrete	Concrete
1		
2		
3	0.5 - 5.5' : Interbedded ash and grannular fill (loamy sand, gravelly to very gravelly), brick, shells, glass, ceramic, metal.	Fill
4		
5		
6	5.5 - 6.5' : Gray silty clay loam to silty clay.	C - Horizon
7	Test pit terminated at 6.5'	
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

NOTES:
Drain line at 4' BGS on South side of pit.
Groundwater not encountered to maximum depth of excavation. Evidence of seasonal high groundwater not identified, however fill composition precludes identification of REDOX features.

TEST PIT NUMBER
Clinton-TP-01

Weston & Sampson

TEST PIT LOG

PROJECT NAME/NO.	Chelsea Mill Creek CZM / ENG22-0200			**TEST PIT NUMBER**
LOCATION	Chelsea, MA			Clinton-TP-02
CLIENT	City of Chelsea			GROUND SURFACE
CONTRACTOR	Tufts	FOREMAN:		ELEVATION ~
OBSERVED BY	LK	DATE	6/17/22	DEPTH TO GROUNDWATER
CHECKED BY	LK	DATE	6/22/22	N/A

DEPTH BELOW GROUND SURFACE (ft.)	SOIL DESCRIPTION	STRATUM DESCRIPTION
Surface	0-0.5' : Concrete	Concrete
1		
2	0.5 - 2.5' : Interbedded ash and granular fill (loamy sand, gravelly to very gravelly), brick, shells, glass, ceramic, metal.	Fill
3	2.5' : Concrete structure (unknown use/ origin).	Concrete
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

NOTES: *Concrete structure encountered at 2.5 to 3.5' below grade.*
Groundwater not encountered to maximum depth of excavation.
Evidence of seasonal high groundwater not identified, however fill composition precludes identification of REDOX features.

TEST PIT NUMBER
Clinton - TP - 02

Weston & Sampson

TEST PIT LOG

PROJECT NAME/NO.	Chelsea Mill Creek CZM / ENG22-0200			**TEST PIT NUMBER**
LOCATION	Chelsea, MA			Voke - TP - 01
CLIENT	City of Chelsea			GROUND SURFACE
CONTRACTOR	Tufts	FOREMAN:		ELEVATION ~
OBSERVED BY	LK	DATE	6/17/22	DEPTH TO GROUNDWATER
CHECKED BY	LK	DATE	6/22/22	3.5'

DEPTH BELOW GROUND SURFACE (ft.)	SOIL DESCRIPTION	STRATUM DESCRIPTION
Surface	0 - 5" : Asphalt	Asphalt
1	5" - 15" : Tan loamy sand, very gravelly	Fill (Road Base)
2, 3, 4	15" - 48" : Interbedded loamy sand and silty clay loam (gravelly to very gravelly). Urban fill components (brick, wood, glass, ash) noted. 6W at 3.5' BGS.	Fill
5, 6	48" + : Gray silty clay loam to silty clay. Limited areas of intermixed fill.	C - Horizon
7	TP terminated at 6.5'	
8		
9		
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NOTES: *Strong petroleum odor, sheen, globules at 15-48".*
PID 289.2 PPMV
Groundwater perched on top of silty clay loam / silty clay layer.

TEST PIT NUMBER
Voke - TP - 01

Weston & Sampson

TEST PIT LOG

PROJECT NAME/NO.	Chelsea Mill Creek CZM / ENG22-0200			**TEST PIT NUMBER**	
LOCATION	Chelsea, MA			Voke - TP - 02	
CLIENT	City of Chelsea			GROUND SURFACE	
CONTRACTOR	Tufts	FOREMAN:		ELEVATION	~
OBSERVED BY	LK	DATE	6/17/22	DEPTH TO GROUNDWATER	
CHECKED BY	LK	DATE	6/22/22		N/A

DEPTH BELOW GROUND SURFACE (ft.)	SOIL DESCRIPTION	STRATUM DESCRIPTION
Surface	Tan loam, gravelly. Roots in top 6". Few cobbles, concrete fragments.	Fill
1		
2		
3	Concrete slab at 2' BGS.	Concrete
4		
5		
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7		
8		
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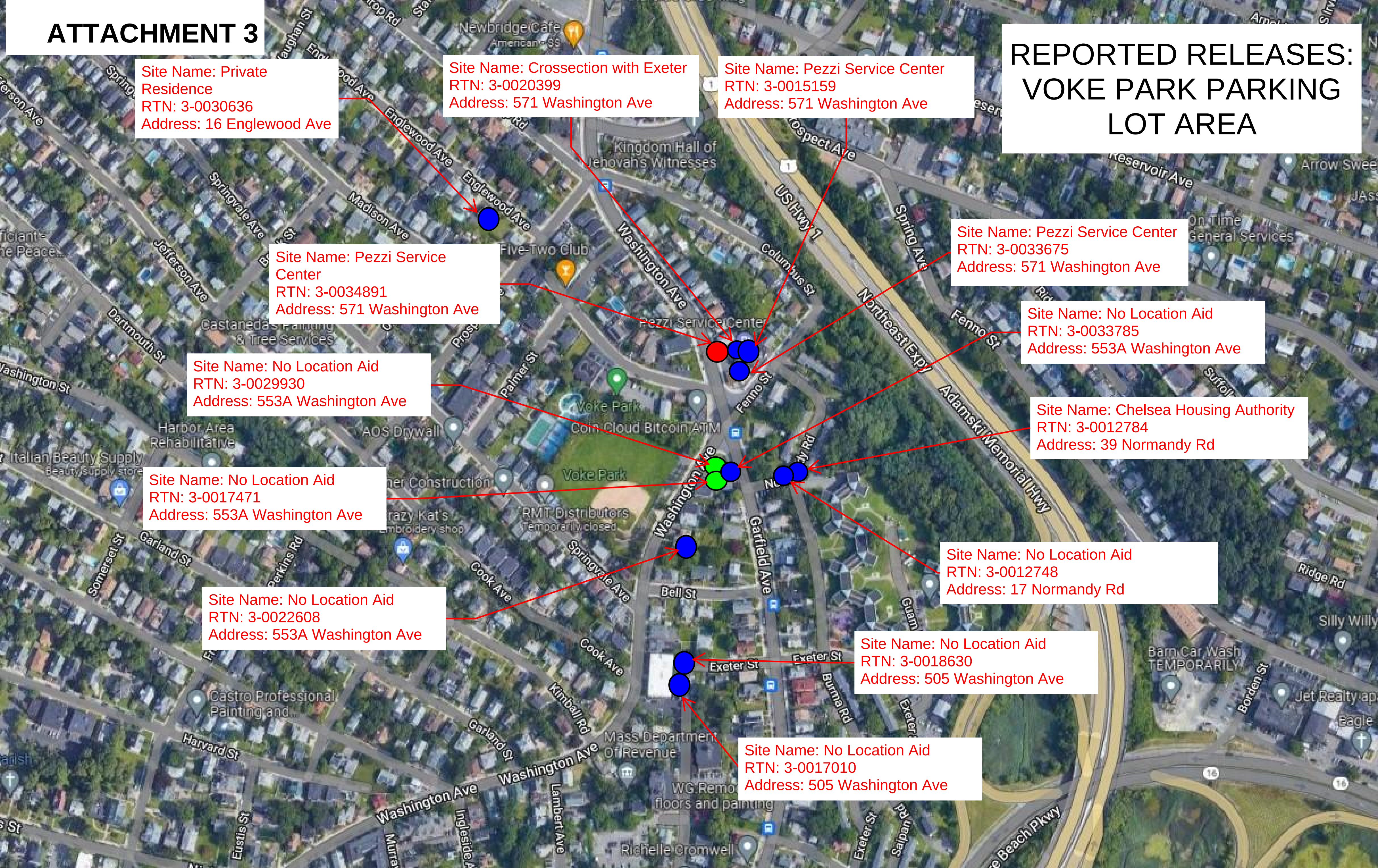
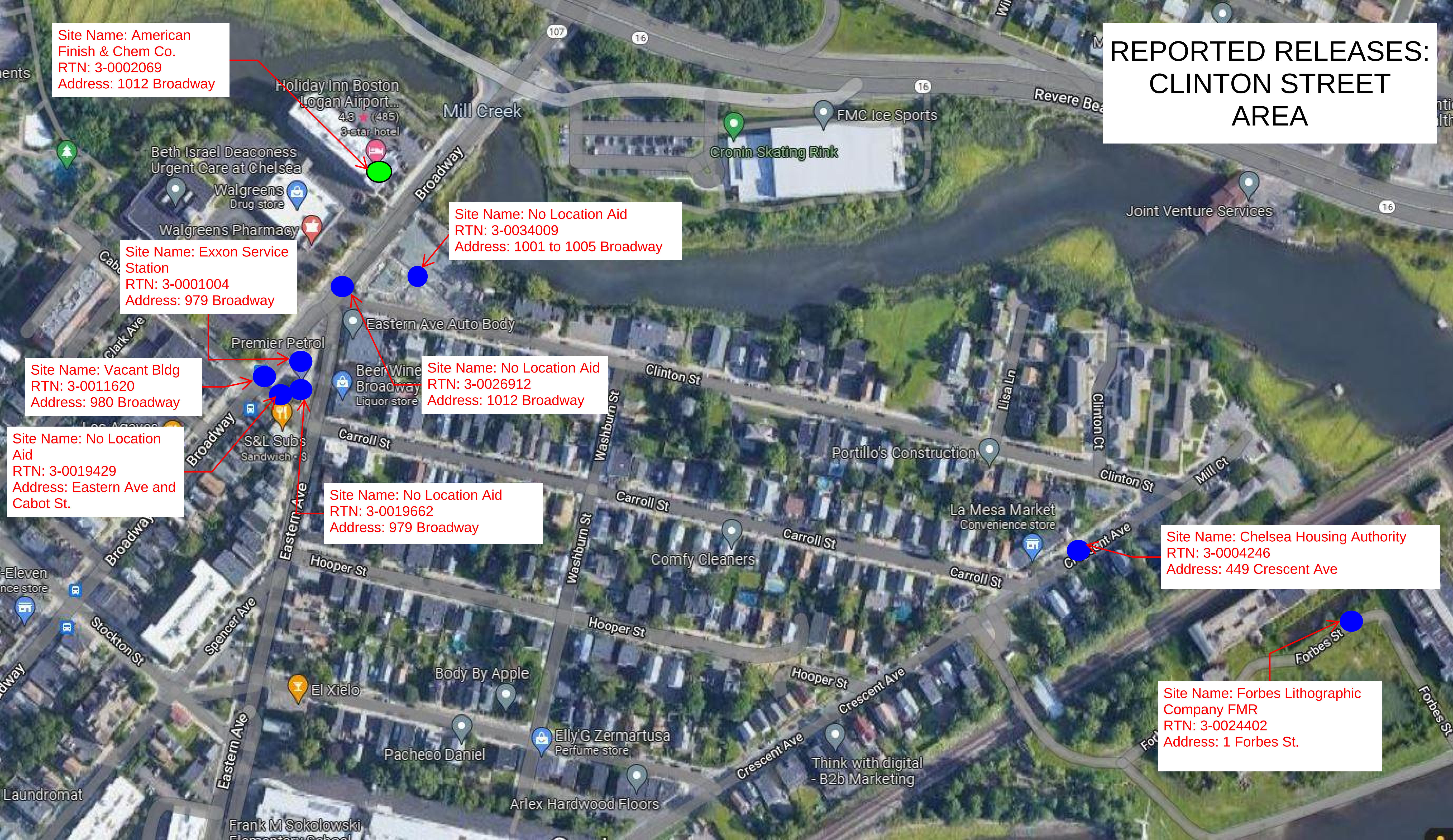
NOTES: *Grass at ground surface.*

TEST PIT NUMBER
Voke - TP - 02

Weston & Sampson


ATTACHMENT 3
REPORTED RELEASES: VOKE PARK PARKING LOT AREA
Site Name: Private Residence
RTN: 3-0030636
Address: 16 Englewood Ave
Site Name: Crossection with Exeter
RTN: 3-0020399
Address: 571 Washington Ave
Site Name: Pezzi Service Center
RTN: 3-0015159
Address: 571 Washington Ave
Site Name: Pezzi Service Center
RTN: 3-0034891
Address: 571 Washington Ave
Site Name: Pezzi Service Center
RTN: 3-0033675
Address: 571 Washington Ave
Site Name: No Location Aid
RTN: 3-0033785
Address: 553A Washington Ave
Site Name: No Location Aid
RTN: 3-0029930
Address: 553A Washington Ave
Site Name: Chelsea Housing Authority
RTN: 3-0012784
Address: 39 Normandy Rd
Site Name: No Location Aid
RTN: 3-0017471
Address: 553A Washington Ave
Site Name: No Location Aid
RTN: 3-0012748
Address: 17 Normandy Rd
Site Name: No Location Aid
RTN: 3-0022608
Address: 553A Washington Ave
Site Name: No Location Aid
RTN: 3-0018630
Address: 505 Washington Ave
Site Name: No Location Aid
RTN: 3-0017010
Address: 505 Washington Ave

RTN	City/Town	Release Address	Site Name Location Aid	Reporting Category	Notification Date	Compliance Status	Date	Phase	RAO Class	Chemical Type	Notes
3-0034891	CHELSEA	571 WASHINGTON AVENUE	PEZZI SERVICE CENTER	120 DY	04/19/2018	TIER 2	04/19/2019	PHASE II		Oil and Hazardous Material	In-place UST closure assessment revealed C5 thru C8 aliphatic hydrocarbons, C9 trhu C10 aromatic hydrocarbons in both groundwater and soil at the site. Benzene, xylene, and PAHs also found in groundwater
3-0033785	CHELSEA	553A WASHINGTON AVENUE	NO LOCATION AID	72 HR	08/30/2016	PSNC	12/20/2016		PN	Oil	Waste oil UST discovered during the demolition of an automobile repair garage at the site. Waste oil from UST found in surrounding soil. Concentrations below applicable reportable concentrations of VPH, VOCs, and EPH detected in groundwater near UST
3-0033675	CHELSEA	571 WASHINGTON AVENUE	PEZZI SERVICE CENTER	120 DY	07/07/2016	PSNC	01/15/2018		PN	Oil and Hazardous Material	(Linked to RTN 3-0034891) Preliminary site investigation prior to UST installation revealed elevated EPH, PAH, and VOCs in soil and groundwater likely due to former used oil UST and former fuel oil UST in the area of the property. Napthalene and methylnalhthalene present in soil at elevated levels as well as VOCs (benzene, ethylbenzene, total xylenes)
3-0030636	CHELSEA	16 ENGLEWOOD AVENUE	PRIVATE RESIDENCE	TWO HR	02/03/2012	RAO	08/30/2013	PHASE II	A2	Oil	Fuel oil release in the basement of the property from a disconnected interior fuel oil AST fill pipe. Spill resulted in significant volume of petroleum impacted soil under and around the residency. No significant groundwater or indoor air contamination found.
3-0029930	CHELSEA	553A WASHINGTON AVE	NO LOCATION AID	120 DY	04/13/2011	RAO	04/12/2012			Oil	Property historically used as automobile repair/gas station. Soil and groundwater contaminated with OHM material (C5 thru C8 aliphatic hydrocarbons) likely caused by USTs on the site
3-0022608	CHELSEA	533A WASHINGTON AVE	NO LOCATION AID	72 HR	02/19/2003	RTN CLOSED	02/26/2004			Hazardous Material	High MTBE found in a monitoring well near a residential area, likely caused by OHM-contaminated soil and gorundwater in the area of the monitoring well as a result of previous gasoline releases nearby (see RTN 3-0017471)
3-0020399	CHELSEA	571 WASHINGTON AVE	CROSSECTION WITH EXETER	TWO HR	02/15/2001	RAO	11/05/2001		A2	Oil	(Linked to RTN 3-0034891) Gasoline spill during gas delivery contaminated soil in the area of the spill. No groundwater contamination.
3-0018630	CHELSEA	505 WASHINGTON AVE	NO LOCATION AID	72 HR	08/12/1999	RTN CLOSED	09/30/1999			Oil	(Linked to RTN 3-0017010) Abandoned on-site UST led to elevated headspace readings in the soil collected within 10 feet of the UST. No reportable groundwater contamination.
3-0017471	CHELSEA	553A WASHINGTON AVE	NO LOCATION AID	72 HR	10/22/1998	RAO	04/09/2007	PHASE V	A3	Oil	(Linked to RTN 3-0033785, RTN 3-0029930 and RTN 3-0022608) Elevated headspace readings found during soil assessment for UST removal and replacement. Surrounding soil contaminated with gasoline. Groundwater contamination was below reportable limits.
3-0017010	CHELSEA	505 WASHINGTON AVE	NO LOCATION AID	120 DY	07/03/1998	RAO	12/02/2005	PHASE II	A2	Oil	(Linked to RTN 3-0018630) A release of #2 fuel oil that contaminated nearby soil discovered during UST abandonment storage activities. C11 thru C22 aromatic hydrocarbons, C9 thru C18 aliphatic hydrocarbons, and C19 thru C36 aliphatic hydrocarbons found at elevated levels on site.
3-0015159	CHELSEA	571 WASHINGTON AVE	PEZZI SERVICE CTR	72 HR	06/03/1997	RAO	03/27/1998		A2	Oil	(Linker to RTN 3-0034891 and RTN 3-0020399) RTN assigned to this site when elevated PID readings were found in soil gas during UST removal. Gasoline contaminated soil and groundwater
3-0012784	CHELSEA	39 NORMANDY RD	CHELSEA HOUSING AUTHORITY	72 HR	08/08/1995	RAO	04/12/1996		A1	Oil	#2 fuel oil released during the moving of a UST. Nearby soil contaminated, but no reportable groundwater contamination.
3-0012748	CHELSEA	17 NORMANDY RD	NO LOCATION AID	72 HR	07/28/1995	RAO	04/12/1996		A1	Oil	#2 fuel oil released during the removal of a UST. No groundwater monitoring wells were installed for this site because of the belief that groundwater had not been impacted by the release.

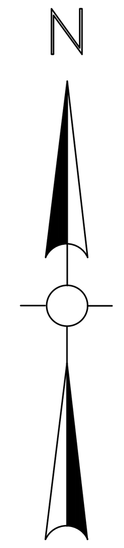

REPORTED RELEASES: CLINTON STREET AREA
Site Name: American Finish & Chem Co.
RTN: 3-0002069
Address: 1012 Broadway
Site Name: No Location Aid
RTN: 3-0034009
Address: 1001 to 1005 Broadway
Site Name: Exxon Service Station
RTN: 3-0001004
Address: 979 Broadway
Site Name: Vacant Bldg
RTN: 3-0011620
Address: 980 Broadway
Site Name: No Location Aid
RTN: 3-0026912
Address: 1012 Broadway
Site Name: No Location Aid
RTN: 3-0019429
Address: Eastern Ave and Cabot St.
Site Name: No Location Aid
RTN: 3-0019662
Address: 979 Broadway
Site Name: Chelsea Housing Authority
RTN: 3-0004246
Address: 449 Crescent Ave
Site Name: Forbes Lithographic Company FMR
RTN: 3-0024402
Address: 1 Forbes St.

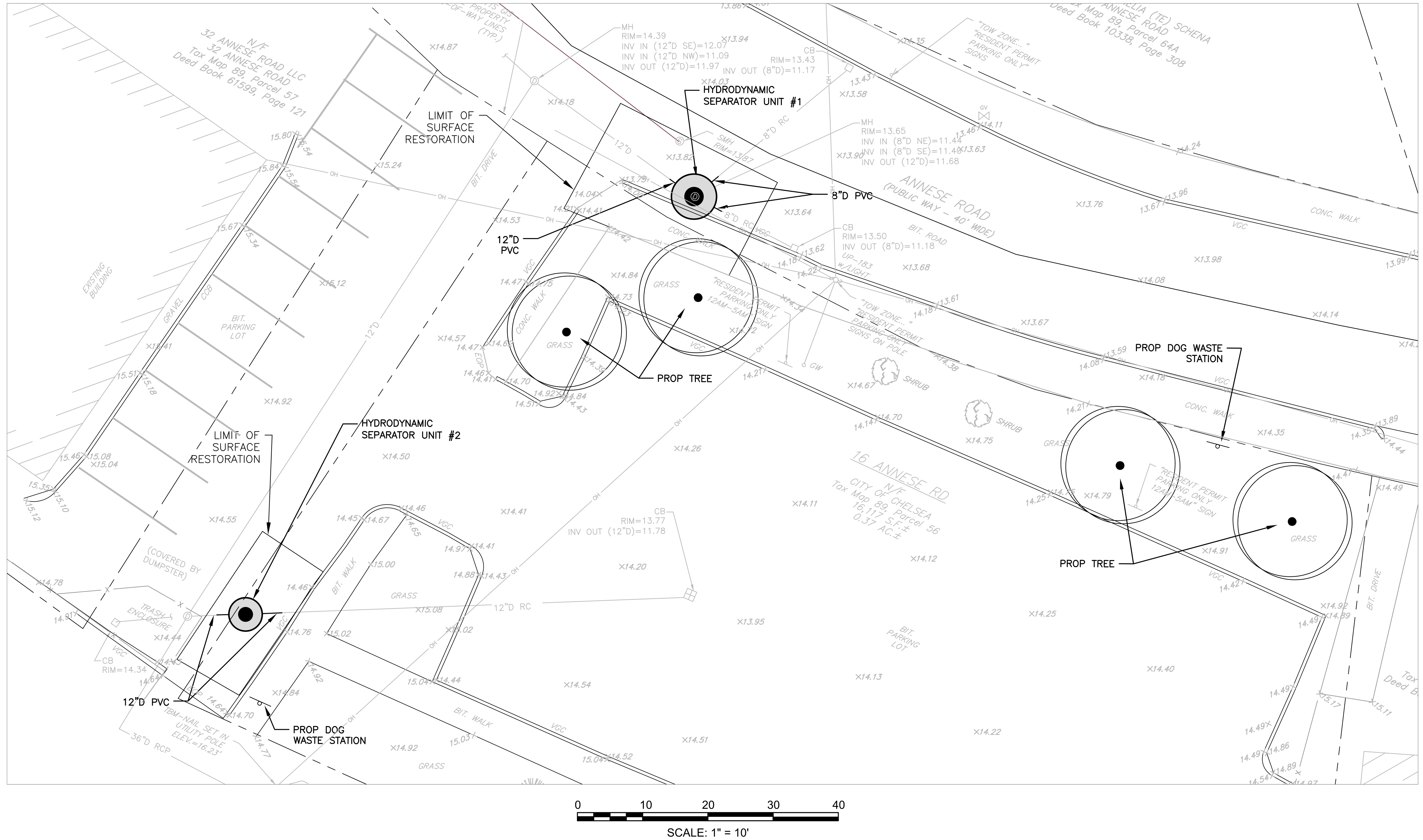
RTN	City/Town	Release Address	Site Name Location Aid	Reporting Category	Notification Date	Compliance Status	Date	Phase	RAO Class	Chemical Type	Notes
3-0034009	CHELSEA	1001 TO 1005 BROADWAY	NO LOCATION AID	72 HR	01/12/2017	PSC	01/03/2022	PHASE III	PC	Oil and Hazardous Material	Elevated PID readings from soil gas from a UST release found during the removal of the UST. C11 thru C22 aromatic hydrocarbons, petroleum, metals, and PAHs also detected in nearby soil. No reportable groundwater contamination present
3-0026912	CHELSEA	1012 BROADWAY	NO LOCATION AID	72 HR	06/28/2007	RTN CLOSED	02/29/2008			Oil	(Linked to RTN 3-0002069) Removal of a gasoline UST resulted in elevated PID readings in soil gas. Surrounding soil contaminated with petroleum following UST release, no groundwater contamination present
3-0024402	CHELSEA	1 FORBES ST	FORBES LITHOGRAPHIC COMPANY FMR	72 HR	11/12/2004	RTN CLOSED	09/26/2005			Hazardous Material	UST closure assessment revealed elevated TOV. A UST system on the site released toluene-based paint thinner into soil in the area. Toluene believed to be localized to the immediate vicinity of former USTs
3-0019662	CHELSEA	979 BROADWAY	NO LOCATION AID	72 HR	06/23/2000	RTN CLOSED	04/19/2001			Oil	(Linked to RTN 3-0001004) Historical gasoline release at this site from Exxon station. Hydraulic oil and hydraulic fluid contamination of soil from a hydraulic lift tank on the site
3-0019429	CHELSEA	EASTERN AVE AND CABOT ST	NO LOCATION AID	120 DY	04/04/2000	URAM	04/11/2000			Hazardous Material	Hazardous materials assessment completed before pipeline alignment revealedelevated VOC, VPH, and PAH concentrations. Some samples also had elevated metal concentrations (particularly lead). One groundwater monitoring well revealed elevated PAH levels
3-0012859	CHELSEA	979 BROADWAY	EXXON	TWO HR	08/28/1995	RTN CLOSED	11/16/2009			Oil	Linked to RTN 3-0001004
3-0011620	CHELSEA	980 BROADWAY	VACANT BLDG	120 DY	09/22/1994	RAO	09/22/1995		A1	Oil	Removal of underground heating oil tank revealed holes in tank resulting in petroleum-impacteds soils in the area, specifcally #2 fuel oil
3-0004246	CHELSEA	449 CRESCENT AVE	CHELSEA HOUSING AUTHORITY	NONE	04/25/1992	RAO	01/15/1999	PHASE II	A2	Oil	Release of petroleum (No. 2 heating oil) from a UST system identified during UST removal. This release resulted in soil contamination and low concentrations of petroleum found in groundwater
3-0002069	CHELSEA	1012 BROADWAY	AMERICAN FINISH & CHEM CO	120 DY	04/15/1989	PSC	06/10/2019	PHASE IV	PA	Oil	(Linked to RTN 3-0011620) Site redevelopment of new hotel revealed residual impacts of VOCs and petroleum present from former industrial and commercial operations contaminating soil and groundwater.
3-0001946	CHELSEA	DRAINAGE PROJECT	MILL CREEK	NONE	01/15/1989	DEPNDS	07/23/1993				Linked to RTN 3-0011620
3-0001755	CHELSEA	1 FORBES STREET MARGINAL ST	FORBES LITHOGRAPHIC CO FMR	NONE	01/15/1987	TMPS	09/03/2014		TN		Linked to RTN 3-0024402
3-0001004	CHELSEA	979 BROADWAY	EXXON SERVICE STATION	NONE	01/15/1990	RAO	05/07/2002	PHASE V	A2	Oil	(Linked to RTN 3-0011620) Petroleum impacted soil discovered during UST excavations. No reported damages to UST besides few small holes in the tank
3-0000292	CHELSEA	FORBES INDUS PARK NR MARGINAL ST	MORRELL REALTY TRUST FMR	NONE	01/15/1987	RTN CLOSED	03/16/1997				Linked to RTN 3-0024402

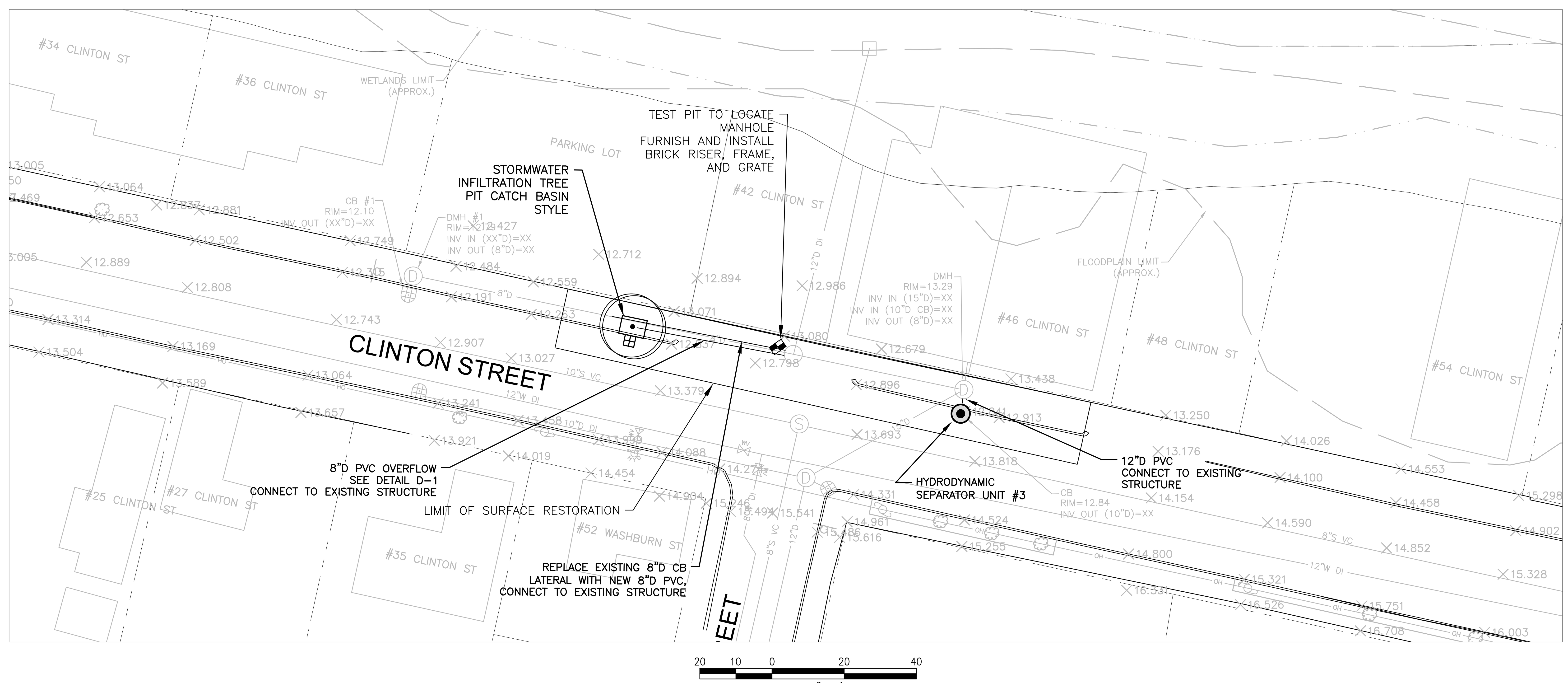
ATTACHMENT 4

CONSTRUCTION NOTES

1. THE CONTRACTOR SHALL CALL DIGSAFE AT 1–888–344–7233 AT LEAST 72 HOURS, SATURDAYS, SUNDAYS, AND HOLIDAYS EXCLUDED, PRIOR TO EXCAVATING AT ANY LOCATION. A COPY OF THE DIGSAFE PROJECT REFERENCE NUMBER(S) SHALL BE GIVEN TO THE OWNER PRIOR TO EXCAVATION.
2. LOCATIONS OF EXISTING PIPES, CONDUITS, UTILITIES, FOUNDATIONS AND OTHER UNDERGROUND OBJECTS ARE NOT WARRANTED TO BE CORRECT AND THE CONTRACTOR SHALL HAVE NO CLAIM ON THAT ACCOUNT SHOULD THEY BE OTHER THAN SHOWN.
3. ALL PAVEMENT DISTURBED BY THE CONTRACTOR'S OPERATIONS SHALL BE REPLACED IN ACCORDANCE WITH THE SPECIFICATIONS AND AS SHOWN ON THE DRAWINGS.
4. THE CONTRACTOR IS REQUIRED TO INSTALL THE SEDIMENT CONTROL DEVICES AT ALL CATCH BASINS IN THE WORK AREAS SHOWN BEFORE BEGINNING OTHER WORK ON SITE.
5. THE CONTRACTOR SHALL POST NOTICES AT LEAST 72 HOURS PRIOR TO OPERATIONS TO ALL AREAS REQUIRING TAKE OF PARKING . PARKING NOTICES SHALL BE SPECIFIC OVER DATES AND TIME PERIOD OF REQUIRED PARKING TAKE.
6. ELEVATIONS REFERENCED ARE NORTH AMERICAN VERTICAL DATUM (NAVD) 1988.
7. EXISTING UTILITIES, PROPERTY LINE INFORMATION, TOPOGRAPHIC INFORMATION, EDGES OF PAVEMENT, UTILITY POLES, AND LOCATIONS OF ABOVE GROUND STRUCTURES ARE DEPICTED BASED ON A COMBINATION OF GIS DATA, RECORD INFORMATION, AND INSTRUMENT SURVEY ON SITE (VOKE PARK).
8. IN PAVED AREAS THE TOP OF MANHOLE COVERS SHALL BE SET OR RESET AS NEEDED TO SIT FLUSH WITH THE TOP–COURSE PAVED SURFACE.
9. THE CONTRACTOR SHALL OBTAIN A HYDRANT METER AND BACKFLOW PREVENTER FROM THE CITY PRIOR TO USING ANY FIRE HYDRANT.
10. CONSTRUCTION MATERIALS AND EXCAVATED MATERIALS MAY NOT BE STOCKPILED ON THE STREET OVERNIGHT. ARRANGEMENTS SHALL BE MADE TO TRANSPORT MATERIALS TO AND FROM THE SITE ON A DAILY BASIS.
11. CONTRACTOR SHALL LOAM AND SEED DISTURBED GRASS SPACES OUTSIDE OF THE RIGHT OF WAY AND PROXIMATE TREE PLANTINGS.
12. CONTRACTOR SHALL REPLACE HOT MIX ASPHALT STREET, LOT, AND SIDEWALK PAVEMENTS IN–KIND. CONTRACTOR SHALL REPLACE CEMENT CONCRETE SIDEWALKS IN–KIND WITHIN LIMITS SHOWN. CURB DISRURBED BY OPERATIONS SHALL BE REMOVED AND RESET.







Project:

MILL CREEK WATER QUALITY IMPROVEMENTS

Weston & Sampson

Weston & Sampson Engineers, Inc.
55 Walkers Brook Drive, Suite 100
Reading, MA 01867
978.532.1900 800.SAMPSON
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Drawn By: AAL
Reviewed By: TPC
Approved By: BWA

W&S Project No.: ENG22-0200
W&S File No.:

Drawing Title:

CONSTRUCTION PLAN

Sheet Number:

C-1

Rev Date: JUNE 2022

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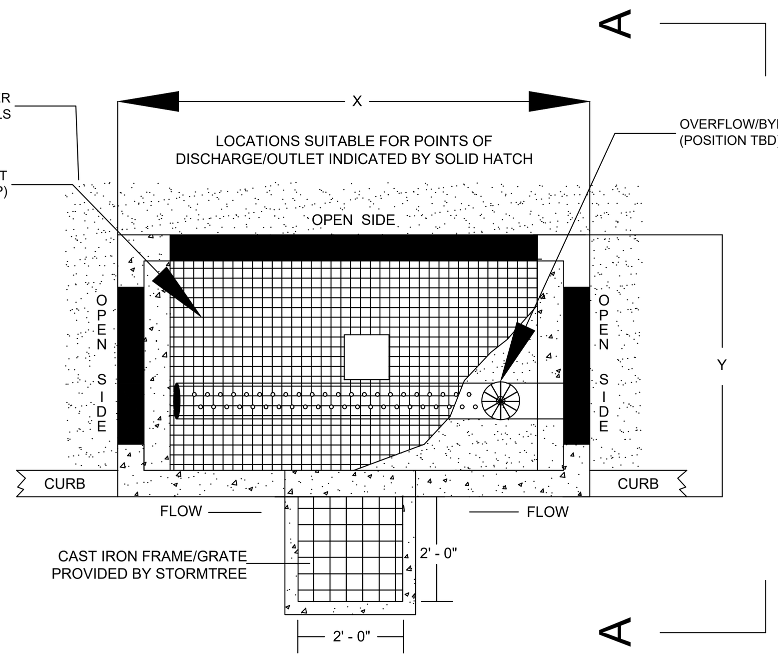
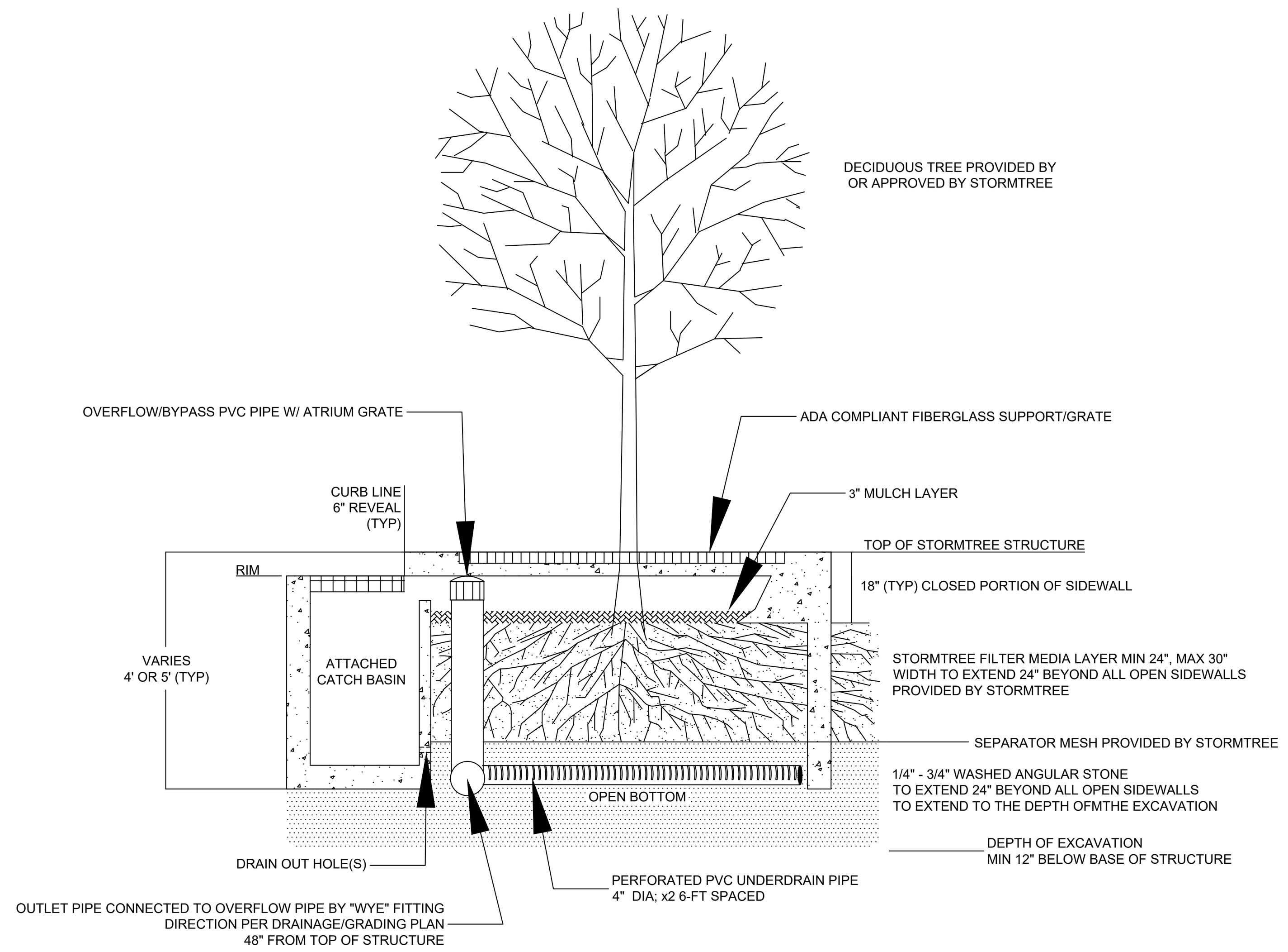


PLAN VIEW
NOT TO SCALE

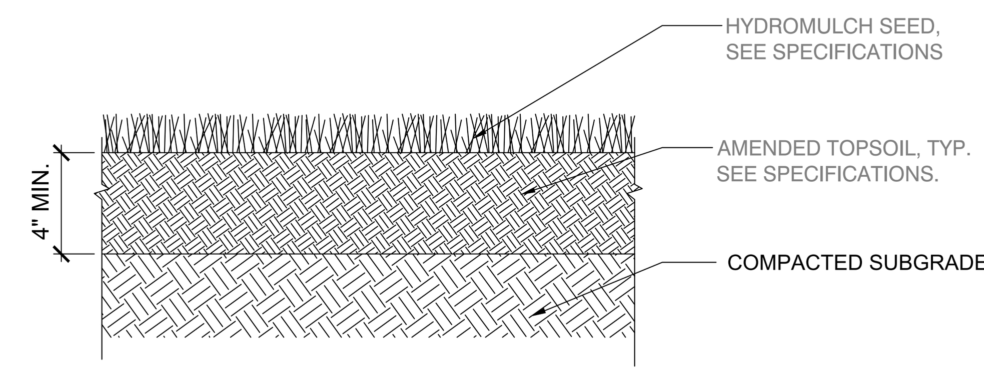


SECTION A-A
NOT TO SCALE

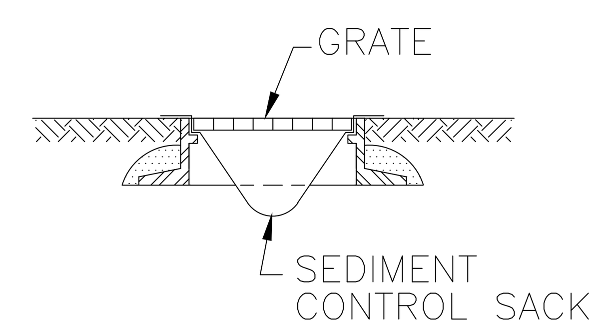
SITE SPECIFIC (CATCH BASIN ENTRY)							
LOCATION	STORMTREE MODEL	RIM INLET ELEV.	OUTLET PIPE ELEV.	TREATMENT FLOW RATE (CFS)	BYPASS FLOW RATE (CFS)	OUTLET PIPE (DIA)	REMARKS
TREE PIT #1	*ST-6X4-CB*	13.0	9.0	*0.082*	*1.02*	*8"*	5" CURB REVEAL

DIMENSIONS AND PERFORMANCE							
MODEL	X	Y	MEDIA BAY	TREATMENT FLOW RATE (CFS)	MAX OUTLET BYPASS PIPE (DIA)	MAX BYPASS FLOW (CFS)	UNDERDRAIN PIPE (DIA)
ST-6X4-CB	7	5	6' X 4'	0.082	8"	1.02	4"

- INFILTRATION TREE PIT
NOT TO SCALE



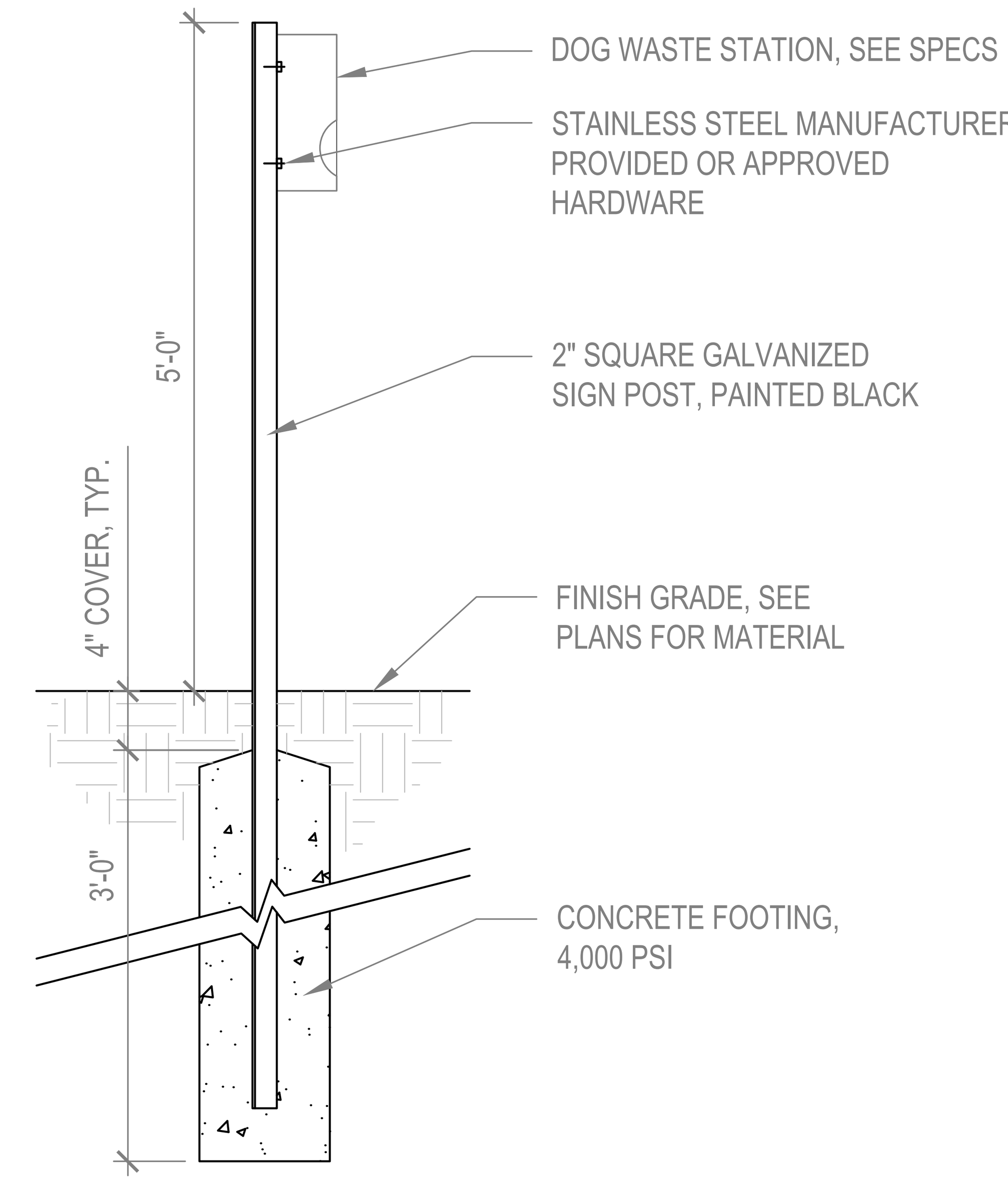
- LOAM AND SEED (AT BACK OF SIDEWALK TRANSITION AND TREES)
SCALE: N.T.S.



- CATCH BASIN PROTECTION DETAIL
SCALE: N.T.S.

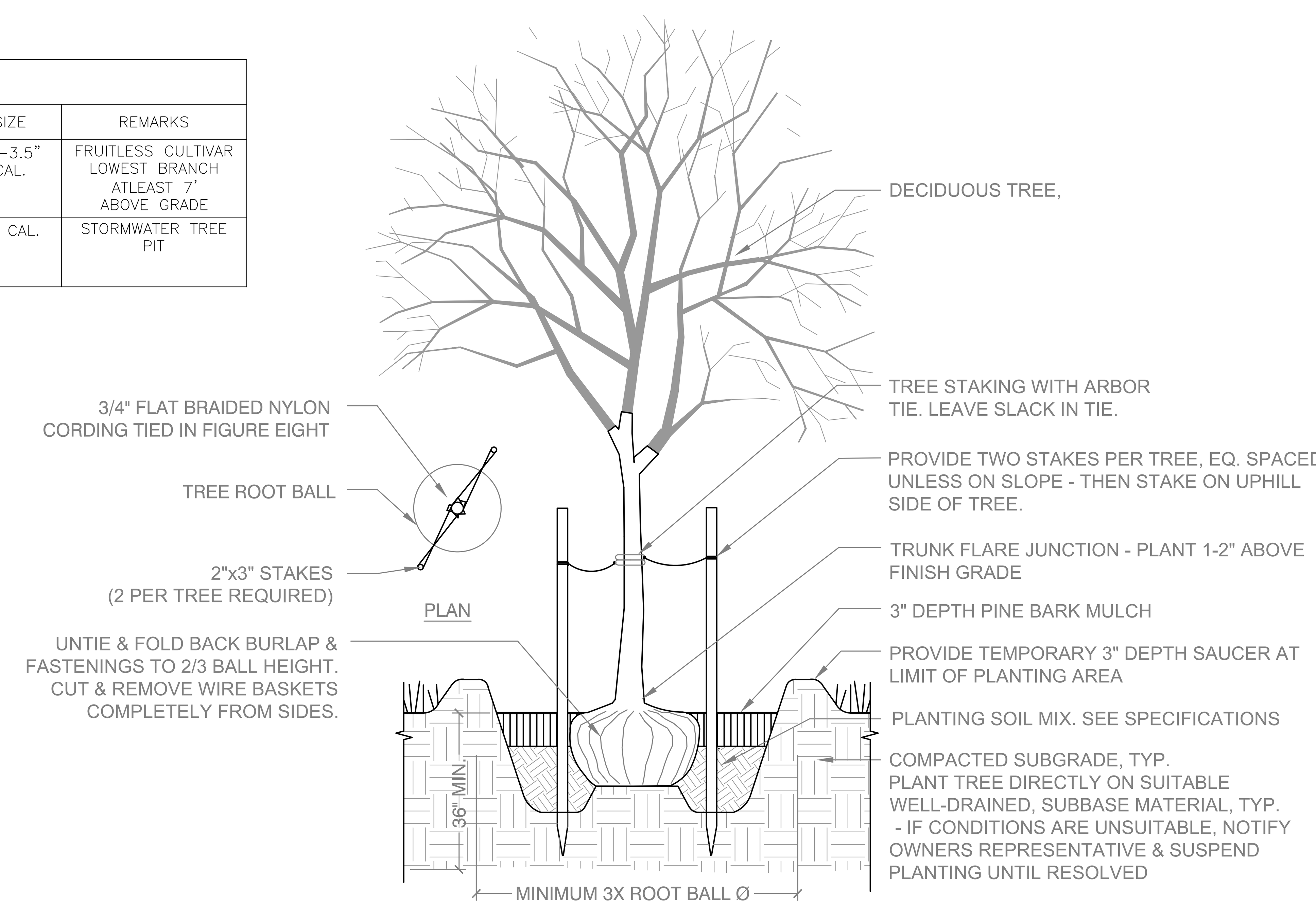
PLANT_SCHEDULE

TREES	CODE	QTY	BOTANICAL NAME	COMMON NAME	SIZE	REMARKS
	LS	4	Liquidambar styraciflua	Sweet Gum	3"–3.5" CAL.	FRUITLESS CULTIVAR LOWEST BRANCH ATLEAST 7' ABOVE GRADE
	MT	1	Acer Buergerianum	Maple Trident	2" CAL.	STORMWATER TREE PIT



NOTES:
CONCRETE FOOTING SHALL CONSIST OF:
A. ONE (1) PART HIGH EARLY STRENGTH CEMENT
B. ONE AND ONE HALF (1 1/2) PARTS CLEAN, SHARP SAND.
C. THREE (3) PARTS COURSE AGGREGATE
D. CLEAN WATER TO FORM MIXTURE

- DOG WASTE STATION
SCALE: 3/4" = 1'-10"



- TREE PLANTING
SCALE: N.T.S.

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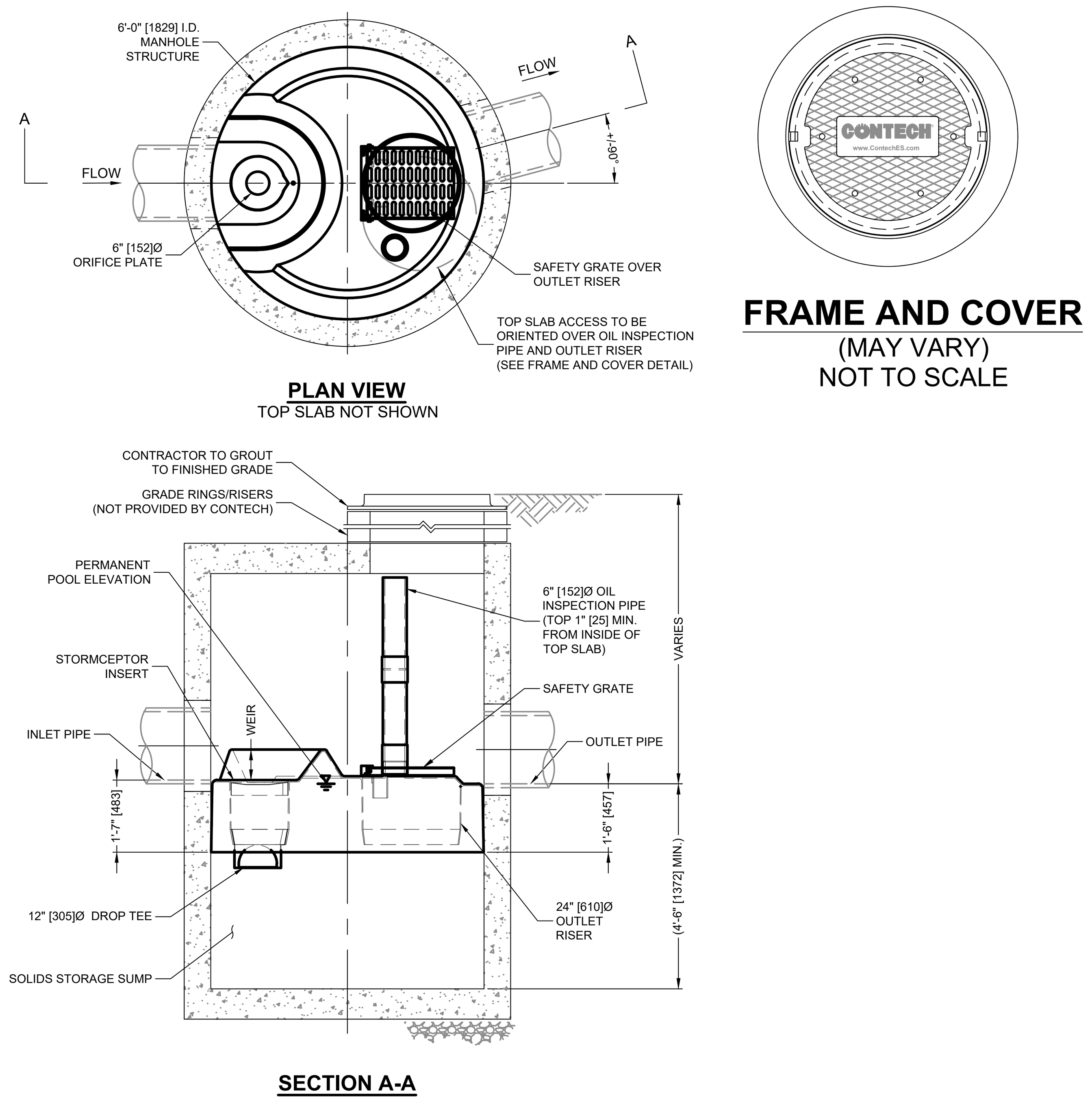
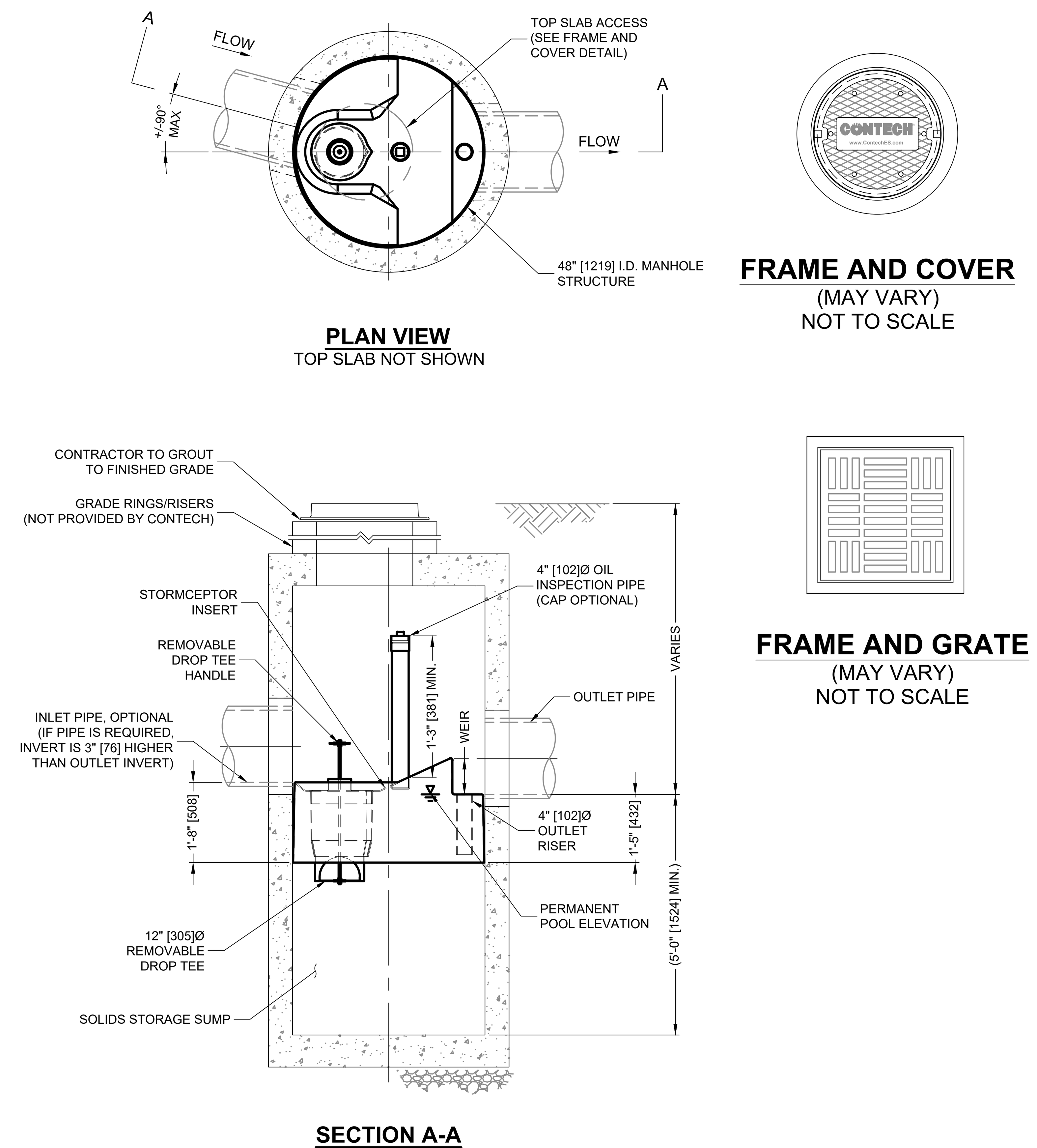


- HYDRODYNAMIC SEPARATOR #1 (WITH x2 INLET PIPE AND MH COVER)

NOT TO SCALE



- HYDRODYNAMIC SEPARATOR #2, #3 (#2 WITH INLET PIPE AND MH COVER, #3 WITH GRATE NO INLET PIPE)

NOT TO SCALE

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Date: JUNE 2022

Drawn By: AAL

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DETAILS 2

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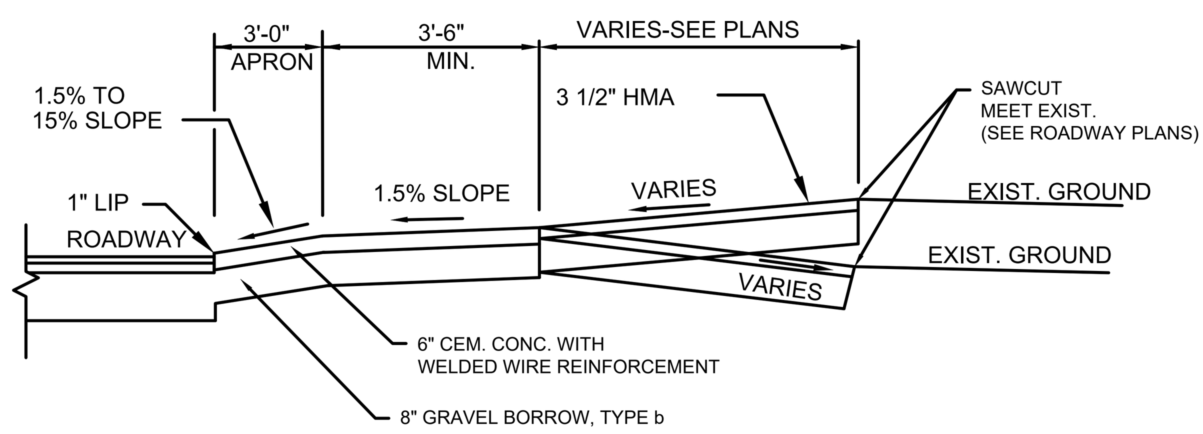
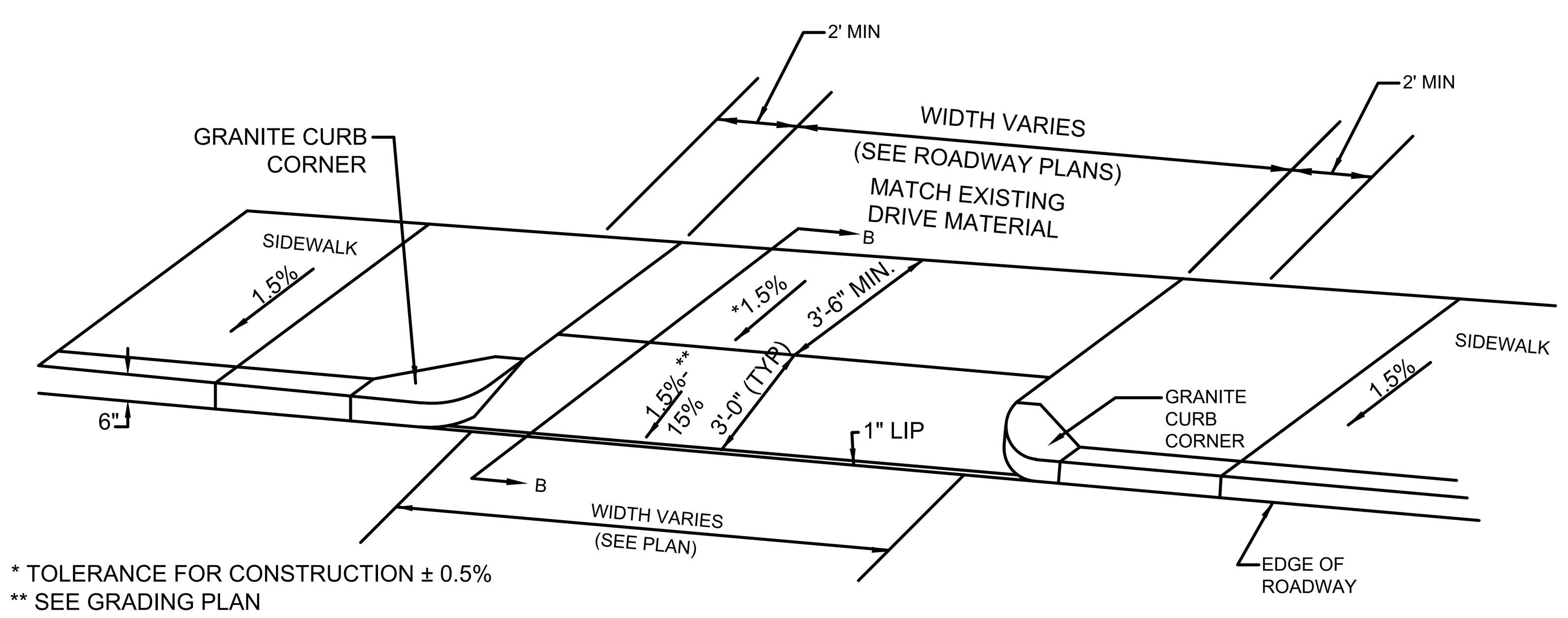


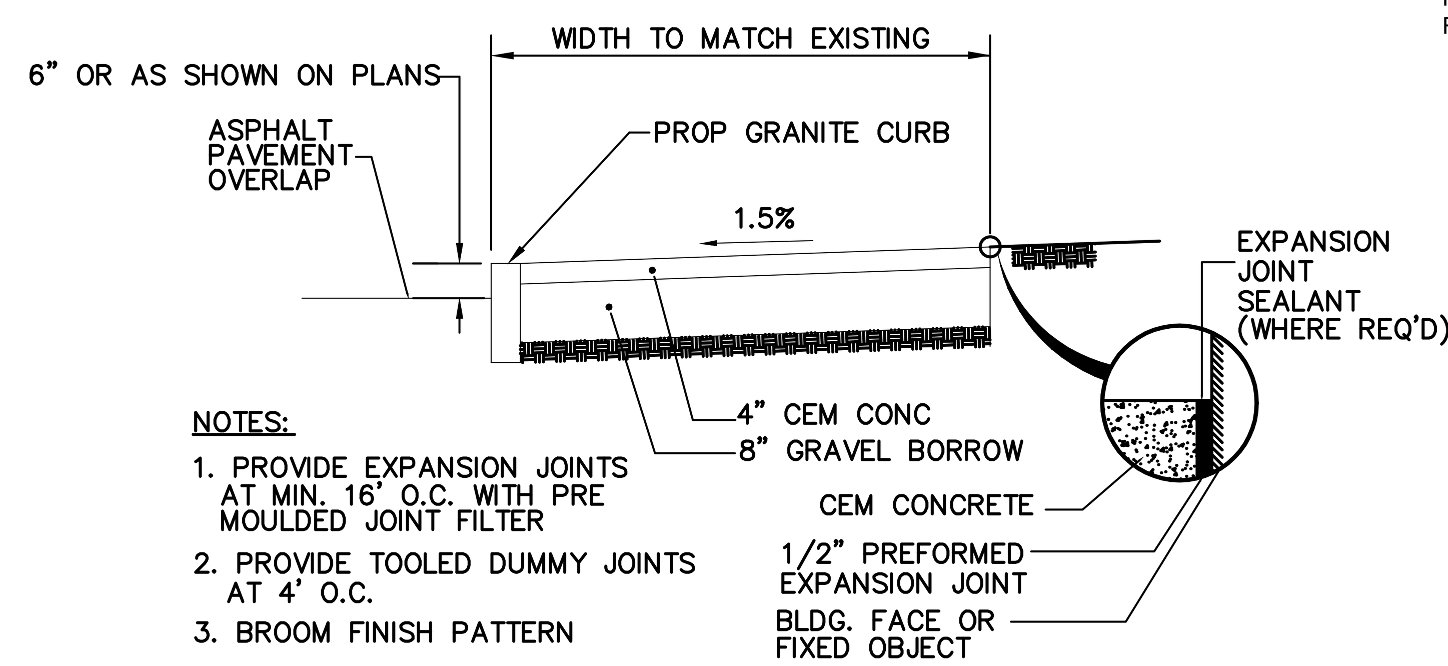
CEM. CONC. DRIVEWAY APRON
N.T.S.



* TOLERANCE FOR CONSTRUCTION ± 0.5%
** SEE GRADING PLAN

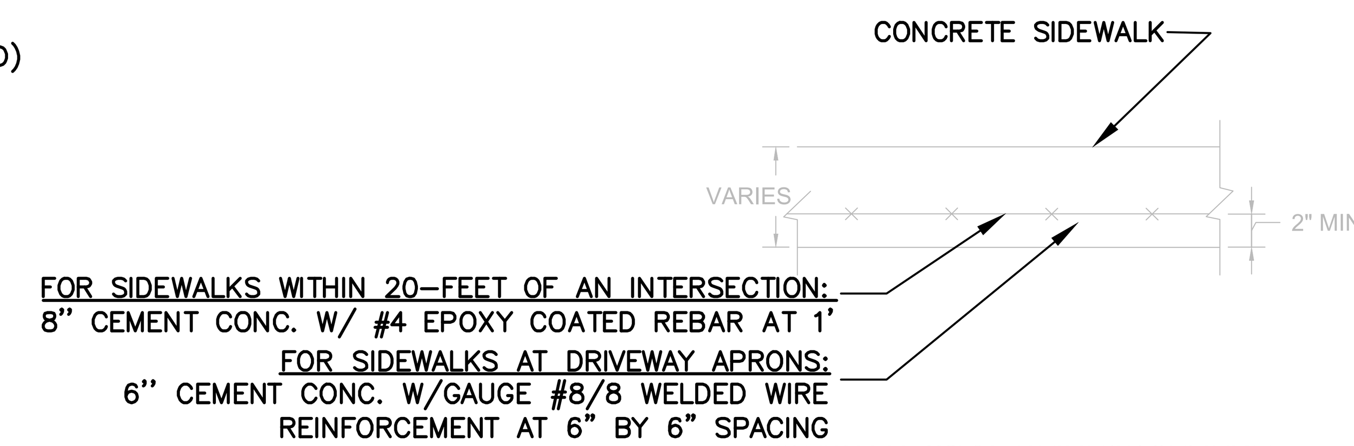
CEMENT CONCRETE DRIVE
N.T.S.

NOTES:
1. EXISTING GRANITE DRIVEWAY CURB CORNERS SHALL BE REMOVED AND RESET OR REMOVED AND REPLACED AS REQUIRED BY THE RESIDENT ENGINEER.

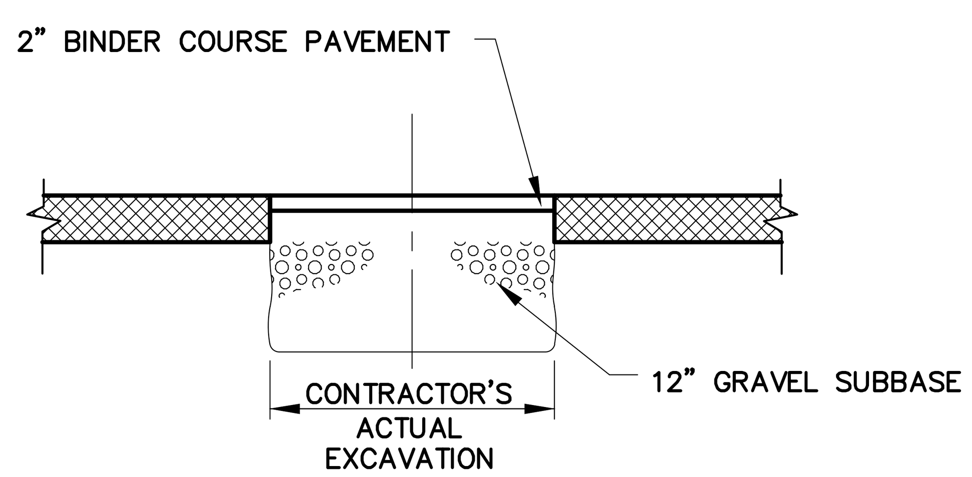


NOTES:
1. PROVIDE EXPANSION JOINTS AT MIN. 16' O.C. WITH PRE MOULDED JOINT FILTER
2. PROVIDE TOOLED DUMMY JOINTS AT 4' O.C.
3. BROOM FINISH PATTERN

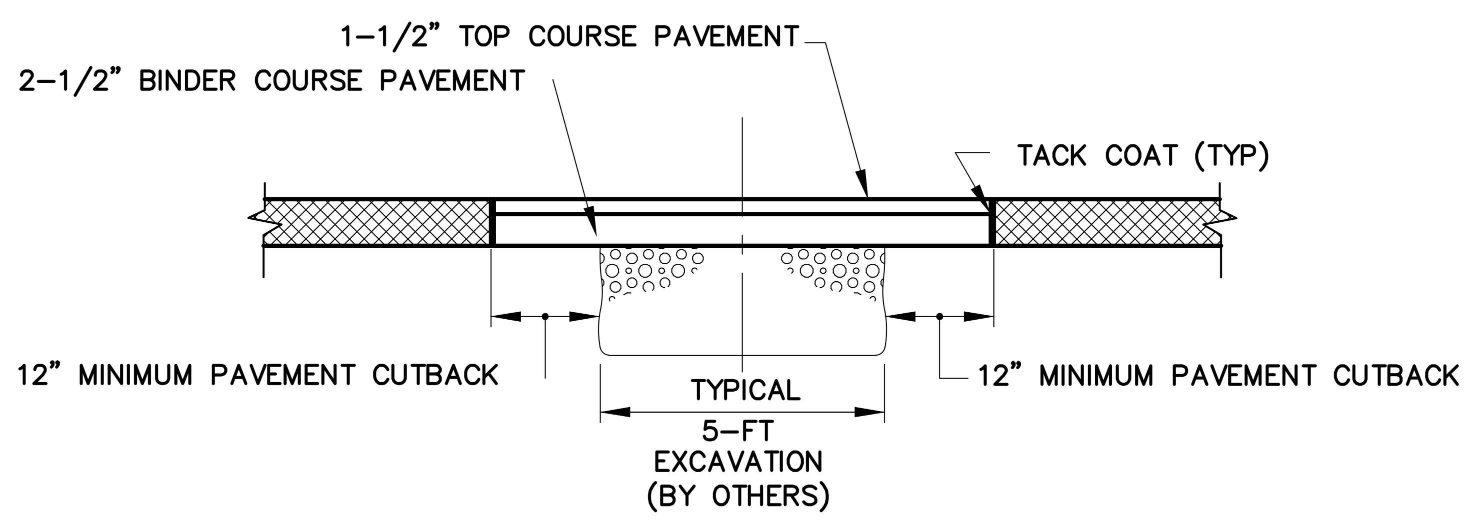
CEMENT CONCRETE WALK
N.T.S.



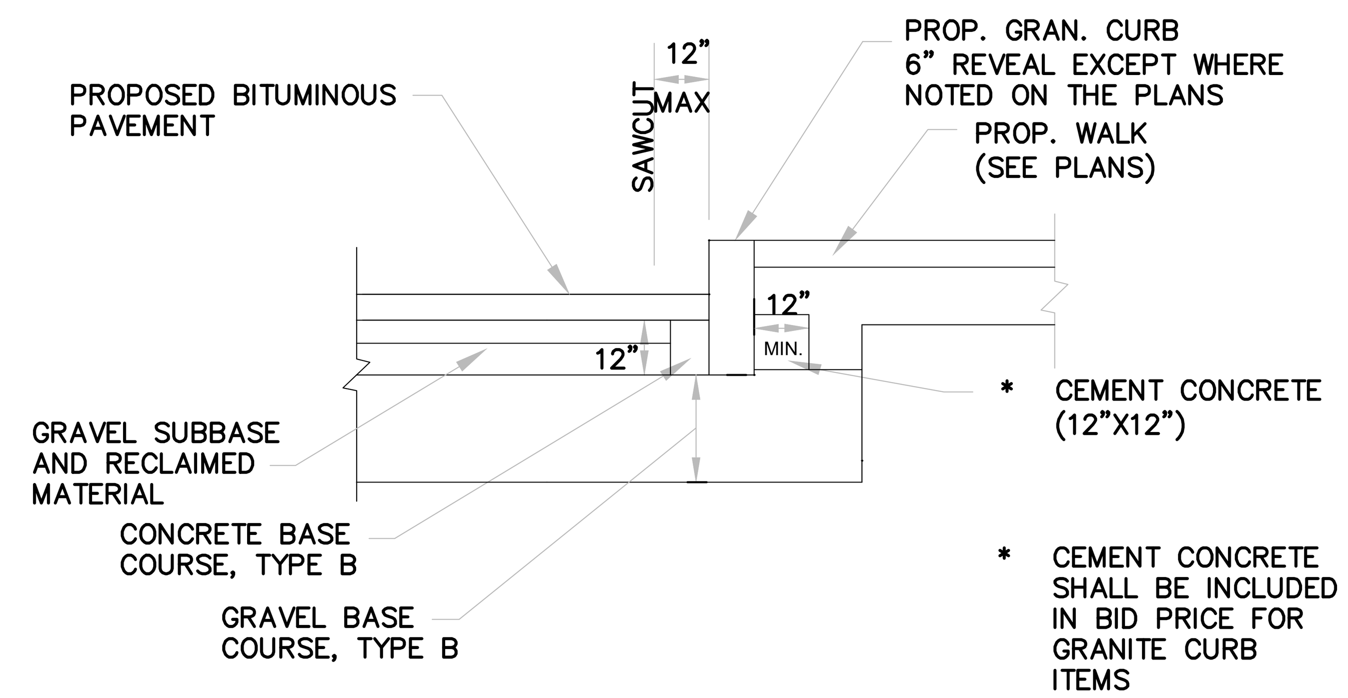
SIDEWALK WITH REINFORCEMENT
N.T.S.



TEMPORARY PAVEMENT DETAIL
N.T.S.



TYPE 2, PERMANENT TRENCH PAVEMENT
N.T.S.



CURB INSTALLATION IN FULL DEPTH PAVEMENT
N.T.S.

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Reviewed By: TPC
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DETAILS 3

Sheet Number:

D-3

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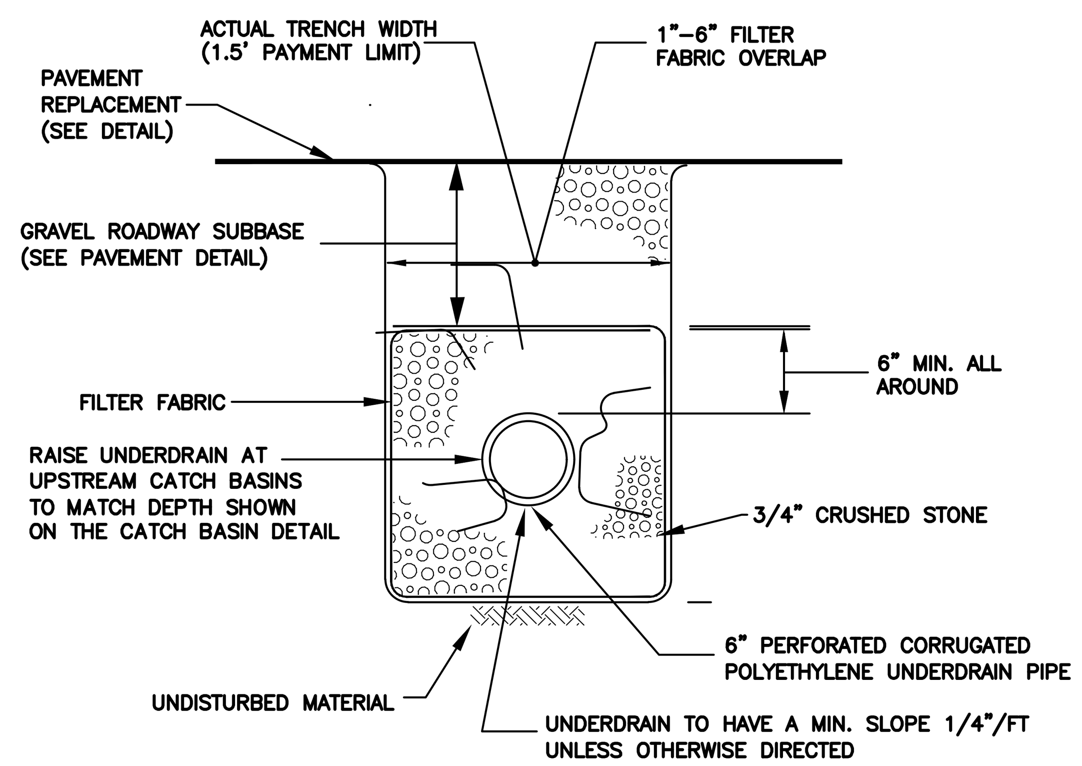
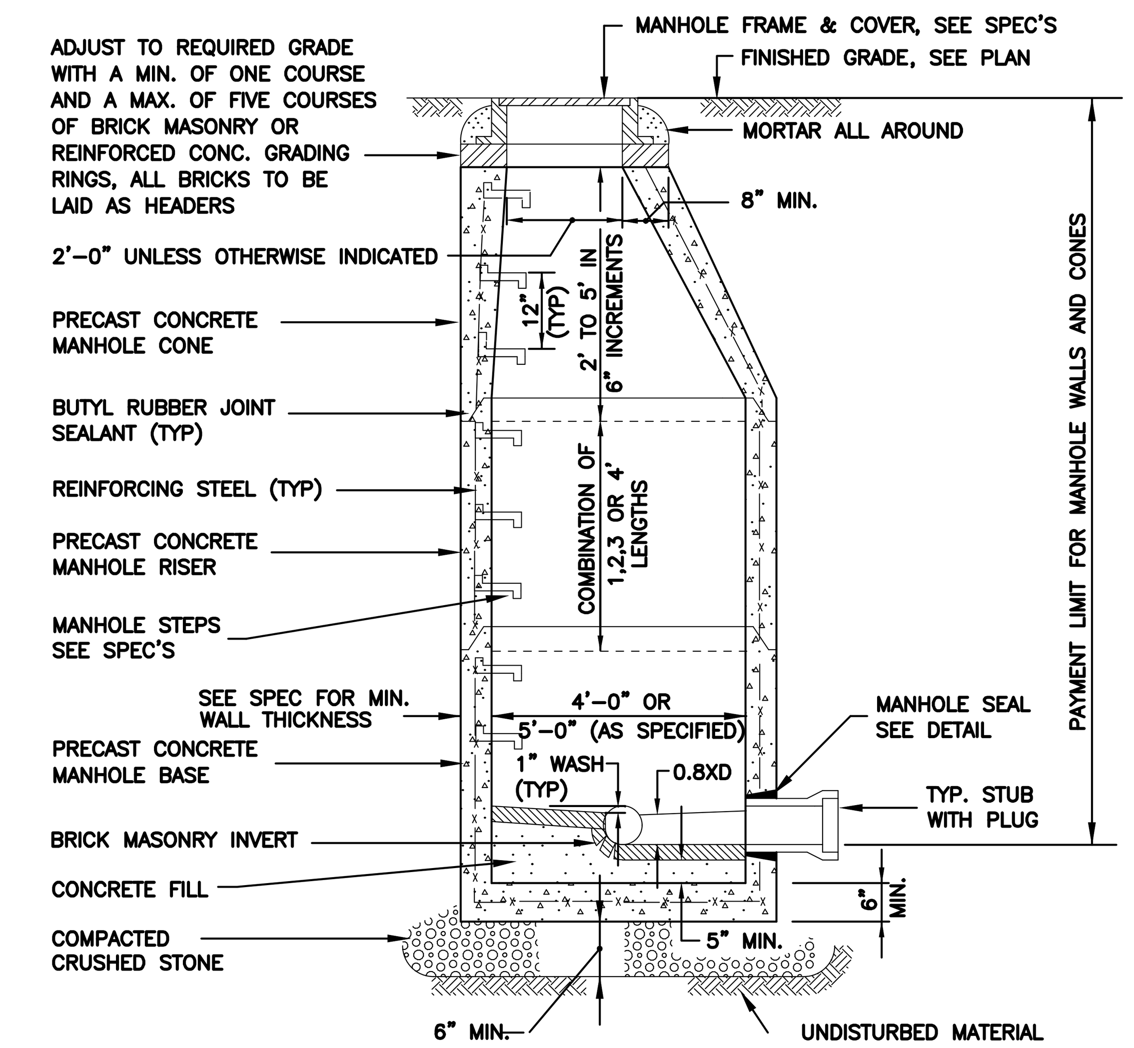
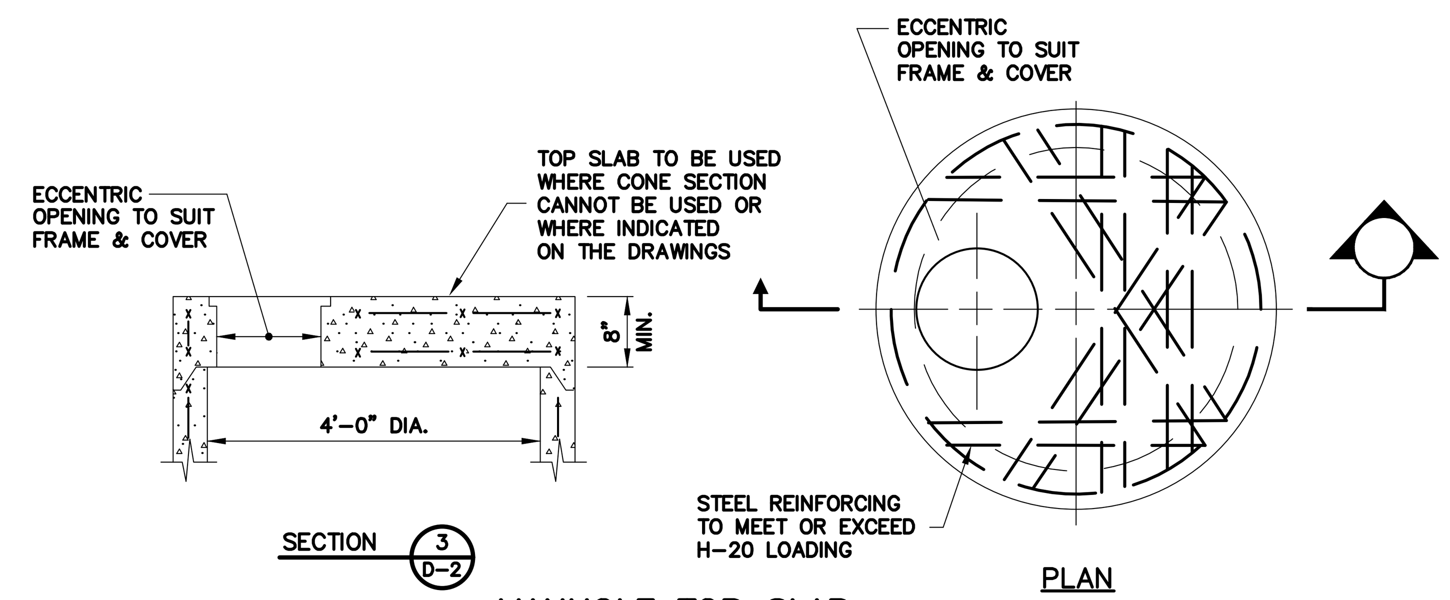


NOTE: A TEE AND CAPPED STUB SHALL BE INSTALLED AT THE CURB FOR EACH RESIDENCE

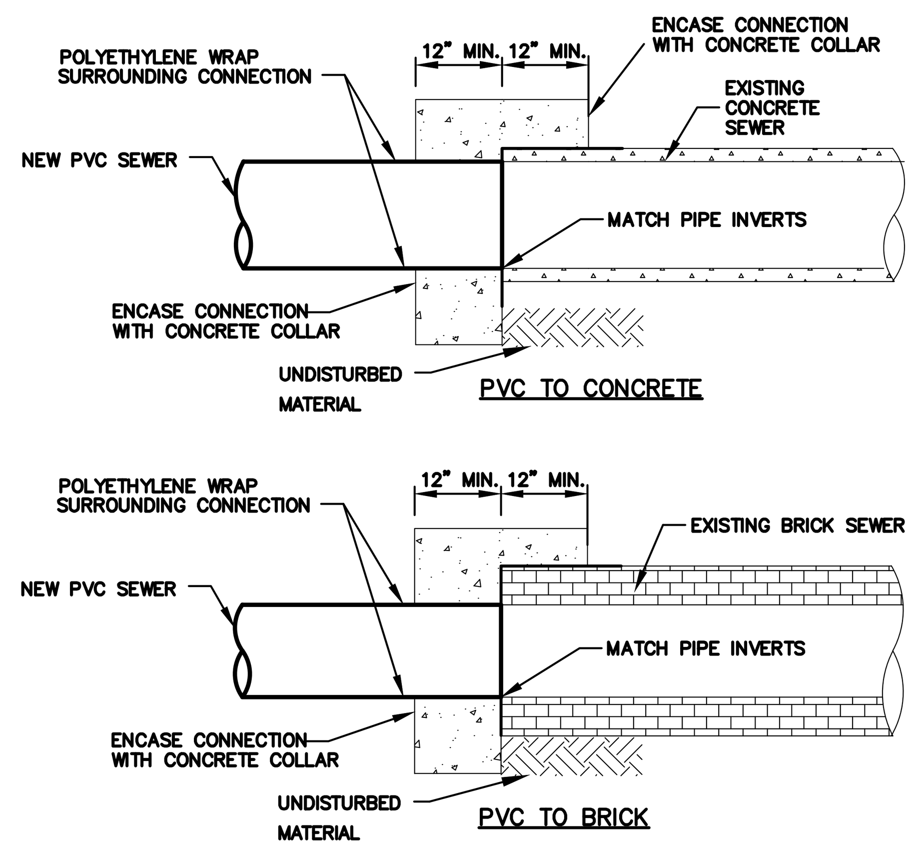
UNDERDRAIN TRENCH DETAIL
N.T.S.



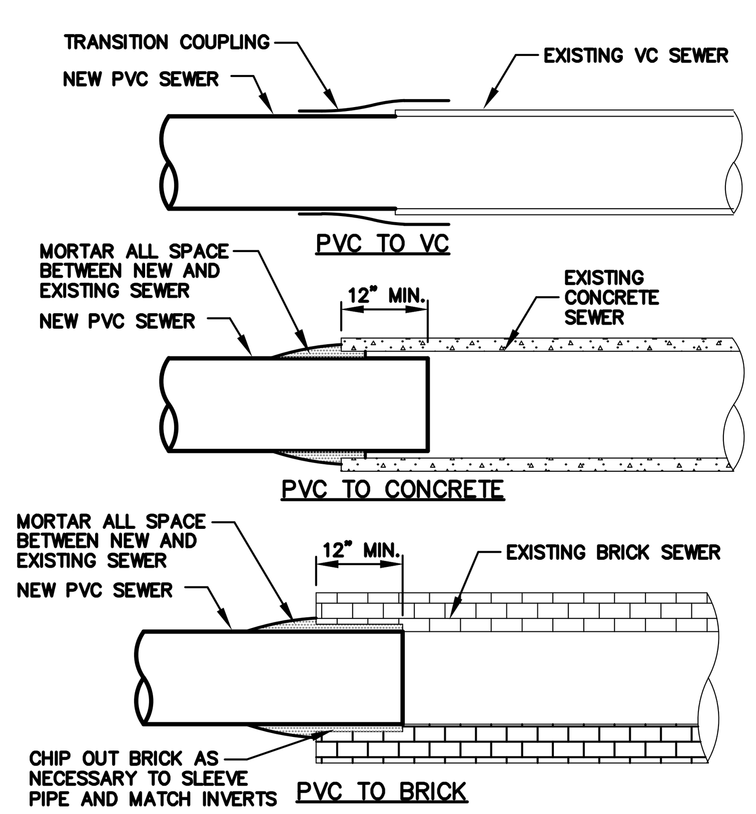
PRECAST CONCRETE MANHOLE DETAIL
N.T.S.



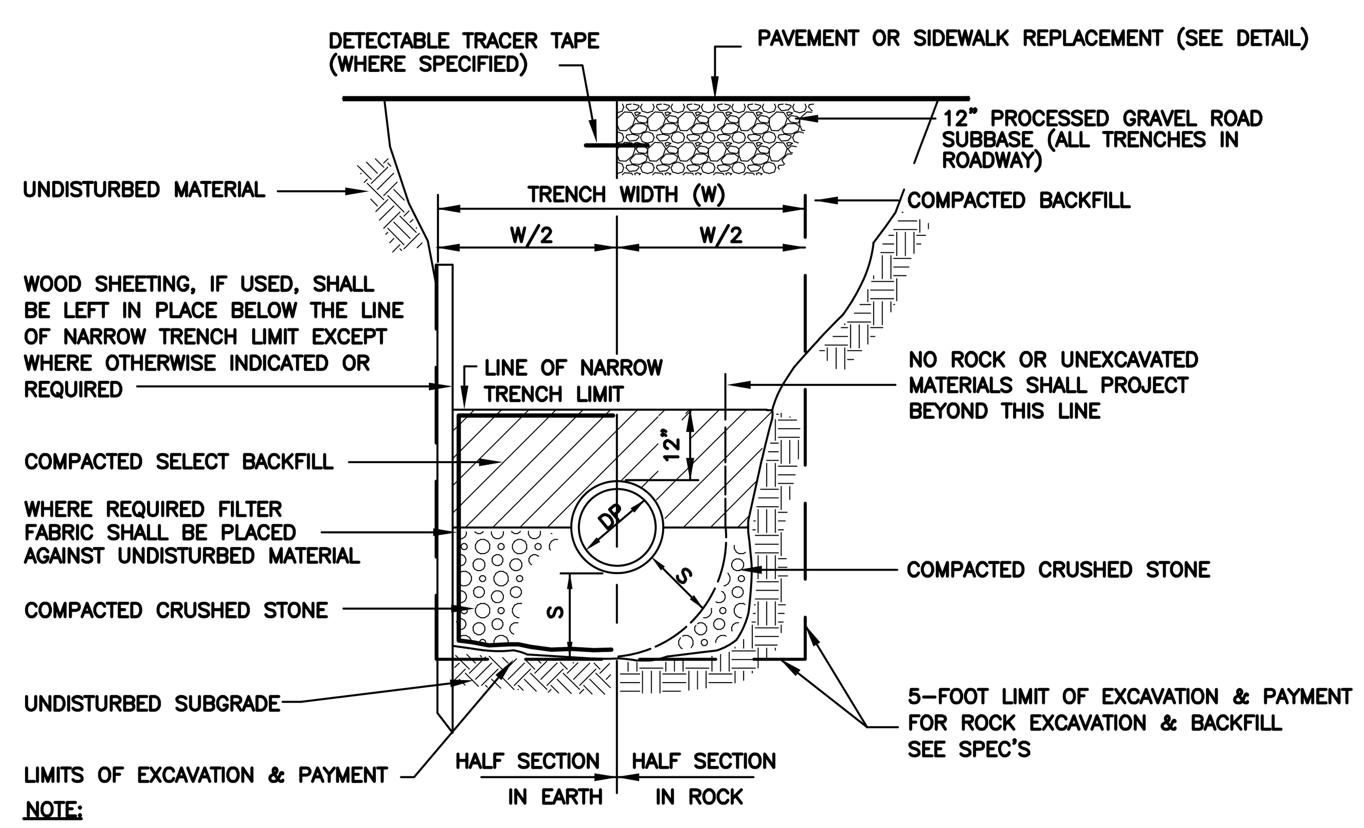
MANHOLE TOP SLAB
N.T.S.



SEWER TRANSITION DETAILS – UPSTREAM CONNECTIONS
N.T.S.



SEWER TRANSITION DETAILS – DOWNSTREAM CONNECTION
N.T.S.



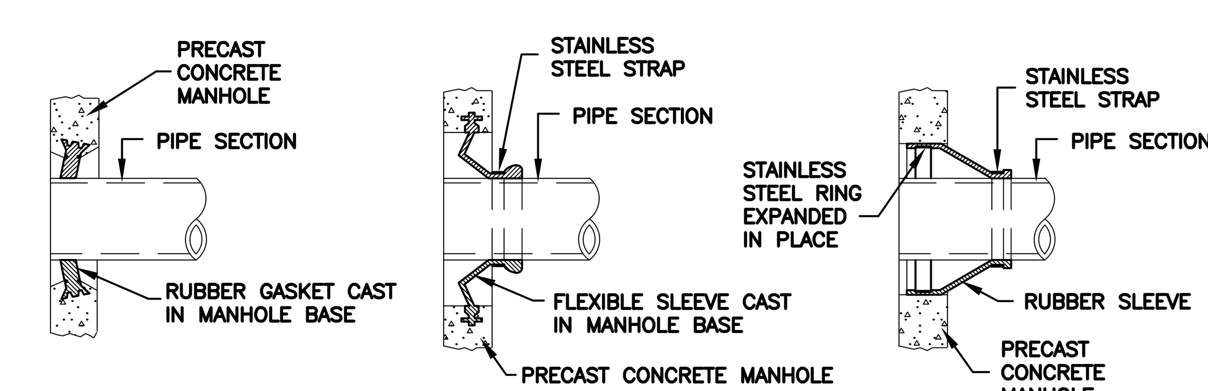
NOTE:
FOR W, DP, & S, SEE TABLE A

TRENCH DETAIL
(SEWER OR DRAIN)
N.T.S.

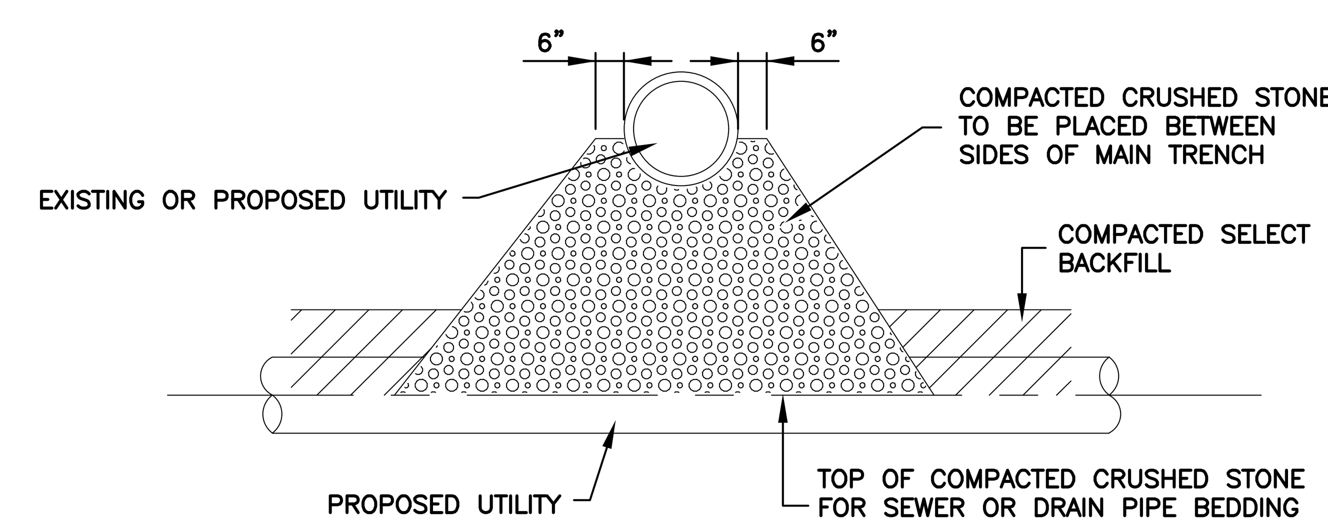
DEPTH TO INVERT	DIAMETER OF PIPE (DP)	MAXIMUM TRENCH WIDTH BELOW LINE OF NARROW TRENCH LIMIT (SHEETED OR UNSHEETED) (W)	MINIMUM CLEARANCE (S)
0–12'	TO 18"	5'	6"
0–12'	21"–24"	5'	7-1/2"
0–12'	27"–36"	6'	9"
OVER 12'	TO 18"	7'	6"
OVER 12'	21"–24"	7'	7-1/2"

TABLE A

NOTE:
THE "DROP OVER" SECTION SHALL BE INDEPENDENTLY SUPPORTED TO ALLOW FOR PROPER CURING OF THE BASE SLAB



MANHOLE SEAL DETAILS
N.T.S.



UTILITY CROSSING DETAIL
N.T.S.

Project:

MILL CREEK WATER QUALITY IMPROVEMENTS

Weston & Sampson
Weston & Sampson Engineers, Inc.
55 Walkers Brook Drive, Suite 100
Reading, MA 01867
978.532.1900 800.SAMPSON
www.westonandsampson.com

Consultants:

Revisions:

No.	Date	Description

Seal:

COA:

Issued For:
50% DRAFT DESIGN

Scale:
Date: JUNE 2022
Drawn By: AAL
Reviewed By: TPC
Approved By: BWA

W&S Project No.: ENG22-0200
W&S File No.:

Drawing Title:
DETAILS 4

Sheet Number:
D-4

Rev Date: JUNE 2022

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ATTACHMENT 5

Stormceptor® STC

Stormceptor STC is the recognized leader in stormwater treatment, offering a range of versatile treatment systems that effectively remove pollutants from stormwater and snowmelt runoff. Stormceptor is flexibly designed to protect waterways from hazardous material spills and stormwater pollution, including suspended sediment, free oils, and other pollutants that attach to particles, no matter how fierce the storm.

Stormceptor's scour prevention technology ensures pollutants are captured and contained during all rainfall events.

Ideal uses

- Sediment (TSS) removal
- Spill control
- Debris and small floatables capture
- Pretreatment for filtration, detention/retention systems, ponds, wetlands, Low Impact Development (LID), green infrastructure, and water-sensitive urban design

Learn More:
www.ContechES.com/stormceptor

Proven performance

With more than 20 years of industry experience, Stormceptor has been performance tested and verified by some of the most stringent technology evaluation programs in North America.

- NJCAT
- Washington ECOLOGY
- EN858 Class 2

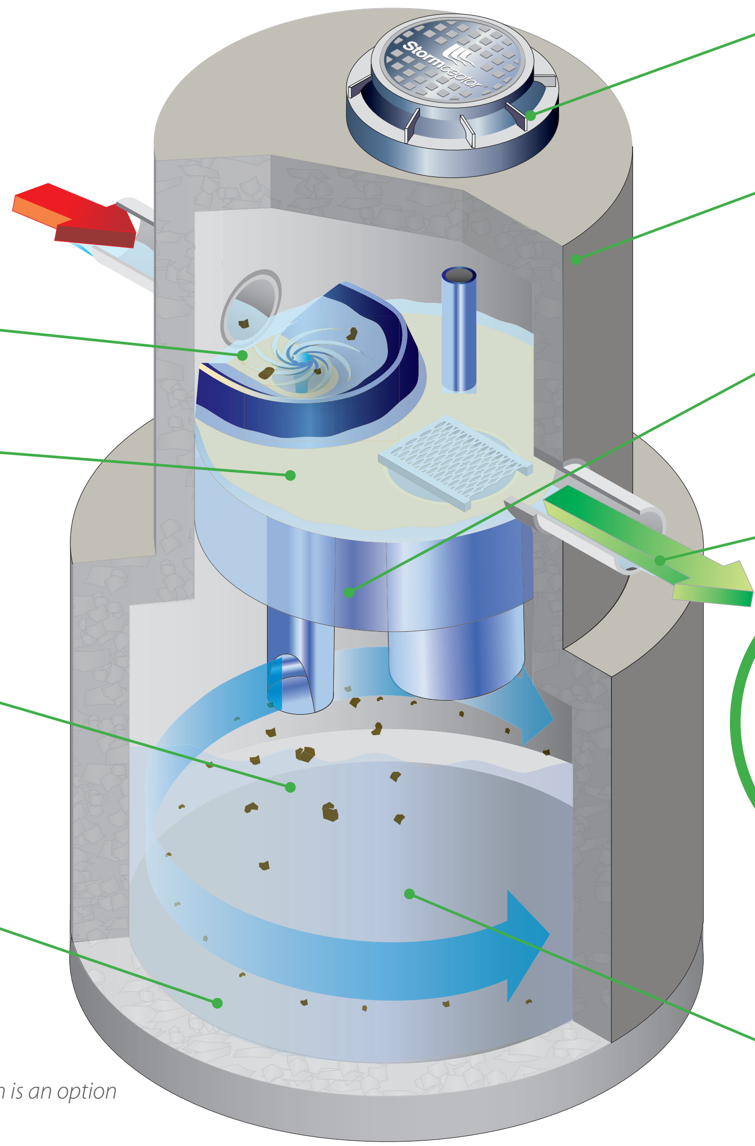
FEATURE	BENEFIT
Patented scour prevention technology	Superior pollutant removal and retention
Can take the place of a conventional junction or inlet structure	Eliminates the need for additional structures
Minimal drop between inlet and outlet	Site flexibility
Multiple inlets can connect to a single unit	Design flexibility
3rd party tested and verified performance (Sediment & Oil)	Eliminates the need for a separate bypass structure

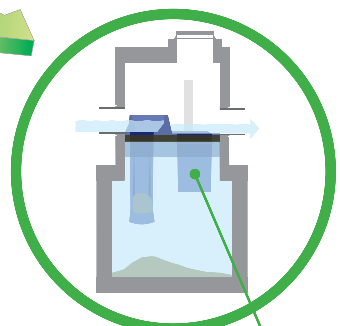
With over 40,000 units operating worldwide, Stormceptor performs and protects every day, in every storm.

A calm treatment environment

CONTECH® ENGINEERED SOLUTIONS

Stormceptor® STC

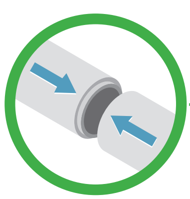




* *Fiberglass construction is an option*

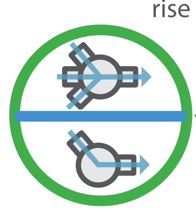
EASY TO INSTALL

Small footprint saves time and money with limited disruption to your site.



SEAMLESS

Minimal drop between inlet and outlet pipes makes Stormceptor ideal for retrofits and new development projects.

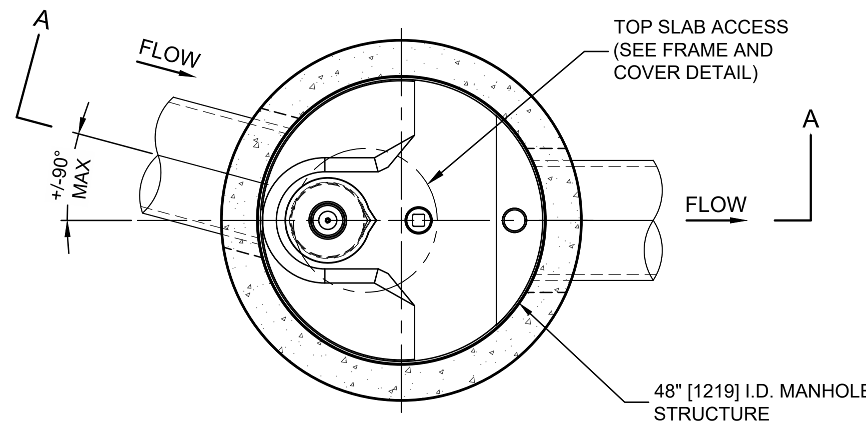


FLEXIBLE

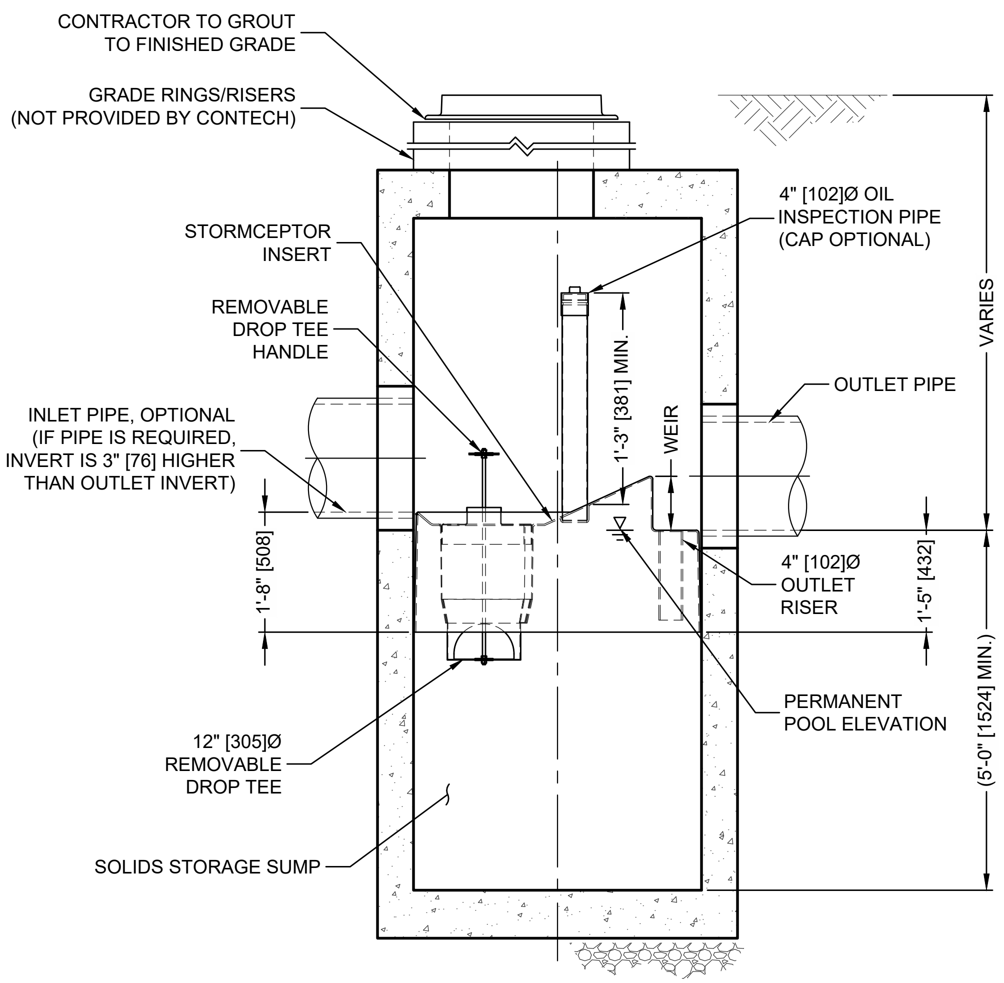
Multiple inlets can connect to a single unit. Can be used as a bend structure.

A calm treatment environment

CONTECH ENGINEERED SOLUTIONS



PLAN VIEW
TOP SLAB NOT SHOWN



SECTION A-A

Stormceptor®

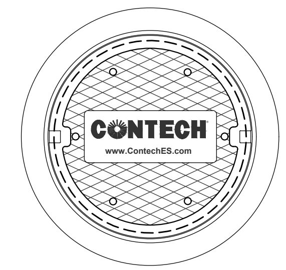
FOR PATENT INFORMATION, GO TO www.ContechES.com/IP

I:\COMMON\CAD\TREATMENT\23 STORMCEPTOR\40 STANDARD DRAWINGS\IN PROCESS\STC450I-DTL.DWG 2/1/2019 3:12 PM

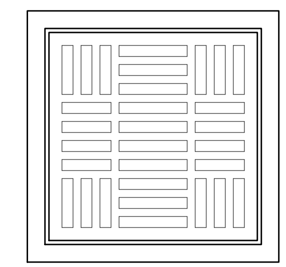
STORMCEPTOR DESIGN NOTES

THE STANDARD STC450I CONFIGURATION WITH ROUND, SOLID FRAME AND COVER, AND INLET PIPE IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES



FRAME AND COVER
(MAY VARY)
NOT TO SCALE



FRAME AND GRATE
(MAY VARY)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (cfs [L/s])			
PEAK FLOW RATE (cfs [L/s])			
RETURN PERIOD OF PEAK FLOW (yrs)			
RIM ELEVATION			
PIPE DATA:	INVERT	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
NOTES / SPECIAL REQUIREMENTS:			

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. STORMCEPTOR WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STORMCEPTOR STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2' [610], AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. STORMCEPTOR STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C478 AND AASHTO LOAD FACTOR DESIGN METHOD.
6. ALTERNATE UNITS ARE SHOWN IN MILLIMETERS [mm].

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMCEPTOR MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

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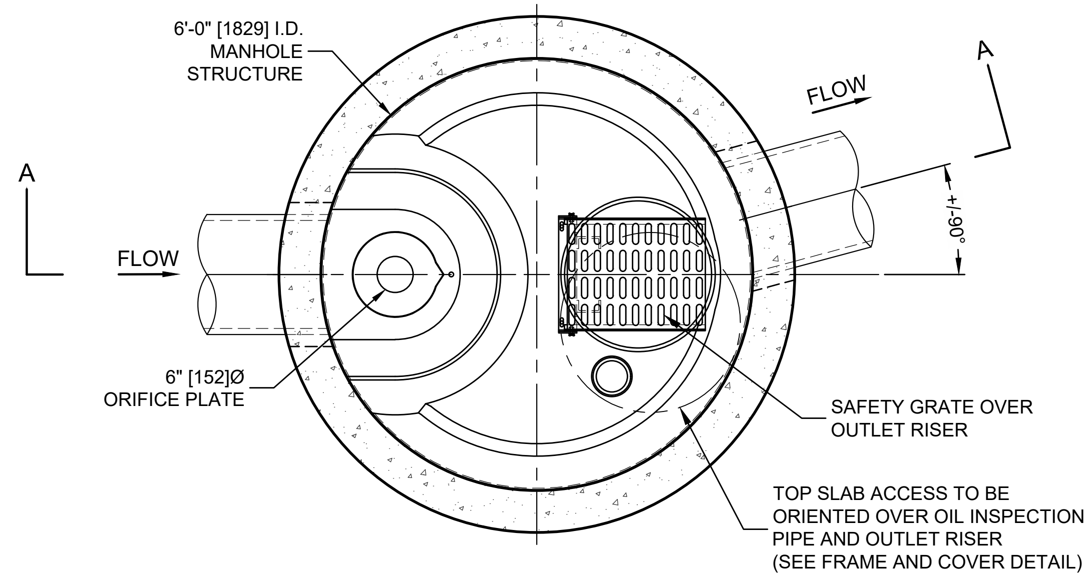
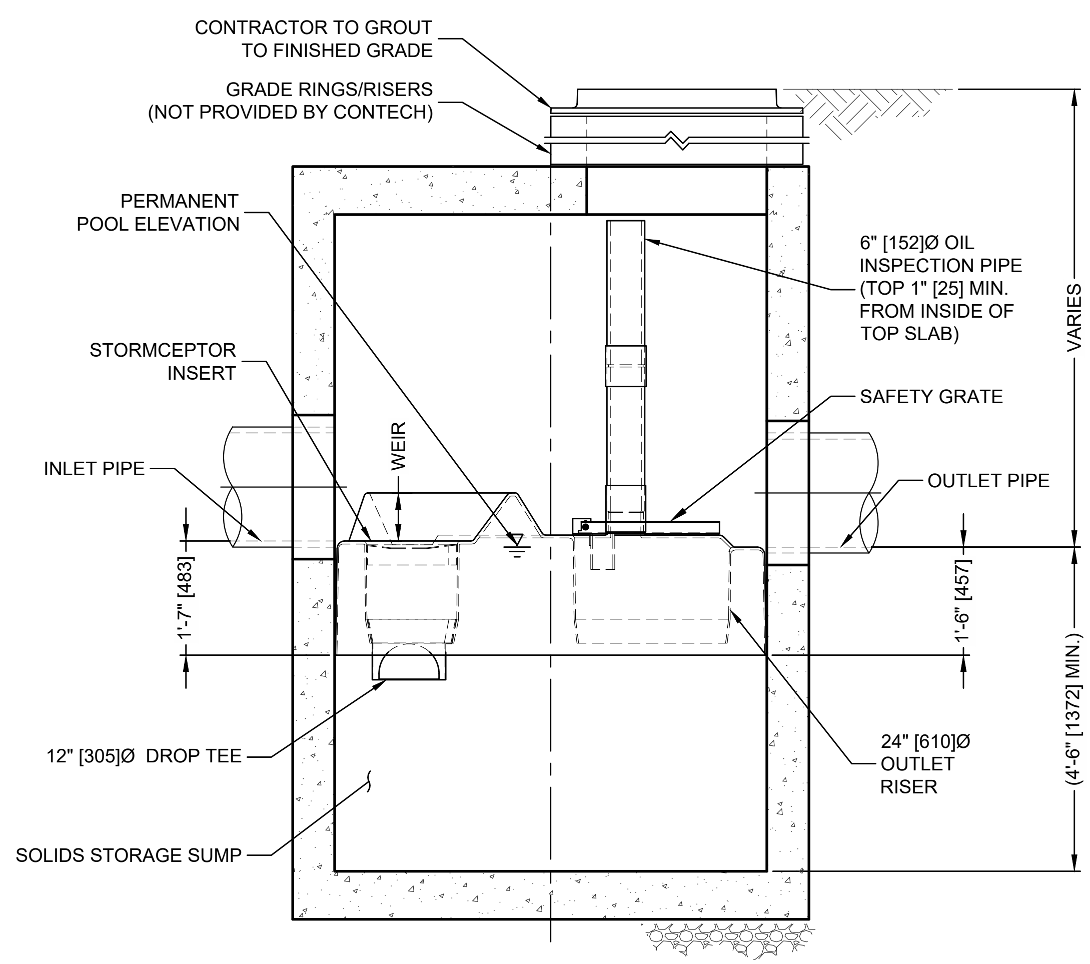
STC450i
STORMCEPTOR
STANDARD DETAIL



PLAN VIEW
TOP SLAB NOT SHOWN



SECTION A-A

Stormceptor®

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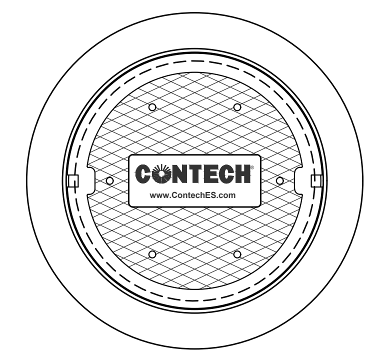
STORMCEPTOR DESIGN NOTES

THE STANDARD STC900 CONFIGURATION IS SHOWN.



FRAME AND COVER
(MAY VARY)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (cfs [L/s])			
PEAK FLOW RATE (cfs [L/s])			
RETURN PERIOD OF PEAK FLOW (yrs)			
RIM ELEVATION			
PIPE DATA:	INVERT	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
NOTES / SPECIAL REQUIREMENTS:			

GENERAL NOTES
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2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. STORMCEPTOR WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
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STC900
STORMCEPTOR
STANDARD DETAIL

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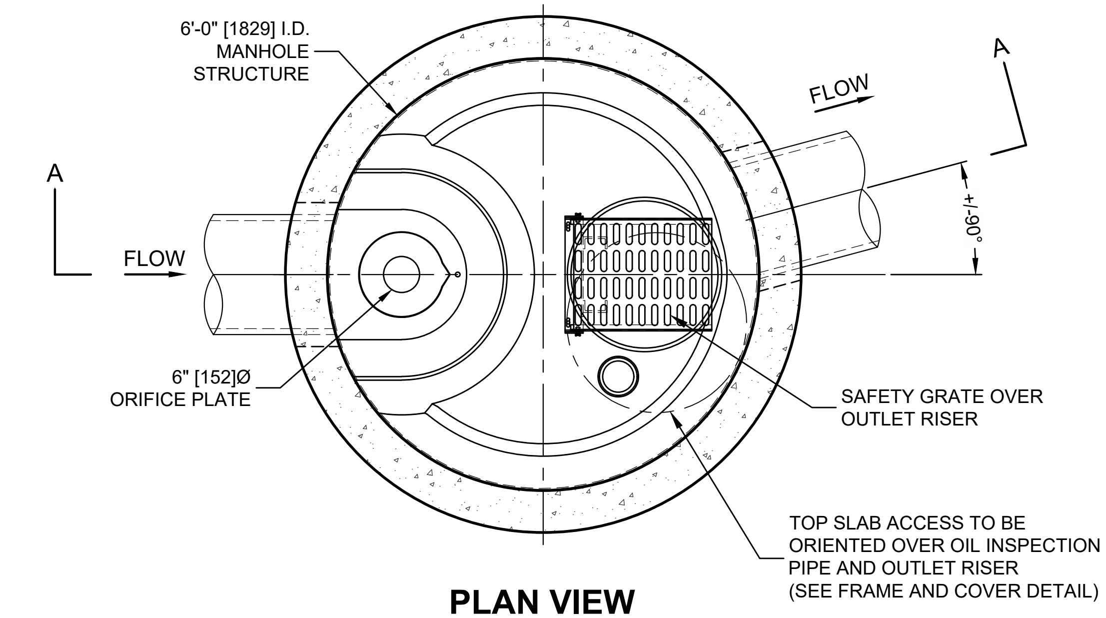
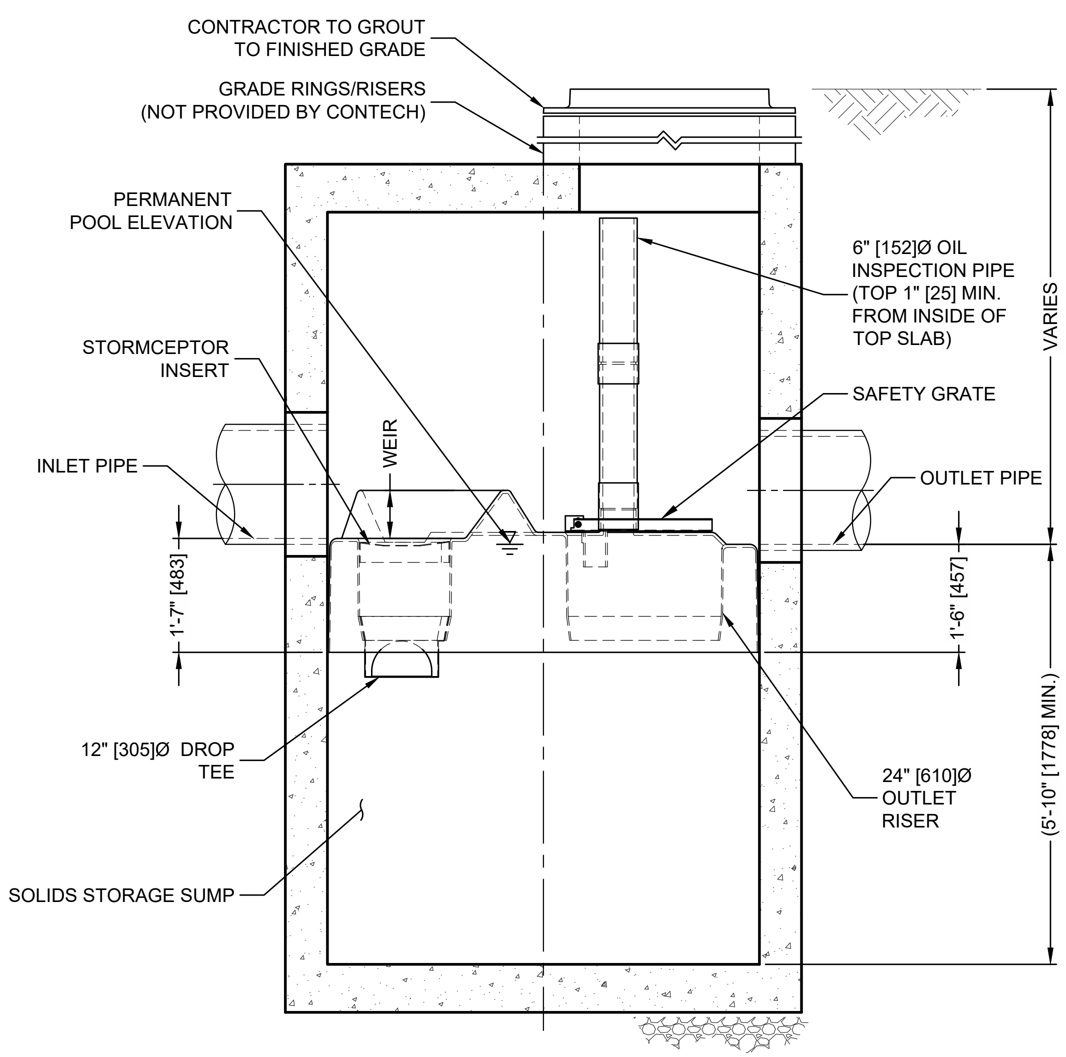


PLAN VIEW
TOP SLAB NOT SHOWN



SECTION A-A

Stormceptor®

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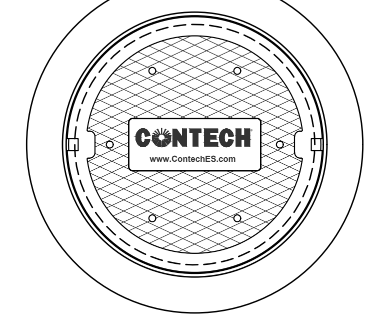
STORMCEPTOR DESIGN NOTES

THE STANDARD STC1200 CONFIGURATION IS SHOWN.



FRAME AND COVER
(MAY VARY)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (cfs [L/s])			
PEAK FLOW RATE (cfs [L/s])			
RETURN PERIOD OF PEAK FLOW (yrs)			
RIM ELEVATION			
PIPE DATA:	INVERT	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
NOTES / SPECIAL REQUIREMENTS:			

GENERAL NOTES
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3. STORMCEPTOR WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
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STC1200
STORMCEPTOR
STANDARD DETAIL

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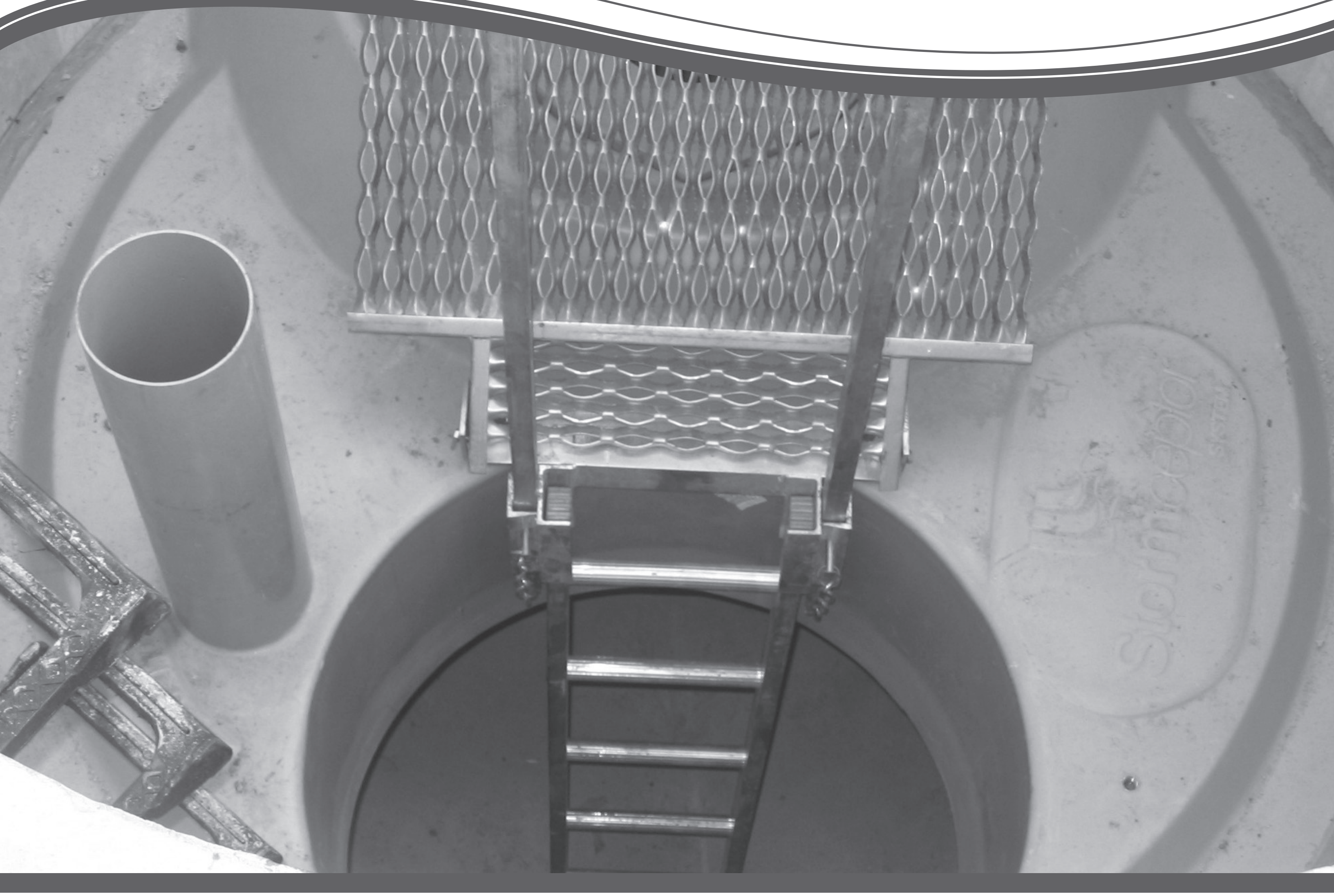
Stormceptor® STC
Operation and Maintenance Guide



Stormceptor Design Notes

- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.

Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences			
Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in. (75 mm)	1 in. (25 mm)	3 in. (75 mm)
Multiple inlet pipes	3 in. (75 mm)	3 in. (75 mm)	Only one inlet pipe.

Maximum inlet and outlet pipe diameters:

Inlet/Outlet Configuration	Inlet Unit STC 450i	In-Line Unit STC 900 to STC 7200	Series* STC 11000 to STC 16000
Straight Through	24 inch (600 mm)	42 inch (1050 mm)	60 inch (1500 mm)
Bend (90 degrees)	18 inch (450 mm)	33 inch (825 mm)	33 inch (825 mm)

- The inlet and in-line Stormceptor units can accommodate turns to a maximum of 90 degrees.
- Minimum distance from top of grade to crown is 2 feet (0.6 m)
- Submerged conditions. A unit is submerged when the standing water elevation at the proposed location of the Stormceptor unit is greater than the outlet invert elevation during zero flow conditions. In these cases, please contact your local Stormceptor representative and provide the following information:
- Top of grade elevation
- Stormceptor inlet and outlet pipe diameters and invert elevations
- Standing water elevation
- Stormceptor head loss, K = 1.3 (for submerged condition, K = 4)

Stormceptor® STC

OPERATION AND MAINTENANCE GUIDE
Table of Content

1. About Stormceptor

The Stormceptor® STC (Standard Treatment Cell) was developed by Imbrium™ Systems to address the growing need to remove and isolate pollution from the storm drain system before it enters the environment. The Stormceptor STC targets hydrocarbons and total suspended solids (TSS) in stormwater runoff. It improves water quality by removing contaminants through the gravitational settling of fine sediments and floatation of hydrocarbons while preventing the re-suspension or scour of previously captured pollutants.

The development of the Stormceptor STC revolutionized stormwater treatment, and created an entirely new category of environmental technology. Protecting thousands of waterways around the world, the Stormceptor System has set the standard for effective stormwater treatment.

1.1. Patent Information

The Stormceptor technology is protected by the following patents:

- Australia Patent No. 693,164 • 693,164 • 707,133 • 729,096 • 779401
- Austrian Patent No. 289647
- Canadian Patent No 2,009,208 •2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 (Pending)
- China Patent No 1168439
- Denmark DK 711879
- German DE 69534021
- Indonesian Patent No 16688
- Japan Patent No 9-11476 (Pending)
- Korea 10-2000-0026101 (Pending)
- Malaysia Patent No PI9701737 (Pending)
- New Zealand Patent No 314646
- United States Patent No 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690
- Stormceptor OSR Patent Pending • Stormceptor LCS Patent Pending

2. Stormceptor Design Overview

2.1. Design Philosophy

The patented Stormceptor System has been designed to focus on the environmental objective of providing long-term pollution control. The unique and innovative Stormceptor design allows for continuous positive treatment of runoff during all rainfall events, while ensuring that all captured pollutants are retained within the system, even during intense storm events.

An integral part of the Stormceptor design is PCSWMM for Stormceptor - sizing software developed in conjunction with Computational Hydraulics Inc. (CHI) and internationally acclaimed expert, Dr. Bill James. Using local historical rainfall data and continuous simulation modeling, this software allows a Stormceptor unit to be designed for each individual site and the corresponding water quality objectives.

By using PCSWMM for Stormceptor, the Stormceptor System can be designed to remove a wide range of particles (typically from 20 to 2,000 microns), and can also be customized to remove a specific particle size distribution (PSD). The specified PSD should accurately reflect what is in the stormwater runoff to ensure the device is achieving the desired water quality objective. Since stormwater runoff contains small particles (less than 75 microns), it is important to design a treatment system to remove smaller particles in addition to coarse particles.

2.2. Benefits

The Stormceptor System removes free oil and suspended solids from stormwater, preventing spills and non-point source pollution from entering downstream lakes and rivers. The key benefits, capabilities and applications of the Stormceptor System are as follows:

- Provides continuous positive treatment during all rainfall events
- Can be designed to remove over 80% of the annual sediment load
- Removes a wide range of particles
- Can be designed to remove a specific particle size distribution (PSD)
- Captures free oil from stormwater
- Prevents scouring or re-suspension of trapped pollutants
- Pre-treatment to reduce maintenance costs for downstream treatment measures (ponds, swales, detention basins, filters)
- Groundwater recharge protection
- Spills capture and mitigation
- Simple to design and specify
- Designed to your local watershed conditions
- Small footprint to allow for easy retrofit installations
- Easy to maintain (vacuum truck)
- Multiple inlets can connect to a single unit
- Suitable as a bend structure
- Pre-engineered for traffic loading (minimum AASHTO HS-20)
- Minimal elevation drop between inlet and outlet pipes
- Small head loss
- Additional protection provided by an 18” (457 mm) fiberglass skirt below the top of the insert, for the containment of hydrocarbons in the event of a spill.

2.3. Environmental Benefit

Freshwater resources are vital to the health and welfare of their surrounding communities. There is increasing public awareness, government regulations and corporate commitment to reducing the pollution entering our waterways. A major source of this pollution originates from stormwater runoff from urban areas. Rainfall runoff carries oils, sediment and other contaminants from roads and parking lots discharging directly into our streams, lakes and coastal waterways.

The Stormceptor System is designed to isolate contaminants from getting into the natural environment. The Stormceptor technology provides protection for the environment from spills that occur at service stations and vehicle accident sites, while also removing contaminated sediment in runoff that washes from roads and parking lots.

3. Key Operation Features

3.1. Scour Prevention

A key feature of the Stormceptor System is its patented scour prevention technology. This innovation ensures pollutants are captured and retained during all rainfall events, even extreme storms. The Stormceptor System provides continuous positive treatment for all rainfall events, including intense storms. Stormceptor slows incoming runoff, controlling and reducing velocities in the lower chamber to create a non-turbulent environment that promotes free oils and floatable debris to rise and sediment to settle.

The patented scour prevention technology, the fiberglass insert, regulates flows into the lower chamber through a combination of a weir and orifice while diverting high energy flows away through the upper chamber to prevent scouring. Laboratory testing demonstrated no scouring when tested up to 125% of the unit's operating rate, with the unit loaded to 100% sediment capacity (NJDEP, 2005). Second, the depth of the lower chamber ensures the sediment storage zone is adequately separated from the path of flow in the lower chamber to prevent scouring.

3.2. Operational Hydraulic Loading Rate

Designers and regulators need to evaluate the treatment capacity and performance of manufactured stormwater treatment systems. A commonly used parameter is the "operational hydraulic loading rate" which originated as a design methodology for wastewater treatment devices.

Operational hydraulic loading rate may be calculated by dividing the flow rate into a device by its settling area. This represents the critical settling velocity that is the prime determinant to quantify the influent particle size and density captured by the device. PCSWMM for Stormceptor uses a similar parameter that is calculated by dividing the hydraulic detention time in the device by the fall distance of the sediment.

$$v_{SC} = \frac{H}{6_H} = \frac{Q}{A_S}$$

Where:

v_{SC} = critical settling velocity, ft/s (m/s)

H = tank depth, ft (m)

$Ø_H$ = hydraulic detention time, ft/s (m/s)

Q = volumetric flow rate, ft3/s (m3/s)

A_S = surface area, ft^2 (m^2)

(Tchobanoglous, G. and Schroeder, E.D. 1987. Water Quality. Addison Wesley.)

Unlike designing typical wastewater devices, stormwater systems are designed for highly variable flow rates including intense peak flows. PCSWMM for Stormceptor incorporates all of the flows into its calculations, ensuring that the operational hydraulic loading rate is considered not only for one flow rate, but for all flows including extreme events.

3.3. Double Wall Containment

The Stormceptor System was conceived as a pollution identifier to assist with identifying illicit discharges. The fiberglass insert has a continuous skirt that lines the concrete barrel wall for a depth of 18 inches (457 mm) that provides double wall containment for hydrocarbons storage. This protective barrier ensures that toxic floatables do not migrate through the concrete wall into the surrounding soils.

4. Stormceptor Product Line

4.1. Stormceptor Models

A summary of Stormceptor models and capacities are listed in Table 1.

Table 1. Stormceptor Models

Stormceptor Model	Total Storage Volume U.S. Gal (L)	Hydrocarbon Storage Capacity U.S. Gal (L)	Maximum Sediment Capacity ft^3 (L)
STC 450i	470 (1,780)	86 (330)	46 (1,302)
STC 900	952 (3,600)	251 (950)	89 (2,520)
STC 1200	1,234 (4,670)	251 (950)	127 (3,596)
STC 1800	1,833 (6,940)	251 (950)	207 (5,861)
STC 2400	2,462 (9,320)	840 (3,180)	205 (5,805)
STC 3600	3,715 (1,406)	840 (3,180)	373 (10,562)
STC 4800	5,059 (1,950)	909 (3,440)	543 (15,376)
STC 6000	6,136 (23,230)	909 (3,440)	687 (19,453)
STC 7200	7,420 (28,090)	1,059 (4,010)	839 (23,757)
STC 11000	11,194 (42,370)	2,797 (10, 590)	1,086 (30,752)
STC 13000	13,348 (50,530)	2,797 (10, 590)	1,374 (38,907)
STC 16000	15,918 (60,260)	3,055 (11, 560)	1,677 (47,487)

NOTE: Storage volumes may vary slightly from region to region. For detailed information, contact your local Stormceptor representative.

4.2. Inline Stormceptor

The Inline Stormceptor, Figure 1, is the standard design for most stormwater treatment applications. The patented Stormceptor design allows the Inline unit to maintain continuous positive treatment of total suspended solids (TSS) year-round, regardless of flow rate. The Inline Stormceptor is composed of a precast concrete tank with a fiberglass insert situated at the invert of the storm sewer pipe, creating an upper chamber above the insert and a lower chamber below the insert.

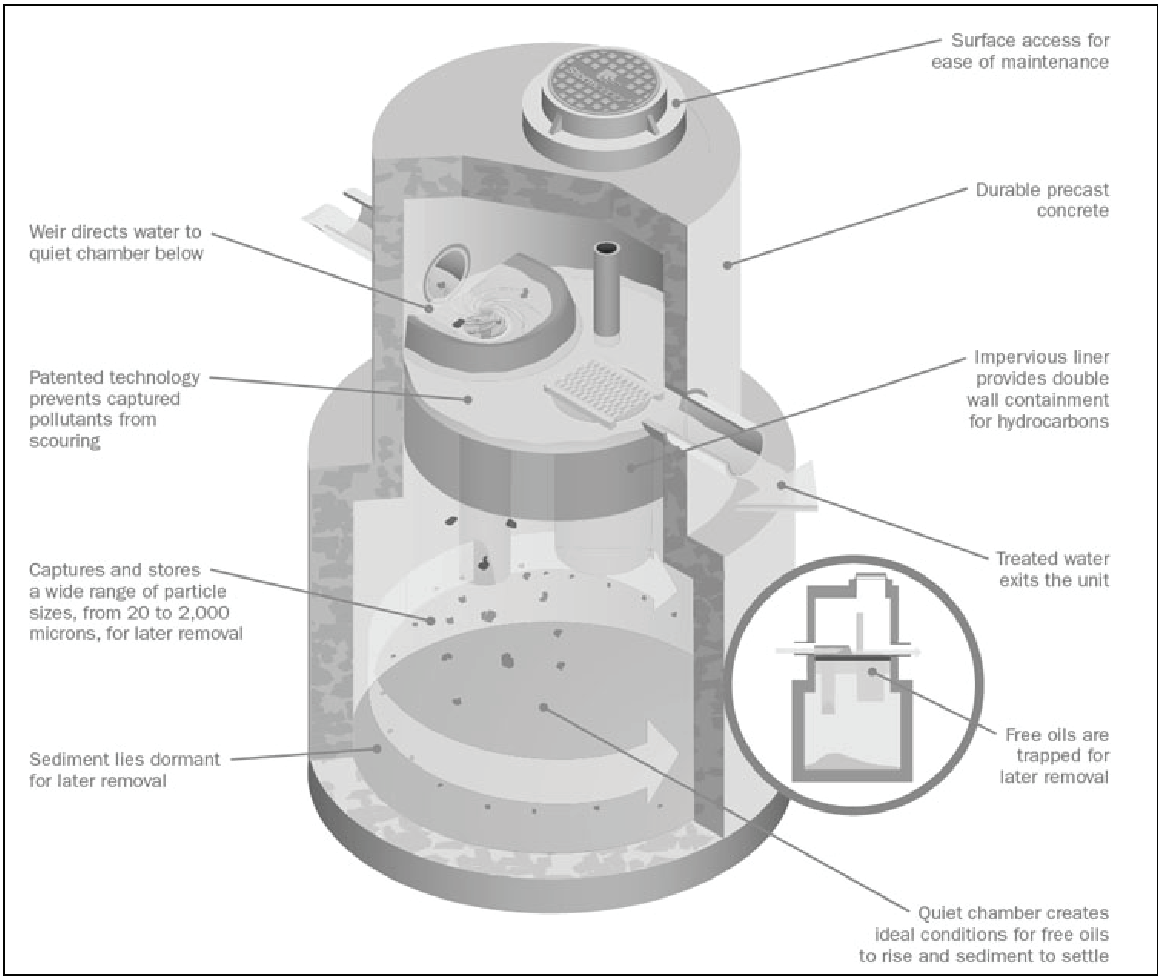


Figure 1. Inline Stormceptor

Operation

As water flows into the Stormceptor unit, it is slowed and directed to the lower chamber by a weir and drop tee. The stormwater enters the lower chamber, a non-turbulent environment, allowing free oils to rise and sediment to settle. The oil is captured underneath the fiberglass insert and shielded from exposure to the concrete walls by a fiberglass skirt. After the pollutants separate, treated water continues up a riser pipe, and exits the lower chamber on the downstream side of the weir before leaving the unit. During high flow events, the Stormceptor System's patented scour prevention technology ensures continuous pollutant removal and prevents re-suspension of previously captured pollutants.

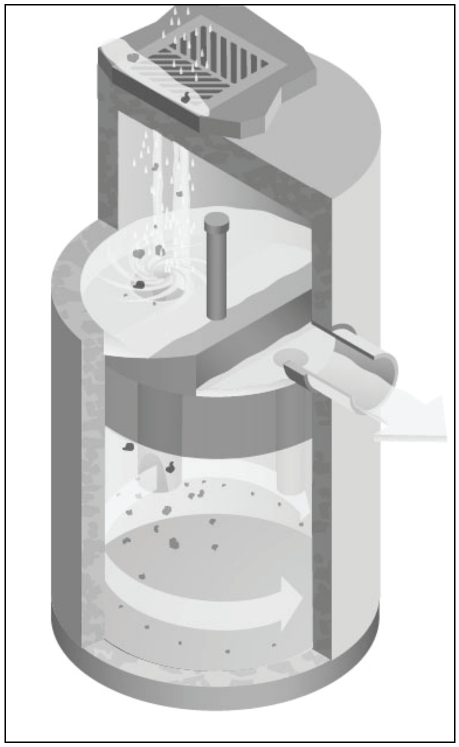


Figure 2. Inlet Stormceptor

4.3. Inlet Stormceptor

The Inlet Stormceptor System, Figure 2, was designed to provide protection for parking lots, loading bays, gas stations and other spill-prone areas. The Inlet Stormceptor is designed to remove sediment from stormwater introduced through a grated inlet, a storm sewer pipe, or both.

The Inlet Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

4.4. Series Stormceptor

Designed to treat larger drainage areas, the Series Stormceptor System, Figure 3, consists of two adjacent Stormceptor models that function in parallel. This design eliminates the need for additional structures and piping to reduce installation costs.

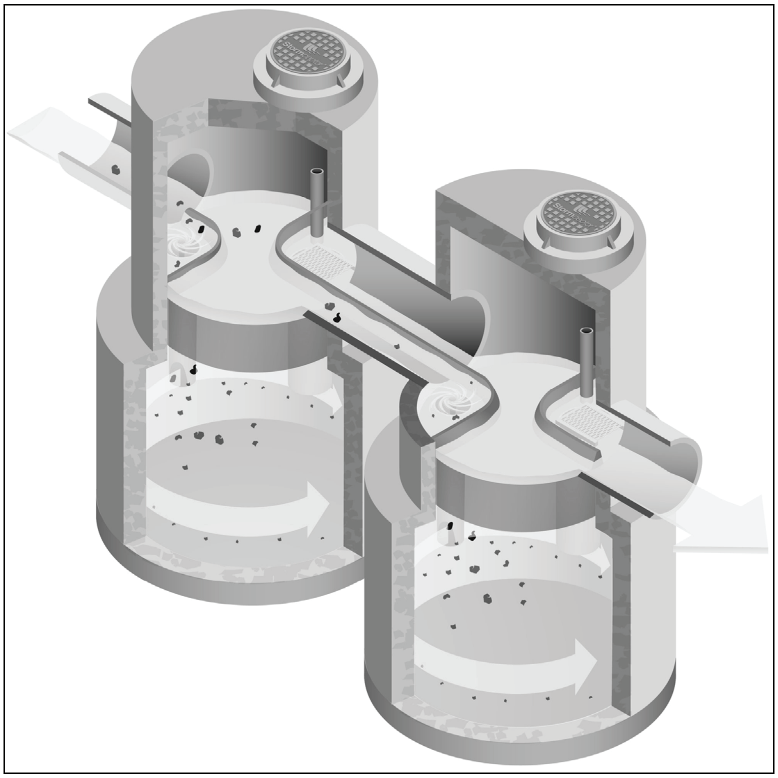


Figure 3. Series System

The Series Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

5. Sizing the Stormceptor System

The Stormceptor System is a versatile product that can be used for many different aspects of water quality improvement. While addressing these needs, there are conditions that the designer needs to be aware of in order to size the Stormceptor model to meet the demands of each individual site in an efficient and cost-effective manner.

PCSWMM for Stormceptor is the support tool used for identifying the appropriate Stormceptor model. In order to size a unit, it is recommended the user follow the seven design steps in the program. The steps are as follows:

STEP 1 – Project Details

The first step prior to sizing the Stormceptor System is to clearly identify the water quality objective for the development. It is recommended that a level of annual sediment (TSS) removal be identified and defined by a particle size distribution.

STEP 2 – Site Details

Identify the site development by the drainage area and the level of imperviousness. It is recommended that imperviousness be calculated based on the actual area of imperviousness based on paved surfaces, sidewalks and rooftops.

STEP 3 – Upstream Attenuation

The Stormceptor System is designed as a water quality device and is sometimes used in conjunction with onsite water quantity control devices such as ponds or underground detention systems. When possible, a greater benefit is typically achieved when installing a Stormceptor unit upstream of a detention facility. By placing the Stormceptor unit upstream of a detention structure, a benefit of less maintenance of the detention facility is realized.

STEP 4 – Particle Size Distribution

It is critical that the PSD be defined as part of the water quality objective. PSD is critical for the design of treatment system for a unit process of gravity settling and governs the size of a treatment system. A range of particle sizes has been provided and it is recommended that clays and silt-sized particles be considered in addition to sand and gravel-sized particles. Options and sample PSDs are provided in PCSWMM for Stormceptor. The default particle size distribution is the Fine Distribution, Table 2, option.

Table 2. Fine Distribution

Particle Size	Distribution	Specific Gravity
20	20%	1.3
60	20%	1.8
150	20%	2.2
400	20%	2.65
2000	20%	2.65

If the objective is the long-term removal of 80% of the total suspended solids on a given site, the PSD should be representative of the expected sediment on the site. For example, a system designed to remove 80% of coarse particles (greater than 75 microns) would provide relatively poor removal efficiency of finer particles that may be naturally prevalent in runoff from the site.

Since the small particle fraction contributes a disproportionately large amount of the total available particle surface area for pollutant adsorption, a system designed primarily for coarse particle capture will compromise water quality objectives.

STEP 5 – Rainfall Records

Local historical rainfall has been acquired from the U.S. National Oceanic and Atmospheric Administration, Environment Canada and regulatory agencies across North America. The rainfall data provided with PCSMM for Stormceptor provides an accurate estimation of small storm hydrology by modeling actual historical storm events including duration, intensities and peaks.

STEP 6 – Summary

At this point, the program may be executed to predict the level of TSS removal from the site. Once the simulation has completed, a table shall be generated identifying the TSS removal of each Stormceptor unit.

STEP 7 – Sizing Summary

Performance estimates of all Stormceptor units for the given site parameters will be displayed in a tabular format. The unit that meets the water quality objective, identified in Step 1, will be highlighted.

5.1. PCSWMM for Stormceptor

The Stormceptor System has been developed in conjunction with PCSWMM for Stormceptor as a technological solution to achieve water quality goals. Together, these two innovations model, simulate, predict and calculate the water quality objectives desired by a design engineer for TSS removal.

PCSWMM for Stormceptor is a proprietary sizing program which uses site specific inputs to a computer model to simulate sediment accumulation, hydrology and long-term total suspended solids removal. The model has been calibrated to field monitoring results from Stormceptor units that have been monitored in North America. The sizing methodology can be described by three processes:

1. Determination of real time hydrology
2. Buildup and wash off of TSS from impervious land areas
3. TSS transport through the Stormceptor (settling and discharge). The use of a calibrated model is the preferred method for sizing stormwater quality structures for the following reasons:
   » The hydrology of the local area is properly and accurately incorporated in the sizing (distribution of flows, flow rate ranges and peaks, back-to-back storms, inter-event times)
   » The distribution of TSS with the hydrology is properly and accurately considered in the sizing
   » Particle size distribution is properly considered in the sizing
   » The sizing can be optimized for TSS removal
   » The cost benefit of alternate TSS removal criteria can be easily assessed
   » The program assesses the performance of all Stormceptor models. Sizing may be selected based on a specific water quality outcome or based on the Maximum Extent Practicable

For more information regarding PCSWMM for Stormceptor, contact your local Stormceptor representative, or visit www.imbriumsystems.com to download a free copy of the program.

5.2. Sediment Loading Characteristics

The way in which sediment is transferred to stormwater can have a considerable effect on which type of system is implemented. On typical impervious surfaces (e.g. parking lots) sediment will build over time and wash off with the next rainfall. When rainfall patterns are examined, a short intense storm will have a higher concentration of sediment than a long slow drizzle. Together with rainfall data representing the site's typical rainfall patterns, sediment loading characteristics play a part in the correct sizing of a stormwater quality device.

Typical Sites

For standard site design of the Stormceptor System, PCSWMM for Stormceptor is utilized to accurately assess the unit's performance. As an integral part of the product's design, the program can be used to meet local requirements for total suspended solid removal. Typical installations of manufactured stormwater treatment devices would occur on areas such as paved parking lots or paved roads. These are considered "stable" surfaces which have non – erodible surfaces.

Unstable Sites

While standard sites consist of stable concrete or asphalt surfaces, sites such as gravel parking lots, or maintenance yards with stockpiles of sediment would be classified as "unstable". These types of sites do not exhibit first flush characteristics, are highly erodible and exhibit atypical sediment loading characteristics and must therefore be sized more carefully. Contact your local Stormceptor representative for assistance in selecting a proper unit sized for such unstable sites.

6. Spill Controls

When considering the removal of total petroleum hydrocarbons (TPH) from a storm sewer system there are two functions of the system: oil removal, and spill capture.

'Oil Removal' describes the capture of the minute volumes of free oil mobilized from impervious surfaces. In this instance relatively low concentrations, volumes and flow rates are considered. While the Stormceptor unit will still provide an appreciable oil removal function during higher flow events and/or with higher TPH concentrations, desired effluent limits may be exceeded under these conditions.

‘Spill Capture’ describes a manner of TPH removal more appropriate to recovery of a relatively high volume of a single phase deleterious liquid that is introduced to the storm sewer system over a relatively short duration. The two design criteria involved when considering this manner of introduction are overall volume and the specific gravity of the material. A standard Stormceptor unit will be able to capture and retain a maximum spill volume and a minimum specific gravity.

For spill characteristics that fall outside these limits, unit modifications are required. Contact your local Stormceptor Representative for more information.

One of the key features of the Stormceptor technology is its ability to capture and retain spills. While the standard Stormceptor System provides excellent protection for spill control, there are additional options to enhance spill protection if desired.

6.1. Oil Level Alarm

The oil level alarm is an electronic monitoring system designed to trigger a visual and audible alarm when a pre-set level of oil is reached within the lower chamber. As a standard, the oil

level alarm is designed to trigger at approximately 85% of the unit’s available depth level for oil capture. The feature acts as a safeguard against spills caused by exceeding the oil storage capacity of the separator and eliminates the need for manual oil level inspection.

The oil level alarm installed on the Stormceptor insert is illustrated in Figure 4.

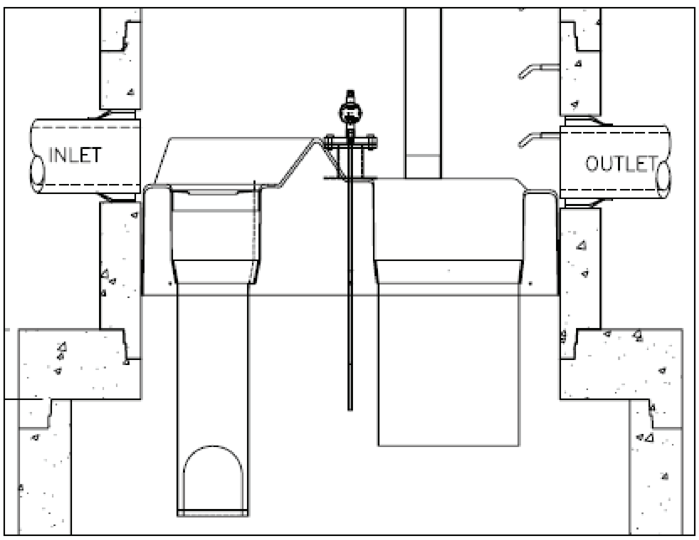


Figure 4. Oil level alarm

6.2. Increased Volume Storage Capacity

The Stormceptor unit may be modified to store a greater spill volume than is typically available. Under such a scenario, instead of installing a larger than required unit, modifications can be made to the recommended Stormceptor model to accommodate larger volumes. Contact your local Stormceptor representative for additional information and assistance for modifications.

7. Stormceptor Options

The Stormceptor System allows flexibility to incorporate to existing and new storm drainage infrastructure. The following section identifies considerations that should be reviewed when installing the system into a drainage network. For conditions that fall outside of the recommendations in this section, please contact your local Stormceptor representative for further guidance.

7.1. Installation Depth Minimum Cover

The minimum distance from the top of grade to the crown of the inlet pipe is 24 inches (600 mm). For situations that have a lower minimum distance, contact your local Stormceptor representative.

7.2. Maximum Inlet and Outlet Pipe Diameters

Maximum inlet and outlet pipe diameters are illustrated in Figure 5. Contact your local Stormceptor representative for larger pipe diameters

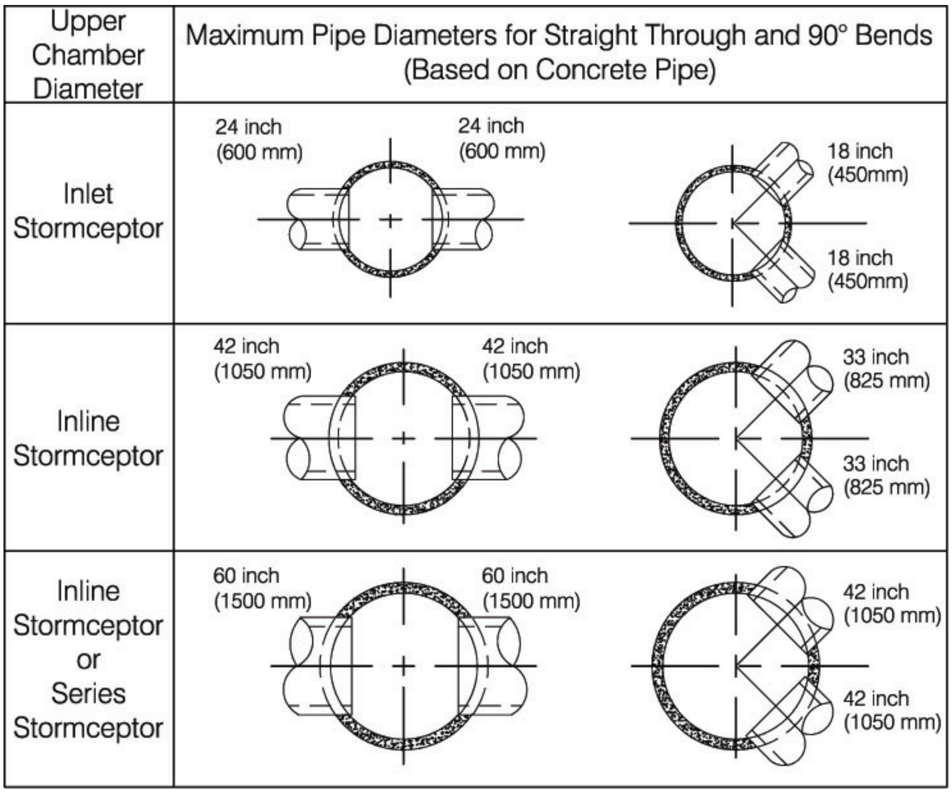


Figure 5. Maximum pipe diameters for straight through and bend applications

*The bend should only be incorporated into the second structure (downstream structure) of the Series Stormceptor System

7.3. Bends

The Stormceptor System can be used to change horizontal alignment in the storm drain network up to a maximum of 90 degrees. Figure 6 illustrates the typical bend situations of the Stormceptor System. Bends should only be applied to the second structure (downstream structure) of the Series Stormceptor System.

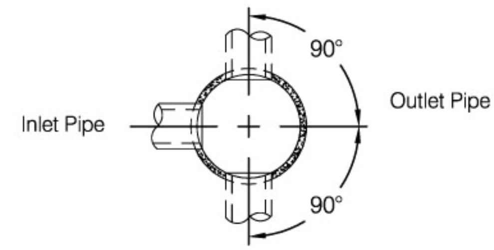
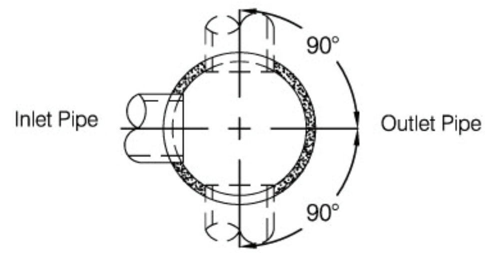
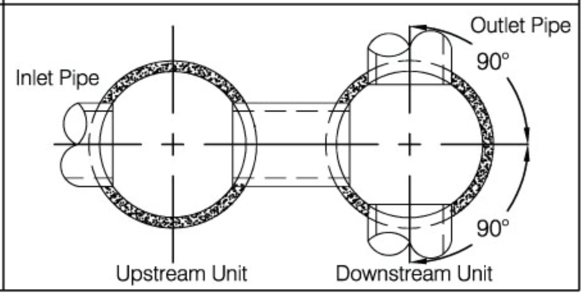
Stormceptor System	Maximum Bend Configurations
Inlet Stormceptor	
Inline Stormceptor	
Series Stormceptor	

Figure 6. Maximum bend angles

7.4. Multiple Inlet Pipes

The Inlet and Inline Stormceptor System can accommodate two or more inlet pipes. The maximum number of inlet pipes that can be accommodated into a Stormceptor unit is a function of the number, alignment and diameter of the pipes and its effects on the structural integrity of the precast concrete. When multiple inlet pipes are used for new developments, each inlet pipe shall have an invert elevation 3 inches (75 mm) higher than the outlet pipe invert elevation.

7.5. Inlet/Outlet Pipe Invert Elevations

Recommended inlet and outlet pipe invert differences are listed in Table 3.

Table 3. Recommended Drops Between Inlet and Outlet Pipe Inverts

Number of Inlet Pipes	Inlet System	In-Line System	Series System
1	3 inches (75 mm)	1 inch (25 mm)	3 inches (75 mm)
>1	3 inches (75 mm)	3 inches (75 mm)	Not Applicable

7.6. Shallow Stormceptor

In cases where there may be restrictions to the depth of burial of storm sewer systems. In this situation, for selected Stormceptor models, the lower chamber components may be increased in diameter to reduce the overall depth of excavation required.

7.7. Customized Live Load

The Stormceptor system is typically designed for local highway truck loading (AASHTO HS- 20). When the project requires live loads greater than HS-20, the Stormceptor System may be customized structurally for a pre-specified live load. Contact your local Stormceptor representative for customized loading conditions.

7.8. Pre-treatment

The Stormceptor System may be sized to remove sediment and for spills control in conjunction with other stormwater BMPs to meet the water quality objective. For pretreatment applications, the Stormceptor System should be the first unit in a treatment train. The benefits of pre-treatment include the extension of the operational life (extension of maintenance frequency) of large stormwater management facilities, prevention of spills and lower total life- cycle maintenance cost.

7.9. Head loss

The head loss through the Stormceptor System is similar to a 60 degree bend at a manhole. The K value for calculating minor losses is approximately 1.3 (minor loss = k*1.3v2/2g).

However, when a Submerged modification is applied to a Stormceptor unit, the corresponding K value is 4.

7.10. Submerged

The Submerged modification, Figure 7, allows the Stormceptor System to operate in submerged or partially submerged storm sewers. This configuration can be installed on all models of the Stormceptor System by modifying the fiberglass insert. A customized weir height and a secondary drop tee are added.

Submerged instances are defined as standing water in the storm drain system during zero flow conditions. In these instances, the following information is necessary for the proper design and application of submerged modifications:

- Stormceptor top of grade elevation
- Stormceptor outlet pipe invert elevation
- Standing water elevation

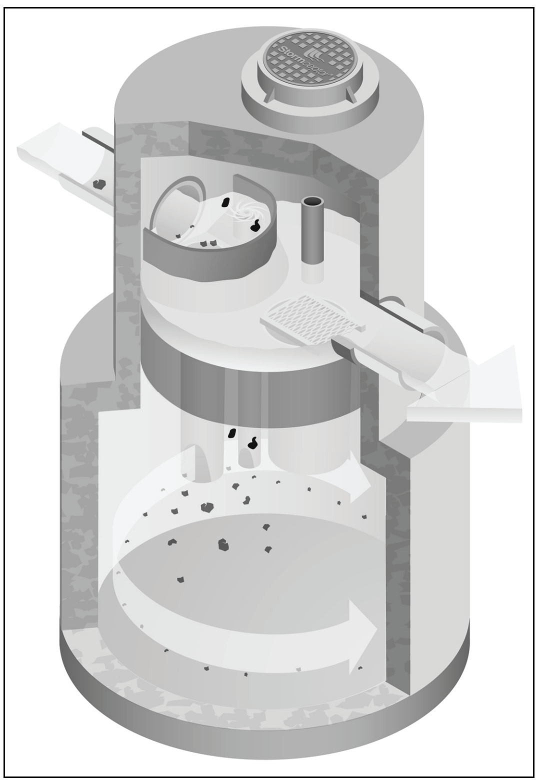


Figure 7. Submerged Stormceptor

8. Comparing Technologies

Designers have many choices available to achieve water quality goals in the treatment of stormwater runoff. Since many alternatives are available for use in stormwater quality treatment it is important to consider how to make an appropriate comparison between “approved alternatives”. The following is a guide to assist with the accurate comparison of differing technologies and performance claims.

8.1. Particle Size Distribution (PSD)

The most sensitive parameter to the design of a stormwater quality device is the selection of the design particle size. While it is recommended that the actual particle size distribution (PSD) for sites be measured prior to sizing, alternative values for particle size should be selected to represent what is likely to occur naturally on the site. A reasonable estimate of a particle size distribution likely to be found on parking lots or other impervious surfaces should consist of a wide range of particles such as 20 microns to 2,000 microns (Ontario MOE, 1994).

There is no absolute right particle size distribution or specific gravity and the user is cautioned to review the site location, characteristics, material handling practices and regulatory requirements when selecting a particle size distribution. When comparing technologies, designs using different PSDs will result in incomparable TSS removal efficiencies. The PSD of the TSS removed needs to be standard between two products to allow for an accurate comparison.

8.2. Scour Prevention

In order to accurately predict the performance of a manufactured treatment device, there must be confidence that it will perform under all conditions. Since rainfall patterns cannot be predicted, stormwater quality devices placed in storm sewer systems must be able to withstand extreme events, and ensure that all pollutants previously captured are retained in the system.

In order to have confidence in a system’s performance under extreme conditions, independent validation of scour prevention is essential when examining different technologies. Lack of independent verification of scour prevention should make a designer wary of accepting any product’s performance claims.

8.3. Hydraulics

Full scale laboratory testing has been used to confirm the hydraulics of the Stormceptor System. Results of lab testing have been used to physically design the Stormceptor System and the sewer pipes entering and leaving the unit. Key benefits of Stormceptor are:

- Low head loss (typical k value of 1.3)
- Minimal inlet/outlet invert elevation drop across the structure
- Use as a bend structure
- Accommodates multiple inlets

The adaptability of the treatment device to the storm sewer design infrastructure can affect the overall performance and cost of the site.

8.4. Hydrology

Stormwater quality treatment technologies need to perform under varying climatic conditions. These can vary from long low intensity rainfall to short duration, high intensity storms. Since a treatment device is expected to perform under all these conditions, it makes sense that any system’s design should accommodate those conditions as well.

Long-term continuous simulation evaluates the performance of a technology under the varying conditions expected in the climate of the subject site. Single, peak event design does not provide this information and is not equivalent to long-term simulation. Designers should request long-term simulation performance to ensure the technology can meet the long-term water quality objective.

9. Testing

The Stormceptor System has been the most widely monitored stormwater treatment technology in the world. Performance verification and monitoring programs are completed to the strictest standards and integrity. Since its introduction in 1990, numerous independent field tests and studies detailing the effectiveness of the Stormceptor System have been completed.

- Coventry University, UK – 97% removal of oil, 83% removal of sand and 73% removal of peat
- National Water Research Institute, Canada, - scaled testing for the development of the Stormceptor System identifying both TSS removal and scour prevention.
- New Jersey TARP Program – full scale testing of an STC 900 demonstrating 75% TSS removal of particles from 1 to 1000 microns. Scour testing completed demonstrated that the system does not scour. The New Jersey Department of Environmental Protection was followed.
- City of Indianapolis – full scale testing of an STC 900 demonstrating over 80% TSS removal of particles from 50 microns to 300 microns at 130% of the unit's operating rate. Scour testing completed demonstrated that the system does not scour.
- Westwood Massachusetts (1997), demonstrated >80% TSS removal
- Como Park (1997), demonstrated 76% TSS removal
- Ontario MOE SWAMP Program – 57% removal of 1 to 25 micron particles
- Laval Quebec – 50% removal of 1 to 25 micron particles

10. Installation

The installation of the concrete Stormceptor should conform in general to state highway, or local specifications for the installation of manholes. Selected sections of a general specification that are applicable are summarized in the following sections.

10.1. Excavation

Excavation for the installation of the Stormceptor should conform to state highway, or local specifications. Topsoil removed during the excavation for the Stormceptor should be stockpiled in designated areas and should not be mixed with subsoil or other materials.

Topsoil stockpiles and the general site preparation for the installation of the Stormceptor should conform to state highway or local specifications.

The Stormceptor should not be installed on frozen ground. Excavation should extend a minimum of 12 inches (300 mm) from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required.

In areas with a high water table, continuous dewatering may be required to ensure that the excavation is stable and free of water.

10.2. Backfilling

Backfill material should conform to state highway or local specifications. Backfill material should be placed in uniform layers not exceeding 12 inches (300mm) in depth and compacted to state highway or local specifications.

11. Stormceptor Construction Sequence

The concrete Stormceptor is installed in sections in the following sequence:

1. Aggregate base
2. Base slab
3. Lower chamber sections
4. Upper chamber section with fiberglass insert
5. Connect inlet and outlet pipes
6. Assembly of fiberglass insert components (drop tee, riser pipe, oil cleanout port and orifice plate
7. Remainder of upper chamber
8. Frame and access cover

The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

Adjustment of the Stormceptor can be performed by lifting the upper sections free of the excavated area, re-leveling the base and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary. Once the Stormceptor has been constructed, any lift holes must be plugged with mortar.

12. Maintenance

12.1. Health and Safety

The Stormceptor System has been designed considering safety first. It is recommended that confined space entry protocols be followed if entry to the unit is required. In addition, the fiberglass insert has the following health and safety features:

- Designed to withstand the weight of personnel
- A safety grate is located over the 24 inch (600 mm) riser pipe opening
- Ladder rungs can be provided for entry into the unit, if required

12.2. Maintenance Procedures

Maintenance of the Stormceptor system is performed using vacuum trucks. No entry into the unit is required for maintenance (in most cases). The vacuum service industry is a well- established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean a Stormceptor will vary based on the size of unit and transportation distances.

The need for maintenance can be determined easily by inspecting the unit from the surface. The depth of oil in the unit can be determined by inserting a dipstick in the oil inspection/cleanout port.

Similarly, the depth of sediment can be measured from the surface without entry into the Stormceptor via a dipstick tube equipped with a ball valve. This tube would be inserted through the riser pipe. Maintenance should be performed once the sediment depth exceeds the guideline values provided in the Table 4.

Table 4. Sediment Depths Indicating Required Servicing*

Particle Size	Specific Gravity
Model	Sediment Depth inches (mm)
450i	8 (200)
900	8 (200)
1200	10 (250)
1800	15 (381)
2400	12 (300)
3600	17 (430)
4800	15 (380)
6000	18 (460)
7200	15 (381)
11000	17 (380)
13000	20 (500)
16000	17 (380)
* based on 15% of the Stormceptor unit’s total storage	

Although annual servicing is recommended, the frequency of maintenance may need to be increased or reduced based on local conditions (i.e. if the unit is filling up with sediment more quickly than projected, maintenance may be required semi-annually; conversely once the site has stabilized maintenance may only be required every two or three years).

Oil is removed through the oil inspection/cleanout port and sediment is removed through the riser pipe. Alternatively oil could be removed from the 24 inches (600 mm) opening if water is removed from the lower chamber to lower the oil level below the drop pipes.

The following procedures should be taken when cleaning out Stormceptor:

1. Check for oil through the oil cleanout port
2. Remove any oil separately using a small portable pump
3. Decant the water from the unit to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank
4. Remove the sludge from the bottom of the unit using the vacuum truck
5. Re-fill Stormceptor with water where required by the local jurisdiction

12.3. Submerged Stormceptor

Careful attention should be paid to maintenance of the Submerged Stormceptor System. In cases where the storm drain system is submerged, there is a requirement to plug both the inlet and outlet pipes to economically clean out the unit.

12.4. Hydrocarbon Spills

The Stormceptor is often installed in areas where the potential for spills is great. The Stormceptor System should be cleaned immediately after a spill occurs by a licensed liquid waste hauler.

12.5. Disposal

Requirements for the disposal of material from the Stormceptor System are similar to that of any other stormwater Best Management Practice (BMP) where permitted. Disposal options for the sediment may range from disposal in a sanitary trunk sewer upstream of a sewage treatment plant, to disposal in a sanitary landfill site. Petroleum waste products collected in the Stormceptor (free oil/chemical/fuel spills) should be removed by a licensed waste management company.

12.6. Oil Sheens

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a rainbow or sheen can be seen at very small oil concentrations (<10 mg/L). Stormceptor will remove over 98% of all free oil spills from storm sewer systems for dry weather or frequently occurring runoff events.

The appearance of a sheen at the outlet with high influent oil concentrations does not mean the unit is not working to this level of removal. In addition, if the influent oil is emulsified the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified conditions.

SUPPORT

Drawings and specifications are available at www.ContechES.com.

Site-specific design support is available from our engineers.

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Technology Assessment Report

Storm*ceptor* ®

CSR™ New England Pipe

Prepared for
The Massachusetts Strategic
Envirotechnology Partnership
STEP

December, 1997

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PROJECT FUNDING

The Step Technology Assessment Project was Funded by
The University Of Massachusetts and The Massachusetts Division of Energy Resources

PREFACE

The STEP technology assessment process is designed to identify those technologies that will support the economic and environmental/energy goals of the Commonwealth of Massachusetts and may benefit from STEP assistance. The process is meant to be one of screening, in which technologies are evaluated by independent technical specialists. Recommendation from this process does not constitute an endorsement of the technology or of the absolute validity of the technology. Rather, STEP technical assessments attest only that, through the screening process, the reviewers feel there may be benefit to the Commonwealth of Massachusetts.

EXECUTIVE SUMMARY

The technology described in this review is Storm*ceptor*® and is currently owned by Storm*ceptor*® Corporation and licensed to CSR/New England Pipe (CSR/NEP) of Wauregan, CT, for distribution in Massachusetts, among other states. The system is being commercialized by CSR/NEP. The Storm*ceptor* technology addresses treatment of stormwater runoff. It is proposed as an effective spill control and stormwater quality enhancement system, capable of retaining grit, suspended solids, oils and grease during periods of both low and high flows. It is proposed as a replacement for conventional manholes within a storm drain system. It is not designed as a catch basin or detention system. It can be used within any new or existing lateral piped conveyance system and comes in several sizes with outlets up to 60". The system is claimed as capable of removing 50 - 80% of TSS when properly sized. The Storm*ceptor* system is recommended as a stand alone or as a component to a system or in combination with different BMPs. An example configuration may include the following components: catch basin or water quality inlet, Stormc*eptor*, detention basin or infiltration system.

The system is a prefabricated well type structure which provides sedimentation, oil, and grease separation. It is manufactured in both concrete or fiberglass. Current sizes range from 900 to 7200 gallons, with diameters between 6 and 12 feet. The design of the system provides two sections, a treatment chamber and bypass chamber. The structural components of the system are separated by an insert which has a weir, inflow drop pipe, and outflow riser. Operation of the system is passive with respect to flow control and treatment. During low flows or frequent storm events, stormwater from the inlet is directed down the inflow drop pipe located adjacent to the inlet of the treatment chamber. Flow in excess of the inflow drop pipe capacity is directed into the bypass chamber to the outlet of the system. The effective treatment capacity is set by a weir which surrounds the inflow drop pipe at the inlet and the volume of the treatment chamber. Effluent from the treatment chamber exits via the outflow riser which extends below the water surface in the treatment chamber up to the overflow chamber and to the system outlet. Sediment is retained in the bottom of the treatment chamber and oils and grease are retained at the top of the treatment chamber in a quiescent area.

The Storm*ceptor* system is stormwater treatment structure providing event based solids separation. The value added in the Storm*ceptor* system is the ability to reduce turbulence in the treatment chamber, which makes it better at removing TSS and TPH than conventional BMPs of the same category. The Storm*ceptor* system has been demonstrated to provide at least 52% removal of TSS when sized according to Storm*ceptor's* "Treatment Train" criteria and 77% when sized according to Storm*ceptor's* "Sensitive Area" criteria. It is likely that a higher removal efficiency, greater than 80%, could be expected if the contributing drainage area is smaller than the sizing recommended. The system is likely to remove grease and oils with its inflow and outflow pipe configurations. The Storm*ceptor* system appears to be a good control technology in areas of higher pollution potential, Standard 5 described in the Stormwater Management Handbooks (DEP and CZM, 1997). Storm*ceptor* system may be used as a component in combination with different BMPs or may be used as a stand alone installation provided it is sized for 80% TSS removal. STEP recommends collection of additional data representing a varied set of operating conditions over a realistic maintenance cycle to verify TSS removal rates greater than 80%.

HIGHLIGHTS

- Performance data available demonstrates that the Storm*ceptor* system can provide TSS removal rates of 77% when sized according to the "Sensitive Area" criteria. Evidence suggests that the Storm*ceptor* system may be capable of achieving TSS removal rates between 89% and 99% when sized accordingly, under conditions similar to those reported in the Westwood Massachusetts site, including: climate and land use intensity.
- Performance data available to this reviewer suggest that the Storm*ceptor* system can provide TSS removal rates of 52% when sized according to the "Treatment Train" criteria.
- Use of the Storm*ceptor* system as a pretreatment component in combination with different BMPs, when sized according to the "Treatment Train" criteria, will likely meet standards 4 and 6 of the Stormwater Management Handbooks (DEP and CZM,1997). Use as a stand alone device may be justified when sized according to the "Sensitive Area" criteria.
- The Storm*ceptor* system is likely to perform in areas with higher potential pollutant levels in Standard 5 of the Stormwater Management Handbooks (DEP and CZM,1997).
- The Storm*ceptor* system is useful for new and retrofit installations in Standard 7 of the Stormwater Management Handbooks (DEP and CZM,1997), especially where space is limited.
- The Storm*ceptor* system is also suited for secondary sediment control from construction related sediment loads specified in Standard 8 (DEP and CZM,1997).

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TECHNOLOGY PROPONENT

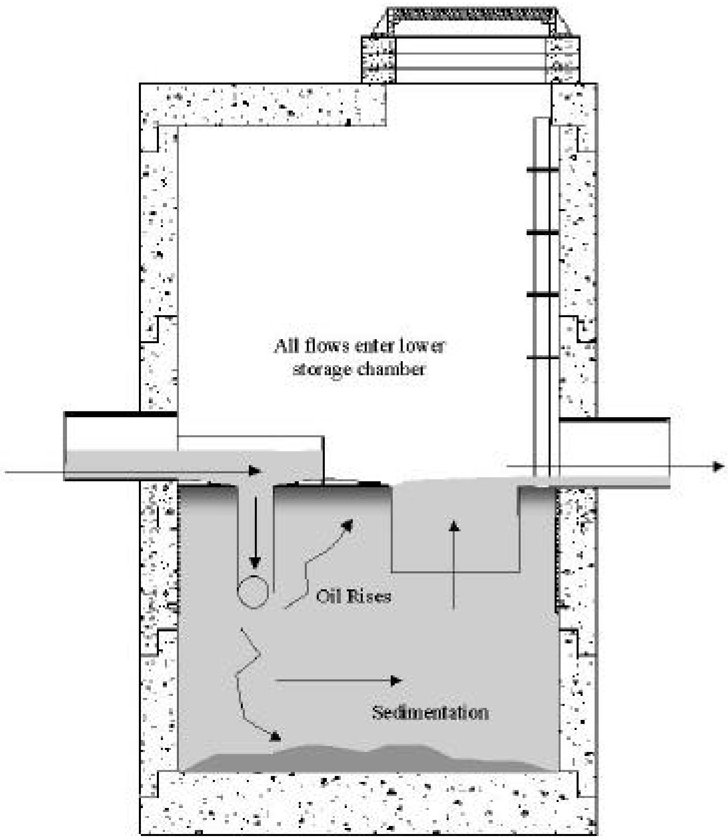
The technology described in this review is Storm*ceptor*® and is currently owned by Storm*ceptor*® Corporation and licensed to CSR/New England Pipe (CSR/NEP) of Wauregan, CT, for distribution in Massachusetts, among other states. The system is being commercialized by CSR/NEP. CSR/NEP is a subsidiary of CSR Hydro Conduit Corporation which manufactures Storm*ceptor* in the most of the United States.

TECHNOLOGY DESCRIPTION

The Storm*ceptor* technology addresses treatment of stormwater runoff. It is proposed as an effective spill control and stormwater quality enhancement system, capable of retaining grit, suspended solids, oils and grease during periods of both low and high flows. It is proposed as a replacement for conventional manholes within a storm drain system. It is not designed as an inlet or detention system. It can be used within any lateral piped conveyance system and comes in several sizes with outlets up to 60". The system is claimed as capable of removing 50 to 80% of TSS when properly sized. The Storm*ceptor* system may be used as a stand alone BMP or as a component within a combination of different BMPs. An example of a combination of different BMPs is a catch basin, Storm*ceptor*, and detention pond. It is compatible with any existing conveyance system. It is proposed that the system has an added value in its small size and its added removal capability over similar conventional BMPs such as catch basins and deep sumps. The system is currently protected by a United States Patent No. 4,985,148.

The system is a prefabricated well type structure which provides sedimentation, oil, and grease separation (Figure 1). It is manufactured in both concrete or fiberglass. Current sizes range from 900 to 7200 gallons, with diameters between 6 and 12 feet. The design of the system provides two sections, a treatment chamber and bypass chamber. The structural components of the system are separated by an insert which has a weir, inflow drop pipe, and outflow riser (Figure 2). The size of the insert and its associated components depends on the overall size of the treatment chamber and bypass chamber.

Operation of the system is passive with respect to flow control and treatment. During low flows or frequent storm events, stormwater from the inlet is directed down the inflow drop pipe located adjacent to the inlet of the treatment chamber. Flow in excess of the inflow drop pipe capacity is directed into the bypass chamber to the outlet of the system. The effective treatment capacity is set by a weir which surrounds the inflow drop pipe at the inlet and the volume of the treatment chamber. Effluent from the treatment chamber exits via the outflow riser which extends below the water surface in the treatment chamber, up to the overflow chamber, and to the system outlet. Sediment is retained in the bottom of the treatment chamber and oils and grease are retained at the top of the treatment chamber in a quiescent area. Oil and grease are prevented from leaving the chamber by the outflow riser.



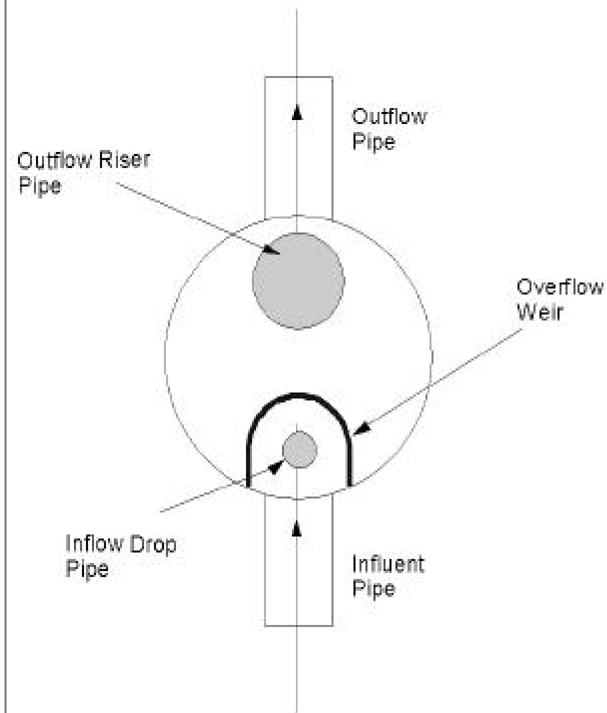


Figure 2. Storm*ceptor* operation during average flow conditions.

Figure 1. Top view of Storm*ceptor* insert.

The inlet and outlet elevations of the system are kept at a minimum with 1" difference in the concrete and fiberglass units. The multiple inlet units have a 3" difference between the inlet and outlet. Approximately 9 inches of hydrostatic head is developed from the influent elevation in the weir. A low head system is designed to reduce the potential for scouring from higher velocities in the treatment chamber. During storm events exceeding the treatment capacity of the chamber the head on the system is kept constant because stormwater elevation over the drop pipe is nearly equivalent to the head over the outflow riser. Studies prepared by Storm*ceptor* Corporation (Marsalek et al., 1994) demonstrated when total flow to the system was increased, in excess of the treatment chamber capacity, flow through the treatment chamber increased initially and then decreased slightly. This implies that treatment performance would not be lowered during high flow events and scouring and resuspension of previously settled solids is prevented.

The system is suited for local or lateral lines within any conveyance system. The system is not recommended for large storm drain trunk lines. The system is not designed to be used as an inlet catch basin. Storm*ceptor* Corporation produces 8 models with different sediment and oil capacities illustrated in Table A1 in the Appendix. Preliminary sizing recommendations are presented in Technical Design Manual (Storm*ceptor* Corporation, 1997) and in Table A2 in the Appendix. The preliminary recommended sizing table specifies units per impervious drainage area based on percentages of treatment.

TECHNICAL FEASIBILITY

The Storm*ceptor* system is stormwater treatment structure providing event based solids separation. The Storm*ceptor* has a greater TSS removal efficiency than water quality inlets. The value added in the Storm*ceptor* system is the ability to reduce turbulence in the treatment chamber, which makes it better at removing TSS and TPH than conventional BMPs of the same category. A significant amount of design engineering has gone into the Storm*ceptor*. In particular, the flow control device developed for the insert is capable of reducing turbulence in the treatment chamber to quiescent levels. This directly increases removal efficiencies for TSS and grease and oils. The system appears to be capable of limiting resuspension of settled particles, a common problem in catch basins.

The basic principle of operation is sedimentation. In addition, some minimal treatment to pollutant parameters associated with the settled solids is likely to occur. In particular, BOD_5, COD, particulate N, P, and pathogens may be associated with the finer fractions of sediments and removed from the stormwater. Oil and grease are less dense than water so they float to the top of the treatment chamber. Since the outflow riser extends below the surface of the water in the treatment chamber, oil and grease will be trapped in the treatment chamber.

COMPETING TECHNOLOGIES

Several direct competing technologies exist for Storm*ceptor*, including other sedimentation chamber technologies like oil and grit separators. Information submitted by a competing technology suggests that Storm*ceptor* is a cost competitive product. However, no comparative data on oil and grit separators was submitted by CSR/NEP on these technologies. Typical oil and grit separators are not likely to achieve the same level of treatment as the Stormceptor system. The Storm*ceptor* system should be competitive with other technologies that produce comparable removal efficiencies. The Storm*ceptor* system has spatial requirement advantages over detention ponds and artificial wetlands which have large area requirements. The Storm*ceptor* system is not a recharging system and therefore not comparable to recharging systems such as infiltration basins and trenches. It may produce equivalent treatment levels as recharging systems, when sized properly. The Stormceptor system is not suitable for meeting recharge Standard 3 as a singular treatment system (DEP and CZM, 1997), but may be well suited for pretreatment in a mixed component system with recharge. The system should be competitive with the other BMPs in the deep sump catch basin category.

DATA SUPPORTING CLAIMS

Prior to considering performance data from any treatment technology, the following notation is advised. Data collected from isolated stormwater treatment systems may be variable. Some of this variability may be due to differences in land use, climate, and soil type. Additionally, it is possible that storm events may have variable pollutant loads, resulting in varied treatment system performance at an individual site. The combination of these two sources of variability, inherent in all BMP performance verification, presents an unknown level of uncertainty. In order to overcome this uncertainty a larger set of data would be required to predict the performance of the technology under a variety of conditions. The Storm*ceptor* system has a limited set of performance data.

The data submitted by CSR/NEP are intended to demonstrate performance capable of achieving Standards 4, 5, 6 and 7 of the Department of Environmental Protection (DEP) Stormwater Management Handbooks (DEP and CZM,1997). In this Technical Assessment, performance is based on available data in the proponent’s submission from installations in Toronto and Edmonton Canada. Bench scale testing and modeling data were used as predictors of performance but not for sizing. A third installation, in Westwood, Massachusetts, supports performance claims at Storm*ceptor’s* “Sensitive Area” criteria of 80%. Storm*ceptor* has more than 1600 units installed in the U.S. and Canada. Additional data from other installations may become available for future performance verifications.

Analytical Modeling and Bench Scale Studies

Storm*ceptor* Corporation has committed resources to study the Storm*ceptor* system using analytical models with bench and pilot scale validation. Several modeling scenarios were developed for Storm*ceptor* by Marshall Macklin Monaghan, LTD. (1994) to evaluate the removal of TSS under a variety of storm event conditions using the Stormwater Management Model (SWMM). Some of the parameters for the model include: rainfall data, temperature, and runoff. The analytical model results are based on non-ideal settling and do not account for flocculation effects due to its considerable complexity. Predicted long term TSS removal rates were calculated as a function of drainage area per unit for 4 different Storm*ceptor* models. Results from this modeling study suggest that in small drainage areas the Storm*ceptor* units had higher removal rates. The long term TSS removal rates for a 1.2 acre/unit drainage area were calculated at 53%, 46%, 39%, and 30% for systems sized at 6800 gal., 4850 gal., 2800 gal., and 1820 gal., respectively. Removal rates decreased proportionately by 25% of the highest rate when the drainage area was doubled. Removal rates were less than 20% at 4.25 acres/unit.

Another laboratory study performed by Marcalek et al. (1994) suggests a much larger variation for TSS removal rates, ranging from 6% to 95%. In these studies flow rate was manipulated along with configurations of the inflow drop pipe and outflow riser. Systems used in these tests were 1/4 size and the sediment used was an ABS polymer used to control particle size more effectively. A scaling factor of 32 was used to estimate the actual prototype design flows based on equivalent Froude number under the special case where no free fluid surface exists with incompressible fluid. The removal rates for fine to medium sands were 95% at 95 gal/min, 77% at 206 gal/min, 68% at 285 gal/min, and 6% at 634 gal/min.

A study from the University of Conventry (Pratt, 1996) tested the equivalent to the STC 900 system at 144 gal/min in a 20 minute event . Sand and crankcase oil were loaded at 4100 mg/l and 90 mg/l, respectively to the influent water. Removal efficiencies were reported at 83% for sand and 98% for oil. While this was a full scale study, the conditions of the test may not accurately reflect field conditions under all circumstances. In particular, the flow rates do not fall within the recommended ranges specified in the Storm*ceptor* Design Manual (Storm*ceptor* Corporation, 1997). Additionally, the use of model sands do not always reflect the behavior of sediments under field conditions. Lastly, the number of replicates do not warrant statistical significance due to limited replications.

Storm*ceptor* Corporation and CSR/NEP have indicated that the preliminary sizing recommendations are based on their field installations and not the laboratory data or modeling data. Review of these data indicate that the laboratory data and modeling data do not give a definitive picture of system performance under field conditions. It is suggested that additional performance data be gathered from field installations and return to the modeling data for model calibration. Analysis of model sensitivity would be appropriate once additional field data has been collected.

Field Installations

A field test of the Storm*ceptor* system was carried out in The City of Edmonton Canada at a parking lot located in the Westmount Shopping center on Fountain Lake. A single Storm*ceptor* unit (Model STC2000, which is equivalent to an STC2400) was installed to treat an approximate impervious drainage area of 9.8 acres. This installation had a unit undersized by a factor of 3. The unit was fitted with automated samplers on inflow and outflow pipes. Water quality was measured on 4 storm events, and included TSS, metals, oil and grease. Average removal efficiencies were 51.5%, 39 to 53%, and 43%, respectively (Table 1). No additional data on the variability of these data were available. Precipitation data for the storm events were not made available to this reviewer at the time of this assessment. Therefore, it is unclear whether these events were 0.5 inch or more. The Storm*ceptor* Corporation's recommended impervious drainage area for the STC 2000 (equivalent to the STC 2400) is 3.35 acres, therefore the system was largely under-sized. The performance of this system exceeded the predicted performance based on the sizing guidelines set by Storm*ceptor*. Under similar environmental conditions, including climate, land use intensity, and soil conditions as that at the Edmonton installation, it is possible that the undersized Storm*ceptor* system will provide at least 52% removal of TSS, sized under Storm*ceptor's* "Treatment Train" criteria (50% TSS removal).

Table 1. Water Quality Tests at Westmount Shopping Center, Edmonton Canada, 1996

Water Quality Parameter	Average Percent Removal Efficiency
TSS	52%
Metals (Fe, Pb, Zn, Cr, and Cu)	39 - 53%
Oil and Grease	43%

Storm*ceptor* conducted a survey of sediment loads to 23 Storm*ceptor* units installed in the City of Toronto, Canada (Bryant et al., 1995). Analysis of the sediment accumulations and estimates of TSS removal efficiency were calculated based on predicted flow and loadings. In this study, a mass balance was not utilized to measure removal efficiency. Rather, estimates based on regional precipitation data and estimated mean concentration (EMC) (Novotny, 1992) were used to determine loadings. The removal efficiency was calculated from the ratio of sediment collected in the unit and corrected for water content, and estimated loading. Solids removal efficiency increased with greater storage capacity (r^2=0.60) (Figure 3). The range of removal efficiencies was 18 to 95%. The authors did not verify whether there were significant losses of sediment out of the units (Bryant et al., 1995). These data indicate a relatively high potential for removal, especially where sediment storage capacity is high. Data from this study were used to calculate preliminary sizing recommendations, detailed later in this review (Appendix, Table A1). The approach used to estimate performance and the subsequent sizing recommendations is based on rational assumptions. Actual performance under conditions other than those tested may require verification to compare with these results.

In Westwood Massachusetts, an ongoing study of a Storm*ceptor* STC 2600, sized according to the "Sensitive Area" criteria, demonstrated 77% TSS removal efficiencies from six storm events. Two events produced no appreciable sediment load over the composite sampling period. The first three events had a mean of 90% TSS removal based on first flush grab samples. Three of the six events had removal rates in excess of 89% and as high as 99%. One event produced a low removal rate of 28% and may have been an artifact of the sampling procedure. Overall the removal efficiency for TSS is near 80%. Removal of TPH averaged 93%, based on first flush grab samples of the first three storm events. Overall TPH removal, based on composite sampling over 5 events, was 80% with 3 events contributing no data to the mean. The mean precipitation and duration of these events were 0.4 inches and 13 hours, respectively.

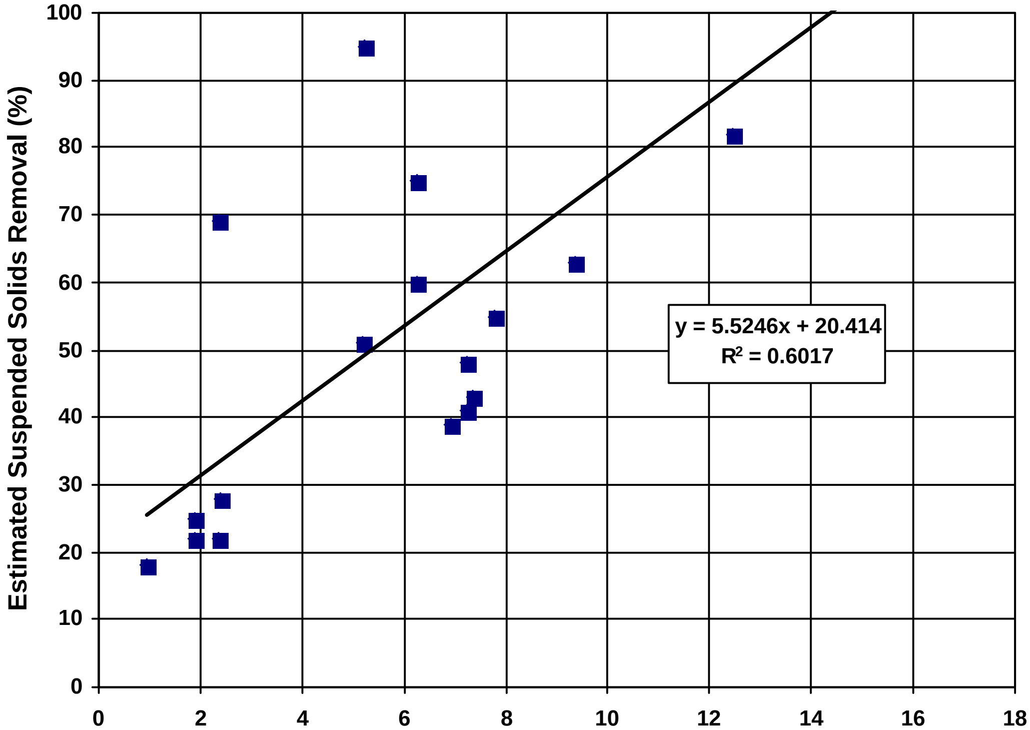


Figure 3: Storm*ceptor*® Sizing Guideline - Removal efficiency as a function of storage capacity from 23 Storm*ceptor* units in Toronto Canada.

Performance Summary

The Storm*ceptor* system has been demonstrated to provide at least 77% removal of TSS when sized under Storm*ceptor*'s "Sensitive Area" criteria and 52% TSS removal when sized under Storm*ceptor*'s "Treatment Train" criteria. Based on these data, the Storm*ceptor* systems receiving stormwater from a drainage area sized according to the "Sensitive Area" criteria are likely to provide a removal efficiency of 80%, on the annual stormwater runoff. While the set of data useful for predicting the relationship between treatment efficiency and loading rates is limited, it is likely that the STC 2400 is capable of meeting standards 4 and 6, for 80% removal of TSS in the first 0.5 or 1.0 inch of a storm event, if sized appropriately. STC 2400 Furthermore, performance of larger and smaller sized units may be capable of achieving removal rates that meet Standards 4 and 6. However, data to support this claim are not currently available.

SITE SUITABILITY RECOMMENDATIONS

The applicability of this technology with respect to TSS removal is similar to that of several other BMPs, including: sand and organic filters, catch basins, and water quality inlets, all described in the Stormwater Management Handbooks (DEP and CZM, 1997). The use of this technology can be made to Standards 4, 5, 6, and 7 in the Stormwater Management Handbooks (DEP and CZM, 1997).

The system is suitable for new and retrofit situations. The Storm*ceptor* system is particularly well suited for constricted areas, areas that require pretreatment for a multi-component treatment system, and redevelopment and retrofits described under Standard 7 in the Stormwater Management Handbook (DEP and CZM, 1997). The Storm*ceptor* system appears to have the ability to trap spills of hydrocarbons, oils, and grease. This makes the system suitable for use on areas with higher potential pollutant loads, specified under Standard 5 in the Stormwater Management Handbooks (DEP and CZM, 1997).

The system can be used on sites with a wide range of drainage areas provided it is sized correctly. On larger drainage area installations, units can be located throughout the drainage area rather than in a central location and provide treatment of runoff closer to its source. The system is suitable on small drainage areas or on individual inlets. The system is generally associated with a conveyance system and is recommended as part of a combination of different BMPs. The system is not designed as a recharge system and is not applicable to Standard 3 (DEP and CZM, 1997) unless combined with an approved recharge system. The system may be used as a pretreatment device for recharging systems. In this application, the life of the recharging system should be extended due to reduced clogging of the infiltrative surface. In high groundwater conditions the system is likely to withstand the hydrostatic pressures created by the saturated soil conditions around the unit. Care must be taken to assure the seam in the concrete unit does not leak. Buoyancy of the unit should be considered in the engineering plan. Storm*ceptor* Corporation recommends use of fiberglass tanks where there is potential for spills of hazardous materials. The precast concrete units are applicable to other installations including roads, highways, and parking lots.

Sizing

The recommended sizing, presented in the Appendix Table A1, was developed by Storm*ceptor* Corporation based on calculated loadings from the Toronto survey of system performance (Bryant et al., 1995). Based on the Edmonton Study, removal efficiencies determined for the STC 2000 (equivalent to the STC 2400) fall within the range of removal rates specified in the sizing guidlines. The performance ratings for the STC 2400, listed in Table A1 under “Treatment Train” criteria, may be conservative estimates, since that system was grossly undersized. When sized appropriately, the system is likely to perform as claimed under similar environmental and operating conditions including: climate, land use intensity, and soil conditions. The larger sized units listed in Table A1 have not been verified. The performance characteristics of these systems may vary as a function of scale. Performance of other sized units may have comparable removal efficiencies and are likely to meet Standards 4 and 6, requiring 80% TSS removal of the first 0.5 and 1 inch of rainfall respectively. The Storm*ceptor* system may be used as a stand alone BMP or as a component within a combination of different BMPs.. It is possible that sizing which corresponds to the “Sensitive Area” category in Table A1 may meet Standard 4 and 6, requiring 80% TSS removal of the first 0.5 and 1.0 inch of rainfall, respectively.

Maintenance

All BMPs require periodic maintenance. Inspection of the sediment load and oil and grease volumes is easily made from the surface with a tube dipstick inserted through a 6" vent tube. Depths of sediment indicating maintenance are presented the Appendix, under maintenance. Inspection of the internal structure should be part of the routine inspection plan. The unit is designed to accept 15% of its capacity in solids annually based on maximum drainage area loading listed in Table 4 of the Technical Design Manual (Storm*ceptor* Corporation, 1997). Removal of sediment, oils, and grease from the system will depend on rates of accumulation. Sediment removal is recommended annually but is likely to vary widely based on site conditions and loadings. The Stormwater Management Handbook (DEP and CZM, 1997) recommends quarterly maintenance. Reduced or more frequent maintenance frequency can be determined after experience with the system increases. Typical maintenance cleaning can be done with a vacuum truck. Maintenance costs are not expected to be in excess of normal costs for maintaining deep sump catch basins. Costs for cleaning, not adjusted for economies of scale, range from $250 to $500 depending on the size of the system and disposal fees.

REGULATORY ISSUES

The performance requirements for stormwater treatment systems are established by the DEP Stormwater Management Standards listed in the Stormwater Management Handbook (DEP and CZM, 1997). Projects subject to the standards may be required to file a Notice of Intent when they are sited in wetlands jurisdictional areas. Under the Wetlands Protection Act, conservation commissions, must apply the standards to new or modified discharges. Permits for surface water discharges under the National Pollutant Discharge Elimination System (NPDES), issued by the Massachusetts DEP Bureau of Resource Protection Division of Watershed Management, are not required if the discharge is tied to a conveyance or system of conveyances operated primarily for the purpose of collecting and conveying uncontaminated stormwater runoff.

CROSS MEDIA IMPACTS

Disposal of sediment from stormwater treatment systems is permitted in lined or unlined permitted solid waste landfills. In the absence of written approval from DEP, sediments are considered non-hazardous solid waste and may be treated in accordance with all DEP regulations policies and guidelines. Typical removal of sediment and biofilter material can be performed with a vacuum truck and disposed of. Grease and oils may accumulate in the sedimentation chambers and can be removed and disposed as non-hazardous solid waste. If the system has received influent from a hazardous materials spill, the system should be managed in accordance with an approved emergency response plan and appropriate state requirements. The Storm*ceptor* system does not present more restrictions for removal of wastes than would be associated with any other BMP.

ENERGY ISSUES{TC "ENERGY ISSUES"}

There are no specific energy issues related to this technology as it is not an energy consumer. There may be energy benefits when this "passive" system is compared to other technologies that may consume energy resources.

NEED FOR ADDITIONAL RESEARCH, DEMONSTRATION, AND STEP SUPPORT

The Storm*ceptor* technology is a unique approach for stormwater pretreatment and appears to be technically feasible based on a preliminary analysis of the available data. Further research on the Storm*ceptor* system should include studies to assess actual sediment loading under a variety of environmental conditions. To establish removal rates in excess of those reported herein, further research on the Storm*ceptor* system should include: i) evaluation of seasonal variation in performance, ii) performance as a function of flow rate, iii) efficiency with dual or multiple inlets, and iv) bacteria and pathogen removal efficiency in dry weather periods. The STEP program will be able to assist in performance verification on an as needed basis. Installations already being monitored by CSR and Storm*ceptor* will continue to provide performance data in a variety of environmental conditions. Existing monitoring programs may be augmented with STEP support through STEP oversight and reporting. STEP support may include development of experimental plans and review of data. Additional data would be useful for confirming field performance claims greater than 80% TSS removal efficiency.

SUMMARY RECOMMENDATION

The Storm*ceptor* system is based on reasonable and accepted principles applied to water treatment and conveyance systems. Review of available data suggests that the Storm*ceptor* system should be capable of providing an effective solution for treatment of stormwater runoff. At present, it is not possible to verify the performance of all the Storm*ceptor* models under the recommended sizing guidelines. The system is likely to be capable of TSS removal for Standards 4 and 6 when sized according to the "Sensitive Area" criteria. Other sized Storm*ceptor* models may provide similar TSS removal rates when sized accordingly under similar climatic conditions, land use intensities, and soil conditions. The Storm*ceptor* system is uniquely designed to trap hydrocarbons and is well suited for areas of higher pollutant potential, Standard 5 in the Stormwater Management Handbook (DEP and CZM, 1997). The system is also likely to remove grease and oils.

Based on available data, the Storm*ceptor* technology may be capable of meeting Standards 4, 5, 6, and 7 in the Stormwater Management Handbook (DEP and CZM, 1997) if installed, designed, and operated according to manufacturer's instructions. Additional data representing a varied set of operating conditions over a realistic maintenance cycle on other Storm*ceptor* models will assist in further clarification of TSS removal rates. Performance claims can be further verified as data is generated on systems currently being monitored. The Storm*ceptor* system compares favorably to other conventional BMP technologies with similar TSS removal rates, offering enhanced treatment and application.

Highlights

- Performance data available demonstrates that the Storm*ceptor* system can provide TSS removal rates of 77% when sized according to the "Sensitive Area" criteria. Evidence suggests that the Storm*ceptor* system may be capable of achieving TSS removal rates between 89% and 99% when sized accordingly, under conditions similar to those reported in the Westwood Massachusetts site, including: climate and land use intensity.
- Performance data available to this reviewer suggest that the Storm*ceptor* system can provide TSS removal rates of 52% when sized according to the "Treatment Train" criteria.
- Use of the Storm*ceptor* system as a pretreatment component in combination with different BMPs, when sized according to the "Treatment Train" criteria, will likely meet standards 4 and 6 of the Stormwater Management Handbooks (DEP and CZM,1997). Use as a stand alone device may be justified when sized according to the "Sensitive Area" criteria.
- The Storm*ceptor* system is likely to perform in areas with higher potential pollutant levels in Standard 5 of the Stormwater Management Handbooks (DEP and CZM,1997).
- The Storm*ceptor* system is useful for new and retrofit installations in Standard 7 of the Stormwater Management Handbooks (DEP and CZM,1997), especially where space is limited.
- The Storm*ceptor* system is also suited for secondary sediment control from construction related sediment loads specified in Standard 8 (DEP and CZM,1997).

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APPENDIX

Table A1. Storm*ceptor*® Capacities*					
Model	Maximum Treatment Flowrate (gal/min.)**	Down Riser Pipe / Orifice Diameter (in.)	Sediment Capacity (ft^3)	Oil Capacity (gal)	Total Holding Capacity (gal)
STA/STC 900	285	6	75	280	950
STA/STC 1200	285	6	110	280	1230
STA/STC 1800	285	6	195	280	1830
STA/STC 2400	475	8	180	880	2495
STA/STC 3600	475	8	345	880	3750
STA/STC 4800	800	10	465	1025	5020
STA/STC 6000	800	10	610	1025	6095
STA/STC 7200	1110	12	725	1100	7415

* approximate, ** without by-passing

Table A2. Maximum Impervious Drainage Area Guidelines (acres)				
Storm*ceptor*® Model (STA / STC)	Sensitive Area (80% TSS removal)	Standard Area (70% TSS removal)	Degraded Area (60% TSS removal)	Treatment Train (50% TSS removal)
900	0.45	0.55	0.70	0.90
1200	0.70	0.85	1.05	1.45
1800	1.25	1.50	1.90	2.55
2400	1.65	2.00	2.50	3.35
3600	2.60	3.15	3.95	5.30
4800	3.60	4.30	5.40	7.25
6000	4.60	5.55	6.95	9.25
7200	5.55	6.70	8.40	11.25

Table 6. Sediment Depths Indicating Required Maintenance***{**tc "Table 6. Sediment Depths Indicating Required Maintenance*"**}Table A3. Sediment Depths Indicating Required Maintenance***	
Model	**Sediment Depth (feet)**
900	0.50
1200	0.75
1800	1.00
2400	1.00
3600	1.25
4800	1.00
6000	1.50
7200	1.25

* based on 15% of the interceptor’s sediment storage

ATTACHMENT 6

SECTION _________

REGULATORY STORMWATER TREE FILTER SYSTEM WITH ATTACHED CATCH BASIN

1. DESCRIPTION

1.1. The work under this section shall govern the furnishing and installation of the StormTree® tree filter system for regulatory compliance in meeting specific nutrient removal rates pursuant to the Ecology TAPE certification program, and other 3rd party certification programs. The work under this section shall govern the furnishing and installation of the StormTree® tree filter system according to the design "Plan".

2. GENERAL

2.1. The Contractor shall furnish and install a precast concrete tree filter system, complete and operable as shown and as specified herein, and in accordance with the requirements of the Plan and contract documents.

2.2. The precast structure shall be manufactured at a concrete products plant with approved facilities. A sample structure shall be made available for inspection by the Engineer. The selected structure shall meet the requirements of the following Manufacturer:

StormTree®
24 Corliss Street, Suite 9092
Providence, RI 02940
Ph.: 401-626-8999
www.storm-tree.com

Alternate systems will be considered, final approval will be determined by the Engineer.

2.3. Submittals shall be provided by the Manufacturer and shall include at a minimum the following:

- Design drawing(s)
- Construction detail with installation notes
- Performance data as requested
- Operation & Maintenance Plan
- Other project/system specific information as requested

2.4. American Society for Testing and Materials (ASTM) Reference Specifications:

2.4.1. ASTM C891: Standard Specification for Installation of Underground Precast Concrete Utility Structures

2.4.2. ASTM C478: Standard Specification for Precast Reinforced Concrete Manhole Sections

2.4.3. ASTM C858: Standard Specification of Underground Precast Concrete Utility Structures

2.4.4. ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

3. MATERIALS

3.1. Precast Concrete Structure: The precast structure shall consist of a four-sided box with open sides below the elevation of the root ball with an open bottom and an attached (monolithic) catch basin with an enclosed bottom. The two sections shall be separated by a precast weir as shown on the drawings. The catch basin shall include a cast iron frame/grate assembly and have weep holes cast into one or more sidewalls. The dimensions of the structure shall match those shown on the Plan. The curb portion of the structure and catch basin shall conform to the requirements of and be capable of supporting HS-20-wheel loading based on local regulatory specifications, unless otherwise modified or specified by the Engineer.

3.2. Grating: The structure shall include a two-piece fiberglass grate. The grating shall be designed to withstand a minimum pedestrian loading of 500 lbs/ft2 as a uniform live loading during the life of the installation. All pieces shall be removable allowing access for the cleaning and maintenance of the system interior. The two-piece grate shall have an opening in each piece that forms a square around the planted tree. The grates shall be recessed flush into the top of the precast structure as shown on the Drawings. The grate shall be of fiberglass or other approved material fabrication and be ADA compliant having no greater than a 0.50" opening. The fiberglass grate shall be 1-1/2 inches deep and supported in the recess of the precast concrete.

3.3. An engineered media consisting of both organic and inorganic aggregates with a minimum depth of 24 inches. The media is designed to provide high flow rate infiltration and promote healthy plant growth.

3.4. A woven geotextile mesh, meeting the Manufacturer's requirements will be placed between the media and stone layers. The mesh shall be such as to allow for the passage of water and restricting sediment transport while minimizing occlusion.

3.5. A perforated PVC underdrain pipe of specific dimension within a washed crush stone layer to convey infiltrating water and provide for sediment accumulation. The underdrain pipe is connected to a vertical closed riser pipe with an open top to serve for overflow/bypass, or access for cleanout.

4. PERFORMANCE

4.1. Function: The tree filter system shall function to remove pollutants by the following treatment processes: sedimentation, physical, and biological processes.

4.2. Pollutants: The tree filter system is designed to reduce or remove debris, trash, coarse and fine particulates, particulate-bound pollutants, metals and nutrients from stormwater during runoff events.

4.3. Bypass: The tree filter system shall typically utilize an internal bypass to divert excessive flows.

4.4. Treatment Capabilities shall be verified via third-party reports following Washington State Ecology TAPE protocols and maintain General Use Level Design (GULD) status for Basic (TSS), Total Phosphorous, and Enhanced (select dissolved metals) as defined.

4.4.1. Engineered biofiltration Media flow rate shall be verified via third-party report following TAPE protocols. The minimum treatment flow rate based on target pollutant shall be as follows:

TSS: 120 in/hr
Phosphorus: 120 in/hr
Metals: 120 in/hr

The System shall be designed to ensure that high flow events shall bypass the engineered biofiltration media preventing erosion and resuspension of pollutants.

4.4.2. The System shall remove a minimum of 90% Total Suspended Solids (TSS) based on aggregated data from field studies following the TAPE protocol.

4.4.3. The System shall remove a minimum of 69% Total Phosphorus based on aggregated data from field studies following TAPE protocol.

4.4.4. The System shall remove a minimum of 38% Dissolved Copper based on aggregated data from field studies following TAPE protocol.

4.4.5. The system shall remove a minimum of 73% Dissolved Zinc based on aggregated data from field studies following TAPE protocol.

4.5. Quality Assurance and Quality Control procedures shall be followed for all batches of engineered biofiltration media produced. Engineered biofiltration media shall be certified by the Manufacturer for performance and composition.

4.5.1. Media particle size distribution and composition shall be verified as per relevant ASTM Standards.

4.5.2. Media pollutant removal performance shall be verified per relevant ASTM Standards as well as TAPE protocol.

4.5.3. Media hydraulic performance shall be verified per relevant ASTM Standards as well as TAPE protocol.

5. CONSTRUCTION METHODS

5.1. Prevent damage to materials during storage and handling. The precast concrete structure shall be delivered to the project site via a flatbed transport. The contractor shall provide equipment at the site that has adequate capacity to offload the precast components. Pick weight will be determined.

5.2. The precast structure shall be placed above a layer of crushed washed stone. The stone will be placed to the limit of the excavation shown on the Plan, but at a minimum will extend one foot beyond the outside dimensions of the precast structure provided that there are no setback restrictions.

5.3. The underdrain pipe and riser assembly will be placed within the stone layer with additional coverage.

5.4. A woven geotextile mesh meeting the Manufacturer’s requirements will be placed and overlie the finished stone layer elevation.

5.5. The engineered media will be placed to the assigned depth and extent.

5.6. The fiberglass grate will be set within the notched ledge of the structure and be flush with the top surface of the structure.

5.7. Any asphalt or concrete pavement, sidewalks, curb, gutter or other structures, including utilities, that were removed to accommodate construction shall be replaced or relocated in a condition equal to or better than that removed, all to the satisfaction of the Engineer.

6. ACTIVATION, INSPECTION AND MAINTENANCE

6.1. Following completion of system installation, demonstrate the system performance to the satisfaction of the Engineer.

ATTACHMENT 7

Path: \\wse03.local\WSE\Depts\Water\Water Resources Group\GIS - Constraints Mapping\Chelsea\Voke Park\Environmental Receptor - MA.mxd **User:** GasparA **Saved:** 11/12/2021 1:57:09 PM **Opened:** 6/8/2022 7:05:30 AM

Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Legend

- Project Area
- Perennial Stream
- Intermittent Stream
- Marsh/Bog
- Wooded marsh
- Cranberry Bog
- Salt Marsh
- Open Water
- Reservoir (with PWSID)
- Tidal Flats
- Beach/Dune

ACECs

- ACECs

NHESP Habitats

- NHESP Estimated Habitats of Rare Wildlife
- NHESP Priority Habitats of Rare Species
- NHESP Certified Vernal Pools
- NHESP Potential Vernal Pools

FEMA National Flood Hazard Layer

Flood Zone Designations

- A: 1% Annual Chance of Flooding, no BFE
- AE: 1% Annual Chance of Flooding, with BFE
- AE: Regulatory Floodway
- AH: 1% Annual Chance of 1-3ft Ponding, with BFE
- AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with Depth
- VE: High Risk Coastal Area
- D: Possible But Undetermined Hazard
- X: 0.2% Annual Chance of Flooding
- X: Reduced Flood Risk due to Levee
- Area Not Included
- Area with no DFIRM - Paper FIRMs in Effect

Outstanding Resource Waters

- Public Water Supply Contributor
- ORW for ACEC
- ORW for both Water Supply and Other

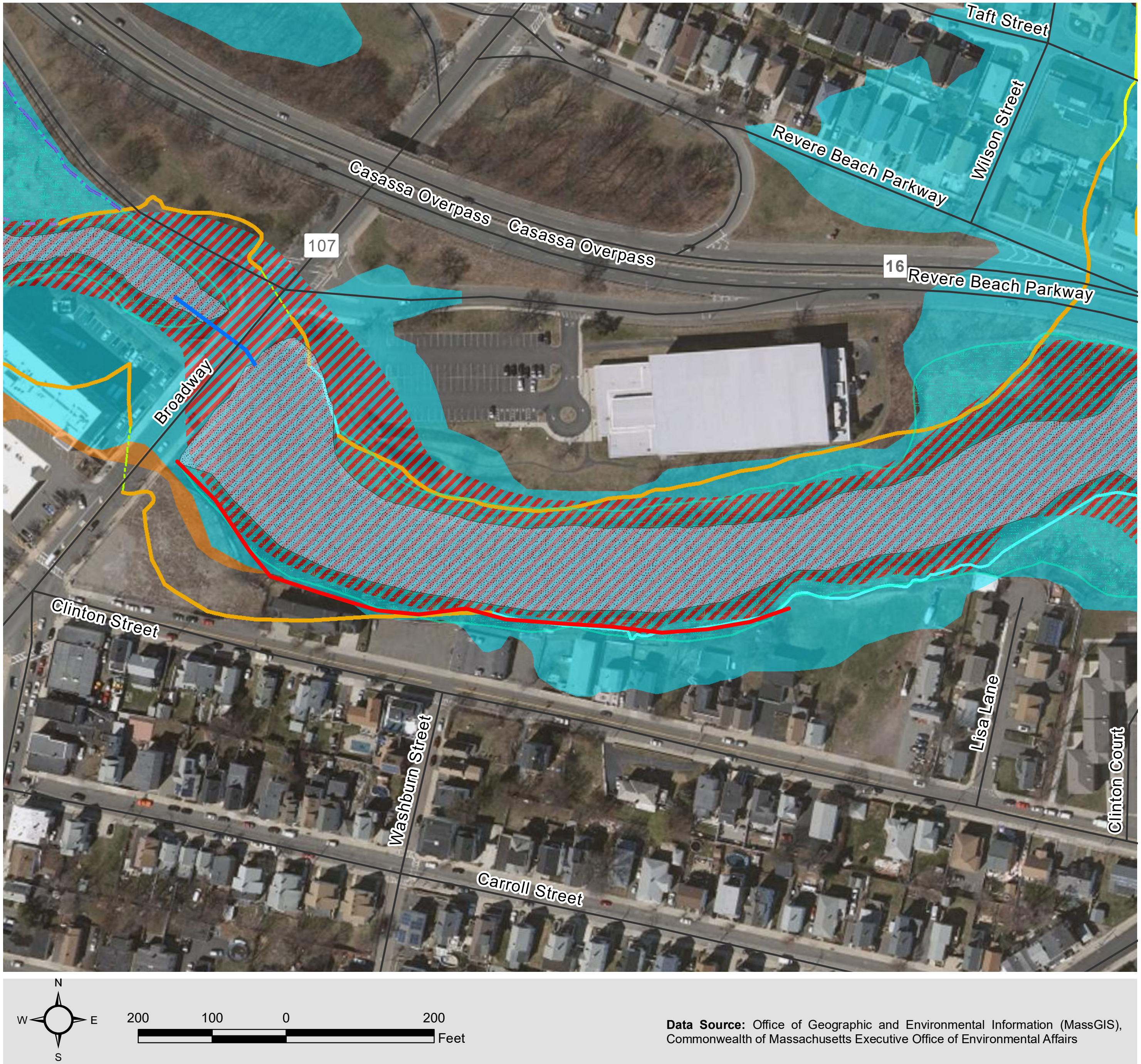
FIGURE 1

Voke Park
Chelsea MA

Environmental
Resource Map

Weston & Sampson

Path: \\wse03.local\WSE\Projects\MA\Chelsea MA\General\MassTrails Mill Creek Path\GIS\maps\Environmental Receptor - Chelsea.mxd User: GasparA Saved: 4/29/2022 2:20:32 PM Opened: 5/5/2022 12:50:36 PM



Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Legend

- Work Area
- Perennial Stream
- Intermittent Stream
- Marsh/Bog
- Wooded marsh
- Cranberry Bog
- Salt Marsh
- Open Water
- Reservoir (with PWSID)
- Tidal Flats
- Beach/Dune

Ch 91 Jurisdiction

- Public Way
- Marsh Boundary - landward
- Landlocked Tidelands
- Jurisdiction
- Historic High Water
- Marsh Boundary - seaward
- Contemporary High Water
- Inferred Contemporary High Water
- Inferred Historic High Water

ACECs

- ACECs

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- VE: High Risk Coastal Area
- D: Possible But Undetermined Hazard
- X: 0.2% Annual Chance of Flooding
- X: Reduced Flood Risk due to Levee
- Area Not Included
- Area with no DFIRM - Paper FIRMs in Effect

FIGURE 1

Mill Creek Pathway
Chelsea, MA

Environmental Resource Map

Weston & Sampson

ATTACHMENT 8

City of Chelsea, Massachusetts
Weston & Sampson Engineers, Inc.

Prep. By:	TPC
Check By:	TPC
Rev. Date:	6/30/2022
ENR (BOS.):	17544.16

Engineer's Estimate of Probable Construction Cost
Mill Creek Water Quality Improvements – BMP 50% Draft Design

Item No.	Description	Est. Unit Price	Quantity	Value
1	**DRAIN & STRUCTURES**			
a	8 & 12 inch PVC drain, per lf	$150.00	90	$13,500.00
b	8 inch PVC overflow pipe assembly (including perforated 4" PVC underdrain and riser), complete, lump sum	$3,500.00	1	$3,500.00
c	Hydrodynamic Separator #1, complete, lump sum	$25,000.00	1	$25,000.00
d	Hydrodynamic Separator #2, complete, lump sum	$11,000.00	1	$11,000.00
e	Hydrodynamic Separator #3, complete, lump sum	$12,000.00	1	$12,000.00
f	Stormwater infiltration tree pit, complete, lump sum	$15,000.00	1	$15,000.00
g	Connection to existing structure, per connection	$800.00	3	$2,400.00
2	**ENVIRONMENTAL PROTECTION**			
a	Catch basin protection, per catch basin	$200.00	8	$1,600.00
3	**PAVEMENT REPLACEMENT**			
a	Temporary pavement, lump sum	$6,000.00	1	$6,000.00
b	Permanent pavement with cutbacks, lump sum	$9,000.00	1	$9,000.00
4	**CURB AND SIDEWALK**			
a	Remove and reset granite curb, per linear foot	$70.00	125	$8,750.00
b	4-inch cement concrete sidewalk, per sq. yd.	$80.00	89	$7,120.00
c	6-inch cement concrete sidewalk with W.W.M., per sq. yd	$100.00	44	$4,400.00
d	Concrete sealant, per sq. yd.	$6.00	133	$798.00
5	**DOG WASTE STATIONS**			
a	Dog waste station, per unit	$715.00	2	$1,430.00
6	**LANDSCAPING**			
a	Tree, per tree	$1,000.00	5	$5,000.00
b	Landscape restoration, lump sum	$3,500.00	3	$10,500.00
7	**EARTHWORK**			
a	Handling and disposal of surplus excavated material (Regulated >RCS-1), per ton	$135.00	332	$44,850.00
b	Test Pits	$1,000.00	3	$3,000.00
8	**PRICE ADJUSTMENTS**			
a	Price Adjustment for Liquid Asphalt used in hot mix asphalt mixtures, where price variance is five (5) percent or greater, per ton	$60.00	8	$480.00
9	**MOBILIZATION**			
a	Mobilization (not to exceed 5% all other items), lump sum	5%	1	$9,300.00
			Construction Subtotal:	**$194,628.00**
			Construction Subtotal (Rounded):	**$195,000.00**