City of Lake Forest

Preliminary Water Quality Management Plan (WQMP)

Project Name:

Commercentre Drive Tract No. 17810

Prepared for:

Meritage Homes Corporation

1250 Corona Pointe Court, Suite 200

Corona, CA 92879

(951) 547-8339

Prepared by:

RBF Consulting

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1st Submittal: November 5, 2014

2nd Submittal: May 8, 2015

3rd Submittal: June 24, 2015

Project Owner's Certification

Permit/Application No.		Grading Permit No.	
Tract/Parcel Map No.	17810	Building Permit No.	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract)			Southwest corner of Alton Parkway and Commercentre Drive, Lake Forest, CA

This Preliminary Water Quality Management Plan (WQMP) has been prepared for Meritage Homes Corporation by RBF Consulting. The WQMP is intended to comply with the requirements of the local NPDES Stormwater Program requiring the preparation of the plan.

The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with the current Orange County Drainage Area Management Plan (DAMP) and the intent of the non-point source NPDES Permit for Waste Discharge Requirements for the County of Orange, Orange County Flood Control District and the incorporated Cities of Orange County within the Santa Ana Region or San Diego Region. Once the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement and amend the WQMP. An appropriate number of approved and signed copies of this document shall be available on the subject site in perpetuity.

Owner: Peter Vanek			
Title	Vice President of Land Development & Forward Planning		
Company	Meritage Homes		
Address	1250 Corona Pointe Court, Suite 200, Corona, CA 92879		
Email	peter.vanek@meritagehomes.com		
Telephone #	(951) 547-8320		
Signature		10/15/19	Date

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Section I Discretionary Permit(s) and Water Quality Conditions

Project Infomation			
Permit/Application No.		Tract/Parcel Map No.	17810
Additional Information/ Comments:			
Water Quality Conditions			
Water Quality Conditions (list verbatim)	Because this project is triggering the significant re-development threshold the project must develop a project specific WQMP to meet the requirements of Order No. R8-2009-0030 and implement BMPs to mitigate for pollutants of concern and hydromodification concerns. According to Table 2.1 in the Orange County Technical Guidance Document (TGD), anticipated pollutants from the site include heavy metals, organic compounds, trash and debris, and oil and grease. Potential pollutants from the project include pathogens (bacteria, viruses), nutrients, pesticides, sediments, and suspended solids. Known water quality impairments as included in the 2010 Section 303(d) List of Impaired Water Bodies for the downstream waterbodies are: • *Borrego Creek* is impaired for ammonia and indicator bacteria. • *San Diego Creek Reach 2* (above Jeffrey Road to the Headwaters) is impaired for indicator bacteria, nutrients, sedimentation/siltation, and unknown toxicity. • *San Diego Creek Reach 1* (below Jeffrey Road) is listed as impaired for fecal coliform, nutrients, pesticides, sedimentation/siltation, selenium, and toxaphene. • *Upper Newport Bay* is listed as impaired for chlordane, copper, dichlorodiphenyltrichloroethane (DDT), indicator bacteria, metals, nutrients, polychlorinated biphenyl (PCBs), pesticides, sedimentation/siltation, and sediment toxicity. • *Lower Newport Bay* is impaired for chlordane, copper, DDT, indicator bacteria, nutrients, polychlorinated biphenyls (PCBs), pesticides, and sediment toxicity. The BMPs implemented on-site must address these pollutants to ensure protection of receiving waters along with the requirements set forth in Order No. R8-2009-0030.		
Watershed-Based Plan Conditions			

Provide applicable conditions from watershed - based plans including WIHMPs and TMDLS.	According to the 2010 303(d) list, the impaired water bodies that are downstream to the project include: • *Borrego Creek* is impaired for ammonia and indicator bacteria. • *San Diego Creek Reach 2* (above Jeffrey Road to the Headwaters) is impaired for indicator bacteria, nutrients, sedimentation/siltation, and unknown toxicity. • *San Diego Creek Reach 1* (below Jeffrey Road) is listed as impaired for fecal coliform, nutrients, pesticides, sedimentation/siltation, selenium, and toxaphene. • *Upper Newport Bay* is listed as impaired for chlordane, copper, dichlorodiphenyltrichloroethane (DDT), indicator bacteria, metals, nutrients, polychlorinated biphenyl (PCBs), pesticides, sedimentation/siltation, and sediment toxicity. • *Lower Newport Bay* is impaired for chlordane, copper, DDT, indicator bacteria, nutrients, polychlorinated biphenyls (PCBs), pesticides, and sediment toxicity. In addition to those pollutants, TMDLs have been developed for pesticides, sedimentation/siltation, and selenium.

Section II Project Description

II.1 Project Description

Description of Proposed Project		
Development Category (Verbatim from WQMP):	Priority Development Project	
Project Area (ft²): 250,470	Number of Dwelling Units: 52	SIC Code: 1521
Narrative Project Description:	The 5.75-acre project site is located in the City of Lake Forest, immediately southwest of the Alton Parkway and Commercentre Drive intersection, commonly referred to as the Davis Property. The project site is bound by existing commercial area to the south. Construction grading for additional residential development is directly east of the project site. A water reservoir is located to the west of the project, along with open space to the north across from Alton Parkway. A previous extension of Alton Parkway coincides with the Commercentre Drive project location. Tract No. 17810 is a residential development that incorporates the construction of 52 units along with utilities and streets. The development will incorporate a total of 41 uncovered parking stalls located along the different access drives, as well as a 0.25-acre recreation area. Consistent with the WQMP requirements for Significant Redevelopment set forth in the amended MS4 Permit Order No. R8-2010-0062, the project area subject to the WQMP requirements is limited to 5.30 acres. The additional 0.45 acres of land on the northwest portion within the project boundary will be disturbed during construction activities to install an underground infiltration chamber. Upon construction, the additional 0.45-acre of land will be restored to their original purpose, original line and grade, and hydraulic capacity, and will remain as self-treating pervious slopes. Compliance with the most recent Construction General Permit in the SWPPP will be based on a total disturbed area of 5.75 acres. The additional 0.45-acre of land are identified as Subarea A-5 on the WQMP Site Map in Appendix B. During construction, disturbance of the existing slopes can be minimized by implementing CASQA BMP EC-2, entitled "Preservation of Existing Vegetation".	

Project Area	Pervious		Impervious	
	Area (acres)	Percentage	Area (acres)	Percentage
Pre-Project Conditions	5.30	100%	0.00	0%
Post-Project Conditions	1.59	30%	3.71	70%
Drainage Patterns/Connections	The project is located in the San Diego Creek Watershed. Runoff generated along and adjacent to the proposed Commercentre Drive alignment primarily flows to an existing off-site storm drain along Alton Parkway. A 42″ RCP conveys flows to the Davis Property (previously a detention basin). Currently, the 42″ RCP is connected directly to a 24″ RCP. This 24″ RCP from the Davis Property conveys to an existing 48″ RCP along the proposed existing Alton alignment.			

II.2 Potential Stormwater Pollutants

Pollutants of Concern			
Pollutant	Circle One: E=Expected to be of concern N=Not Expected to be of concern		Additional Information and Comments
Suspended-Solid/ Sediment	E	N	
Nutrients	E	N	
Heavy Metals	E	N	
Pathogens (Bacteria/Virus)	E	N	
Pesticides	E	N	
Oil and Grease	E	N	
Toxic Organic Compounds	E	N	
Trash and Debris	E	N	

- **Suspended Solids / Sediment:** consist of soils or other surficial materials that are eroded and then transported or deposited by wind, water, or gravity. Excessive sedimentation can increase turbidity, clog fish gills, reduce spawning habitat, lower young aquatic organisms survival rates, smother bottom dwelling organisms, and suppress aquatic vegetation growth. Sediments in runoff also transport other pollutants that adhere to them, including trace metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and phosphorus. The largest source of suspended solids / sediment is typically erosion from disturbed soils.
- **Nutrients:** includes the macro-nutrients nitrogen and phosphorus. They commonly exist in the form of mineral salts dissolved or suspended in water and as particulate organic matter transported by storm water. Excessive discharge of nutrients to water bodies and streams can cause eutrophication, including excessive aquatic algae and plant growth, loss of dissolved oxygen, release of toxins in sediment, and significant swings in hydrogen ion concentration (pH). Primary sources of nutrients in urban runoff are fertilizers, trash and

debris, and eroded soils. Urban areas with improperly managed landscapes can be substantial sources.

- **Metals:** includes certain metals that can be toxic to aquatic life if concentrations become high enough to stress natural processes. Metals of concern include cadmium, chromium, copper, lead, mercury, and zinc. Lead and chromium have been used as corrosion inhibitors in primer coatings and are also raw material components in non-metal products such as fuels, adhesives, paints, and other coatings. Copper and zinc are typically associated with building materials, including galvanized metal and ornamental copper, and automotive products, including tires and brake pads. Humans can be impacted from contaminated groundwater resources, and bioaccumulation of metals in fish and shellfish. Environmental concerns regarding the potential for release of metals to the environment have already led to restricted metal usage in certain applications, for example lead additives in gasoline. The primary source of metals in urban storm water is typically commercially available metal products and automobiles.
- **Microbial Pathogens (Bacteria and Viruses):** include bacteria and viruses, which are ubiquitous microorganisms that thrive under a range of environmental conditions. Water containing excessive pathogenic bacteria and viruses can create a harmful environment for humans and aquatic life. The source of pathogenic bacteria and viruses is typically the transport of animal or human fecal wastes from the watershed, but pathogenic organisms do occur in the natural environment.
- **Oil and Grease:** are characterized as high-molecular weight organic compounds. Elevated oil and grease content can decrease the aesthetic value of the water body, as well as the water quality. Introduction of these pollutants to water bodies may occur due to the wide uses and applications of some of these products in municipal, residential, commercial, industrial, and construction areas. Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids.
- **Toxic Organic Compounds:** include organic compounds (pesticides, solvents, hydrocarbons) which at toxic concentrations constitute a hazard to humans and aquatic organisms. Storm water coming into contact with organic compounds can transport excessive levels organics to receiving waters. Dirt, grease, and grime retained in cleaning fluid or rinse water may also adsorb levels of organic compounds that are harmful or hazardous to aquatic life. Sources of organic compounds include landscape maintenance areas, vehicle maintenance areas, waste handling areas, and potentially most other urban areas.
- **Trash and Debris:** includes trash, such as paper, plastic, and various waste materials, that can typically be found throughout the urban landscape, and debris which includes waste products of natural origin which are not naturally discharged to water bodies such as landscaping waste, woody debris, etc. The presence of trash and debris may have a significant impact on the recreational value of a water body and upon the health of aquatic habitat.

II.3 Hydrologic Conditions of Concern

Determine if streams located downstream from the project area are determined to be potentially susceptible to hydromodification impacts. Refer to Section 2.2.3.1 in the TGD for NOC or Section 2.2.3.2 for <SOC>.

☐ No – Show map

☒ Yes – Describe applicable hydrologic conditions of concern below.

In the North Orange County permit area, HCOCs are considered to exist if any streams located downstream from the project are determined to be potentially susceptible to hydromodification impacts and either of the following conditions exists:

- Post-development runoff volume for the 2-yr, 24-hr storm exceeds that of the predevelopment condition by more than 5 percent

  OR
- Time of concentration of post-development runoff for the 2-yr, 24-hr storm event is greater than the time of concentration of the pre-development condition by more than 5 percent.

Hydrology has been performed for the 2 year storm event. The table below provides a brief summary of the hydrologic findings. Refer to Appendix B for full analysis and calculations.

2-Year Storm Event	**Peak Flowrate (cfs)**	**Runoff Volume (ac-ft)**	**Time of Concentration (min)**
Existing Condition	4.09	0.30	11.49
Proposed Condition	6.99	0.72	10.97

The project implements StormTech MC-3500 Underground Infiltration Chambers to address HCOC requirements. The delta volume of the 2-year storm event will be captured and infiltrated, meeting the volume requirement in addition to significantly reducing the peak flowrate and increasing the time of concentration.

II.4 Post Development Drainage Characteristics

Runoff from the site is collected and infiltrated through a series of StormTech MC-3500 Underground Infiltration Chambers located at 4 separate locations on the project site. The 4 underground infiltration chambers are hydraulically connected to the proposed storm drain system as flow-by systems. Runoff from the development is routed to proposed storm drain and travels northeast to tie into an existing storm drain (42-inch reinforced concrete pipe) on Commercentre Drive. At the locations where runoff is able to flow to the underground chambers, a low-flow splitter will direct the runoff associated with the 2-year event to the underground chambers, while all runoff above the 2-year event will by-pass the underground chambers and discharge directly to the existing storm drain line that travels northwest on Commercentre Drive. Runoff then turns west into the storm drain running on Alton Parkway (48-inch reinforced concrete pipe), and eventually discharges to San Diego Creek.

II.5 Property Ownership/Management

The proposed residential development is located on the Meritage Homes Corporation property. Meritage Homes Corporation is responsible for the ongoing property ownership, management, and maintenance of the structures and adjacent areas. Operation and maintenance of the BMPs and on-site storm drain facilities are the responsibility of the owner unless designated otherwise.

A Home Owner's Association (HOA) will be formed upon completion of the development. At that time it is the owner's responsibility to transfer all operation and maintenance related activities including a funding mechanism to the HOA. See Notice of Transfer of Responsibility Form located in Appendix C. A copy of the WQMP and BMP maintenance records will be kept by the HOA at all times and made available upon request.

Covenants Conditions and Restrictions (CC&Rs) are being developed and will be provided during the Final WQMP. These will cover activity restrictions throughout the property as well as maintenance and financial responsibility for all of the on-site improvements including the BMPs covered in this report.

Section III Site Description

III.1 Physical Setting

Planning Area/ Community Name	Tract No. 17810
Location/Address	Southwest corner of Alton Parkway and Commercentre Drive, Lake Forest, CA
Land Use	Residential
Zoning	R2 – Multifamily Dwellings District (proposed)
Acreage	5.30 acres
Predominant Soil Type	Pending Final Geotechnical Investigation, County of Orange Hydrological Soil Maps show Soil Types A, B, C and D are present at the site. Please see Appendix D for Soils Map.

III.2 Site Characteristics

Precipitation Zone	Tract No. 17810 is located in the 0.87-inch design capture storm depth rainfall zone.
Topography	The development is located in the City of Lake Forest. Slopes within the property are relatively flat, ranging from 0.5% to 2%.
Drainage Patterns/Connections	Tract 17810 drains to an existing 42-inch reinforced concrete pipe on Commercentre Drive. Water Quality facilities are designed per the Model WQMP requirements and discussed in detail in subsequent sections.
Soil Type, Geology, and Infiltration Properties	Pending Final Geotechnical Report. A desktop study shows the project site to be predominantly of Hydrologic Soil Type A. A percolation rate of 2.0 in/hr is assumed, in addition to a factor of safety of 2. Thus, a conservative infiltration rate of 1.0 inch/hour has

	been assumed until submittal of Final Geotechnical Report. See Appendix D for relevant soils information.

Site Characteristics (continued)	
Hydrogeologic (Groundwater) Conditions	Pending Final Geotechnical Report.
Geotechnical Conditions (relevant to infiltration)	Pending Final Geotechnical Report.
Off-Site Drainage	Off-site drainage up-gradient to the project is collected and controlled by engineered MS4 storm drain systems. These systems are owned and maintained by the City of Lake Forest.
Utility and Infrastructure Information	Existing on-site storm drains and other utilities including water, sanitary sewer, and electrical, are owned and maintained by Meritage Homes Corporation. All residential development within the project will also be owned and maintained by Meritage Homes Corporation. Upon completion of the project, a Home Owner's Association (HOA) will be formed and take responsibility of utilities for the project. The proposed storm drain system and piping networks within the project are a private system. The City of Lake Forest assumes no liability or responsibility for the storm drain system, the stormwater conveyed within it, or maintenance of the storm drain system. Upon completion of the project, Meritage Homes Corporation will be responsible for the transfer of ownership and responsibilities. The HOA is required to maintain all storm drains and remove accumulated sediments to ensure adequate drainage.

III.3 Watershed Description

Receiving Waters	Borrego Creek, San Diego Creek, Newport Bay, Pacific Ocean
303(d) Listed Impairments	According to the 2010 303(d) list, the impaired water bodies that are downstream to the project include: • *Borrego Creek* is impaired for ammonia and indicator bacteria. • *San Diego Creek Reach 2* (above Jeffrey Road to the Headwaters) is impaired for indicator bacteria, nutrients, sedimentation/siltation, and unknown toxicity. • *San Diego Creek Reach 1* (below Jeffrey Road) is listed as impaired for fecal coliform, nutrients, pesticides, sedimentation/siltation, selenium, and toxaphene. • *Upper Newport Bay* is listed as impaired for chlordane, copper, dichlorodiphenyltrichloroethane (DDT), indicator bacteria, metals, nutrients, polychlorinated biphenyl (PCBs), pesticides, sedimentation/siltation, and sediment toxicity. • *Lower Newport Bay* is impaired for chlordane, copper, DDT, indicator bacteria, nutrients, polychlorinated biphenyls (PCBs), pesticides, and sediment toxicity.
Applicable TMDLs	TMDLs have been developed for metals, nutrients, pathogens, pesticides, sedimentation/siltation, and selenium.
Pollutants of Concern for the Project	Organic compounds, trash and debris, oil and grease, nutrients, pesticides, sediments and suspended solids, and heavy metals.
Environmentally Sensitive and Special Biological Significant Areas	2010 303(d) list of impaired water bodies; The confluence of Newport Bay with the Pacific Ocean is located approximately 2 miles north from Robert E. Badham ASBS (ASBS NO. 32).

Environmentally Sensitive Areas (ESAs) in the vicinity: According to the 2013 Orange County Technical Guidance Document (TGD), an ESA exists if a water body has been listed on the 303(d) list as an impaired water body. Newport Bay is listed under the 303(d) list of impaired water bodies.

Figure 1: 303(d) Impaired Water Bodies

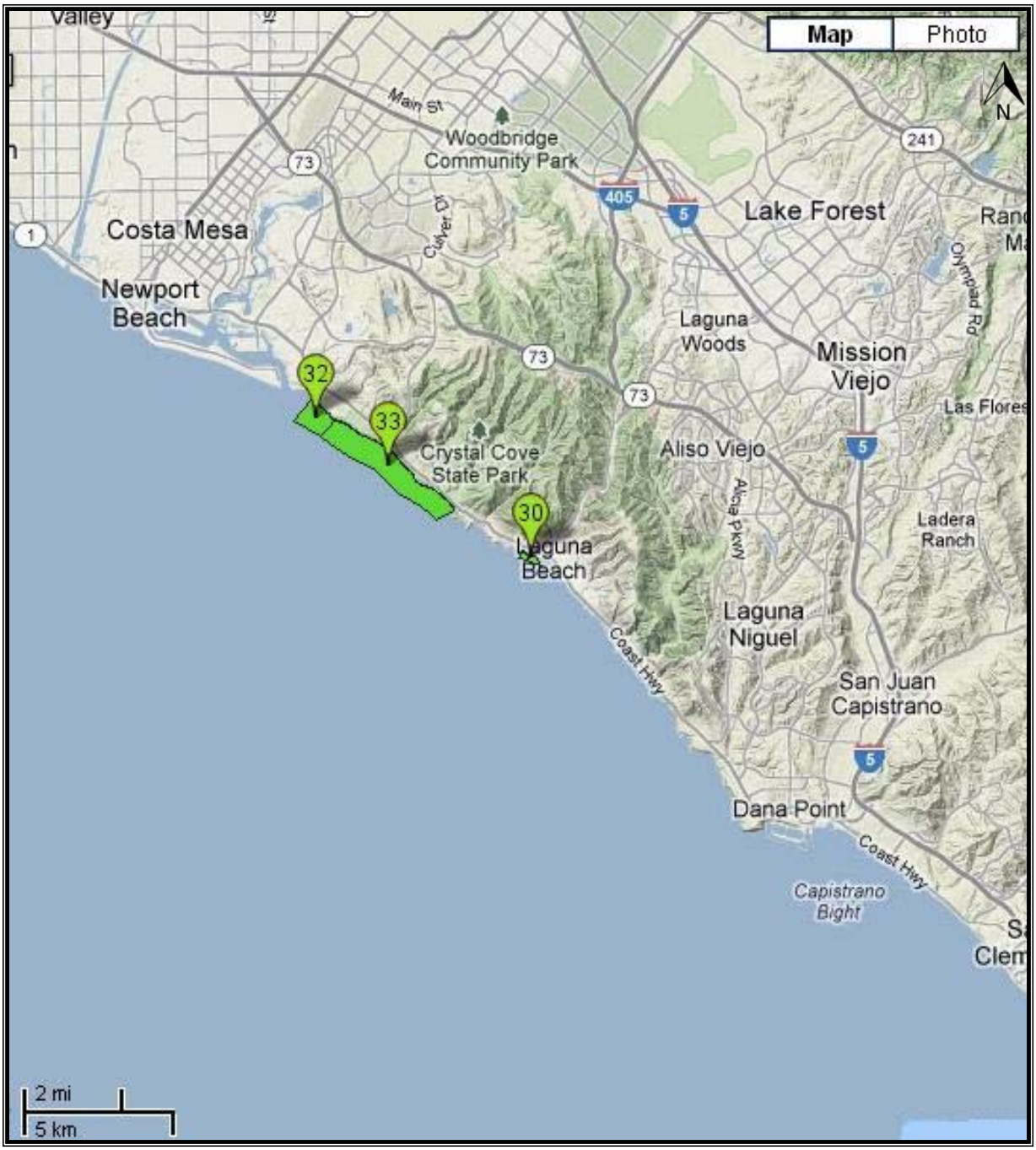


Figure 2: Areas or Special Biological Significance Near the Project

Section IV Best Management Practices (BMPs)

IV. 1 Project Performance Criteria

(NOC Permit Area only) Is there an approved WIHMP or equivalent for the project area that includes more stringent LID feasibility criteria or if there are opportunities identified for implementing LID on regional or sub-regional basis?	YES ☐	NO ☒
If yes, describe WIHMP feasibility criteria or regional/sub-regional LID opportunities.	N/A	

Project Performance Criteria (continued)	
If HCOC exists, list applicable hydromodification control performance criteria (Section 7.II-2.4.2.2 in MWQMP)	For proposed projects within the North County permit area that may have an HCOC, each Priority Project proponent must determine the impact of the proposed development on the downstream hydrologic characteristics. The evaluation of potential impacts is based on the following for a two-year frequency storm event: • Increases in runoff volume; • Decreases in infiltration; • Changes in time of concentration; • Potential for increases in post development downstream erosion; and, • Potential for adverse downstream impacts on physical structure, aquatic and riparian habitat. A project does not have an HCOC if either of the following conditions is met: • The volumes and time of concentration of stormwater runoff for the post-development condition do not significantly exceed those of the predevelopment condition for a two year frequency storm event (a difference of five percent or less is considered insignificant). • The site infiltrates at least the runoff from a two-year storm event.
List applicable LID performance criteria (Section 7.II-2.4.3 from MWQMP)	Priority Development Projects must infiltrate, harvest and use, evapotranspire, or biofilter, the 85th percentile, 24-hour storm event (Design Capture Volume). In addition to this requirement, additional volume capacity has been added to the DCV to meet drawdown time requirements. Refer to Appendix B for calculations.
List applicable treatment control BMP performance criteria (Section 7.II-3.2.2 from MWQMP)	If it is not feasible to meet LID performance criteria through retention and/or biotreatment provided on-site or at a sub-regional/regional scale, then treatment control BMPs shall be provided on-site or offsite prior to discharge to waters of the US. Sizing of treatment control BMP(s) shall be based on either the unmet volume after claiming applicable water quality credits, if appropriate and as calculated in TGD Appendix VI. If treatment control BMPs can treat all of the remaining unmet volume and have a medium to high effectiveness for reducing the primary POCs, the project is considered to be in compliance; a waiver application and participation in an alternative program is not required. If the cost of providing treatment control BMPs greatly outweighs the pollution control

	benefits they would provide, a waiver of treatment control and LID requirements can be requested and alternative compliance approaches must be used to fulfill the remaining unmet volume.
Calculate LID design storm capture volume for Project.	DCV = Area (ac) x Design Storm Depth (in) x Runoff Coefficient x (43,560 ft^2/12 in) DCV = 5.3 (ac) x 0.87 (in) x 0.675 x (43,560 ft^2/12 in) = 11,298 ft^3

IV.2. SITE DESIGN AND DRAINAGE PLAN

This Project is located in the San Diego Creek Watershed as discussed in Section II.1 in the regional drainage section. This project is located within the limits of the City of Lake Forest, which is bound on the northwest by the City of Irvine, and on the south by the City of Mission Viejo. Figure 3 shows the location of Tract No. 17810 from a regional perspective.

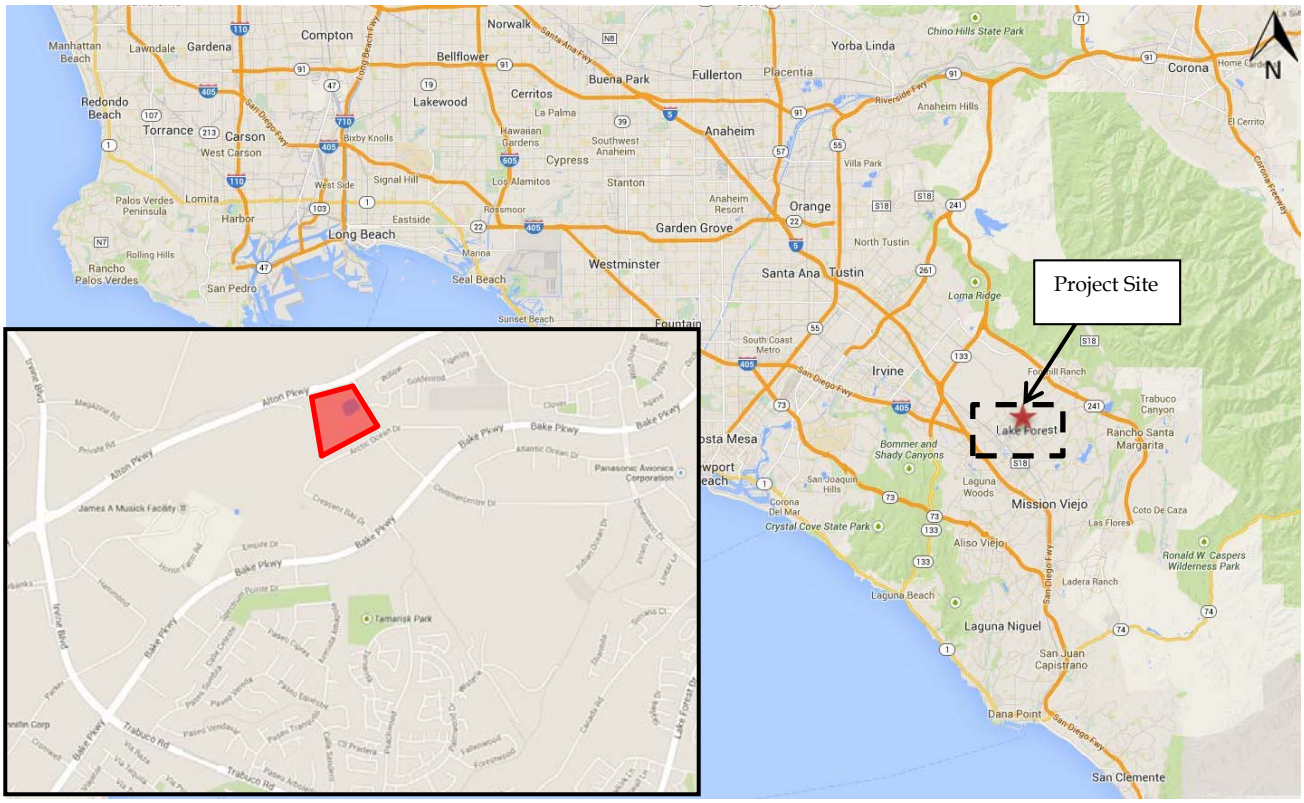


Figure 3: Regional Location of Commercentre Drive Tract No. 17810

Two site design principles consistent with Section 3 of the OC TGD are incorporated into the proposed site layout, while maintaining the functionality of the residential development:

- ***Minimize Impervious Area*** – compaction activities will be minimized in the vicinity of the proposed infiltration chambers during construction;
- ***Maximize Natural Infiltration Capacity*** – the location of the 4 underground infiltration chambers coincides with the areas of natural infiltration capacity (hydrologic soil group A)

The project implements the use of StormTech MC-3500 Underground infiltration chambers to not only meet LID requirements, but to also address HCOCs. The proposed underground infiltration chambers will **capture and infiltrate the delta volume associated with the existing and proposed 2-year storm event.** Below is a summary of the Water Quality Volume calculations. Water quality volume, hydrologic, and BMP sizing calculations can be found in Appendix B. Please refer to the WQMP Site Map in Appendix B for BMP location.

Per OC TGD, December 20, 2013

	DCV Calculation					
Drainage Area	**Area (ac)**	**Percentage of Site**	**Design Storm Depth (in)**	**% Impervious**	**Runoff Coefficient**	**Design Capture Volume (ft^3)**
A-1	1.59	30.00%	0.87	70%	0.675	**3,389**
A-2	0.99	18.68%	0.87	70%	0.675	**2,110**
A-3	1.95	36.79%	0.87	70%	0.675	**4,157**
A-4	0.77	14.53%	0.87	70%	0.675	**1,641**
	5.3					**11,298**

IV.3 LID BMP SELECTION AND PROJECT CONFORMANCE ANALYSIS

IV.3.1 Hydrologic Source Controls

Due to the implementation of Infiltration BMPs (StormTech MC-3500 Underground Infiltration Chambers), Hydrologic Source Controls are not required for this project.

IV.3.2 Infiltration BMPs

Identify infiltration BMPs to be used in project. If design volume cannot be met state why BMPs cannot be met

Name	Included?
Bioretention without underdrains	☐
Rain gardens	☐
Porous landscaping	☐
Infiltration planters	☐
Retention swales	☐
Infiltration trenches	☐
Infiltration basins	☐
Drywells	☐
Subsurface infiltration galleries	☒
French drains	☐
Permeable asphalt	☐
Permeable concrete	☐
Permeable concrete pavers	☐
Other:	☐
Other:	☐

See Appendix B for StormTech MC-3500 Underground Infiltration Chambers calculations.

IV.3.3 Evapotranspiration, Rainwater Harvesting BMPs

The full Design Storm Capture Volume can be met with infiltration BMPs, therefore, evapotranspiration, and rainwater harvesting BMPs are not applicable for this project.

IV.3.4 Biotreatment BMPs

The full Design Storm Capture Volume can be met with infiltration BMPs, therefore, bioretention BMPs are not applicable for this project.

IV.3.5 Hydromodification Control BMPs

Hydromodification control BMPs are needed for this project. The proposed underground infiltration chambers will capture and infiltrate the runoff delta volume associated with the 2-year event, thus complying HCOC requirements. Refer to the table below for a summary of StormTech chamber volumes and capacities. See Appendix B for complete hydrologic calculations and chamber sizing.

2-Year Storm Event	Total Drainage Area (ac)	Required Storage Volume (ft^3)	Provided Storage Volume (ft^3)
System 1	0.99	3,418	3,933
System 2	1.95	6,732	7,475
System 3	2.36*	5,489	4,524
System 4	2.36*	2,658	3,473

*Systems 3 and 4 treat the total runoff volume associated with Drainage Areas A-1 and A-4. See WQMP Site Plan in Appendix B for further detail.

IV.3.6 Regional/Sub-Regional LID BMPs

Regional/sub-regional LID BMPs are not applicable for this project.

IV.3.7 Treatment Control BMPs

The full Design Storm Capture Volume can be met with infiltration BMPs, therefore, treatment control BMPs are not applicable for this project.

IV.3.8 Non-structural Source Control BMPs

Non-Structural Source Control BMPs				
Identifier	**Name**	**Check One**		**If not applicable, state brief reason**
		Included	**Not Applicable**	
N1	Education for Property Owners, Tenants and Occupants	☒	☐	
N2	Activity Restrictions	☒	☐	
N3	Common Area Landscape Management	☒	☐	
N4	BMP Maintenance	☒	☐	
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	No commercial/industrial/restaurants buildings are part of the development
N6	Local Industrial Permit Compliance	☐	☒	No fuel dispenser/gas station are part of the development
N7	Spill Contingency Plan	☐	☒	No commercial/industrial/restaurants buildings are part of the development
N8	Underground Storage Tank Compliance	☐	☒	No fuel dispenser/gas station are part of the development
N9	Hazardous Materials Disclosure Compliance	☐	☒	No commercial/industrial/restaurants buildings are part of the development
N10	Uniform Fire Code Implementation	☐	☒	No commercial/industrial/restaurants buildings are part of the development
N11	Common Area Litter Control	☒	☐	
N12	Employee Training	☒	☐	
N13	Housekeeping of Loading Docks	☐	☒	No loading docks on site.
N14	Common Area Catch Basin Inspection	☒	☐	

N15	Street Sweeping Private Streets and Parking Lots	☒	☐	
N16	Retail Gasoline Outlets	☐	☒	No retail gas outlets on site.

IV.3.9 Structural Source Control BMPs

Structural Source Control BMPs				
Identifier	**Name**	**Check One**		**If not applicable, state brief reason**
		Included	**Not Applicable**	
S1	Provide storm drain system stenciling and signage	☒	☐	
S2	Design and construct outdoor material storage areas to reduce pollution introduction	☐	☒	No outdoor material areas on site.
S3	Design and construct trash and waste storage areas to reduce pollution introduction	☐	☒	Residents will have trash bins for each residence. There are no dumpsters or trash storage areas on site.
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	☒	☐	
S5	Protect slopes and channels and provide energy dissipation	☐	☒	No slopes or channels.
	Incorporate requirements applicable to individual priority project categories (from SDRWQCB NPDES Permit)	☐	☒	N/A
S6	Dock areas	☐	☒	No dock areas.
S7	Maintenance bays	☐	☒	No Maintenance bays.
S8	Vehicle wash areas	☐	☒	No Vehicle wash areas.
S9	Outdoor processing areas	☐	☒	No outdoor processing areas.
S10	Equipment wash areas	☐	☒	No equipment wash areas.
S11	Fueling areas	☐	☒	No fueling activities.
S12	Hillside landscaping	☒	☐	
S13	Wash water control for food preparation areas	☐	☒	No food preparation areas.
S14	Community car wash racks	☐	☒	No community car wash racks anticipated on-site.

IV.4 ALTERNATIVE COMPLIANCE PLAN (IF APPLICABLE)

IV.4.1 Water Quality Credits

Water Quality Credits are not applicable to this project because the underground infiltration chambers are meeting the requirements of the Permit. Therefore, this section is not applicable.

IV.4.2 Alternative Compliance Plan Information

Alternative Compliance Measures are not applicable to this project because the underground infiltration chambers are meeting the requirements of the Permit. Therefore, this section is not applicable.

Section V Inspection/Maintenance Responsibility for BMPs

BMP Inspection/Maintenance			
BMP	**Reponsible Party(s)**	**Inspection/ Maintenance Activities Required**	**Minimum Frequency of Activities**
Underground Infiltration Chambers (StormTech MC-3500)	Meritage Homes Corporation	Inspection of isolator row	Before/after rainy season, after each storm event. The invert of the device needs to be inspected to determine if the invert is clogged and if soil, sediment, or debris needs to be removed.
Catch Basin Stencilling	Meritage Homes Corporation	Inspect stencils for fading or vandalism	Bi-monthly, as needed
Drainage Facility Inspection and Maintenance	Meritage Homes Corporation	Inspect annually at the end of summer or in early fall and remove sediment/debris. Check for trash and sediment build-up within catch basin.	Bi-monthly, as needed
Mechanical Street Sweeping	Meritage Homes Corporation	Mechanically sweep streets and entrances associated with the site	Monthly

BMP Inspection/Maintenance			
BMP	**Reponsible Party(s)**	**Inspection/ Maintenance Activities Required**	**Minimum Frequency of Activities**
Common Area Landscaping	Meritage Homes Corporation	Routine landscape maintenance, pickup and disposal of sediment and green waste	Daily, as needed
Landscape and Irrigation System Design/ Maintenance	Meritage Homes Corporation	Repair or replace any malfunctioning irrigation equipment as needed.	Weekly and as needed.
Trash/Litter Control	Meritage Homes Corporation	Proper pickup and disposal of trash throughout the site	Daily, as needed

Section VI Site Plan and Drainage Plan

VI.1 SITE PLAN AND DRAINAGE PLAN

Refer to Appendix B for hydrology and BMP Maps.

Section VII Educational Materials

Education Materials			
Residential Material (http://www.ocwatersheds.com)	**Check If Applicable**	**Business Material (http://www.ocwatersheds.com)**	**Check If Applicable**
The Ocean Begins at Your Front Door	☒	Tips for the Automotive Industry	☐
Tips for Car Wash Fund-raisers	☐	Tips for Using Concrete and Mortar	☐
Tips for the Home Mechanic	☒	Tips for the Food Service Industry	☐
Homeowners Guide for Sustainable Water Use	☒	Proper Maintenance Practices for Your Business	☐
Household Tips	☒	**Other Material**	**Check If Attached**
Proper Disposal of Household Hazardous Waste	☒		
Recycle at Your Local Used Oil Collection Center (North County)	☐		☐
Recycle at Your Local Used Oil Collection Center (Central County)	☐		☐
Recycle at Your Local Used Oil Collection Center (South County)	☐		☐
Tips for Maintaining a Septic Tank System	☐		☐
Responsible Pest Control	☒		☐
Sewer Spill	☐		☐
Tips for the Home Improvement Projects	☒		☐
Tips for Horse Care	☐		☐
Tips for Landscaping and Gardening	☒		☐
Tips for Pet Care	☒		☐
Tips for Pool Maintenance	☐		☐
Tips for Residential Pool, Landscape and Hardscape Drains	☐		☐
Tips for Projects Using Paint	☒		☐

Appendix A:

Educational Materials

The Ocean Begins at Your Front Door

Orange County Stormwater Program

Even if you live miles from the Pacific Ocean, you may be unknowingly polluting it.

Dumping one quart of motor oil into a storm drain can contaminate 250,000 gallons of water.

Did You Know?

- Most people believe that the largest source of water pollution in urban areas comes from specific sources such as factories and sewage treatment plants. In fact, the largest source of water pollution comes from city streets, neighborhoods, construction sites and parking lots. This type of pollution is sometimes called "non-point source" pollution.
- There are two types of non-point source pollution: stormwater and urban runoff pollution.
- Stormwater runoff results from rainfall. When rainstorms cause large volumes of water to rinse the urban landscape, picking up pollutants along the way.
- Urban runoff can happen any time of the year when excessive water use from irrigation, vehicle washing and other sources carries trash, lawn clippings and other urban pollutants into storm drains.

Where Does It Go?

- Anything we use outside homes, vehicles and businesses – like motor oil, paint, pesticides, fertilizers and cleaners – can be blown or washed into storm drains.
- A little water from a garden hose or rain can also send materials into storm drains.
- Storm drains are separate from our sanitary sewer systems; unlike water in sanitary sewers (from sinks or toilets), water in storm drains is not treated before entering our waterways.

Sources of Non-Point Source Pollution

- Automotive leaks and spills.
- Improper disposal of used oil and other engine fluids.
- Metals found in vehicle exhaust, weathered paint, rust, metal plating and tires.
- Pesticides and fertilizers from lawns, gardens and farms.
- Improper disposal of cleaners, paint and paint removers.
- Soil erosion and dust debris from landscape and construction activities.
- Litter, lawn clippings, animal waste, and other organic matter.
- Oil stains on parking lots and paved surfaces.

The Effect on the Ocean

Non-point source pollution can have a serious impact on water quality in Orange County. Pollutants from the storm drain system can harm marine life as well as coastal and wetland habitats. They can also degrade recreation areas such as beaches, harbors and bays.

Stormwater quality management programs have been developed throughout Orange County to educate and encourage the public to protect water quality, monitor runoff in the storm drain system, investigate illegal dumping and maintain storm drains.

Support from Orange County residents and businesses is needed to improve water quality and reduce urban runoff pollution. Proper use and disposal of materials will help stop pollution before it reaches the storm drain and the ocean.

For More Information

California Environmental Protection Agency
www.calepa.ca.gov

- **Air Resources Board**
  www.arb.ca.gov
- **Department of Pesticide Regulation**
  www.cdpr.ca.gov
- **Department of Toxic Substances Control**
  www.dtsc.ca.gov
- **Integrated Waste Management Board**
  www.ciwmb.ca.gov
- **Office of Environmental Health Hazard Assessment**
  www.oehha.ca.gov
- **State Water Resources Control Board**
  www.waterboards.ca.gov

Earth 911 - Community-Specific Environmental Information 1-800-cleanup or visit www.1800cleanup.org

Health Care Agency's Ocean and Bay Water Closure and Posting Hotline
(714) 433-6400 or visit www.ocbeachinfo.com

Integrated Waste Management Dept. of Orange County (714) 834-6752 or visit www.oclandfills.com for information on household hazardous waste collection centers, recycling centers and solid waste collection

O.C. Agriculture Commissioner
(714) 447-7100 or visit www.ocagcomm.com

Stormwater Best Management Practice Handbook
Visit www.cabmphandbooks.com

UC Master Gardener Hotline
(714) 708-1646 or visit www.uccemg.com

The Orange County Stormwater Program has created and moderates an electronic mailing list to facilitate communications, take questions and exchange ideas among its users about issues and topics related to stormwater and urban runoff and the implementation of program elements. To join the list, please send an email to ocstormwaterinfo-join@list.ocwatersheds.com

Aliso Viejo	(949)	425-2535
Anaheim Public Works Operations	(714)	765-6860
Brea Engineering	(714)	990-7666
Buena Park Public Works	(714)	562-3655
Costa Mesa Public Services	(714)	754-5323
Cypress Public Works	(714)	229-6740
Dana Point Public Works	(949)	248-3584
Fountain Valley Public Works	(714)	593-4441
Fullerton Engineering Dept.	(714)	738-6853
Garden Grove Public Works	(714)	741-5956
Huntington Beach Public Works	(714)	536-5431
Irvine Public Works	(949)	724-6315
La Habra Public Services	(562)	905-9792
La Palma Public Works	(714)	690-3310
Laguna Beach Water Quality	(949)	497-0378
Laguna Hills Public Services	(949)	707-2650
Laguna Niguel Public Works	(949)	362-4337
Laguna Woods Public Works	(949)	639-0500
Lake Forest Public Works	(949)	461-3480
Los Alamitos Community Dev.	(562)	431-3538
Mission Viejo Public Works	(949)	470-3056
Newport Beach, Code & Water Quality Enforcement	(949)	644-3215
Orange Public Works	(714)	532-6480
Placentia Public Works	(714)	993-8245
Rancho Santa Margarita	(949)	635-1800
San Clemente Environmental Programs	(949)	361-6143
San Juan Capistrano Engineering	(949)	234-4413
Santa Ana Public Works	(714)	647-3380
Seal Beach Engineering	(562)	431-2527 x317
Stanton Public Works	(714)	379-9222 x204
Tustin Public Works/Engineering	(714)	573-3150
Villa Park Engineering	(714)	998-1500
Westminster Public Works/Engineering	(714)	898-3311 x446
Yorba Linda Engineering	(714)	961-7138
Orange County Stormwater Program	(877)	897-7455

Orange County 24-Hour
Water Pollution Problem Reporting Hotline
1-877-89-SPILL (1-877-897-7455)

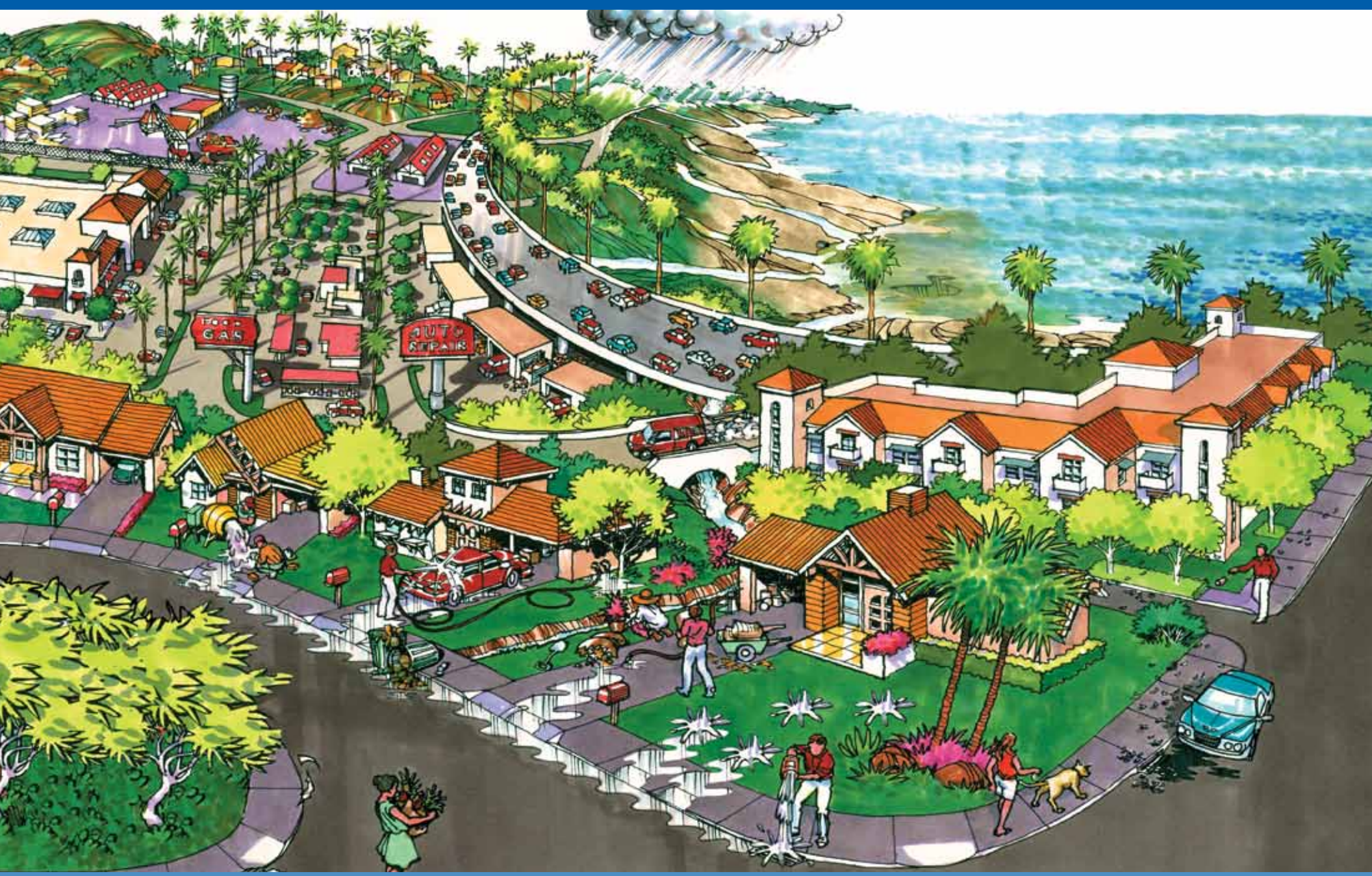
On-line Water Pollution Problem Reporting Form

www.ocwatersheds.com

Printed on Recycled Paper

PROJECT Pollution PREVENTION

The Ocean Begins at Your Front Door



Never allow pollutants to enter the street, gutter or storm drain!

Follow these simple steps to help reduce water pollution:

Household Activities

- Do not rinse spills with water. Use dry cleanup methods such as applying cat litter or another absorbent material, sweep and dispose of in the trash. Take items such as used or excess batteries, oven cleaners, automotive fluids, painting products and cathode ray tubes, like TVs and computer monitors, to a Household Hazardous Waste Collection Center (HHWCC).
- For a HHWCC near you call (714) 834-6752 or visit www.oclandfills.com.
- Do not hose down your driveway, sidewalk or patio to the street, gutter or storm drain. Sweep up debris and dispose of it in the trash.

Automotive

- Take your vehicle to a commercial car wash whenever possible. If you wash your vehicle at home, choose soaps, cleaners, or detergents labeled non-toxic, phosphate- free or biodegradable. Vegetable and citrus-based products are typically safest for the environment.
- Do not allow washwater from vehicle washing to drain into the street, gutter or storm drain. Excess washwater should be disposed of in the sanitary sewer (through a sink or toilet) or onto an absorbent surface like your lawn.
- Monitor your vehicles for leaks and place a pan under leaks. Keep your vehicles well maintained to stop and prevent leaks.
- Never pour oil or antifreeze in the street, gutter or storm drain. Recycle these substances at a service station, a waste oil collection center or used oil recycling center. For the nearest Used Oil Collection Center call 1-800-CLEANUP or visit www.1800cleanup.org.

Pool Maintenance

- Pool and spa water must be dechlorinated and free of excess acid, alkali or color to be allowed in the street, gutter or storm drain.
- When it is not raining, drain dechlorinated pool and spa water directly into the sanitary sewer.
- Some cities may have ordinances that do not allow pool water to be disposed of in the storm drain. Check with your city.

Landscape and Gardening

- Do not over-water. Water your lawn and garden by hand to control the amount of water you use or set irrigation systems to reflect seasonal water needs. If water flows off your yard onto your driveway or sidewalk, your system is over-watering. Periodically inspect and fix leaks and misdirected sprinklers.
- Do not rake or blow leaves, clippings or pruning waste into the street, gutter or storm drain. Instead, dispose of waste by composting, hauling it to a permitted landfill, or as green waste through your city's recycling program.
- Follow directions on pesticides and fertilizer, (measure, do not estimate amounts) and do not use if rain is predicted within 48 hours.
- Take unwanted pesticides to a HHWCC to be recycled. For locations and hours of HHWCC, call (714) 834-6752 or visit www.oclandfills.com.

Trash

- Place trash and litter that cannot be recycled in securely covered trash cans.
- Whenever possible, buy recycled products.
- Remember: Reduce, Reuse, Recycle.

Pet Care

- Always pick up after your pet. Flush waste down the toilet or dispose of it in the trash. Pet waste, if left outdoors, can wash into the street, gutter or storm drain.
- If possible, bathe your pets indoors. If you must bathe your pet outside, wash it on your lawn or another absorbent/permeable surface to keep the washwater from entering the street, gutter or storm drain.
- Follow directions for use of pet care products and dispose of any unused products at a HHWCC.

Common Pollutants

Home Maintenance
- Detergents, cleaners and solvents
- Oil and latex paint
- Swimming pool chemicals
- Outdoor trash and litter

Lawn and Garden
- Pet and animal waste
- Pesticides
- Clippings, leaves and soil
- Fertilizer

Automobile
- Oil and grease
- Radiator fluids and antifreeze
- Cleaning chemicals
- Brake pad dust

Clean beaches and healthy creeks, rivers, bays and ocean are important to Orange County. However, if we are not careful, our daily activities can lead directly to water pollution problems. Water that drains through your watershed can pick up pollutants which are then transported to our waterways and beautiful ocean.

You can prevent water pollution by taking personal action and by working with members of your watershed community to prevent urban runoff from entering your waterway.

For more information,
please call the
Orange County Stormwater Program
at **1.877.89.SPILL**
or visit
www.ocwatersheds.com

To report a spill,
call the
Orange County 24-Hour Water Pollution Problem Reporting Hotline
at **1.877.89.SPILL**.

For emergencies, dial 911.

The tips contained in this brochure provide useful information to help protect your watershed. If you have other suggestions, please contact your city's stormwater representatives or call the Orange County Stormwater Program.

Printed on Recycled Paper

Help Prevent Ocean Pollution:
Tips For Protecting Your Watershed

The Ocean Begins at Your Front Door

PROJECT Pollution PREVENTION

Tips for Protecting Your Watershed

My Watershed. Our Ocean.

Water + shed, *noun: A region of land within which water flows down into a specified water body, such as a river, lake, sea, or ocean; a drainage basin or catchment basin.*

Orange County is comprised of 11 major watersheds into which most of our water flows, connecting all of Orange County to the Pacific Ocean.

As water from rain (stormwater) or sprinklers and hoses (urban runoff) runs down your driveway and into your neighborhood streets, sidewalks and gutters, it flows into storm drains that lead to waterways within your watershed. The waterways from other cities merge as they make their way through our watersheds until all the runoff water in Orange County meets at the Pacific Ocean. The water that reaches our ocean is not pure. As it flows through the watershed, it picks up pollutants such as litter, cigarette butts, fertilizer, pesticides, pet waste, motor oil and lawn clippings. Unlike water that enters the sewer (from sinks and toilets), water that enters the storm drain is not treated before it flows, ultimately, to the ocean.

Water quality can be improved by "Adopting Your Watershed." Through this effort, we are challenging citizens and organizations to join the Orange County Stormwater Program and others who are working to protect and restore our creeks, rivers, bays and ocean.

There are many opportunities to get involved:

- Appreciate your watershed - explore the creeks, trails and ocean and make observations about its conditions. If you see anything abnormal (such as dead fish, oil spills, leaking barrels, and other pollution) contact the Orange County 24-hour water pollution problem reporting hotline at 1.877.89.SPILL to report the problem.
- Research your watershed. Learn about what watershed you live in by visiting www.ocwatersheds.com.
- Find a watershed organization in your community and volunteer to help. If there are no active groups, consider starting your own.
- Visit EPA's Adopt Your Watershed's Catalog of Watershed Groups at www.epa.gov/adopt to locate groups in your community.
- Organize or join in a creek, river, bay or ocean cleanup event such as Coastal & Inner Coastal Cleanup Day that takes place the 3rd Saturday of every September. For more information visit www.coast4u.org.

Follow these simple tips to protect the water quality of your watershed:

- **Sweep up debris and dispose of it in the trash. Do not hose down driveways or sidewalks into the street or gutter.**
- **Use dry cleanup methods such as cat litter to absorb spills and sweep up residue.**
- **Set your irrigation systems to reflect seasonal water needs or use weather-based controllers. Inspect for runoff regularly.**
- **Cover trashcans securely.**
- **Take hazardous waste to a household hazardous waste collection center. (For example, paint, batteries and petroleum products)**
- **Pick up after your pet.**
- **Follow application and disposal directions for pesticides and fertilizers.**
- **If you wash your car at home, wash it on your lawn or divert the runoff onto a landscaped area. Consider taking your car to a commercial car wash, where the water is reclaimed or recycled.**
- **Keep your car well maintained.**
- **Never pour oil or antifreeze in the street, gutter or storm drain.**

Do your part to prevent water pollution in our creeks, rivers, bays and ocean.

Clean beaches and healthy creeks, rivers, bays, and ocean are important to Orange County. However, many common household activities can lead to water pollution if you're not careful.

REMEMBER THE WATER IN YOUR STORM DRAIN IS NOT TREATED BEFORE IT ENTERS OUR WATERWAYS

Litter, oil, chemicals and other substances that are left on your yard or driveway can be blown or washed into storm drains that flow to the ocean. Over-watering your lawn and washing your car can also flush materials into the storm drains. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated.

You would never pour soap, fertilizers or oil into the ocean, so don't let them enter streets, gutters or storm drains. Follow the easy tips in this brochure to help prevent water pollution.

For more information,
please call the
Orange County Stormwater Program
at **1-877-89-SPILL** (1-877-897-7455)
or visit
www.ocwatersheds.com

To report a spill,
call the
Orange County 24-Hour Water Pollution Problem Reporting Hotline
1-877-89-SPILL (1-877-897-7455).

For emergencies, dial 911.

The tips contained in this brochure provide useful information to help prevent water pollution while performing everyday household activities. If you have other suggestions, please contact your city's stormwater representatives or call the Orange County Stormwater Program.

GENUINE RECYCLED PAPER
50% PRE-CONSUMER AND 15% POST-CONSUMER

RECYCLE USED OIL

Help Prevent Ocean Pollution:

Household Tips

The Ocean Begins at Your Front Door

PROJECT Pollution PREVENTION

Pollution Prevention

Household Activities

- **Do not rinse spills with water!** Sweep outdoor spills and dispose of in the trash. For wet spills like oil, apply cat litter or another absorbent material, then sweep and bring to a household hazardous waste collection center (HHWCC).
- Securely cover trash cans.
- Take household hazardous waste to a household hazardous waste collection center.
- Store household hazardous waste in closed, labeled containers inside or under a cover.
- Do not hose down your driveway, sidewalk or patio. Sweep up debris and dispose of in trash.
- Always pick up after your pet. Flush waste down the toilet or dispose of in the trash.
- Bathe pets indoors or have them professionally groomed.

Household Hazardous Wastes include:

- ▲ **Batteries**
- ▲ **Paint thinners, paint strippers and removers**
- ▲ **Adhesives**
- ▲ **Drain openers**
- ▲ **Oven cleaners**
- ▲ **Wood and metal cleaners and polishes**
- ▲ **Herbicides and pesticides**
- ▲ **Fungicides/wood preservatives**
- ▲ **Automotive fluids and products**
- ▲ **Grease and rust solvents**
- ▲ **Thermometers and other products containing mercury**
- ▲ **Fluorescent lamps**
- ▲ **Cathode ray tubes, e.g. TVs, computer monitors**
- ▲ **Pool and spa chemicals**

Gardening Activities

- Follow directions on pesticides and fertilizers, (measure, do not estimate amounts) and do not use if rain is predicted within 48 hours.
- Water your lawn and garden by hand to control the amount of water you use. Set irrigation systems to reflect seasonal water needs. If water flows off your yard and onto your driveway or sidewalk, your system is over-watering.
- Mulch clippings or leave them on the lawn. If necessary, dispose in a green waste container.
- Cultivate your garden often to control weeds.

Washing and Maintaining Your Car

- Take your car to a commercial car wash whenever possible.
- Choose soaps, cleaners, or detergents labeled "non-toxic," "phosphate free" or "biodegradable." Vegetable and citrus-based products are typically safest for the environment, **but even these should not be allowed into the storm drain.**
- Shake floor mats into a trash can or vacuum to clean.
- Do not use acid-based wheel cleaners and "hose off" engine degreasers at home. They can be used at a commercial facility, which can properly process the washwater.
- **Do not dump washwater onto your driveway, sidewalk, street, gutter or storm drain.** Excess washwater should be disposed of in the sanitary sewers (through a sink, or toilet) or onto an absorbent surface like your lawn.
- Use a nozzle to turn off water when not actively washing down automobile.
- Monitor vehicles for leaks and place pans under leaks. Keep your car well maintained to stop and prevent leaks.
- Use cat litter or other absorbents and sweep to remove any materials deposited by vehicles. Contain sweepings and dispose of at a HHWCC.
- Perform automobile repair and maintenance under a covered area and use drip pans or plastic sheeting to keep spills and waste material from reaching storm drains.
- **Never pour oil or antifreeze in the street, gutter or storm drains.** Recycle these substances at a service station, HHWCC, or used oil recycling center. For the nearest Used Oil Collection Center call 1-800-CLEANUP or visit www.ciwmb.ca.gov/UsedOil.

For locations and hours of Household Hazardous Waste Collection Centers in Anaheim, Huntington Beach, Irvine and San Juan Capistrano, call (714)834-6752 or visit www.oclandfills.com.

The Pollution Solution

Several residential activities can result in water pollution. Among these activities are car washing and hosing off driveways and sidewalks. Both activities can waste water and result in excess runoff. Water conservation methods described in this pamphlet can prevent considerable amounts of runoff and conserve water. By taking your car to a commercial car wash and by sweeping driveways and sidewalks, you can further prevent the transport of pollutants to Orange County waterways. Here are some of the common pollutants for which you can be part of the solution:

1 Pesticides and Fertilizer

- **Pollution:** The same pesticides that are designed to be toxic to pests can have an equally lethal impact on our marine life. The same fertilizer that promotes plant growth in lawns and gardens can also create nuisance algae blooms, which remove oxygen from the water and clog waterways when it decomposes.
- **Solution:** Never use pesticides or fertilizer within 48 hours of an anticipated rainstorm. Use only as much as is directed on the label and keep it off driveways and sidewalks.

2 Dirt and Sediment

- **Pollution:** Dirt or sediment can impede the flow of the stormwater and negatively impact stream habitat as it travels through waterways and deposits downstream. Pollutants can attach to sediment, which can then be transported through our waterways.
- **Solution:** Protect dirt stockpiles by covering them with tarps or secure plastic sheets to prevent wind or rain from allowing dirt or sediment to enter the storm drain system.

3 Metals

- **Pollution:** Metals and other toxins present in car wash water can harm important plankton, which forms the base of the aquatic food chain.
- **Solution:** Take your car to a commercial car wash where the wash water is captured and treated at a local wastewater treatment plant.

DID YOU KNOW?

Did you know that most of the pollution found in our waterways is not from a single source, but from a "non-point" source meaning the accumulation of pollution from residents and businesses throughout the community

4 Pet Waste

- **Pollution:** Pet waste carries bacteria through our watersheds and eventually will be washed out to the ocean. This can pose a health risk to swimmers and surfers.
- **Solution:** Pick up after your pets!

5 Trash and Debris

- **Pollution:** Trash and debris can enter waterways by wind, littering and careless maintenance of trash receptacles. Street sweeping collects some of this trash; however, much of what isn't captured ends up in our storm drain system where it flows untreated out to the ocean.
- **Solution:** Don't litter and make sure trash containers are properly covered. It is far more expensive to clean up the litter and trash that ends up in our waterways than it is to prevent it in the first place. Come out to one of Orange County's many locations for Coastal and Inner-Coastal Cleanup Day, which is held in September.

6 Motor Oil / Vehicle Fluids

- **Pollution:** Oil and petroleum products from our vehicles are toxic to people, wildlife and plants.
- **Solution:** Fix any leaks from your vehicle and keep the maintenance up on your car. Use absorbent material such as cat litter on oil spills, then sweep it up and dispose of it in the trash. Recycle used motor oil at a local Household Hazardous Waste Collection Center.

A TEAM EFFORT

The Orange County Stormwater Program has teamed with the Municipal Water District of Orange County (MWDOC) and the University of California Cooperative Extension Program (UCCE) to develop this pamphlet.

Low Impact Development (LID) and sustainable water use prevents water pollution and conserves water for drinking and reuse. Reducing your water use and the amount of water flowing from your home protects the environment and saves you money.

Thank you for making water protection a priority!

For more information, please visit
www.ocwatersheds.com/publiced/

www.mwdoc.com

www.uccemg.com

To report a spill, call the Orange County 24-Hour Water Pollution Prevention Reporting Hotline
at 1-877-89-SPILL \ (1-877-897-7455)

Special Thanks to
The City of Los Angeles Stormwater Program for the use of its artwork

The Metropolitan Water District of Southern California for the use of the California-Friendly Plant and Native Habitat photos

Homeowners Guide for Sustainable Water Use

Low Impact Development, Water Conservation & Pollution Prevention

The Ocean Begins at Your Front Door

RUNOFF, RAINWATER AND REUSE

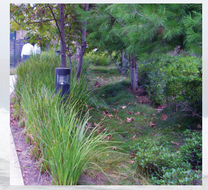
Where Does Water Runoff Go?

Stormwater, or water from rainfall events, and runoff from outdoor water use such as sprinklers and hoses flows from homes directly into catch basins and the storm drain system. After entering the storm drain, the water flows untreated into streams, rivers, bays and ultimately the Pacific Ocean. Runoff can come from lawns, gardens, driveways, sidewalks and roofs. As it flows over hard, impervious surfaces, it picks up pollutants. Some pollutants carried by the water runoff include trash, pet waste, pesticides, fertilizer, motor oil and more.

Water Conservation

Pollution not only impairs the water quality for habitat and recreation, it can also reduce the water available for reuse. Runoff allowed to soak into the ground is cleaned as it percolates through the soil, replenishing depleted groundwater supplies. Groundwater provides at least 50% of the total water for drinking and other indoor household activities in north and central Orange County. When land is covered with roads, parking lots, homes, etc., there is less land to take in the water and more hard surfaces over which the water can flow.

In Orange County, 60-70% of water used by residents and businesses goes to irrigation and other outdoor uses. Reusing rainwater to irrigate our lawn not only reduces the impact of water pollution from runoff, but it also is a great way to conserve our precious water resources and replenish our groundwater basin.



What is Low Impact Development (LID)?

Low Impact Development (LID) is a method of development that seeks to maintain the natural hydrologic character of an area. LID provides a more sustainable and pollution-preventative approach to water management.

New water quality regulations require implementation of LID in larger new developments and encourage implementation of LID and other sustainable practices in existing residential areas. Implementing modifications to your lawn or garden can reduce pollution in our environment, conserve water and reduce your water bill.

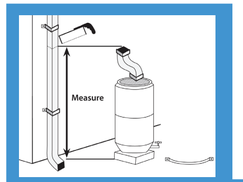
Permeable pavement allows water runoff to infiltrate through the soil and prevents most pollutants from reaching the storm drain system.

OPTIONS FOR RAINWATER HARVESTING AND REUSE

Rainwater harvesting is a great way to save money, prevent pollution and reduce potable water use. To harvest your rainwater, simply redirect the runoff from roofs and downspouts to rain barrels. Rain gardens are another option; these reduce runoff as well as encourage infiltration.

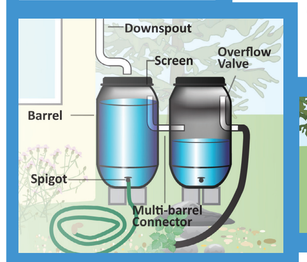
Downspout Disconnection/Redirection

Disconnecting downspouts from pipes running to the gutter prevents runoff from transporting pollutants to the storm drain. Once disconnected, downspouts can be redirected to rain gardens or other vegetated areas, or be connected to a rain barrel.



Rain Barrels

Rain barrels capture rainwater flow from roofs for reuse in landscape irrigation. Capacity of rain barrels needed for your home will depend on the amount of roof area and rainfall received. When purchasing your rain barrel, make sure it includes a screen, a spigot to siphon water for use, an overflow tube to allow for excess water to run out and a connector if you wish to connect multiple barrels to add capacity of water storage.

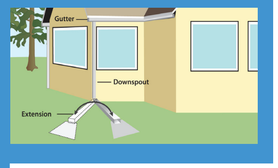


Mosquito growth prevention is very important when installing a rain barrel. The best way to prevent mosquito breeding is to eliminate entry points by ensuring all openings are sealed tightly. If these methods are unsuccessful, products are available to kill mosquito larvae, but that are harmless to animals and humans. Regular application of these products is essential. Please visit the Orange County Vector Control website for more information at www.ocvcd.org/mosquitoes3.php.

Rain Gardens

Rain gardens allow runoff to be directed from your roof downspout into a landscaped area. Vegetation and rocks in the garden will slow the flow of water to allow for infiltration into the soil. Plants and soil particles will absorb pollutants from the roof runoff. By utilizing a native plant palate, rain gardens can be maintained all year with minimal additional irrigation. These plants are adapted to the semi-arid climate of Southern California, require less water and can reduce your water bill.

Before modifying your yard to install a rain garden, please consult your local building and/or planning departments to ensure your garden plan follows pertinent building codes and ordinances. Besides codes and ordinances, some home owner associations also have guidelines for yard modifications. If your property is in hill areas or includes engineered slopes, please seek professional advice before proceeding with changes.



For information on how to disconnect a downspout or to install and maintain a rain barrel or rain garden at your home, please see the Los Angeles Rainwater Harvesting Program, A Homeowner's "How-To" Guide, November 2009 at www.larainwaterharvesting.org/

OTHER WATER CONSERVATION AND POLLUTION PREVENTION TECHNIQUES

Native Vegetation and Maintenance

"California Friendly" plants or native vegetation can significantly reduce water use. These plants often require far less fertilizers and pesticides, which are two significant pollutants found in Orange County waterways. Replacing water "thirsty" plants and grass types with water efficient natives is a great way to save water and reduce the need for potentially harmful pesticides and fertilizer.

Please see the California Friendly Garden Guide produced by the Metropolitan Water District of Southern California and associated Southern California Water Agencies for a catalog of California friendly plants and other garden resources at www.bewaterwise.com/Gardensoft.

Weed Free Yards

Weeds are water thieves. They often reproduce quickly and rob your yard of both water and nutrients. Weed your yard by hand if possible. If you use herbicides to control the weeds, use only the amount recommended on the label and never use it if rain is forecast within the next 48 hours.

Soil Amendments

Soil amendments such as green waste (e.g. grass clippings, compost, etc.) can be a significant source of nutrients and can help keep the soil near the roots of plants moist. However, they can cause algal booms if they get into our waterways, which reduces the amount of oxygen in the water and impacts most aquatic organisms. It is important to apply soil amendments more than 48 hours prior to predicted rainfall.

IRRIGATE EFFICIENTLY

Water runoff from sprinklers left on too long will carry pollutants into our waterways.

Smart Irrigation Controllers

Smart Irrigation Controllers have internal clocks as well as sensors that will turn off the sprinklers in response to environmental changes. If it is raining, too windy or too cold, the smart irrigation control sprinklers will automatically shut off.

Check with your local water agency for available rebates on irrigation controllers and smart timers.

- Aim your sprinklers at your lawn, not the sidewalk – By simply adjusting the direction of your sprinklers you can save water, prevent water pollution from runoff, keep your lawn healthy and save money.
- **Set a timer for your sprinklers** – lawns absorb the water they need to stay healthy within a few minutes of turning on the sprinklers. Time your sprinklers; when water begins running off your lawn, you can turn them off. Your timer can be set to water your lawn for this duration every time.
- **Water at Sunrise** – Watering early in the morning will reduce water loss due to evaporation. Additionally, winds tend to die down in the early morning so the water will get to the lawn as intended.
- **Water by hand** – Instead of using sprinklers, consider watering your yard by hand. Hand-watering ensures that all plants get the proper amount of water and you will prevent any water runoff, which wastes water and carries pollutants into our waterways.
- **Fix leaks** - Nationwide, households waste one trillion gallons of water a year to leaks – that is enough water to serve the entire state of Texas for a year. If your garden hose is leaking, replace the nylon or rubber hose washer and ensure a tight connection. Fix broken sprinklers immediately.

R-8
WATER CONSERVATION

Excessive irrigation and/or the overuse of water is often the most significant factor in transporting pollutants to the storm drain system. Pollutants from a wide variety of sources including automobile repair and maintenance, automobile washing, automobile parking, home and garden care activities and pet care may dissolve in the water and be transported to the storm drain. In addition, particles and materials coated with fertilizers and pesticides may be suspended in the flow and be transported to the storm drain.

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	x
Bacteria	x
Foaming Agents	x
Metals	x
Hydrocarbons	x
Hazardous Materials	x
Pesticides and Herbicides	x
Other	x

Hosing off outside areas to wash them down not only consumes large quantities of water, but also transports any pollutants, sediments, and waste to the storm drain system. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before using water. Remember - The ocean starts at your front door.

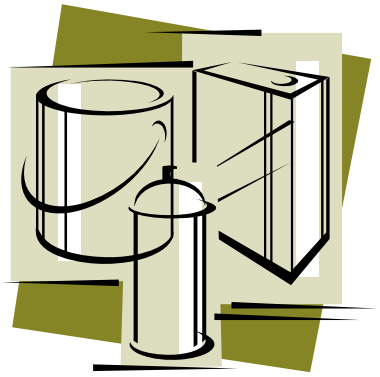
Required Activities

- Irrigation systems must be properly adjusted to reflect seasonal water needs.
- Do not hose off outside surfaces to clean, sweep with a broom instead.

Recommended Activities

- Fix any leaking faucets and eliminate unnecessary water sources.
- Use xeroscaping and drought tolerant landscaping to reduce the watering needs.
- Do not over watering lawns or gardens. Over watering wastes water and promotes diseases.
- Use a bucket to re-soak sponges/rags while washing automobiles and other items outdoors. Use hose only for rinsing.
- Wash automobiles at a commercial car wash employing water recycling.

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov



R-7
HOUSEHOLD HAZARDOUS WASTE

Household hazardous wastes (HHW) are defined as waste materials which are typically found in homes or similar sources, which exhibit characteristics such as: corrosivity, ignitability, reactivity, and/or toxicity, or are listed as hazardous materials by EPA.

The activities outlined in this fact sheet target the following pollutants:	
Sediment	
Nutrients	
Bacteria	
Foaming Agents	x
Metals	x
Hydrocarbons	x
Hazardous Materials	x
Pesticides and Herbicides	x
Other	x

List of most common HHW products:

- Drain openers
- Oven cleaners
- Wood and metal cleaners and polishes
- Automotive oil and fuel additives
- Grease and rust solvents
- Carburetor and fuel injection cleaners
- Starter fluids
- Batteries
- Paint Thinners
- Paint strippers and removers
- Adhesives
- Herbicides
- Pesticides
- Fungicides/wood preservatives

Many types of waste can be recycled; however options for each waste type are limited. Recycling is always preferable to disposal of unwanted materials. All gasoline, antifreeze, waste oil, and lead-acid batteries can be recycled. Latex and oil-based paint can be reused, as well as recycled. Materials that cannot be reused or recycled should be disposed of at a properly permitted landfill.

RECYCLE USED OIL

Think before disposing of any household hazardous waste. Remember - The Ocean starts at your front door.

Required Activities

- Dispose of HHW at a local collection facility. Call (714) 834-6752 for the household hazardous waste center closest to your area.
- Household hazardous materials must be stored indoors or under cover, and in closed and labeled containers.
- If safe, contain, clean up, and properly dispose all household hazardous waste spills. If an unsafe condition exists, call 911 to activate the proper response team.

Recommended Activities

- Use non-hazardous or less-hazardous products.
- Participate in HHW reuse and recycling. Call (714) 834-6752 for the participating household hazardous waste centers.

The California Integrated Waste Management Board has a Recycling Hotline (800) 553-2962, that provides information and recycling locations for used oil.

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov

R-6
DISPOSAL OF GREEN WASTES

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	x
Bacteria	x
Foaming Agents	
Metals	
Hydrocarbons	
Hazardous Materials	x
Pesticides and Herbicides	x
Other	

Green wastes entering the storm drain may clog the system creating flooding problems. Green wastes washed into receiving waters create an oxygen demand as they are decomposed, reducing the available oxygen for aquatic life. Pesticide and nutrient residues may be carried to the receiving water with the green wastes. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before disposing of any green wastes – Remember - The Ocean starts at your front door.

Required Activities

- Green wastes can not be disposed of in the street, gutter, public right-of-way, storm drain, or receiving water. Dispose of green wastes as a part of the household trash. If the quantities are too large, arrange a pick up with the local waste hauler.

- After conducting yard or garden activities sweep the area and properly dispose of the clippings and waste. Do not sweep or blow out into the street or gutter.

Recommended Activities

- Utilize a commercial landscape company to conduct the landscape activities and waste disposal.

- Utilize native plants and drought tolerant species to reduce the water use and green waste produced.

- Use a lawn mower that has a mulching function so that the grass clippings remain on the lawn and do not have to be collected and disposed of.

- Compost materials in a designated area within the yard.

- Recycle lawn clippings and greenery waste through local programs if available.

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov

R-5
DISPOSAL OF PET WASTES

Pet wastes left in the environment may introduce solids, bacteria, and nutrients to the storm drain. The type and quantity of waste will dictate the proper disposal method. Small quantities of waste are best disposed with regular trash or flushed down a toilet. Large quantities of wastes from herbivore animals may be composted for subsequent use or disposal to landfill.

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	x
Bacteria	x
Foaming Agents	
Metals	
Hydrocarbons	
Hazardous Materials	
Pesticides and Herbicides	
Other	

Pick up after your pet! It's as easy as 1-2-3. 1) Bring a bag. 2) Clean it up. 3) Dispose of it properly (toilet or trash). The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before you dispose of any pet wastes. Remember - The ocean starts at your front door.

Required Activities

- All pet wastes must be picked up and properly disposed of. Pet waste should be disposed of in the regular trash, flushed down a toilet, or composted as type and quantities dictate.

- Properly dispose of unused flea control products (shampoo, sprays, or collars).

- Manure produced by livestock in uncovered areas should be removed at least daily for composting or storage in water-tight container prior to disposal. Never hose down to stream or storm drain. Composting or storage areas should be configured and maintained so as not to allow contact with runoff. Compost may be donated to greenhouses, nurseries, and botanical parks. Topsoil companies and composting centers may also accept composted manure.

- Line waste pits or trenches with an impermeable layer, such as thick plastic sheeting.

- When possible, allow wash water to infiltrate into the ground, or collect in an area that is routed to the sanitary sewer.

- Confine livestock in fenced in areas except during exercise and grazing times. Restrict animal access to creeks and streams, preferably by fencing.

- Install gutters that will divert roof runoff away from livestock areas.

Recommended Activities

- In order to properly dispose of pet waste, carry bags, pooper-scooper, or equivalent to safely pick up pet wastes while walking with pets.
- Bathe pets indoors and use less toxic shampoos. When possible, have pets professionally groomed.
- Properly inoculate your pet in order to maintain their health and reduce the possibility of pathogens in pet wastes.
- Maintain healthy and vigorous pastures with at least three inches of leafy material.
- Consider indoor feeding of livestock during heavy rainfall, to minimize manure exposed to potential runoff.
- Locate barns, corrals, and other high use areas on portions of property that either drain away from or are located distant form nearby creeks or storm drains.

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov

R-4
HOME AND GARDEN CARE ACTIVITIES

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	
Bacteria	x
Foaming Agents	x
Metals	x
Hydrocarbons	x
Hazardous Materials	x
Pesticides and Herbicides	
Other	x

HOME CARE

Many hazardous materials may be used in and around residences during routine maintenance activities (such as: oils, paints, cleaners, bleaches, pesticides, glues, solvents, and other products). Improper or excessive use of these products can increase the potential for pollutants to be transported to the storm drain by runoff. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before conducting home care activities. Remember - The Ocean starts at your front door.

Required Activities

- Clean out painting equipment in an area where the waste can be contained and properly disposed of (latex – sewer, oil based – household hazardous waste center).
- Rinse off cement mixers and cement laden tools in a contained washout area. Dispose of dried concrete waste in household trash.
- If safe, contain, clean up, and properly dispose all household hazardous waste spills. If an unsafe condition exists, call 911 to activate the proper response team.
- Household hazardous materials must be stored indoors or under cover, and in closed and labeled containers. Dispose of them at a household hazardous waste center.
- Household wash waters (e.g. washer machine effluent, mop water, etc.) must be disposed of in the sanitary sewer.
- Pool and spa water may be discharged to the storm drain if residual chlorine is less than 0.1 mg/L, the pH is between 6.5 and 8.5, and the water is free from any unusual coloration. (Call 714-834-6107 to obtain information on a pool drain permit). Pool filter media must be contained and disposed of properly.

Recommended Activities

- Only purchase the types and amounts of materials needed.
- Share unused portions of products with neighbors or community programs (latex paint)

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov

GARDEN CARE

Garden activities may contribute pollutants via soil erosion, green waste, fertilizer and pesticide use. Plant and garden care activities such as landscape maintenance, fertilization, and pesticide application have the potential to discharge significant quantities of pollutants to the storm drain system. Nonvegetated surfaces may allow for significant erosion leading to high sediment loads. Other pollutants such as pesticides may adsorb onto the soil particles and be transported off site. Excess fertilizer and pesticide pollutants from over application may be carried to the storm drain by dissolving in irrigation runoff or rainwater. Green wastes may also contain organic matter and may have adsorbed fertilizers and pesticides.

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	x
Bacteria	x
Foaming Agents	
Metals	
Hydrocarbons	
Hazardous Materials	
Pesticides and Herbicides	x
Other	x

Excessive irrigation is often the most significant factor in home and garden care activities. Pollutants may dissolve in irrigation water and then be transported to the storm drain, or particles and materials coated with fertilizers and pesticides may be suspended in the irrigation flow and carried to the storm drain. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before conducting garden care activities. Remember - The ocean starts at your front door.

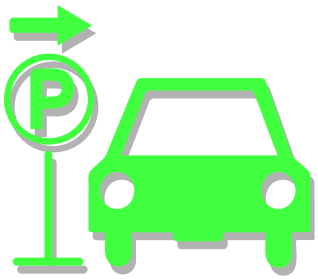
Required Activities

- Irrigation systems must be properly adjusted to reflect seasonal water needs.
- Minimize the use of pesticides and fertilizers. Read the labels and follow directions to avoid improper use. Do not apply chemicals if it is windy or about to rain.
- Properly clean up and dispose of spills of gardening chemicals, fertilizes, or soils. If possible, return the spilled material to the container for future use.
- Lawn and garden care products must be stored in closed labeled containers, in covered areas, or off-ground and under protective tarps.
- Household hazardous waste must be properly disposed at a household hazardous waste center.
- Cover nonvegetated surfaces to prevent erosion.

Recommended Activities

- Utilize xeroscaping and use of drought and insect resistant landscaping.
- Cultivate garden often to control weeds
- Use integrated pest management (IPM). Planting pest repelling plants (e.g. Marigolds) or using pest eating insects (e.g. ladybugs) may reduce the need for pesticides.
- Do not leave food (human or pet) outside overnight
- Remove fruit and garden waste

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov



R-3
AUTOMOBILE PARKING

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	
Bacteria	
Foaming Agents	
Metals	X
Hydrocarbons	X
Hazardous Materials	x
Pesticides and Herbicides	
Other	

Parked automobiles may contribute pollutants to the storm drain because poorly maintained vehicles may leak fluids containing hydrocarbons, metals, and other pollutants. In addition, heavily soiled automobiles may drop clods of dirt onto the parking surface, contributing to the sediment load when runoff is present. During rain events, or wash-down activities, the pollutants may be carried into the storm drain system. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before parking your car. Remember - The ocean starts at your front door.

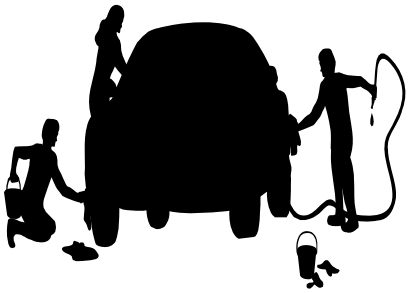
Required Activities

- If required, vehicles have to be removed from the street during designated street sweeping/cleaning times.
- If the automobile is leaking, place a pan or similar collection device under the automobile, until such time as the leak may be repaired.
- Use dry cleaning methods to remove any materials deposited by vehicles (e.g. adsorbents for fluid leaks, sweeping for soil clod deposits).

Recommended Activities

- Park automobiles over permeable surfaces (e.g. gravel, or porous cement).
- Limit vehicle parking to covered areas.
- Perform routine maintenance to minimize fluid leaks, and maximize fuel efficiency.

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov



R-2
AUTOMOBILE WASHING

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	X
Bacteria	
Foaming Agents	X
Metals	X
Hydrocarbons	X
Hazardous Materials	x
Pesticides and Herbicides	
Other	

Automobile washing activities have the potential to contribute pollutants because road dust washed from vehicles may contain metals and hydrocarbons. Any leaking fluids washed from the automobile may be carried to the storm drain by the wash water. Detergents used for automobile washing may also contain phosphorus and foaming agents, which contribute to the eutrophication of receiving waterbodies. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before conducting automobile washing activities. Remember - The Ocean starts at your front door.

Required Activities

- Shake floor mats into trashcan or vacuum to clean. Do not shake over ground.
- If using cleaners (such as acid based wheel cleaners) use a rag to wipe them on and off, do not rinse them off with water.
- If possible, divert runoff from automobile washing to a grassy surface large enough to contain and allow complete infiltration
- Dispose of excess wash water into the sanitary sewer (i.e. via sink, or toilet) or onto a landscaped area that will allow for complete infiltration.
- Conduct engine degreasing at a commercial facility that is set up to handle that type of waste.

Recommended Activities

- When possible, use commercial wash facilities
- Wash vehicles over pervious surfaces such as lawns and gravel areas
- Choose soaps, cleaners, or detergents labeled “non-toxic”, “phosphate free”, or “biodegradable”. Vegetable and citrus-based products are typically safest for the environment.
- Turn off water when not actively washing down automobile.
- If available, use established neighborhood wash areas, where runoff is properly controlled and managed.

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov

R-1
AUTOMOBILE REPAIR AND MAINTENANCE

Automobile repair and maintenance activities have the potential to contribute directly to storm drain systems primarily through spills or the dumping of waste fluids being conveyed to the storm drain. Automotive fluids, such as oils, greases, and solvents, are hydrocarbon based, and may contain metals, chlorinated hydrocarbons, and other toxic compounds. Removal of caked dirt and grime from an automobile increases the sediment load to the storm drain system. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	
Bacteria	
Foaming Agents	
Metals	x
Hydrocarbons	x
Hazardous Materials	x
Pesticides and Herbicides	
Other	

Think before conducting automobile repair and maintenance activities. Remember - The ocean starts at your front door.

Required Activities

- Recycle used oil and antifreeze by taking them to service stations and other recycling centers. Never pour oil in storm drains or other areas.
- Do not perform repair and maintenance activities during rain events.
- Immediately clean up and contain any spills. Dispose of all waste and adsorbent materials properly.
- Store hazardous materials and wastes (including, but not limited to, fluids, solvents, parts containing fluids, batteries) indoors, under cover, or in watertight containers.
- Perform automobile maintenance and repairs over impervious surfaces such as concrete, so spills and waste material should be readily cleaned up. Use drip pans, plastic sheeting, etc. to contain spills and waste material.
- Dispose of cleaning solvents at the designated hazardous waste center.

RECYCLE USED OIL

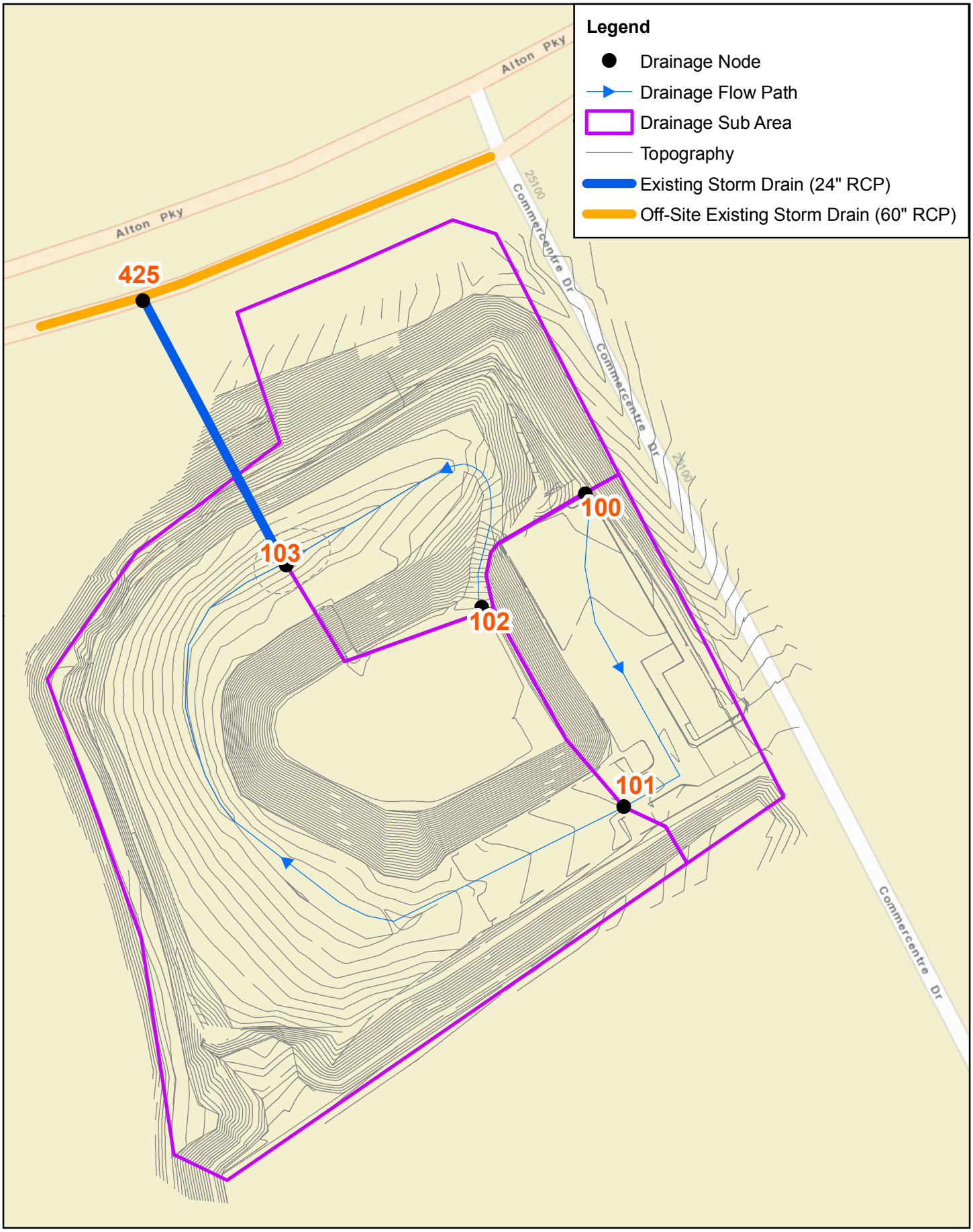
Recommended Activities

- Conduct auto repair activities at a commercial repair facility
- Perform automobile repair and maintenance activities under a covered area.
- Do not buy fluids containing target pollutants (e.g. degreasers containing PERC).
- Monitor parked or stored vehicles and equipment for leaks and place pans under leaks to collect fluids for proper disposal or recycling.

For additional information contact:
City of Lake Forest – Public Works Department
(949)461-3480 or visit our website at: www.lakeforestca.gov

Appendix B:

Maps and Calculations



RBF CONSULTING A Baker Company

N 0 125 250 Feet

Source:

Commercentre Drive: Existing Condition

Hydrologic Work Map

Figure 5

```
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
           (Reference: 1986 ORANGE COUNTY HYDROLOGY CRITERION)
         (c) Copyright 1983-2013 Advanced Engineering Software (aes)
             Ver. 20.0  Release Date: 06/01/2013  License ID 1264

                          Analysis prepared by:

                              RBF Consulting
                           14257 Alton Parkway
                                Irvine, CA
                                  92618

 ************************** DESCRIPTION OF STUDY **************************
* DRAINAGE STUDY - COMMERCENTRE DRIVE                                      *
* 2-YR EXISTING DAVIS PROPERTY                                             *
* REVISED JUNE 2015 IESCOBAR                                               *
 ***************************************************************************

  FILE NAME: CCE2.DAT
  TIME/DATE OF STUDY: 17:44 06/18/2015
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  *DATA BANK RAINFALL USED*
  *ANTECEDENT MOISTURE CONDITION (AMC) I ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150
  2   15.0     10.0    0.017/0.017/0.020   0.50    1.50 0.0312 0.125 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   300.00
  ELEVATION DATA: UPSTREAM(FEET) =    597.00  DOWNSTREAM(FEET) =    594.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.912
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.313
  SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
```

```
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  NATURAL FAIR COVER
  "OPEN BRUSH"              A        0.25      0.40     1.000    28   17.36
  NATURAL FAIR COVER
  "OPEN BRUSH"              B        0.06      0.30     1.000    46   17.36
  NATURAL POOR COVER
  "BARREN"                  A        0.50      0.40     1.000    61   12.91
  NATURAL POOR COVER
  "BARREN"                  B        0.05      0.30     1.000    72   12.91
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.39
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =      0.72
  TOTAL AREA(ACRES) =      0.86   PEAK FLOW RATE(CFS) =      0.72

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    103.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    594.00  DOWNSTREAM(FEET) =    586.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   618.00   CHANNEL SLOPE =  0.0129
  CHANNEL BASE(FEET) =    2.00   "Z" FACTOR =   2.000
  MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =  10.00
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.101
  SUBAREA LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  NATURAL FAIR COVER
  "OPEN BRUSH"              A        2.00      0.40     1.000    28
  NATURAL POOR COVER
  "BARREN"                  A        0.21      0.40     1.000    61
  NATURAL FAIR COVER
  "OPEN BRUSH"              C        1.19      0.25     1.000    59
  NATURAL FAIR COVER
  "OPEN BRUSH"              D        0.09      0.20     1.000    67
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.34
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.92
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   2.22
  AVERAGE FLOW DEPTH(FEET) =   0.33   TRAVEL TIME(MIN.) =   4.63
  Tc(MIN.) =   17.54
  SUBAREA AREA(ACRES) =     3.49       SUBAREA RUNOFF(CFS) =    2.38
  EFFECTIVE AREA(ACRES) =      4.35     AREA-AVERAGED Fm(INCH/HR) =   0.35
  AREA-AVERAGED Fp(INCH/HR) =   0.35  AREA-AVERAGED Ap =   1.00
  TOTAL AREA(ACRES) =        4.3         PEAK FLOW RATE(CFS) =       2.93

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.41   FLOW VELOCITY(FEET/SEC.) =   2.54
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    103.00 =     918.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    103.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   17.54
  RAINFALL INTENSITY(INCH/HR) =   1.10
  AREA-AVERAGED Fm(INCH/HR) =  0.35
  AREA-AVERAGED Fp(INCH/HR) =  0.35
  AREA-AVERAGED Ap =  1.00
```

```
  EFFECTIVE STREAM AREA(ACRES) =       4.35
  TOTAL STREAM AREA(ACRES) =       4.35
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       2.93

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   300.00
  ELEVATION DATA: UPSTREAM(FEET) =    613.00  DOWNSTREAM(FEET) =    586.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.189
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.426
  SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  NATURAL FAIR COVER
  "OPEN BRUSH"               A        0.76      0.40     1.000    28   11.19
  NATURAL FAIR COVER
  "OPEN BRUSH"               D        0.64      0.20     1.000    67   11.19
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.31
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =      1.41
  TOTAL AREA(ACRES) =      1.40   PEAK FLOW RATE(CFS) =      1.41

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    103.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.19
  RAINFALL INTENSITY(INCH/HR) =   1.43
  AREA-AVERAGED Fm(INCH/HR) =  0.31
  AREA-AVERAGED Fp(INCH/HR) =  0.31
  AREA-AVERAGED Ap =  1.00
  EFFECTIVE STREAM AREA(ACRES) =       1.40
  TOTAL STREAM AREA(ACRES) =       1.40
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       1.41

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        2.93   17.54    1.101  0.35( 0.35) 1.00       4.3     100.00
      2        1.41   11.19    1.426  0.31( 0.31) 1.00       1.4     102.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        4.09   11.19    1.426  0.34( 0.34) 1.00       4.2     102.00
      2        3.93   17.54    1.101  0.34( 0.34) 1.00       5.8     100.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       4.09    Tc(MIN.) =    11.19
  EFFECTIVE AREA(ACRES) =       4.17   AREA-AVERAGED Fm(INCH/HR) =  0.34
```

```
  AREA-AVERAGED Fp(INCH/HR) =  0.34  AREA-AVERAGED Ap =  1.00
  TOTAL AREA(ACRES) =        5.8
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    103.00 =     918.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    425.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   586.00  DOWNSTREAM(FEET) =   555.00
  FLOW LENGTH(FEET) =   243.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   4.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  13.42
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       4.09
  PIPE TRAVEL TIME(MIN.) =   0.30    Tc(MIN.) =   11.49
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    425.00 =    1161.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        5.8  TC(MIN.) =     11.49
  EFFECTIVE AREA(ACRES) =      4.17  AREA-AVERAGED Fm(INCH/HR)=  0.34
  AREA-AVERAGED Fp(INCH/HR) =  0.34  AREA-AVERAGED Ap = 1.000
  PEAK FLOW RATE(CFS)   =       4.09

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        4.09   11.49    1.404  0.34( 0.34) 1.00       4.2     102.00
      2        3.93   17.85    1.090  0.34( 0.34) 1.00       5.8     100.00
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

Lake Forest Commercentre Drive Tract 13343 – Existing 2-yr Volume

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RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
TOTAL CATCHMENT AREA(ACRES) = 5.90
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.400
LOW LOSS FRACTION = 0.780
TIME OF CONCENTRATION(MIN.) = 11.19
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 2
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.17
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.41
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.57
3-HOUR POINT RAINFALL VALUE(INCHES) = 1.02
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.46
24-HOUR POINT RAINFALL VALUE(INCHES) = 2.58

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 0.30
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.96

****

TIME (HOURS)	VOLUME (AF)	Q (CFS)	0.	2.5	5.0	7.5	10.0
0.15	0.0003	0.05	Q	.	.	.	.
0.33	0.0011	0.05	Q	.	.	.	.
0.52	0.0019	0.05	Q	.	.	.	.
0.71	0.0027	0.05	Q	.	.	.	.
0.89	0.0035	0.05	Q	.	.	.	.
1.08	0.0044	0.05	Q	.	.	.	.
1.27	0.0052	0.05	Q	.	.	.	.
1.45	0.0060	0.05	Q	.	.	.	.
1.64	0.0069	0.05	Q	.	.	.	.
1.83	0.0077	0.05	Q	.	.	.	.
2.01	0.0086	0.06	Q	.	.	.	.
2.20	0.0094	0.06	Q	.	.	.	.
2.39	0.0103	0.06	Q	.	.	.	.
2.57	0.0111	0.06	Q	.	.	.	.
2.76	0.0120	0.06	Q	.	.	.	.
2.95	0.0129	0.06	Q	.	.	.	.
3.13	0.0138	0.06	Q	.	.	.	.
3.32	0.0147	0.06	Q	.	.	.	.
3.50	0.0156	0.06	Q	.	.	.	.
3.69	0.0165	0.06	Q	.	.	.	.

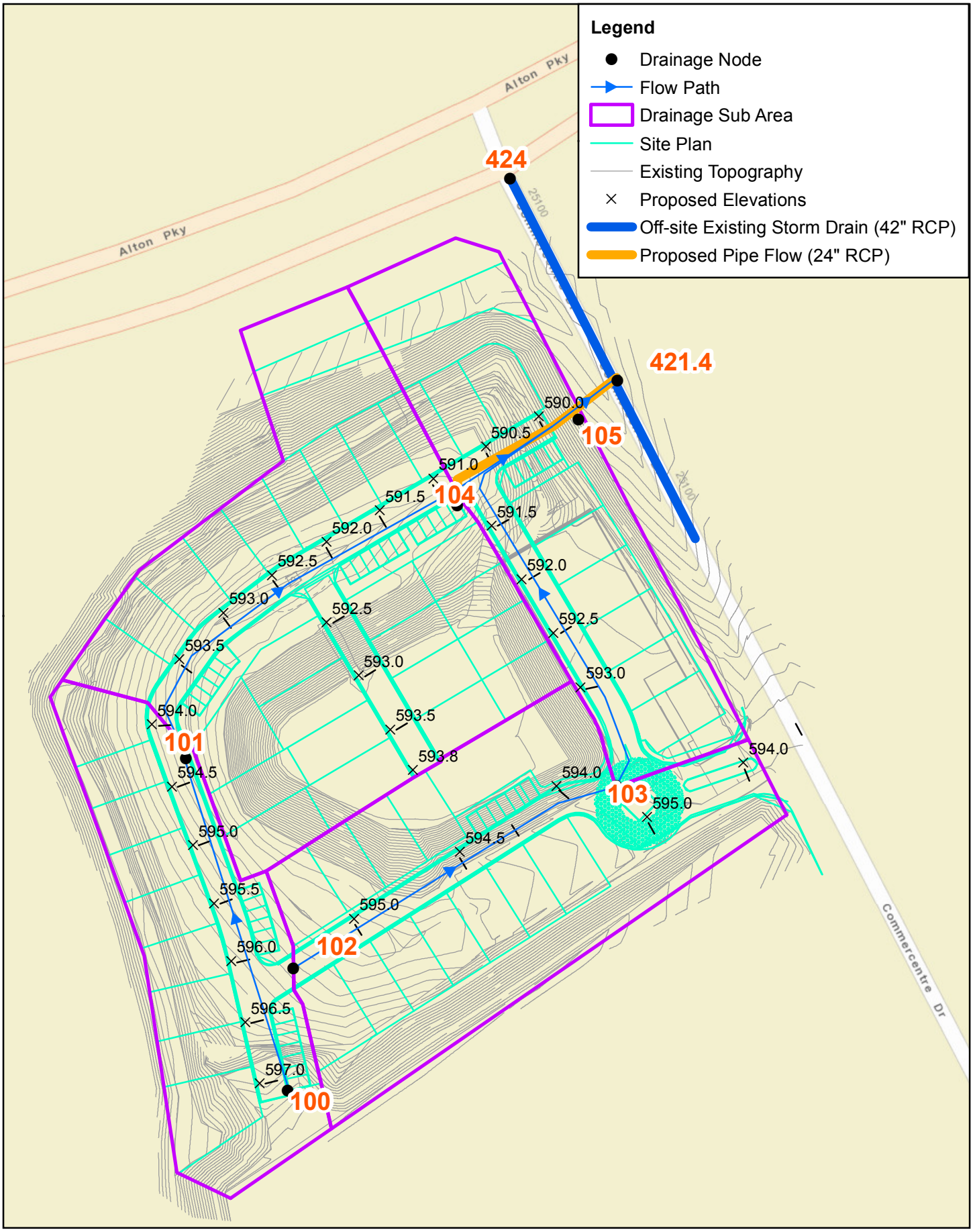
3.88	0.0175	0.06	Q	.	.	.	.
4.06	0.0184	0.06	Q	.	.	.	.
4.25	0.0193	0.06	Q	.	.	.	.
4.44	0.0203	0.06	Q	.	.	.	.
4.62	0.0212	0.06	Q	.	.	.	.
4.81	0.0222	0.06	Q	.	.	.	.
5.00	0.0232	0.06	Q	.	.	.	.
5.18	0.0242	0.06	Q	.	.	.	.
5.37	0.0252	0.07	Q	.	.	.	.
5.56	0.0262	0.07	Q	.	.	.	.
5.74	0.0272	0.07	Q	.	.	.	.
5.93	0.0282	0.07	Q	.	.	.	.
6.12	0.0293	0.07	Q	.	.	.	.
6.30	0.0303	0.07	Q	.	.	.	.
6.49	0.0314	0.07	Q	.	.	.	.
6.68	0.0325	0.07	Q	.	.	.	.
6.86	0.0336	0.07	Q	.	.	.	.
7.05	0.0347	0.07	Q	.	.	.	.
7.23	0.0358	0.07	Q	.	.	.	.
7.42	0.0369	0.07	Q	.	.	.	.
7.61	0.0380	0.07	Q	.	.	.	.
7.79	0.0392	0.08	Q	.	.	.	.
7.98	0.0404	0.08	Q	.	.	.	.
8.17	0.0416	0.08	Q	.	.	.	.
8.35	0.0428	0.08	Q	.	.	.	.
8.54	0.0440	0.08	Q	.	.	.	.
8.73	0.0452	0.08	Q	.	.	.	.
8.91	0.0465	0.08	Q	.	.	.	.
9.10	0.0478	0.08	Q	.	.	.	.
9.29	0.0491	0.08	Q	.	.	.	.
9.47	0.0504	0.09	Q	.	.	.	.
9.66	0.0517	0.09	Q	.	.	.	.
9.85	0.0531	0.09	Q	.	.	.	.
10.03	0.0545	0.09	Q	.	.	.	.
10.22	0.0559	0.09	Q	.	.	.	.
10.40	0.0573	0.09	Q	.	.	.	.
10.59	0.0588	0.10	Q	.	.	.	.
10.78	0.0603	0.10	Q	.	.	.	.
10.96	0.0618	0.10	Q	.	.	.	.
11.15	0.0634	0.10	Q	.	.	.	.
11.34	0.0650	0.11	Q	.	.	.	.
11.52	0.0666	0.11	Q	.	.	.	.
11.71	0.0683	0.11	Q	.	.	.	.
11.90	0.0700	0.11	Q	.	.	.	.
12.08	0.0718	0.12	Q	.	.	.	.
12.27	0.0739	0.15	Q	.	.	.	.
12.46	0.0762	0.15	Q	.	.	.	.
12.64	0.0786	0.16	Q	.	.	.	.

12.83	0.0810	0.16	Q	.	.	.	.
13.02	0.0835	0.16	Q	.	.	.	.
13.20	0.0861	0.17	Q	.	.	.	.
13.39	0.0888	0.17	Q	.	.	.	.
13.58	0.0915	0.18	Q	.	.	.	.
13.76	0.0944	0.19	Q	.	.	.	.
13.95	0.0974	0.20	Q	.	.	.	.
14.13	0.1005	0.20	Q	.	.	.	.
14.32	0.1037	0.22	Q	.	.	.	.
14.51	0.1072	0.23	Q	.	.	.	.
14.69	0.1109	0.25	Q	.	.	.	.
14.88	0.1148	0.26	.Q	.	.	.	.
15.07	0.1190	0.29	.Q	.	.	.	.
15.25	0.1235	0.30	.Q	.	.	.	.
15.44	0.1284	0.34	.Q	.	.	.	.
15.63	0.1337	0.35	.Q	.	.	.	.
15.81	0.1401	0.49	.Q	.	.	.	.
16.00	0.1501	0.81	. Q	.	.	.	.
16.19	0.1949	5.01	.	.	Q	.	.
16.37	0.2366	0.39	.Q	.	.	.	.
16.56	0.2421	0.32	.Q	.	.	.	.
16.75	0.2467	0.27	.Q	.	.	.	.
16.93	0.2506	0.24	Q	.	.	.	.
17.12	0.2541	0.22	Q	.	.	.	.
17.31	0.2573	0.19	Q	.	.	.	.
17.49	0.2601	0.18	Q	.	.	.	.
17.68	0.2628	0.17	Q	.	.	.	.
17.86	0.2653	0.16	Q	.	.	.	.
18.05	0.2677	0.15	Q	.	.	.	.
18.24	0.2697	0.11	Q	.	.	.	.
18.42	0.2715	0.11	Q	.	.	.	.
18.61	0.2731	0.10	Q	.	.	.	.
18.80	0.2746	0.10	Q	.	.	.	.
18.98	0.2761	0.10	Q	.	.	.	.
19.17	0.2776	0.09	Q	.	.	.	.
19.36	0.2790	0.09	Q	.	.	.	.
19.54	0.2803	0.09	Q	.	.	.	.
19.73	0.2816	0.08	Q	.	.	.	.
19.92	0.2829	0.08	Q	.	.	.	.
20.10	0.2841	0.08	Q	.	.	.	.
20.29	0.2853	0.08	Q	.	.	.	.
20.48	0.2864	0.07	Q	.	.	.	.
20.66	0.2876	0.07	Q	.	.	.	.
20.85	0.2887	0.07	Q	.	.	.	.
21.04	0.2897	0.07	Q	.	.	.	.
21.22	0.2908	0.07	Q	.	.	.	.
21.41	0.2918	0.07	Q	.	.	.	.
21.59	0.2928	0.06	Q	.	.	.	.

21.78	0.2938	0.06	Q	.	.	.	.
21.97	0.2948	0.06	Q	.	.	.	.
22.15	0.2957	0.06	Q	.	.	.	.
22.34	0.2967	0.06	Q	.	.	.	.
22.53	0.2976	0.06	Q	.	.	.	.
22.71	0.2985	0.06	Q	.	.	.	.
22.90	0.2994	0.06	Q	.	.	.	.
23.09	0.3003	0.06	Q	.	.	.	.
23.27	0.3011	0.06	Q	.	.	.	.
23.46	0.3020	0.05	Q	.	.	.	.
23.65	0.3028	0.05	Q	.	.	.	.
23.83	0.3036	0.05	Q	.	.	.	.
24.02	0.3044	0.05	Q	.	.	.	.
24.21	0.3048	0.00	Q	.	.	.	.

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

Percentile of Estimated Peak Flow Rate	Duration (minutes)
0%	1443.5
10%	22.4
20%	11.2
30%	11.2
40%	11.2
50%	11.2
60%	11.2
70%	11.2
80%	11.2
90%	11.2



RBF CONSULTING A Baker Company

N 0 125 250 Feet

Source:

Commercentre Drive: Proposed Condition

Hydrologic Work Map

Figure 6

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****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
           (Reference: 1986 ORANGE COUNTY HYDROLOGY CRITERION)
         (c) Copyright 1983-2013 Advanced Engineering Software (aes)
             Ver. 20.0  Release Date: 06/01/2013  License ID 1264

                          Analysis prepared by:

                              RBF Consulting
                           14257 Alton Parkway
                                Irvine, CA
                                  92618

 ************************** DESCRIPTION OF STUDY **************************
* DRAINAGE STUDY - COMMERCENTRE DRIVE                                      *
* 2-YR PROPOSED DAVIS PROPERTY                                             *
* REVISED JUNE 2015 IESCOBAR                                               *
 ***************************************************************************

  FILE NAME: CC2.DAT
  TIME/DATE OF STUDY: 17:23 06/18/2015
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  *DATA BANK RAINFALL USED*
  *ANTECEDENT MOISTURE CONDITION (AMC) I ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150
  2   15.0     10.0    0.017/0.017/0.020   0.50    1.50 0.0313 0.125 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   334.00
  ELEVATION DATA: UPSTREAM(FEET) =    597.00  DOWNSTREAM(FEET) =    594.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.499
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.669
  SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
```

```
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "11+ DWELLINGS/ACRE"       C        0.70      0.25     0.200    50    8.50
  RESIDENTIAL
  "11+ DWELLINGS/ACRE"       A        0.29      0.40     0.200    17    8.50
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.29
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA RUNOFF(CFS) =      1.44
  TOTAL AREA(ACRES) =      0.99   PEAK FLOW RATE(CFS) =      1.44

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    104.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  594.00  DOWNSTREAM ELEVATION(FEET) =  591.00
  STREET LENGTH(FEET) =   315.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 30.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  20.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.018
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.018

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.73
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.30
    HALFSTREET FLOOD WIDTH(FEET) =    7.59
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.92
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.57
  STREET FLOW TRAVEL TIME(MIN.) =   2.73   Tc(MIN.) =   11.23
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.423
  SUBAREA LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  RESIDENTIAL
  "11+ DWELLINGS/ACRE"       A        1.61      0.40     0.200    17
  RESIDENTIAL
  "11+ DWELLINGS/ACRE"       C        0.01      0.25     0.200    50
  RESIDENTIAL
  "11+ DWELLINGS/ACRE"       D        0.50      0.20     0.200    57
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.35
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA AREA(ACRES) =    2.12      SUBAREA RUNOFF(CFS) =    2.58
  EFFECTIVE AREA(ACRES) =      3.11    AREA-AVERAGED Fm(INCH/HR) =  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.33  AREA-AVERAGED Ap =  0.20
  TOTAL AREA(ACRES) =        3.1        PEAK FLOW RATE(CFS) =       3.80

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.32   HALFSTREET FLOOD WIDTH(FEET) =   9.03
  FLOW VELOCITY(FEET/SEC.) =  2.06   DEPTH*VELOCITY(FT*FT/SEC.) =   0.67
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    104.00 =     649.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    104.00 TO NODE    105.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
```

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==============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   591.00  DOWNSTREAM(FEET) =   590.50
  FLOW LENGTH(FEET) =    28.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   6.6 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.50
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       3.80
  PIPE TRAVEL TIME(MIN.) =   0.07    Tc(MIN.) =   11.30
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    105.00 =     677.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    105.00 TO NODE    105.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
==============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.30
  RAINFALL INTENSITY(INCH/HR) =   1.42
  AREA-AVERAGED Fm(INCH/HR) =  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.33
  AREA-AVERAGED Ap =  0.20
  EFFECTIVE STREAM AREA(ACRES) =       3.11
  TOTAL STREAM AREA(ACRES) =       3.11
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       3.80

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   315.00
  ELEVATION DATA: UPSTREAM(FEET) =    596.00  DOWNSTREAM(FEET) =    594.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.899
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.626
  SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "11+ DWELLINGS/ACRE"       A        0.99      0.40     0.200    17    8.90
  RESIDENTIAL
  "11+ DWELLINGS/ACRE"       C        0.48      0.25     0.200    50    8.90
  PUBLIC PARK                A        0.12      0.40     0.850    17   13.27
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.36
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.249
  SUBAREA RUNOFF(CFS) =      2.20
  TOTAL AREA(ACRES) =      1.59   PEAK FLOW RATE(CFS) =      2.20

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    105.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
==============================================================================
  UPSTREAM ELEVATION(FEET) =  594.00  DOWNSTREAM ELEVATION(FEET) =  590.50
  STREET LENGTH(FEET) =   260.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 30.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  20.00
```

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INSIDE STREET CROSSFALL(DECIMAL) =  0.018
OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.018

SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.85
  STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
  STREET FLOW DEPTH(FEET) =  0.29
  HALFSTREET FLOOD WIDTH(FEET) =    7.03
  AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.24
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.65
STREET FLOW TRAVEL TIME(MIN.) =   1.93   Tc(MIN.) =   10.83
*   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.453
SUBAREA LOSS RATE DATA(AMC  I ):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"11+ DWELLINGS/ACRE"       A        0.71      0.40     0.200    17
RESIDENTIAL
"11+ DWELLINGS/ACRE"       B        0.11      0.30     0.200    36
RESIDENTIAL
"11+ DWELLINGS/ACRE"       D        0.23      0.20     0.200    57
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.35
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
SUBAREA AREA(ACRES) =    1.05      SUBAREA RUNOFF(CFS) =    1.31
EFFECTIVE AREA(ACRES) =      2.64    AREA-AVERAGED Fm(INCH/HR) =  0.08
AREA-AVERAGED Fp(INCH/HR) =  0.36  AREA-AVERAGED Ap =  0.23
TOTAL AREA(ACRES) =        2.6        PEAK FLOW RATE(CFS) =       3.26

END OF SUBAREA STREET FLOW HYDRAULICS:
DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   7.59
FLOW VELOCITY(FEET/SEC.) =  2.30   DEPTH*VELOCITY(FT*FT/SEC.) =   0.68
LONGEST FLOWPATH FROM NODE    102.00 TO NODE    105.00 =     575.00 FEET.

****************************************************************************
FLOW PROCESS FROM NODE    105.00 TO NODE    105.00 IS CODE =   1
----------------------------------------------------------------------------
>>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
>>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
TOTAL NUMBER OF STREAMS =  2
CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
TIME OF CONCENTRATION(MIN.) =   10.83
RAINFALL INTENSITY(INCH/HR) =   1.45
AREA-AVERAGED Fm(INCH/HR) =  0.08
AREA-AVERAGED Fp(INCH/HR) =  0.36
AREA-AVERAGED Ap =  0.23
EFFECTIVE STREAM AREA(ACRES) =       2.64
TOTAL STREAM AREA(ACRES) =       2.64
PEAK FLOW RATE(CFS) AT CONFLUENCE =       3.26

** CONFLUENCE DATA **
 STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
 NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
    1        3.80   11.30    1.418  0.33( 0.07) 0.20       3.1     100.00
    2        3.26   10.83    1.453  0.36( 0.08) 0.23       2.6     102.00

RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
CONFLUENCE FORMULA USED FOR  2 STREAMS.
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  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        6.99   10.83    1.453  0.35( 0.07) 0.21       5.6     102.00
      2        6.97   11.30    1.418  0.35( 0.07) 0.21       5.8     100.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       6.99    Tc(MIN.) =    10.83
  EFFECTIVE AREA(ACRES) =       5.62   AREA-AVERAGED Fm(INCH/HR) =  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.35  AREA-AVERAGED Ap =  0.21
  TOTAL AREA(ACRES) =        5.8
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    105.00 =     677.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    105.00 TO NODE    421.40 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   590.50  DOWNSTREAM(FEET) =   577.50
  FLOW LENGTH(FEET) =   124.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   5.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  14.58
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       6.99
  PIPE TRAVEL TIME(MIN.) =   0.14    Tc(MIN.) =   10.97
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    421.40 =     801.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        5.8  TC(MIN.) =     10.97
  EFFECTIVE AREA(ACRES) =      5.62  AREA-AVERAGED Fm(INCH/HR)=  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.35  AREA-AVERAGED Ap = 0.214
  PEAK FLOW RATE(CFS)   =       6.99

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        6.99   10.97    1.442  0.35( 0.07) 0.21       5.6     102.00
      2        6.97   11.44    1.408  0.35( 0.07) 0.21       5.8     100.00
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
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Lake Forest Commercentre Drive Tract 13343 – Proposed 2-yr Volume

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RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
TOTAL CATCHMENT AREA(ACRES) = 5.90
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.100
LOW LOSS FRACTION = 0.416
TIME OF CONCENTRATION(MIN.) = 10.48
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 2
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.17
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.41
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.57
3-HOUR POINT RAINFALL VALUE(INCHES) = 1.02
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.46
24-HOUR POINT RAINFALL VALUE(INCHES) = 2.58

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 0.72
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.54

****

TIME (HOURS)	VOLUME (AF)	Q (CFS)	0.	2.5	5.0	7.5	10.0
0.11	0.0006	0.14	Q	.	.	.	.
0.28	0.0026	0.14	Q	.	.	.	.
0.45	0.0046	0.14	Q	.	.	.	.
0.63	0.0066	0.14	Q	.	.	.	.
0.80	0.0086	0.14	Q	.	.	.	.
0.98	0.0106	0.14	Q	.	.	.	.
1.15	0.0127	0.14	Q	.	.	.	.
1.33	0.0147	0.14	Q	.	.	.	.
1.50	0.0168	0.14	Q	.	.	.	.
1.68	0.0189	0.15	Q	.	.	.	.
1.85	0.0210	0.15	Q	.	.	.	.
2.03	0.0231	0.15	Q	.	.	.	.
2.20	0.0253	0.15	Q	.	.	.	.
2.38	0.0274	0.15	Q	.	.	.	.
2.55	0.0296	0.15	Q	.	.	.	.
2.73	0.0318	0.15	Q	.	.	.	.
2.90	0.0340	0.15	Q	.	.	.	.
3.07	0.0362	0.15	Q	.	.	.	.
3.25	0.0384	0.16	Q	.	.	.	.
3.42	0.0407	0.16	Q	.	.	.	.

3.60	0.0429	0.16	Q	.	.	.	.
3.77	0.0452	0.16	Q	.	.	.	.
3.95	0.0475	0.16	Q	.	.	.	.
4.12	0.0499	0.16	Q	.	.	.	.
4.30	0.0522	0.16	Q	.	.	.	.
4.47	0.0546	0.16	Q	.	.	.	.
4.65	0.0570	0.17	Q	.	.	.	.
4.82	0.0594	0.17	Q	.	.	.	.
5.00	0.0618	0.17	Q	.	.	.	.
5.17	0.0643	0.17	Q	.	.	.	.
5.35	0.0668	0.17	Q	.	.	.	.
5.52	0.0693	0.17	Q	.	.	.	.
5.69	0.0718	0.18	Q	.	.	.	.
5.87	0.0743	0.18	Q	.	.	.	.
6.04	0.0769	0.18	Q	.	.	.	.
6.22	0.0795	0.18	Q	.	.	.	.
6.39	0.0822	0.18	Q	.	.	.	.
6.57	0.0848	0.18	Q	.	.	.	.
6.74	0.0875	0.19	Q	.	.	.	.
6.92	0.0902	0.19	Q	.	.	.	.
7.09	0.0930	0.19	Q	.	.	.	.
7.27	0.0958	0.19	Q	.	.	.	.
7.44	0.0986	0.20	Q	.	.	.	.
7.62	0.1014	0.20	Q	.	.	.	.
7.79	0.1043	0.20	Q	.	.	.	.
7.97	0.1072	0.20	Q	.	.	.	.
8.14	0.1102	0.21	Q	.	.	.	.
8.31	0.1132	0.21	Q	.	.	.	.
8.49	0.1162	0.21	Q	.	.	.	.
8.66	0.1193	0.21	Q	.	.	.	.
8.84	0.1224	0.22	Q	.	.	.	.
9.01	0.1255	0.22	Q	.	.	.	.
9.19	0.1287	0.22	Q	.	.	.	.
9.36	0.1320	0.23	Q	.	.	.	.
9.54	0.1353	0.23	Q	.	.	.	.
9.71	0.1387	0.23	Q	.	.	.	.
9.89	0.1421	0.24	Q	.	.	.	.
10.06	0.1455	0.24	Q	.	.	.	.
10.24	0.1491	0.25	Q	.	.	.	.
10.41	0.1526	0.25	Q	.	.	.	.
10.59	0.1563	0.26	.Q	.	.	.	.
10.76	0.1600	0.26	.Q	.	.	.	.
10.93	0.1638	0.27	.Q	.	.	.	.
11.11	0.1677	0.27	.Q	.	.	.	.
11.28	0.1716	0.28	.Q	.	.	.	.
11.46	0.1756	0.28	.Q	.	.	.	.
11.63	0.1798	0.29	.Q	.	.	.	.
11.81	0.1840	0.29	.Q	.	.	.	.

11.98	0.1883	0.30	.Q . . . .
12.16	0.1929	0.34	.Q . . . .
12.33	0.1983	0.40	.Q . . . .
12.51	0.2041	0.41	.Q . . . .
12.68	0.2101	0.42	.Q . . . .
12.86	0.2162	0.43	.Q . . . .
13.03	0.2225	0.44	.Q . . . .
13.21	0.2289	0.45	.Q . . . .
13.38	0.2355	0.47	.Q . . . .
13.55	0.2424	0.48	.Q . . . .
13.73	0.2495	0.50	. Q . . . .
13.90	0.2568	0.51	. Q . . . .
14.08	0.2644	0.54	. Q . . . .
14.25	0.2725	0.57	. Q . . . .
14.43	0.2810	0.61	. Q . . . .
14.60	0.2899	0.63	. Q . . . .
14.78	0.2993	0.68	. Q . . . .
14.95	0.3093	0.71	. Q . . . .
15.13	0.3203	0.81	. Q . . . .
15.30	0.3325	0.89	. Q . . . .
15.48	0.3459	0.98	. Q . . . .
15.65	0.3609	1.09	. Q . . . .
15.83	0.3816	1.78	. Q . . . .
16.00	0.4125	2.50	. Q. . . .
16.17	0.4799	6.84	. . . Q . .
16.35	0.5389	1.33	. Q . . . .
16.52	0.5556	0.98	. Q . . . .
16.70	0.5680	0.74	. Q . . . .
16.87	0.5781	0.65	. Q . . . .
17.05	0.5870	0.59	. Q . . . .
17.22	0.5951	0.53	. Q . . . .
17.40	0.6024	0.49	.Q . . . .
17.57	0.6093	0.46	.Q . . . .
17.75	0.6157	0.43	.Q . . . .
17.92	0.6218	0.41	.Q . . . .
18.10	0.6277	0.40	.Q . . . .
18.27	0.6327	0.30	.Q . . . .
18.45	0.6369	0.29	.Q . . . .
18.62	0.6409	0.27	.Q . . . .
18.79	0.6448	0.26	.Q . . . .
18.97	0.6485	0.25	.Q . . . .
19.14	0.6521	0.24	Q . . . .
19.32	0.6556	0.24	Q . . . .
19.49	0.6589	0.23	Q . . . .
19.67	0.6622	0.22	Q . . . .
19.84	0.6653	0.22	Q . . . .
20.02	0.6684	0.21	Q . . . .
20.19	0.6714	0.20	Q . . . .

20.37	0.6743	0.20	Q	.	.	.	.
20.54	0.6772	0.19	Q	.	.	.	.
20.72	0.6800	0.19	Q	.	.	.	.
20.89	0.6827	0.19	Q	.	.	.	.
21.07	0.6853	0.18	Q	.	.	.	.
21.24	0.6879	0.18	Q	.	.	.	.
21.41	0.6905	0.18	Q	.	.	.	.
21.59	0.6930	0.17	Q	.	.	.	.
21.76	0.6955	0.17	Q	.	.	.	.
21.94	0.6979	0.17	Q	.	.	.	.
22.11	0.7002	0.16	Q	.	.	.	.
22.29	0.7026	0.16	Q	.	.	.	.
22.46	0.7049	0.16	Q	.	.	.	.
22.64	0.7071	0.15	Q	.	.	.	.
22.81	0.7093	0.15	Q	.	.	.	.
22.99	0.7115	0.15	Q	.	.	.	.
23.16	0.7137	0.15	Q	.	.	.	.
23.34	0.7158	0.15	Q	.	.	.	.
23.51	0.7179	0.14	Q	.	.	.	.
23.69	0.7199	0.14	Q	.	.	.	.
23.86	0.7220	0.14	Q	.	.	.	.
24.03	0.7240	0.14	Q	.	.	.	.
24.21	0.7250	0.00	Q	.	.	.	.

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

Percentile of Estimated Peak Flow Rate	Duration (minutes)
0%	1446.2
10%	115.3
20%	31.4
30%	21.0
40%	10.5
50%	10.5
60%	10.5
70%	10.5
80%	10.5
90%	10.5

Lake Forest Commercentre Drive Tract 17810

Per OC TGD, December 20, 2013

	DCV Calculation					
Drainage Area	**Area (ac)**	**Percentage of Site**	**Design Storm Depth (in)**	**% Impervious**	**Runoff Coefficient**	**Design Capture Volume (ft^3)**
A-1	1.59	30.00%	0.87	70%	0.675	**3,389**
A-2	0.99	18.68%	0.87	70%	0.675	**2,110**
A-3	1.95	36.79%	0.87	70%	0.675	**4,157**
A-4	0.77	14.53%	0.87	70%	0.675	**1,641**
	5.3					**11,298**

Commercentre Drive Tract No. 17810
StormTech MC-3500 Underground Infiltration Chambers

End Cap Storage = 15.6 ft^3	15.6 ft^3
Chamber Storage = 109.9 ft^3	109.9 ft^3
End Cap Length = 26.5"	26.5 in
Chamber Length = 90"	90 in
Chamber Height = 45"	45 in
Chamber Width = 77"	77 in

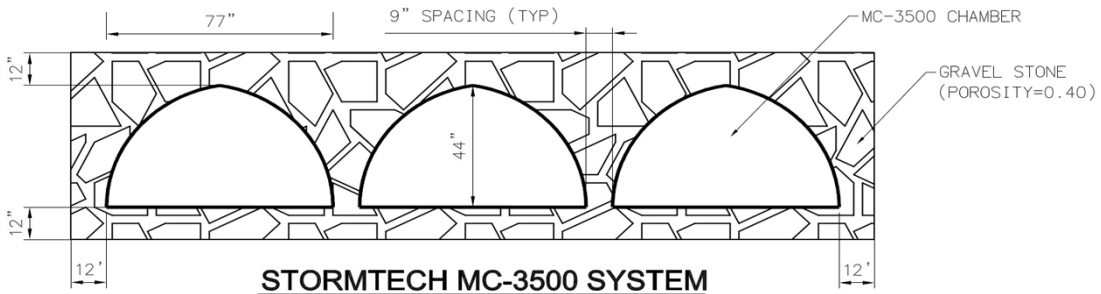
9" Spacing between rows, 12" Stone above/under, 12" Stone outsides

System	TDA (ac)	Design Capture Volume (ft^3)	Fraction of Hydromod Volume (Weighted Area)	Required Storage Volume (ft^3)	# Rows	# Chambers/ Row	System Length (ft)	System Width (ft)	System Height (ft)	Exterior Volume (ft^3)	Chamber Volume (ft^3)	Stone Volume (ft^3)	Stone Porosity	Stone Storage Volume (ft^3)	Total Storage Volume (ft^3)	Storage Footprint (ft^2)	Effective Depth (ft)	Design Infiltration Rate (in/hr)**	Drawdown Time (hr)	Drawdown Time <48 hr
1	0.99	2,110	18.68%	**3,418**	3	6	51.42	22.75	5.75	6,726	2,072	4,654	0.40	1861.65708	**3,933**	1,170	3.36	1.00	40.4	Yes
2	1.95	4,157	36.79%	**6,732**	3	12	96.42	22.75	5.75	12,613	4,050	8,563	0.40	3425.00208	**7,475**	2,193	3.41	1.00	40.9	Yes
3***	1.59	3,389	30.00%	**5,489**	3	7	58.92	22.75	5.75	7,707	2,402	5,306	0.40	2122.21458	**4,524**	1,340	3.38	1.00	40.5	Yes
4***	0.77	1,641	14.53%	**2,658**	2	8	66.42	15.58	5.75	5,951	1,821	4,130	0.40	1652.16403	**3,473**	1,035	3.36	1.00	40.3	Yes
SUM	**5.30**	**11,297**		**18,296** *											**19,405**					

*Hydromodification Delta Volume = (Proposed 2-year runoff volume) - (Existing 2-year runoff volume) = 0.72 ac-ft - 0.30 ac-ft = 0.42 ac-ft = 18,296 cf. See 2-year volume calculations in Appedix B

** Assumed 1 in/hr; pending Final Geotechnical Investigation

*** 2 separate systems combined to meet volume requirements. See WQMP Map in Appendix B for further clarification



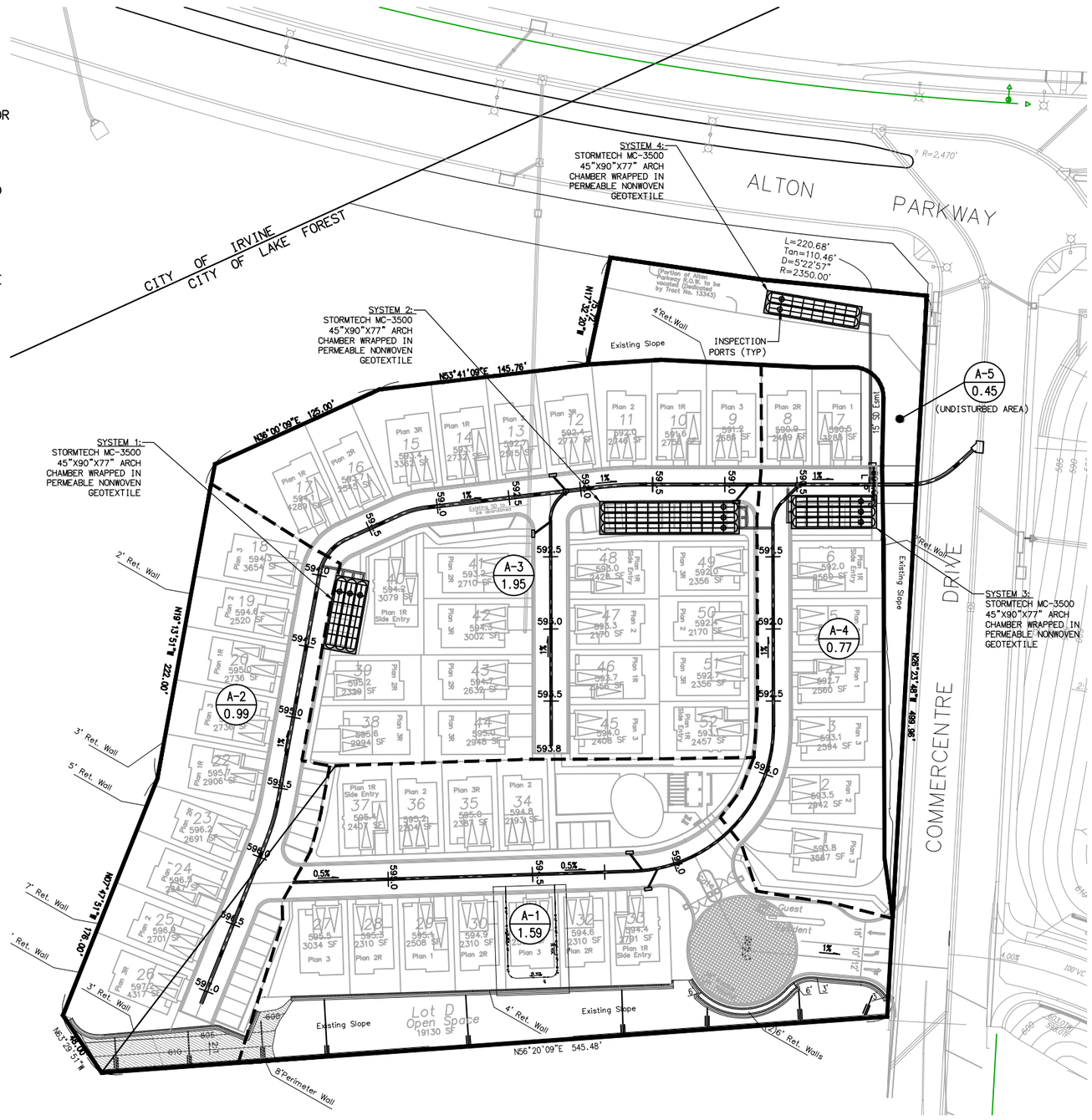
STORMTECH MC-3500 SYSTEM

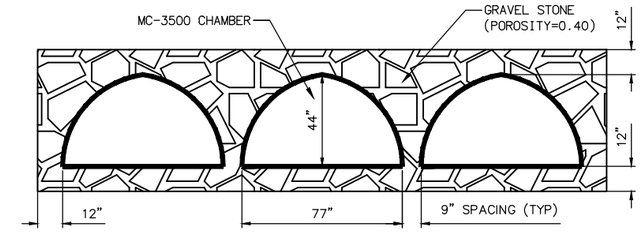
NOT TO SCALE - NO. OF ROWS AND CHAMBERS VARY

GENERAL NOTES

THE FOLLOWING STRUCTURAL SOURCE CONTROL BMPs SHALL BE IMPLEMENTED THROUGHOUT THE SITE:

1. S1 - PROVIDE STORM DRAIN SYSTEM STENCILING.
2. S3 - DESIGN AND CONSTRUCT TRASH/WASTE STORAGE AREAS TO REDUCE POLLUTION INTRODUCTION. COLLECT AND DISPOSE OF TRASH AND DEBRIS. DO NOT ALLOW TRASH OR DEBRIS TO STORM DRAINS OR BMPs.
3. S4 - IMPLEMENT EFFICIENT IRRIGATION SYSTEMS PER DETAILS PROVIDED IN WQMP. SYSTEM SHALL INCLUDE AUTOMATIC RAIN SHUT-OFF VALVES, MOISTURE SENSORS, AND SMARTTIMER. TEST SYSTEM SEMI-ANNUALLY.
4. S5 & S12 -STABILIZE BARE SLOPES, USE NATIVE VEGETATION WHERE FEASIBLE. MAINTAIN VEGETATED AND OPEN AREAS. CONTROL UP-SLOPE EROSION SOURCES TO PREVENT SEDIMENT FROM FILLING DRAINAGE SYSTEMS. KEEP ALL DRAINAGE FACILITIES CLEAR OF TRASH, SEDIMENT, AND DEBRIS.





STORMTECH MC-3500 CHAMBER SYSTEM
NOT TO SCALE - NO. OF ROWS AND CHAMBERS VARY

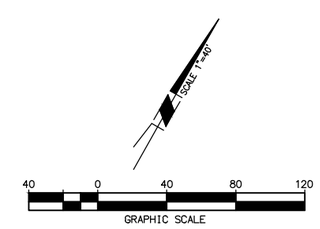
STORMTECH MC-3500 UNDERGROUND INFILTRATION SYSTEMS							
SYSTEM	TDA	ROWS	CHAMBERS	FOOTPRINT	STORAGE VOLUME	LAT.	LONG.
(#)	(ac)	(#)	(#)	(FT)	(AF)	(DEG)	(DEG)
1	0.99	3	6	1,170	3,933	33.6686	-117.6909
2	1.95	3	12	2,193	7,475	33.6691	-117.6904
3	2.36*	3	7	1,340	4,524	33.6692	-117.6900
4	2.36*	2	8	1,035	3,473	33.6695	-117.6903

*SYSTEM 3 AND 4 TREAT THE TOTAL VOLUME ASSOCIATED WITH A-1 AND A-4.

STORMTECH MC-3500 UNDERGOUND INFILTRATION CHAMBERS
END CAP STORAGE = 15.6 FT3
END CAP LENGTH = 26.5"
CHAMBER STORAGE = 109.9 FT3
CHAMBER LENGTH = 90"
CHAMBER HEIGHT = 45"
CHAMBER WIDTH = 77"
-9" SPACING BETWEEN ROWS
-12" STONE ABOVE/UNDER CHAMBERS & OUTSIDE ENDCAPS

LEGEND

DRAINAGE BOUNDARY
SUBAREA BOUNDARY
FLOW PATH
B-12 / 11.3 — SUBAREA DESIGNATION / AREA (ACRES)
STORMTECH MC-3500 UNDERGROUND INFILTRATION CHAMBERS



RBF CONSULTING
A Baker Company

WQMP SITE MAP
COMMERCENTRE DRIVE
TRACT NO. 17810

H:\pdata\142216\CADD\Strmwater\Exhibits\BMP Map_05072015.dwg 05/08/15 - 2:27pm jenny.mital

MC-3500 / MC-4500

StormTech®

Detention • Retention • Water Quality

MC-3500 and MC-4500 Design Manual

StormTech® Chamber Systems for Stormwater Management

U.S. GREEN BUILDING COUNCIL MEMBER

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8.0 General Notes 21

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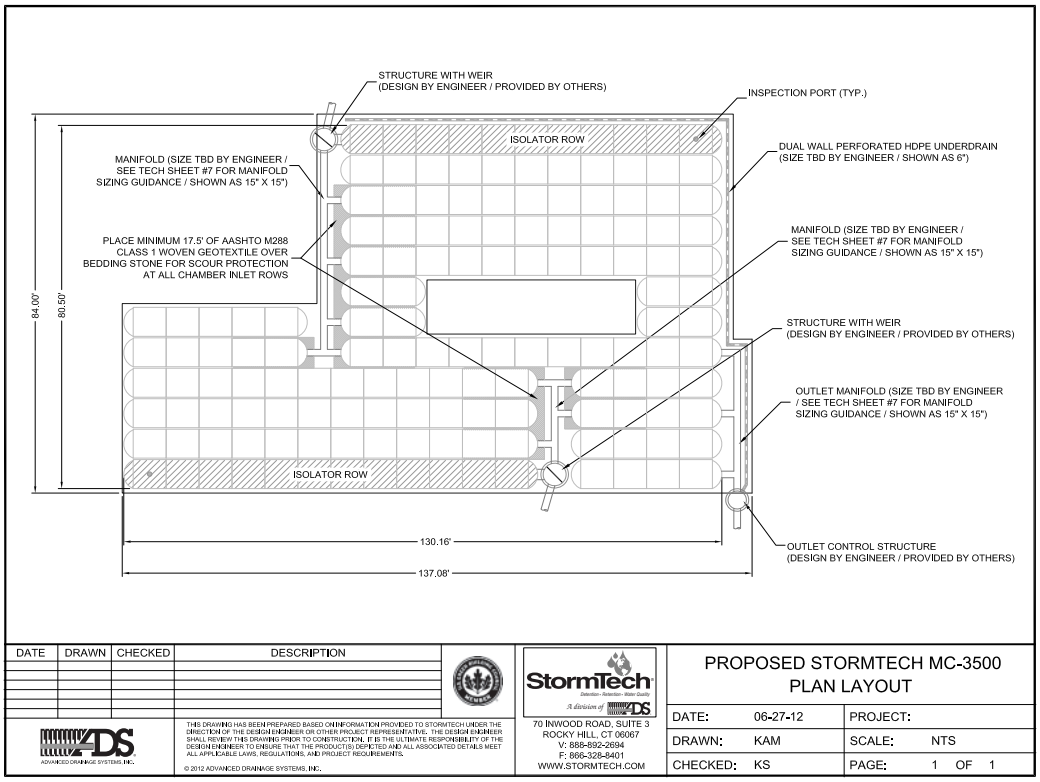
*For SC-310, SC-740 & DC-780 designs, please refer to the SC-310/SC-740/DC-780 Design Manual.

StormTech Technical Services Department assists design professionals in specifying StormTech stormwater systems. This assistance includes the layout of chambers to meet the engineer's volume requirements and the connections to and from the chambers. The Technical Department can also assist converting and cost engineering projects currently specified with ponds, pipe, concrete vaults and other manufactured stormwater detention/retention products. Please note that it is the responsibility of the design engineer to ensure that the chamber bed layout meets all design requirements and is in compliance with applicable laws and regulations governing a project.



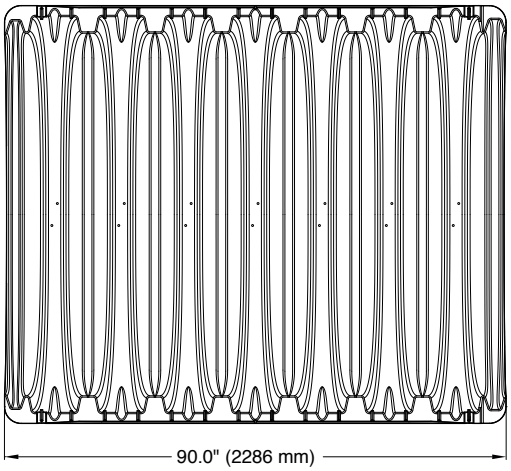
This manual is exclusively intended to assist engineers in the design of subsurface stormwater systems using StormTech chambers.

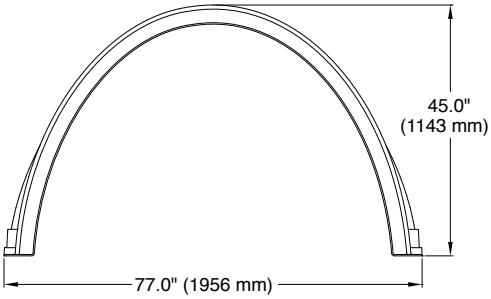
1.0 Product Information

FIGURE 1 – StormTech MC-3500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	90" (2286 mm) x 77" (1956 mm) x 45" (1143 mm)
Chamber Storage	109.9 ft^3 (3.11 m^3)
Min. Installed Storage*	178.9 ft^3 (5.06 m^3)
Nominal Weight	134 lbs (60.8 kg)





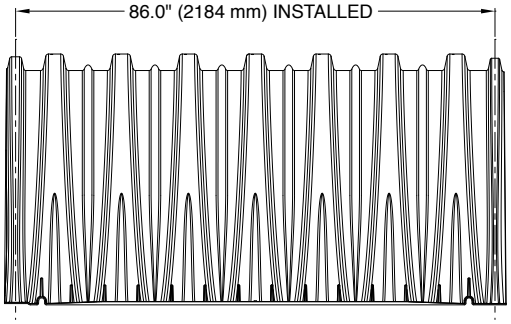
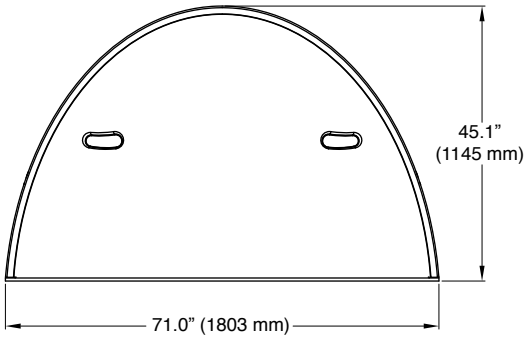
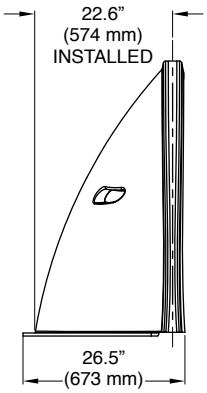


FIGURE 2 – StormTech MC-3500 End Cap (not to scale)

Nominal End Cap Specifications

Size (L x W x H)	26.5" (673 mm) x 71" (1803 mm) x 45.1" (1145 mm)
End Cap Storage	15.6 ft^3 (0.44 m^3)
Min. Installed Storage*	46.9 ft^3 (1.33 m^3)
Nominal Weight	43 lbs (19.5 kg)





* This assumes a minimum of 12" (305 mm) of stone above, 9" (229 mm) of stone below and 9" (229 mm) of stone between the chambers/end caps and 40% stone porosity. The end cap minimum installed storage also includes the stone storage located in the 6" (152 mm) stone perimeter.

FIGURE 3 – StormTech MC-4500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	52" (1321 mm) x 100" (2540 mm) x 60" (1524 mm)
Chamber Storage	106.5 ft^3 (3.01 m^3)
Min. Installed Storage*	162.6 ft^3 (4.60 m^3)
Nominal Weight	120 lbs (54.4 kg)

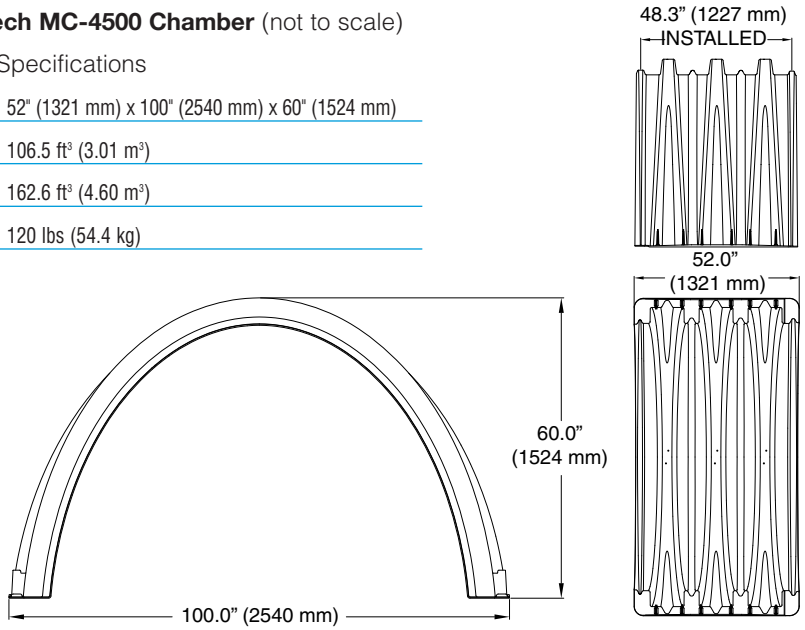
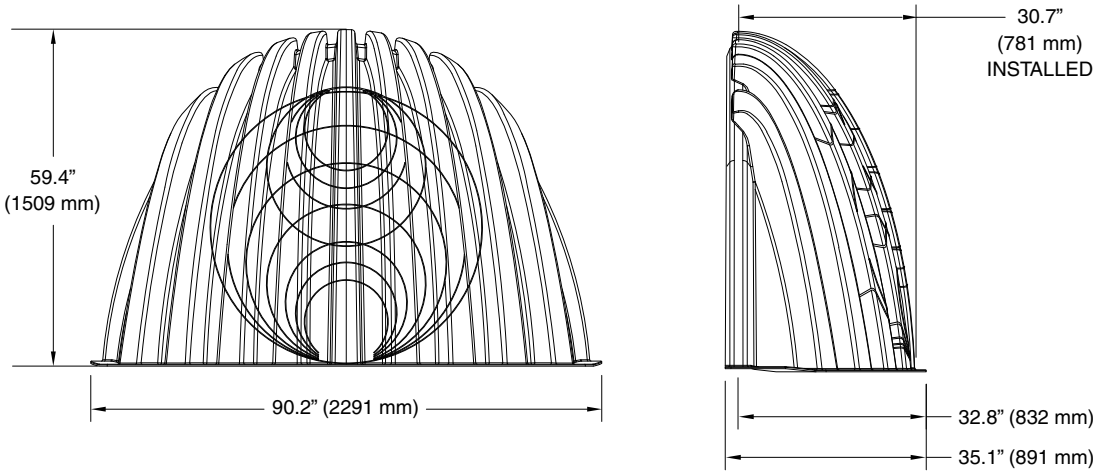


FIGURE 4 – StormTech MC-4500 End Cap (not to scale)

Nominal End Cap Specifications

Size (L x W x H)	35.1" (891 mm) x 90.2" (2291 mm) x 59.4" (1509 mm)
End Cap Storage	35.7 ft^3 (1.01 m^3)
Min. Installed Storage*	108.7 ft^3 (3.08 m^3)
Nominal Weight	120 lbs (54.4 kg)



* This assumes a minimum of 12" (305 mm) of stone above, 9" (229 mm) of stone below and 9" (229 mm) of stone between the chambers/end caps and 40% stone porosity. The end cap minimum installed storage also includes the stone storage located in the 12" (305 mm) stone perimeter.

1.0 Product Information

1.1 PRODUCT DESIGN

StormTech's commitment to thorough product testing programs, materials evaluation and adherence to national standards has resulted in two more superior products. Like other StormTech chambers, the MC-3500 and MC-4500 are designed to meet the full scope of design requirements of Section 12.12 of the AASHTO LRFD Bridge Design Specifications and produced to the requirements of the American Society of Testing Materials (ASTM) International specification F 2418 "Standard Specification for Polypropylene (PP) Corrugated Stormwater Collection Chambers".

The StormTech MC-3500 and MC-4500 chambers provide the full AASHTO safety factors for live loads and permanent earth loads. The ASTM F 2418 standard is linked to the AASHTO LRFD Bridge Design Specifications Section 12.12 design standard. ASTM F 2418 requires that the safety factors included in the AASHTO guidance are achieved as a prerequisite to meeting ASTM F 2418. StormTech chambers are also designed in accordance with ASTM F 2787 "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers" which provides specific guidance on how to design thermoplastic chambers in accordance with AASHTO Section 12.12. The three standards provide both the assurance of product quality and safe structural design.

The design of larger chambers in the same tradition of our other chambers required the collaboration of experts in soil-structure interaction, plastics and manufacturing. Years of extensive research, including laboratory testing and field verification, were required to produce chambers that are ready to meet both the rigors of installation and the longevity expected by engineers and owners.

This Design Manual provides the details and specifications necessary for consulting engineers to design stormwater management systems using the MC-3500 and MC-4500 chambers. It provides specifications for storage capacities, layout dimensions as well as requirements for design to ensure a long service life. The basic design concepts for foundation and backfill materials, subgrade bearing capacities and row spacing remain equally as pertinent for the MC-3500 and MC-4500 as the SC-740, SC-310 and DC-780 chamber systems. However, since many design values and dimensional requirements are different for these larger chambers than the SC-740, SC-310 and DC-780 chambers, design manuals and installation instructions are not interchangeable.

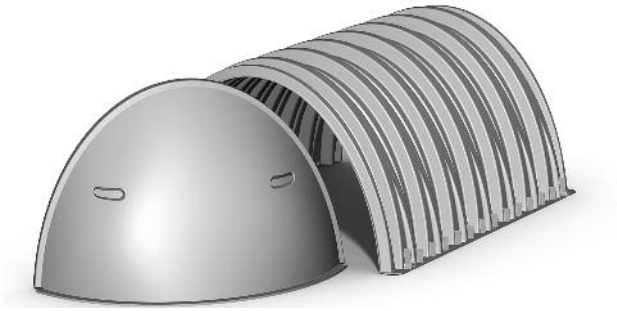
This manual includes only those details, dimensions, cover limits, etc for the MC-3500 and MC-4500 and is intended to be a stand-alone design guide for the MC-3500 and MC-4500 chambers. A Construction Guide specifically for these two chamber models has also been published.

1.2 TECHNICAL SUPPORT

The StormTech Technical Services Department is available to assist the engineer with the layout of MC-3500 and MC-4500 chamber systems and answer questions regarding all the StormTech chamber models. Call the Technical Services Department, email us at info@stormtech.com or contact your local StormTech representative.

1.3 MC-3500 AND MC-4500 CHAMBERS

All StormTech chambers are designed to the full scope of AASHTO requirements without repeating end walls or other structural reinforcing. StormTech's continuously curved, elliptical arch and the surrounding angular backfill are the key components of the structural system. With the addition of patent pending integral stiffening ribs **(Figure 5)**, the MC-3500 and MC-4500 are assured to provide a long, safe service life. Like other StormTech chambers, the MC-3500 and MC-4500 are produced from high quality, impact modified resins which are tested for short-term and long-term mechanical properties.



With all StormTech chambers, one chamber type is used for the start, middle and end of rows. Rows are formed by overlapping the *upper joint corrugation* of the next chamber over the *lower joint corrugation* of the previous chamber **(Figure 6)**.

1.4 CHAMBER JOINTS

All StormTech chambers are designed with an optimized joining system. The height and width of the end corrugations have been designed to provide the required structural safety factors while providing an unobstructed flow path down each row.

MC-4500 chamber joints require (6) screws for joint assembly. See the MC-3500/MC-4500 Construction Guide for details.

To assist the contractor, StormTech chambers are molded with simple assembly instructions and arrows that indicate the direction in which to build rows. The corrugation valley immediately adjacent to the lower joint corrugation is marked “Overlap Here - Lower Joint.” The corrugation valley immediately adjacent to the upper joint corrugation is marked “Build This Direction - Upper Joint.”

Two people can safely and efficiently carry and place chambers without cumbersome connectors, special tools or heavy equipment. Each row of chambers must begin and end with a joint corrugation. Since joint corrugations are of a different size than the corrugations along the body of the chamber, chambers cannot be field cut and installed. Only whole MC-3500 and MC-4500 chambers can be used. For system layout assistance contact StormTech.

1.5 MC-3500 AND MC-4500 END CAPS

The MC-3500 and MC-4500 end caps are easy to install. These end caps are designed with a corrugation joint that fits over the top of either end of the chamber. The end cap joint is simply set over the top of either of the upper or lower chamber joint corrugations **(Figure 7)**. MC-3500 end caps require three (3) screws to fasten the end cap to the chamber. See the MC-3500/MC-4500 Construction Guide for details.

1.6 MC-3500 END CAPS

Handles are molded into the MC-3500 end cap to enable one person to carry and set the end cap in place. MC-3500 end caps are available pre-cored for a variety of pipe sizes at predetermined inverts. See StormTech details. Custom invert pre-cored end caps are also available.

FIGURE 5 – Chamber and End Cap Components

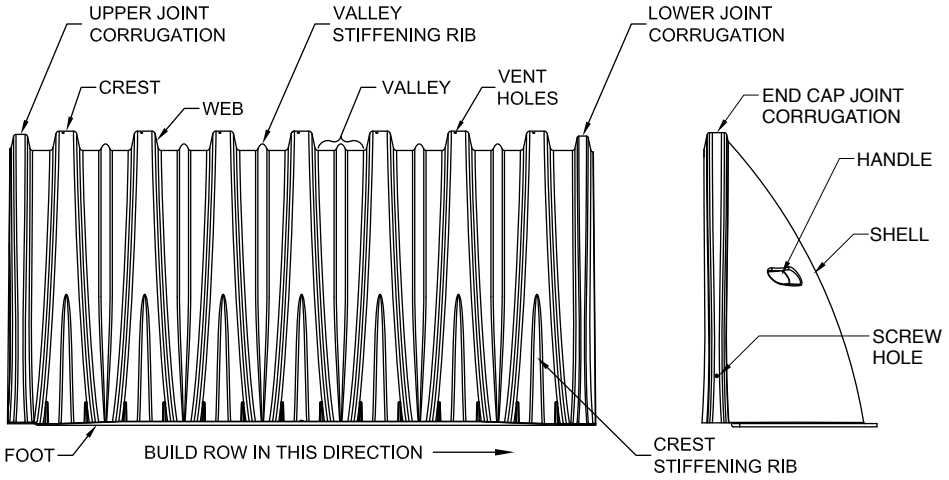
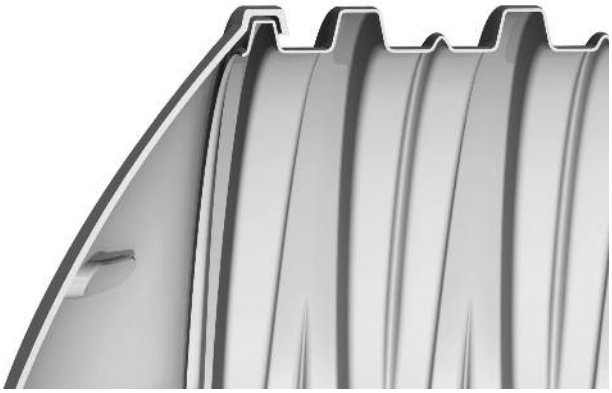


FIGURE 6 – Chamber Joint Overlap

FIGURE 7 – End Cap Joint Overlap



1.7 MC-4500 END CAPS

The MC-4500 end cap has pipe cutting guides for 12"– 42" (300 mm – 1050 mm) bottom inverts and 12" – 24" (300 mm – 600 mm) top inverts. Standard and custom, pre-cored end caps are available.

FIGURE 8 – MC-4500 End Cap Inverts

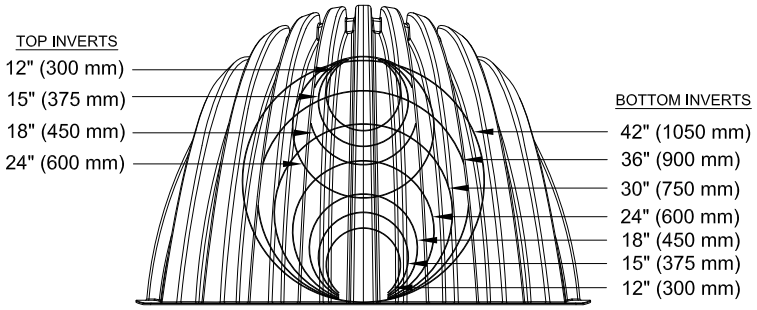
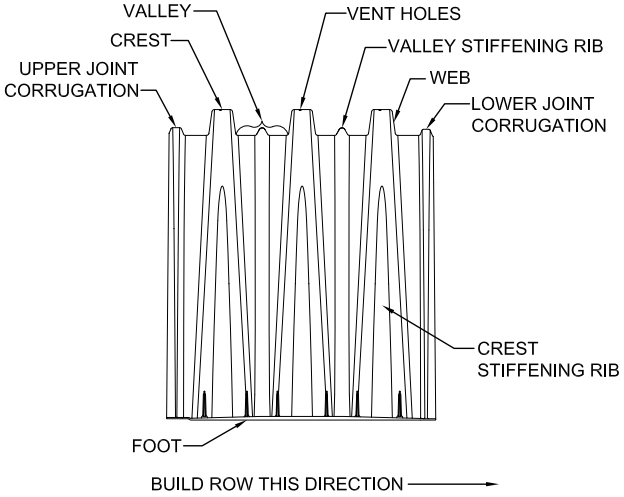
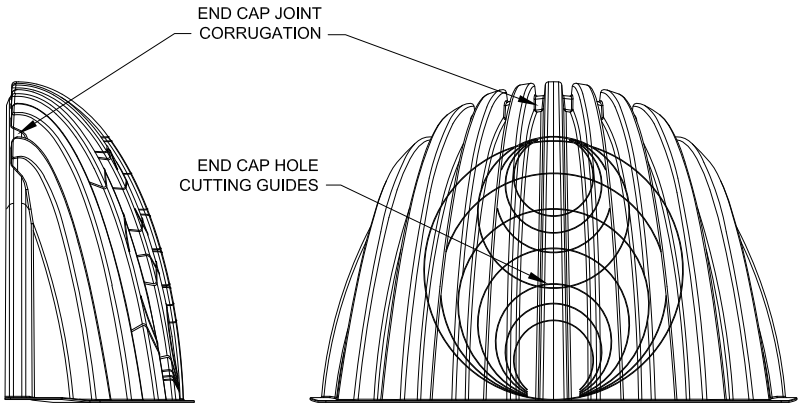


FIGURE 9 – MC-4500 Chamber and End Cap Components



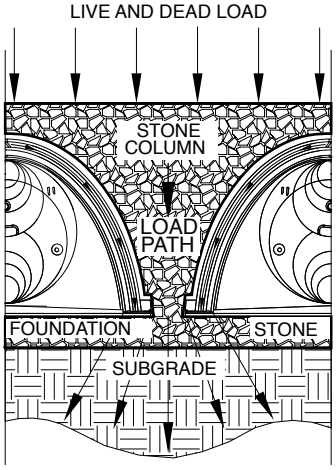


2.0 Foundations for Chambers

2.1 FOUNDATION REQUIREMENTS

StormTech chamber systems can be installed in various soil types. The subgrade bearing capacity and the cover height over the chambers determine the required depth of clean, crushed, angular foundation stone below the chambers. Foundation stone, also called bedding, is the stone between the subgrade soils and the feet of the chamber. Flexible structures are designed to transfer a significant portion of both live and dead loads through the surrounding soils. Chamber systems accomplish this by creating load paths through the columns of embedment stone between and around the rows of chambers. This creates load concentrations at the base of the columns between the rows. The foundation stone spreads out the concentrated loads to distributed loads that can be supported by the subgrade soils.

Since increasing the cover height (top of chamber to finished grade) causes increasing soil load, a greater depth of foundation stone is necessary to distribute the load to the subgrade soils. **Table 1** and **2** specify the minimum required foundation depths for varying cover heights and allowable subgrade bearing capacities. These tables are based on StormTech service loads. The minimum required foundation depth is 9" (229 mm) for both chambers.



2.2 WEAKER SOILS

StormTech has not provided guidance for subgrade bearing capacities less than 2000 pounds per square foot [(2.0 ksf) (96 kPa)]. These soils are often highly variable, may contain organic materials and could be more sensitive to moisture. A geotechnical engineer must be consulted if soils with bearing capacities less than 2000 psf (96 kPa) are present.

TABLE 1 – MC-3500 Minimum Required Foundation Depth in inches (millimeters)
Assumes 9" (229 mm) row spacing.

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																								
	4.4 (211)	4.3 (206)	4.2 (201)	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
2.0 (0.61)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)
2.5 (0.76)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)
3.0 (0.91)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)
3.5 (1.07)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (305)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)
4.0 (1.22)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)
4.5 (1.37)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)
5.0 (1.52)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)
5.5 (1.68)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)
6.0 (1.83)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	30 (762)
6.5 (1.98)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	30 (762)	30 (762)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

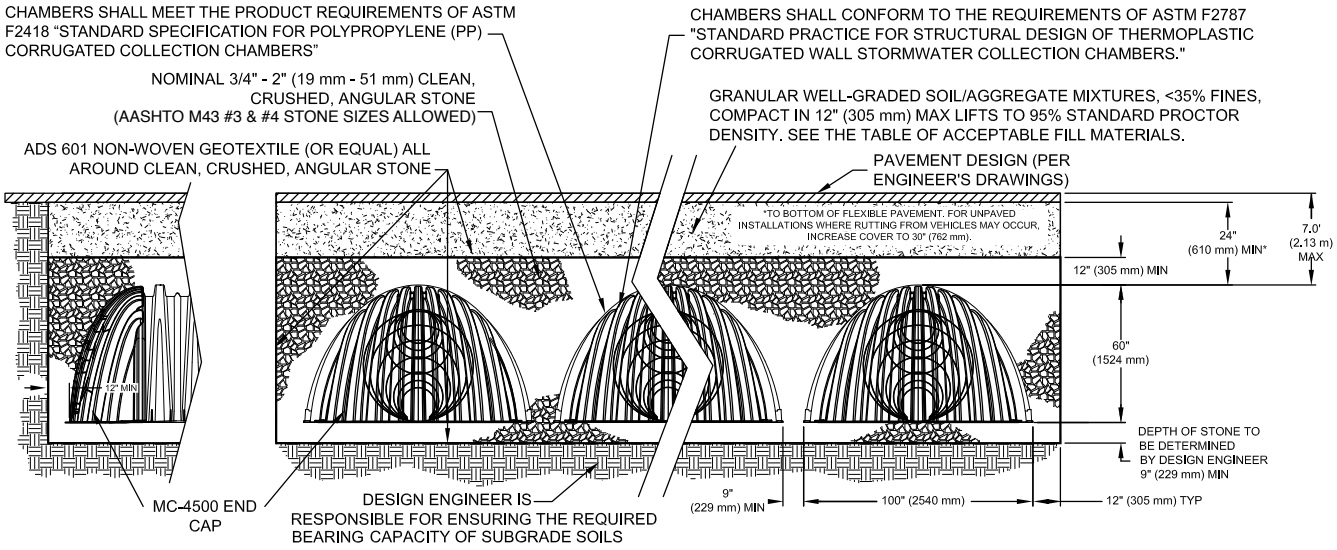
2.0 Foundations for Chambers

TABLE 2 – MC-4500 Minimum Required Foundation Depth in inches (millimeters)
Assumes 9" (229 mm) row spacing.

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																					
	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
2.0 (0.61)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)
2.5 (0.76)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)
3.0 (0.91)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	30 (762)
3.5 (1.07)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	36 (914)
4.0 (1.22)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	36 (914)	36 (914)
4.5 (1.37)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	36 (914)	36 (914)	42 (1067)
5.0 (1.52)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	36 (914)	36 (914)	42 (1067)	48 (1219)
5.5 (1.68)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	30 (762)	36 (914)	36 (914)	42 (1067)	48 (1219)	54 (1371)
6.0 (1.83)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	30 (762)	36 (914)	36 (914)	42 (1067)	42 (1067)	48 (1219)	54 (1372)
6.5 (1.98)	12 (305)	15 (381)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	30 (762)	36 (914)	36 (914)	42 (1067)	42 (1067)	48 (1219)	54 (1372)	66 (1676)
7.0 (2.13)	15 (381)	15 (381)	15 (381)	18 (457)	18 (457)	18 (457)	24 (610)	24 (610)	24 (610)	24 (610)	30 (762)	30 (762)	30 (762)	30 (762)	36 (914)	36 (914)	42 (1067)	42 (1067)	48 (1219)	54 (1372)	60 (1524)	66 (1676)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

FIGURE 10 – MC-4500 Structural Cross Section Detail (Not to Scale)



THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

3.1 FOUNDATION AND EMBEDMENT STONE

The stone surrounding the chambers consists of the *foundation* stone below the chambers and *embedment* stone surrounding the chambers. The foundation stone and embedment stone are important components of the structural system and also provide open void space for stormwater storage. **Table 3** provides the stone specifications that achieve both structural requirements and a porosity of 40% for stormwater storage. **Figure 11** specifies the extents of each backfill stone location.

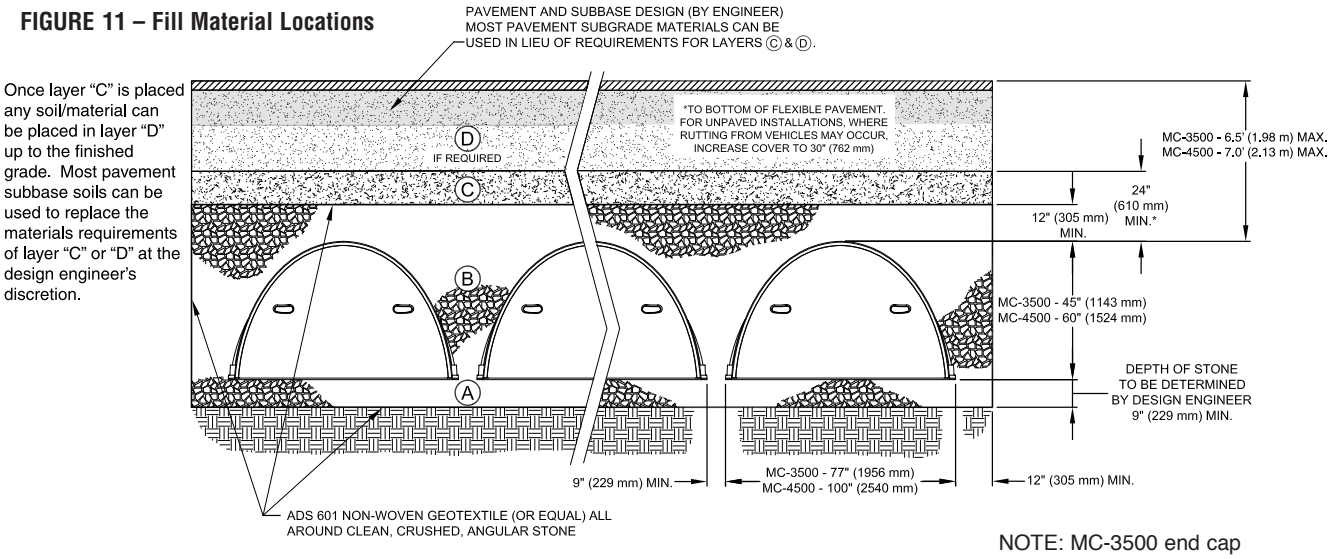
TABLE 3 – Acceptable Fill Materials

Material Location	Description	AASHTO M43 Designation[1]	Compaction/Density Requirement
(D) Fill Material for layer 'D' starts from the top of the 'C' layer to the bottom of flexible pavement or unpaved finished grade above. Note that the pavement subbase may be part of the 'D' layer.	Any soil/rock materials, native soils or per engineer's plans. Check plans for pavement subgrade requirements.	N/A	Prepare per engineer's plans. Paved installations may have stringent material and preparation requirements.
(C) Fill Material for layer 'C' starts from the top of the embedment stone ('B' layer) to 24" (610 mm) above the top of the chamber. Note that pavement subbase may be part of the 'C' layer.	Granular well-graded soil/aggregate mixtures, <35% fines. Most pavement subbase materials can be used in lieu of this layer. (AASHTO M145 A-1, A-2, A-3)	3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	Begin compaction after 24" (610 mm) of material over the chambers is reached. Compact additional layers in 12" (305 mm) max. lifts to a min. 95% Standard Proctor density. See MC-3500 and MC-4500 Construction Guide for acceptable compaction equipment loads.
(B) Embedment Stone surrounding chambers from the foundation stone to the 'C' layer above.	Clean, crushed, angular stone, nominal size distribution 3/4 - 2" (19 mm - 51 mm)	3, 4	No compaction required.
(A) Foundation Stone below the chambers from the subgrade up to the foot (bottom) of the chamber.	Clean, crushed, angular stone, nominal size distribution 3/4 - 2" (19 mm - 51 mm)	3, 4	Plate compact or roll to achieve a 95% Standard Proctor Density.[2]

PLEASE NOTE:

1. ***The listed AASHTO designations are for gradations only. The stone must also be clean, crushed, angular. For example, a specification for #4 stone would state: "clean, crushed, angular no. 4 (AASHTO M43) stone."***
2. ***As an alternate to Proctor Testing and field density measurements on open graded stone, StormTech compaction requirements are met for 'A' location materials when placed and compacted in 9" (229 mm) (max) lifts using two full passes with an appropriate compactor.***

FIGURE 11 – Fill Material Locations



NOTE: MC-3500 end cap shown.

3.0 Required Materials/Row Separation

3.2 FILL ABOVE CHAMBERS

Refer to **Table 3** and **Figure 11** for acceptable fill material above the clean, crushed, angular stone. StormTech requires a minimum of 24" (610 mm) from the top of the chamber to the bottom of flexible pavement. For non-paved installations where rutting from vehicles may occur StormTech requires a minimum of 30" (762 mm) from top of chamber to finished grade.

3.3 GEOTEXTILE SEPARATION

A non-woven geotextile meeting AASHTO M288 Class 2 separation requirements must be installed to completely envelope the system and prevent soil intrusion into the crushed, angular stone. Overlap adjacent geotextile rolls per AASHTO M288 separation guidelines. Contact StormTech for a list of acceptable geotextiles.

3.4 PARALLEL ROW SEPARATION/ PERPENDICULAR BED SEPARATION

Parallel Row Separation

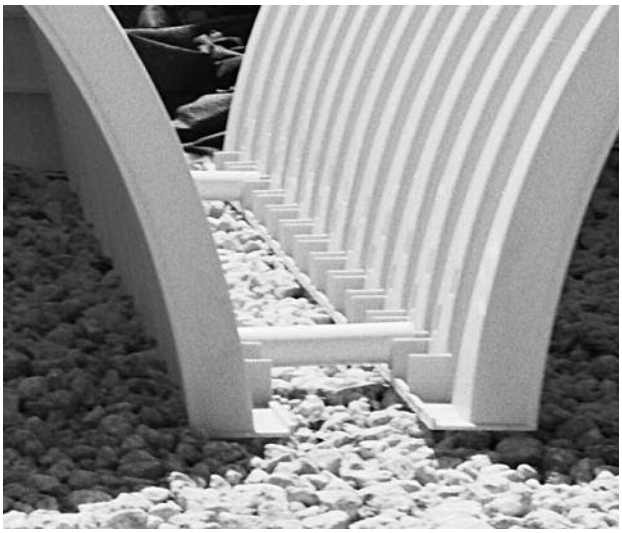
The minimum installed spacing between parallel rows after backfilling is 9” (229 mm) for the MC-3500 and MC-4500 chambers (measurement taken between the outside edges of the feet). Spacers may be used for layout convenience. Row spacing wider than the minimum spacing above may be specified.

Increasing the spacing between chamber rows may allow the application of StormTech chambers with either less foundation stone or with weaker subgrade soils. This may be a good option where vertical restrictions on site prevent the use of a deeper foundation.

Perpendicular Bed Separation

When beds are laid perpendicular to each other, a minimum installed spacing of 36" (914 mm) between beds is required.

System cross section.



Spacers for row separation.

4.1 GENERAL

StormTech subsurface chamber systems offer the flexibility for a variety of inlet and outlet configurations. Contact the StormTech Technical Services Department or your local StormTech representative for assistance configuring inlet and outlet connections.

The open graded stone around and under the chambers provides a significant conveyance capacity ranging from approximately 0.8 cfs (23 l/s) to 13 cfs (368 l/s) per MC-3500 chamber and 0.54 cfs (15 l/s) to 8.5 cfs (240 l/s) for the MC-4500 chamber. The actual conveyance capacity is dependent upon stone size, depth of foundation stone and head of water. Although the high conveyance capacity of the open graded stone is an important component of the flow network, StormTech recommends that a system of inlet and outlet manifolds be designed to distribute and convey the peak flow through the chamber system.

It is the responsibility of the design engineer to provide the design flow rates and storage volumes for the stormwater system and to ensure that the final design meets all conveyance and storage requirements. However, StormTech will work with the design engineer to assist with manifold and chamber layouts that meet the design objectives.

4.2 THE ISOLATOR® ROW

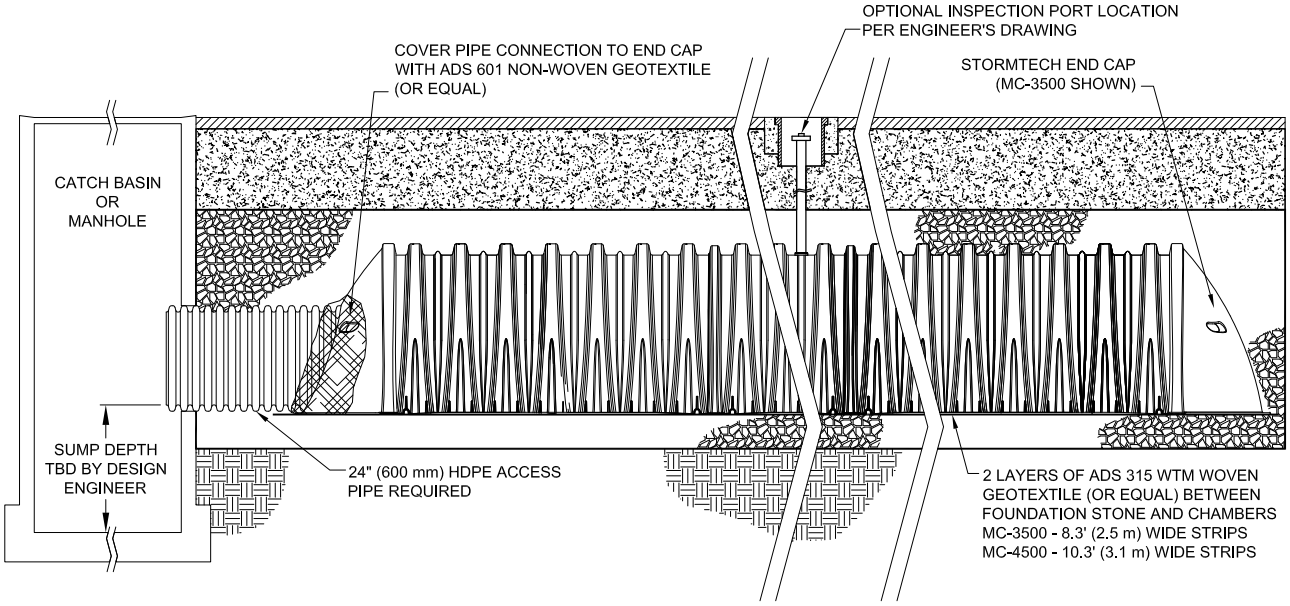
The Isolator Row is a patented system that inexpensively captures total suspended solids (TSS) and debris and provides easy access for inspection and maintenance. A double layer of woven geotextile between the bottom of the chambers and the foundation stone provides the filter media that satisfies most contaminant removal objectives. Each installed MC-3500 chamber and MC-3500 end cap provides 42.9 ft^2 (4.0 m^2) and 7.5 ft^2 (0.7 m^2) of bottom filter area respectively. Each installed MC-4500 chamber and MC-4500 end cap provides 30.1 ft^2 (2.80 m^2) and 12.8 ft^2 (1.19 m^2) of bottom filter area respectively.

The Isolator Row can be configured for maintenance objectives or, in some regulatory jurisdictions, for water quality objectives. For water quality applications, Isolator Rows can be sized based on water quality volume or flow rate.

All Isolator Rows require: 1) a manhole for maintenance access, 2) a means of diversion of flows to the Isolator Row and 3) a high flow bypass. Flow diversion can be accomplished by either a weir in the upstream access manhole or simply by feeding the Isolator Row at a lower elevation than the high flow bypass. Contact StormTech for assistance sizing Isolator Rows.

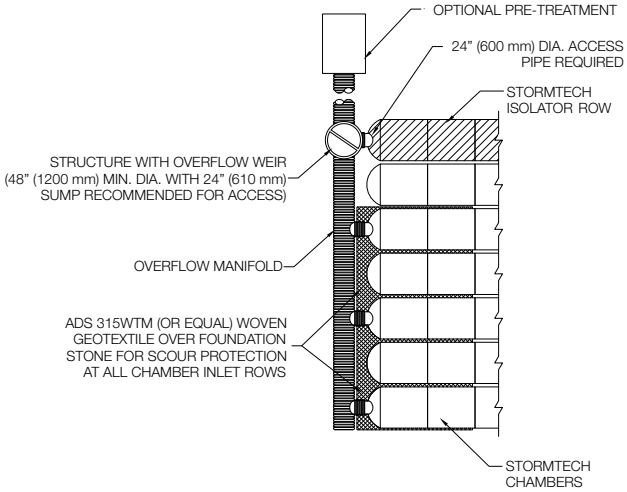
When additional stormwater treatment is required, StormTech systems can be configured using a treatment train approach where other stormwater BMPs are located in series.

FIGURE 12 – StormTech Isolator Row Detail



4.0 Hydraulics

FIGURE 13 – Typical Inlet Configuration With Isolator Row and Scour Protection



4.3 INLET MANIFOLDS

The primary function of the inlet manifold is to convey and distribute flows to a sufficient number of rows in the chamber bed such that there is ample conveyance capacity to pass the peak flows without creating an unacceptable backwater condition in upstream piping or scour the foundation stone under the chambers.

Manifolds are connected to the end caps either at the top or bottom of the end cap. High inlet flow rates from either connection location produce a shear scour potential of the foundation stone. Inlet flows from top inlets also produce impingement scour potential. Scour potential is reduced when standing water is present over the foundation stone. However, for safe design across the wide range of applications, StormTech assumes minimal standing water at the time the design flow occurs.

To minimize scour potential, StormTech recommends the installation of woven scour protection fabric at each inlet row. This enables a protected transition zone from the concentrated flow coming out of the inlet pipe to a uniform flow across the entire width of the chamber for both top and bottom connections.

Allowable flow rates for design are dependent upon: the elevation of inlet pipe, foundation stone size and scour protection. With an appropriate scour protection geotextile installed from the end cap to at least 14.5' (4.42 m) in front of the inlet pipe for the MC-3500 and for the MC-4500, for both top and bottom feeds, the flow rates listed in **Table 4** can be used for all StormTech specified foundation stone gradations.

***See StormTech's Tech Sheet #7 for manifold sizing guidance.**

TABLE 4 – Allowable Inlet Flows*

Inlet Pipe Diameter Inches (mm)	Allowable Maximum Flow Rate cfs (l/s)
12 (300)	2 (57)
15 (375)	3.5 (99)
18 (450)	5.5 (156)
24 (600)	8.5 (241) [MC-3500]
24 (600)	9.5 (269) [MC-4500]

* Assumes appropriate length of scour fabric per section 4.3.

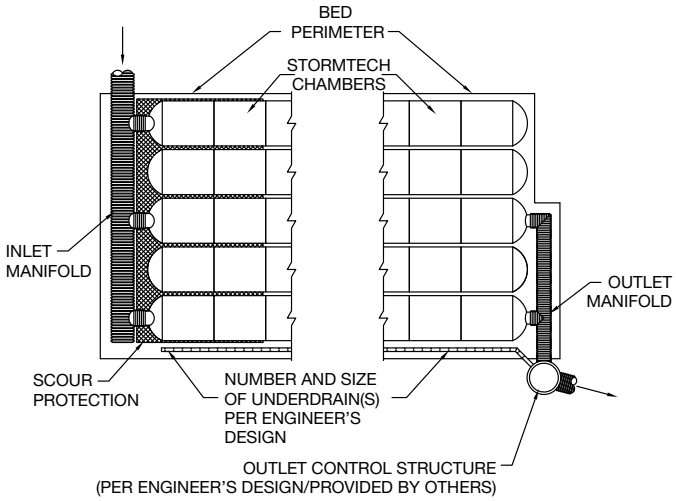
4.4 OUTLET MANIFOLDS

The primary function of the outlet manifold is to convey peak flows from the chamber system to the outlet control structure. Outlet manifolds are often sized for attenuated flows. They may be smaller in diameter and have fewer row connections than inlet manifolds. In some applications however, the intent of the outlet piping is to convey an unattenuated bypass flow rate and manifolds may be sized similar to inlet manifolds.

Since chambers are generally flowing at or near full at the time of the peak outlet flow rate, scour is generally not governing and outlet manifold sizing is based on pipe flow equations. In most cases, StormTech recommends that outlet manifolds connect the same rows that are connected to an inlet manifold. This provides a continuous flow path through open conduits to pass the peak flow without dependence on passing peak flows through stone.

The primary function of the underdrains is to draw down water stored in the stone below the invert of the manifold. Underdrains are generally not sized for conveyance of the peak flow.

FIGURE 14 – Typical Inlet, Outlet and Underdrain Configuration



5.0 Cumulative Storage Volumes

Tables 5 and **6** provide cumulative storage volumes for the MC-3500 chamber and end cap. These tables can be used to calculate the stage–storage relationship for the retention or detention system. Digital spreadsheets in which the number of chambers and end caps can be input for quick cumulative storage calculations are available at www.stormtech.com. For assistance with site-specific calculations or input into routing software, contact the StormTech Technical Services Department.

TABLE 5 – MC-3500 Incremental Storage Volume Per Chamber

Assumes 40% stone porosity. Calculations are based upon a 9" (229 mm) stone base under the chambers, 12" (305 mm) of stone above chambers, and 9" (229 mm) spacing between chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
66 (1676)	0.00	178.96 (5.068)
65 (1651)	0.00	177.25 (5.019)
64 (1626)	Stone 0.00	175.54 (4.971)
63 (1600)	Cover 0.00	173.83 (4.922)
62 (1575)	0.00	172.11 (4.874)
61 (1549)	0.00	170.40 (4.825)
60 (1524)	0.00	168.69 (4.777)
59 (1499)	0.00	166.98 (4.728)
58 (1473)	0.00	165.27 (4.680)
57 (1448)	0.00	163.55 (4.631)
56 (1422)	0.00	161.84 (4.583)
55 (1397)	0.00	160.13 (4.534)
54 (1372)	109.95 (3.113)	158.42 (4.486)
53 (1346)	109.89 (3.112)	156.67 (4.436)
52 (1321)	109.69 (3.106)	154.84 (4.385)
51 (1295)	109.40 (3.098)	152.95 (4.331)
50 (1270)	109.00 (3.086)	151.00 (4.276)
49 (1245)	108.31 (3.067)	148.88 (4.216)
48 (1219)	107.28 (3.038)	146.55 (4.150)
47 (1194)	106.03 (3.003)	144.09 (4.080)
46 (1168)	104.61 (2.962)	141.52 (4.007)
45 (1143)	103.04 (2.918)	138.86 (3.932)
44 (1118)	101.33 (2.869)	136.13 (3.855)
43 (1092)	99.50 (2.818)	133.32 (3.775)
42 (1067)	97.56 (2.763)	130.44 (3.694)
41 (1041)	95.52 (2.705)	127.51 (3.611)
40 (1016)	93.39 (2.644)	124.51 (3.526)
39 (991)	91.16 (2.581)	121.47 (3.440)
38 (965)	88.86 (2.516)	118.37 (3.352)
37 (940)	86.47 (2.449)	115.23 (3.263)
36 (914)	84.01 (2.379)	112.04 (3.173)
35 (889)	81.49 (2.307)	108.81 (3.081)
34 (864)	78.89 (2.234)	105.54 (2.989)
33 (838)	76.24 (2.159)	102.24 (2.895)
32 (813)	73.52 (2.082)	98.90 (2.800)
31 (787)	70.75 (2.003)	95.52 (2.705)
30 (762)	67.92 (1.923)	92.12 (2.608)
29 (737)	65.05 (1.842)	88.68 (2.511)
28 (711)	62.12 (1.759)	85.21 (2.413)
27 (686)	59.15 (1.675)	81.72 (2.314)
26 (660)	56.14 (1.590)	78.20 (2.214)
25 (635)	53.09 (1.503)	74.65 (2.114)
24 (610)	49.99 (1.416)	71.09 (2.013)
23 (584)	46.86 (1.327)	67.50 (1.911)
22 (559)	43.70 (1.237)	63.88 (1.809)
21 (533)	40.50 (1.147)	60.25 (1.706)
20 (508)	37.27 (1.055)	56.60 (1.603)
19 (483)	34.01 (0.963)	52.93 (1.499)
18 (457)	30.72 (0.870)	49.25 (1.395)
17 (432)	27.40 (0.776)	45.54 (1.290)
16 (406)	24.05 (0.681)	41.83 (1.184)
15 (381)	20.69 (0.586)	38.09 (1.079)
14 (356)	17.29 (0.490)	34.34 (0.973)
13 (330)	13.88 (0.393)	30.58 (0.866)
12 (305)	10.44 (0.296)	26.81 (0.759)
11 (279)	6.98 (0.198)	23.02 (0.652)
10 (254)	3.51 (0.099)	19.22 (0.544)
9 (229)	0.00	15.41 (0.436)
8 (203)	0.00	13.70 (0.388)
7 (178)	0.00	11.98 (0.339)
6 (152)	Stone 0.00	10.27 (0.291)
5 (127)	Foundation 0.00	8.56 (0.242)
4 (102)	0.00	6.85 (0.194)
3 (76)	0.00	5.14 (0.145)
2 (51)	0.00	3.42 (0.097)
1 (25)	0.00	1.71 (0.048)

NOTE: Add 1.71 ft³ (0.048 m³) of storage for each additional inch (25 mm) of stone foundation.

Contact StormTech for cumulative volume spreadsheets in digital format.

TABLE 6 – MC-3500 Incremental Storage Volume Per End Cap

Assumes 40% stone porosity. Calculations are based upon a 9" (229 mm) stone base under the end caps, 12" (305 mm) of stone above end caps, 9" (229 mm) of spacing between end caps and 6" (152 mm) of stone perimeter.

Depth of Water in System Inches (mm)	Cumulative End Cap Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
66 (1676)	0	46.96 (1.330)
65 (1651)	0	46.39 (1.314)
64 (1626)	Stone 0	45.82 (1.298)
63 (1600)	Cover 0	45.25 (1.281)
62 (1575)	0	44.68 (1.265)
61 (1549)	0	44.11 (1.249)
60 (1524)	0	43.54 (1.233)
59 (1499)	0	42.98 (1.217)
58 (1473)	0	42.41 (1.201)
57 (1448)	0	41.84 (1.185)
56 (1422)	0	41.27 (1.169)
55 (1397)	0	40.70 (1.152)
54 (1372)	15.64 (0.443)	40.13 (1.136)
53 (1346)	15.64 (0.443)	39.56 (1.120)
52 (1321)	15.63 (0.443)	38.99 (1.104)
51 (1295)	15.62 (0.442)	38.41 (1.088)
50 (1270)	15.60 (0.442)	37.83 (1.071)
49 (1245)	15.56 (0.441)	37.24 (1.054)
48 (1219)	15.51 (0.439)	36.64 (1.037)
47 (1194)	15.44 (0.437)	36.02 (1.020)
46 (1168)	15.35 (0.435)	35.40 (1.003)
45 (1143)	15.25 (0.432)	34.77 (0.985)
44 (1118)	15.13 (0.428)	34.13 (0.966)
43 (1092)	14.99 (0.424)	33.48 (0.948)
42 (1067)	14.83 (0.420)	32.81 (0.929)
41 (1041)	14.65 (0.415)	32.13 (0.910)
40 (1016)	14.45 (0.409)	31.45 (0.890)
39 (991)	14.24 (0.403)	30.75 (0.871)
38 (965)	14.00 (0.396)	30.03 (0.850)
37 (948)	13.74 (0.389)	29.31 (0.830)
36 (914)	13.47 (0.381)	28.58 (0.809)
35 (889)	13.18 (0.373)	27.84 (0.788)
34 (864)	12.86 (0.364)	27.08 (0.767)

Depth of Water in System Inches (mm)	Cumulative End Cap Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
33 (838)	12.53 (0.355)	26.30 (0.745)
32 (813)	12.18 (0.345)	25.53 (0.723)
31 (787)	11.81 (0.335)	24.74 (0.701)
30 (762)	11.42 (0.323)	23.93 (0.678)
29 (737)	11.01 (0.312)	23.12 (0.655)
28 (711)	10.58 (0.300)	22.29 (0.631)
27 (686)	10.13 (0.287)	21.45 (0.607)
26 (680)	9.67 (0.274)	20.61 (0.583)
25 (610)	9.19 (0.260)	19.75 (0.559)
24 (609)	8.70 (0.246)	18.88 (0.559)
23 (584)	8.19 (0.232)	18.01 (0.510)
22 (559)	7.67 (0.217)	17.13 (0.485)
21 (533)	7.13 (0.202)	16.24 (0.460)
20 (508)	6.59 (0.187)	15.34 (0.434)
19 (483)	6.03 (0.171)	14.43 (0.409)
18 (457)	5.46 (0.155)	13.52 (0.383)
17 (432)	4.88 (0.138)	12.61 (0.357)
16 (406)	4.30 (0.122)	11.69 (0.331)
15 (381)	3.70 (0.105)	10.76 (0.305)
14 (356)	3.10 (0.088)	9.83 (0.278)
13 (330)	2.49 (0.071)	8.90 (0.252)
12 (305)	1.88 (0.053)	7.96 (0.225)
11 (279)	1.26 (0.036)	7.02 (0.199)
10 (254)	0.63 (0.018)	6.07 (0.172)
9 (229)	0	5.12 (0.145)
8 (203)	0	4.55 (0.129)
7 (178)	0	3.99 (0.113)
6 (152)	0	3.42 (0.097)
5 (127)	Stone 0	2.85 (0.081)
4 (102)	Foundation 0	2.28 (0.064)
3 (76)	0	1.71 (0.048)
2 (51)	0	1.14 (0.032)
1 (25)	0	0.56 (0.016)

NOTE: Add 0.56 ft³ (0.016 m³) of storage for each additional inch (25 mm) of stone foundation.

Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volumes

Tables 7 and **8** provide cumulative storage volumes for the MC-4500 chamber and end cap. These tables can be used to calculate the stage-storage relationship for the retention or detention system. Digital spreadsheets in which the number of chambers and end caps can be input for quick cumulative storage calculations are available at www.stormtech.com. For assistance with site-specific calculations or input into routing software, contact the StormTech Technical Services Department.

TABLE 7 – MC-4500 Incremental Storage Volume Per Chamber

Assumes 40% stone porosity. Calculations are based upon a 9" (229 mm) stone base under the chambers, 12" (305 mm) of stone above chambers, and 9" (229 mm) spacing between chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
81 (2057)	0	162.62 (4.605)
80 (2032)	0	161.40 (4.570)
79 (2007)	Stone 0	160.18 (4.536)
78 (1981)	Cover 0	158.96 (4.501)
77 (1956)	0	157.74 (4.467)
76 (1930)	0	156.52 (4.432)
75 (1905)	0	155.30 (4.398)
74 (1880)	0	154.09 (4.363)
73 (1854)	0	152.87 (4.329)
72 (1829)	0	151.65 (4.294)
71 (1803)	0	150.43 (4.260)
70 (1778)	0	149.21 (4.225)
69 (1753)	106.51 (3.016)	147.99 (4.191)
68 (1727)	106.47 (3.015)	146.75 (4.156)
67 (1702)	106.35 (3.012)	145.46 (4.119)
66 (1676)	106.18 (3.007)	144.14 (4.082)
65 (1651)	105.98 (3.001)	142.80 (4.044)
64 (1626)	105.71 (2.993)	141.42 (4.005)
63 (1600)	105.25 (2.981)	139.93 (3.962)
62 (1575)	104.59 (2.962)	138.31 (3.917)
61 (1549)	103.79 (2.939)	136.61 (3.869)
60 (1524)	102.88 (2.913)	134.85 (3.819)
59 (1499)	101.88 (2.885)	133.03 (3.767)
58 (1473)	100.79 (2.854)	131.16 (3.714)
57 (1448)	99.63 (2.821)	129.24 (3.660)
56 (1422)	98.39 (2.786)	127.28 (3.604)
55 (1397)	97.10 (2.749)	125.28 (3.548)
54 (1372)	95.73 (2.711)	123.25 (3.490)
53 (1346)	94.32 (2.671)	121.18 (3.431)
52 (1321)	92.84 (2.629)	119.08 (3.372)
51 (1295)	91.32 (2.586)	116.94 (3.311)
50 (1270)	89.74 (2.541)	114.78 (3.250)
49 (1245)	88.12 (2.495)	112.59 (3.188)
48 (1219)	86.45 (2.448)	110.37 (3.125)
47 (1194)	84.75 (2.400)	108.13 (3.062)
46 (1168)	83.00 (2.350)	105.86 (2.998)
45 (1143)	81.21 (2.300)	103.56 (2.933)
44 (1118)	79.38 (2.248)	101.25 (2.867)
43 (1092)	77.52 (2.195)	98.91 (2.801)
42 (1067)	75.62 (2.141)	96.55 (2.734)
41 (1041)	73.69 (2.087)	94.18 (2.667)
40 (1016)	71.72 (2.031)	91.78 (2.599)
39 (991)	69.73 (1.974)	89.36 (2.531)
38 (965)	67.70 (1.917)	86.93 (2.462)
37 (948)	65.65 (1.859)	84.48 (2.392)
36 (914)	63.57 (1.800)	82.01 (2.322)
35 (889)	61.46 (1.740)	79.53 (2.252)
34 (864)	59.32 (1.680)	77.03 (2.181)
33 (838)	57.17 (1.619)	74.52 (2.110)
32 (813)	54.98 (1.557)	71.99 (2.038)
31 (787)	52.78 (1.495)	69.45 (1.966)
30 (762)	50.55 (1.431)	66.89 (1.894)
29 (737)	48.30 (1.368)	64.32 (1.821)
28 (711)	46.03 (1.303)	61.74 (1.748)
27 (686)	43.74 (1.239)	59.15 (1.675)
26 (680)	41.43 (1.173)	56.55 (1.601)
25 (610)	39.11 (1.107)	53.93 (1.527)
24 (609)	36.77 (1.041)	51.31 (1.453)
23 (584)	34.41 (0.974)	48.67 (1.378)
22 (559)	32.03 (0.907)	46.03 (1.303)
21 (533)	29.64 (0.839)	43.38 (1.228)
20 (508)	27.23 (0.771)	40.71 (1.153)
19 (483)	24.81 (0.703)	38.04 (1.077)
18 (457)	22.38 (0.634)	35.37 (1.001)
17 (432)	19.94 (0.565)	32.68 (0.925)
16 (406)	17.48 (0.495)	29.99 (0.849)
15 (381)	15.01 (0.425)	27.29 (0.773)
14 (356)	12.53 (0.355)	24.58 (0.696)
13 (330)	10.05 (0.284)	21.87 (0.619)
12 (305)	7.55 (0.214)	19.15 (0.542)
11 (279)	5.04 (0.143)	16.43 (0.465)
10 (254)	2.53 (0.072)	13.70 (0.388)
9 (229)	0	10.97 (0.311)
8 (203)	0	9.75 (0.276)
7 (178)	0	8.53 (0.242)
6 (152)	Stone 0	7.31 (0.207)
5 (127)	Foundation 0	6.09 (0.173)
4 (102)	0	4.87 (0.138)
3 (76)	0	3.66 (0.104)
2 (51)	0	2.44 (0.069)
1 (25)	0	1.22 (0.035)

NOTE: Add 1.22 ft³ (0.035 m³) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

TABLE 8 – MC-4500 Incremental Storage Volume Per End Cap

Assumes 40% stone porosity. Calculations are based upon a 9" (229 mm) stone base under the end caps, 12" (305 mm) of stone above end caps, 9" (229 mm) of spacing between end caps and 12" (305 mm) of stone perimeter.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
81 (2057)	0	108.69 (3.078)
80 (2032)	0	107.62 (3.047)
79 (2007)	Stone 0	106.54 (3.017)
78 (1981)	Cover 0	105.46 (2.986)
77 (1956)	0	104.38 (2.956)
76 (1930)	0	103.31 (2.925)
75 (1905)	0	102.23 (2.895)
74 (1880)	0	101.15 (2.864)
73 (1854)	0	100.07 (2.834)
72 (1829)	0	99.00 (2.803)
71 (1803)	0	97.92 (2.773)
70 (1778)	0	96.84 (2.742)
69 (1753)	35.71 (1.011)	95.76 (2.712)
68 (1727)	35.71 (1.011)	94.69 (2.681)
67 (1702)	35.70 (1.011)	93.60 (2.651)
66 (1676)	35.67 (1.010)	92.51 (2.620)
65 (1651)	35.62 (1.009)	91.40 (2.588)
64 (1626)	35.56 (1.007)	90.29 (2.557)
63 (1600)	35.47 (1.004)	89.16 (2.525)
62 (1575)	35.36 (1.001)	88.01 (2.492)
61 (1549)	35.21 (0.997)	86.85 (2.459)
60 (1524)	35.05 (0.992)	85.67 (2.426)
59 (1499)	34.86 (0.987)	84.48 (2.392)
58 (1473)	34.64 (0.981)	83.27 (2.358)
57 (1448)	34.40 (0.974)	82.05 (2.323)
56 (1422)	34.13 (0.966)	80.81 (2.288)
55 (1397)	33.83 (0.958)	79.55 (2.253)
54 (1372)	33.51 (0.949)	78.28 (2.217)
53 (1346)	33.16 (0.939)	77.00 (2.180)
52 (1321)	32.79 (0.928)	75.70 (2.144)
51 (1295)	32.39 (0.917)	74.38 (2.106)
50 (1270)	31.98 (0.906)	73.06 (2.069)
49 (1245)	31.54 (0.893)	71.71 (2.031)
48 (1219)	31.07 (0.880)	70.36 (1.992)
47 (1194)	30.59 (0.866)	68.99 (1.954)
46 (1168)	30.09 (0.852)	67.61 (1.915)
45 (1143)	29.56 (0.837)	66.22 (1.875)
44 (1118)	29.02 (0.822)	64.81 (1.835)
43 (1092)	28.45 (0.806)	63.40 (1.795)

NOTE: Add 1.08 ft³ (0.031 m³) of storage for each additional inch (25 mm) of stone foundation. Contact stormtech for cumulative volume spreadsheets in digital format.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
42 (1067)	27.87 (0.789)	61.97 (1.755)
41 (1041)	27.27 (0.772)	60.53 (1.714)
40 (1016)	26.65 (0.755)	59.08 (1.673)
39 (991)	26.01 (0.736)	57.62 (1.632)
38 (965)	25.35 (0.718)	56.15 (1.590)
37 (948)	24.68 (0.699)	54.67 (1.548)
36 (914)	23.99 (0.679)	53.18 (1.506)
35 (889)	23.28 (0.659)	51.68 (1.463)
34 (864)	22.56 (0.639)	50.17 (1.421)
33 (838)	21.82 (0.618)	48.64 (1.377)
32 (813)	21.06 (0.596)	47.11 (1.334)
31 (787)	20.29 (0.575)	45.57 (1.290)
30 (762)	19.50 (0.552)	44.02 (1.247)
29 (737)	18.70 (0.530)	42.46 (1.202)
28 (711)	17.88 (0.506)	40.89 (1.158)
27 (686)	17.04 (0.483)	39.31 (1.113)
26 (680)	16.19 (0.459)	37.73 (1.068)
25 (610)	15.33 (0.434)	36.14 (1.023)
24 (609)	14.46 (0.410)	34.53 (0.978)
23 (584)	13.58 (0.384)	32.93 (0.932)
22 (559)	12.68 (0.359)	31.31 (0.887)
21 (533)	11.77 (0.333)	29.69 (0.841)
20 (508)	10.85 (0.307)	28.06 (0.794)
19 (483)	9.91 (0.281)	26.42 (0.748)
18 (457)	8.97 (0.254)	24.77 (0.702)
17 (432)	8.01 (0.227)	23.12 (0.655)
16 (406)	7.04 (0.199)	21.46 (0.608)
15 (381)	6.07 (0.172)	19.80 (0.561)
14 (356)	5.08 (0.144)	18.13 (0.513)
13 (330)	4.08 (0.116)	16.45 (0.466)
12 (305)	3.07 (0.087)	14.77 (0.418)
11 (279)	2.06 (0.058)	13.09 (0.371)
10 (254)	1.03 (0.029)	11.39 (0.323)
9 (229)	0	9.70 (0.275)
8 (203)	0	8.62 (0.244)
7 (178)	0	7.54 (0.214)
6 (152)	Stone 0	6.46 (0.183)
5 (127)	Foundation 0	5.39 (0.153)
4 (102)	0	4.31 (0.122)
3 (76)	0	3.23 (0.092)
2 (51)	0	2.15 (0.061)
1 (25)	0	1.08 (0.031)

6.0 MC-3500 Chamber System Sizing

The following steps provide the calculations necessary for preliminary sizing of an MC-3500 chamber system. For custom bed configurations to fit specific sites, contact the StormTech Technical Services Department or your local StormTech representative.

1) Determine the amount of storage volume (V_S) required. It is the design engineer's sole responsibility to determine the storage volume required.

TABLE 9 – Storage Volume Per Chamber/End Cap ft³ (m³)

MC-3500	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9" (229 mm)	12" (305 mm)	15" (381 mm)	18" (457 mm)
Chamber	109.9 (3.11)	178.9 (5.06)	184.0 (5.21)	189.2 (5.36)	194.3 (5.5)
End Cap	15.64 (0.44)	46.9 (1.33)	48.6 (1.38)	50.3 (1.43)	52.0 (1.47)

NOTE: Assumes 9" (229 mm) row spacing, 40% stone porosity, 12" (305 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 6" (152 mm) stone perimeter.

2) Determine the number of chambers (C) required. To calculate the number of chambers required for adequate storage, divide the storage volume (Vs) by the storage volume of the chamber (from **Table 9**), as follows: **C = Vs / Storage Volume per Chamber**

3) Determine the number of end caps required. The number of end caps (EC) required depends on the number of rows required by the project. Once the number of chamber rows is determined, multiply the number of chamber rows by 2 to determine the number of end caps required. **EC = No. of Chamber Rows x 2**

NOTE: Additional end caps may be required for systems having inlet locations within the chamber bed.

4) Determine additional storage provided by end caps. End Caps will provide additional storage to the project. Multiply the number of end caps (EC) by the storage volume per end cap (ECs) to determine the additional storage (As) provided by the end caps. **As = EC x ECs**

5) Adjust number of chambers (C) to account for additional end cap storage (As). The original number of chambers (C) can now be reduced due to the additional storage in the end caps. Divide the additional storage (As) by the storage volume per chamber to determine the number of chambers that can be removed. **Number of chambers to remove = As/ volume per chamber**

NOTE: Additional storage exists in the stone perimeter as well as in the inlet and outlet manifold systems. Contact StormTech's Technical Services Department for assistance with determining the number of chambers and end caps required for your project.

6) Determine the required bed size (S). The size of the bed will depend on the number of chambers and end caps required:
MC-3500 area per chamber = 51.4 ft² (4.8 m²)
MC-3500 area per end cap = 13.5 ft² (1.3 m²)

S = (C x area per chamber) + (EC x area per end cap)

NOTE: It is necessary to add 12" (305 mm) of stone perimeter parallel to the chamber rows and 6" (152 mm) of stone perimeter from the base of all end caps. The additional area due to perimeter stone is not included in the area numbers above.

7) Determine the amount of stone (V_{St}) required. To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) and the number of end caps (EC) by the selected weight of stone from **Table 10.**

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

TABLE 10 – Amount of Stone Per Chamber/End Cap

ENGLISH tons (yds³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-3500	9.1 (6.4 yd³)	9.7 (6.9 yd³)	10.4 (7.3 yd³)	11.1 (7.8 yd³)
End Cap	4.1 (2.9 yd³)	4.3 (3.1 yd³)	4.6 (3.2 yd³)	4.8 (3.4 yd³)
METRIC kg (m³)	**229 mm**	**305 mm**	**381 mm**	**457 mm**
MC-3500	8220 (4.9 m³)	8831 (5.3 m³)	9443 (5.6 m³)	10054 (6.0 m³)
End Cap	3729 (2.2 m³)	3933 (2.3 m³)	4136 (2.5 m³)	4339 (2.6 m³)

NOTE: Assumes 12" (305 mm) of stone above, 9" (229 mm) row spacing, and 6" (152 mm) of perimeter stone in front of end caps.

8) Determine the volume of excavation (Ex) required. Each additional foot of cover will add a volume of excavation of 1.9 yd³ (1.5 m³) per MC-3500 chamber and 0.6 yd³ (0.5 m³) per MC-3500 end cap.

TABLE 11 – Volume of Excavation Per Chamber/End Cap in yd³ (m³)

	Stone Foundation Depth			
	9" (229 mm)	12" (305 mm)	15" (381 mm)	18" (457 mm)
MC-3500	12.4 (9.5)	12.8 (9.8)	13.3 (10.2)	13.8 (10.5)
End Cap	4.1 (3.1)	4.3 (3.3)	4.4 (3.4)	4.6 (3.5)

NOTE: Assumes 9" (229 mm) of separation between chamber rows, 6" (152 mm) of perimeter in front of end caps, and 24" (610 mm) of cover. The volume of excavation will vary as the depth of cover increases.

9) Determine the area of geotextile (F) required. The bottom, top and sides of the bed must be covered with a non-woven geotextile (filter fabric) that meets AASHTO M288 Class 2 requirements. The area of the sidewalls must be calculated and a 24" (610 mm) overlap must be included for all seams. Geotextiles typically come in 15 foot (4.57 m) wide rolls.

6.0 MC-4500 Chamber System Sizing

The following steps provide the calculations necessary for preliminary sizing of an MC-4500 chamber system. For custom bed configurations to fit specific sites, contact the StormTech Technical Services Department or your local StormTech representative.

1) Determine the amount of storage volume (V_S) required. It is the design engineer's sole responsibility to determine the storage volume required.

TABLE 12 – Storage Volume Per Chamber/End Cap ft³ (m³)

MC-4500	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm) 9" (229 mm)	12" (305 mm)	15" (381 mm)	18" (457 mm)
Chamber	106.5 (3.01)	162.6 (4.60)	166.3 (4.71)	169.9 (4.81)	173.6 (4.91)
End Cap	35.7 (1.01)	108.7 (3.08)	111.9 (3.17)	115.2 (3.26)	118.4 (3.35)

NOTE: Assumes 9" (229 mm) row spacing, 40% stone porosity, 12" (305 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 12" (305 mm) stone perimeter.

2) Determine the number of chambers (C) required. To calculate the number of chambers required for adequate storage, divide the storage volume (Vs) by the storage volume of the chamber (from **Table 12**), as follows: **C = Vs / Storage Volume per Chamber**

3) Determine the number of end caps required. The number of end caps (EC) required depends on the number of rows required by the project. Once the number of chamber rows is determined, multiply the number of chamber rows by 2 to determine the number of end caps required. **EC = No. of Chamber Rows x 2**

NOTE: Additional end caps may be required for systems having inlet locations within the chamber bed.

4) Determine additional storage provided by end caps. End Caps will provide additional storage to the project. Multiply the number of end caps (EC) by the storage volume per end cap (ECs) to determine the additional storage (As) provided by the end caps. **As = EC x ECs**

5) Adjust number of chambers (C) to account for additional end cap storage (As). The original number of chambers (C) can now be reduced due to the additional storage in the end caps. Divide the additional storage (As) by the storage volume per chamber to determine the number of chambers that can be removed. **Number of chambers to remove = As/ volume per chamber**

NOTE: Additional storage exists in the stone perimeter as well as in the inlet and outlet manifold systems. Contact StormTech's Technical Services Department for assistance with determining the number of chambers and end caps required for your project.

6) Determine the required bed size (S). The size of the bed will depend on the number of chambers and end caps required:
MC-4500 area per chamber = 36.6 ft² (3.4 m²)
MC-4500 area per end cap = 23.2 ft² (2.2 m²)

S = (C x area per chamber) + (EC x area per end cap)

NOTE: It is necessary to add 12" (305 mm) of stone perimeter parallel to the chamber rows and 12" (305 mm) of stone perimeter from the base of all end caps. The additional area due to perimeter stone is not included in the area numbers above.

7) Determine the amount of stone (V_{St}) required. To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) and the number of end caps (EC) by the selected weight of stone from **Table 13.**

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

TABLE 13 – Amount of Stone Per Chamber/End Cap

ENGLISH tons (yds³)	Stone Foundation Depth 9"	12"	15"	18"
MC-4500	7.4 (5.2)	7.8 (5.5)	8.3 (5.9)	8.8 (6.2)
End Cap	9.6 (6.8)	10.0 (7.1)	10.4 (7.4)	10.9 (7.7)
METRIC kg (m³)	**229 mm**	**305 mm**	**381 mm**	**457 mm**
MC-4500	6681 (4.0)	7117 (4.2)	7552 (4.5)	7987 (4.7)
End Cap	8691 (5.2)	9075 (5.4)	9460 (5.6)	9845 (5.9)

NOTE: Assumes 12" (305 mm) of stone above, 9" (229 mm) row spacing, and 12" (305 mm) of perimeter stone in front of end caps.

8) Determine the volume of excavation (Ex) required. Each additional foot of cover will add a volume of excavation of 1.4 yd³ (1.0 m³) per MC-4500 chamber and 1.2 yd³ (0.9 m³) per MC-4500 end cap.

TABLE 14 – Volume of Excavation Per Chamber/End Cap in yd³ (m³)

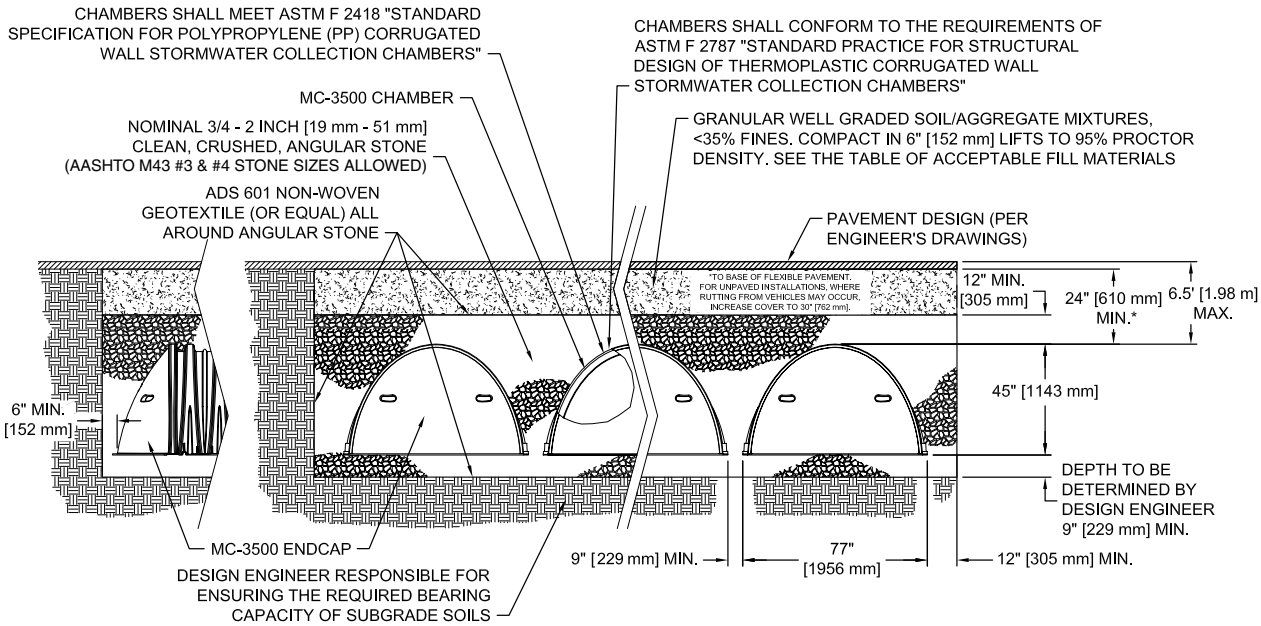
	Stone Foundation Depth 9" (229 mm)	12" (305 mm)	15" (381 mm)	18" (457 mm)
MC-4500	10.5 (8.0)	10.8 (8.3)	11.2 (8.5)	11.5 (8.8)
End Cap	9.3 (7.1)	9.6 (7.3)	9.9 (7.6)	10.2 (7.8)

NOTE: Assumes 9" (229 mm) of separation between chamber rows, 12" (305 mm) of perimeter in front of end caps, and 24" (610 mm) of cover. The volume of excavation will vary as the depth of cover increases.

9) Determine the area of geotextile (F) required. The bottom, top and sides of the bed must be covered with a non-woven geotextile (filter fabric) that meets AASHTO M288 Class 2 requirements. The area of the sidewalls must be calculated and a 24" (610 mm) overlap must be included for all seams. Geotextiles typically come in 15 foot (4.57 m) wide rolls.

7.0 Structural Cross Sections and Specifications

Figure 15 – MC-3500 Structural Cross Section Detail – (not to scale)



THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

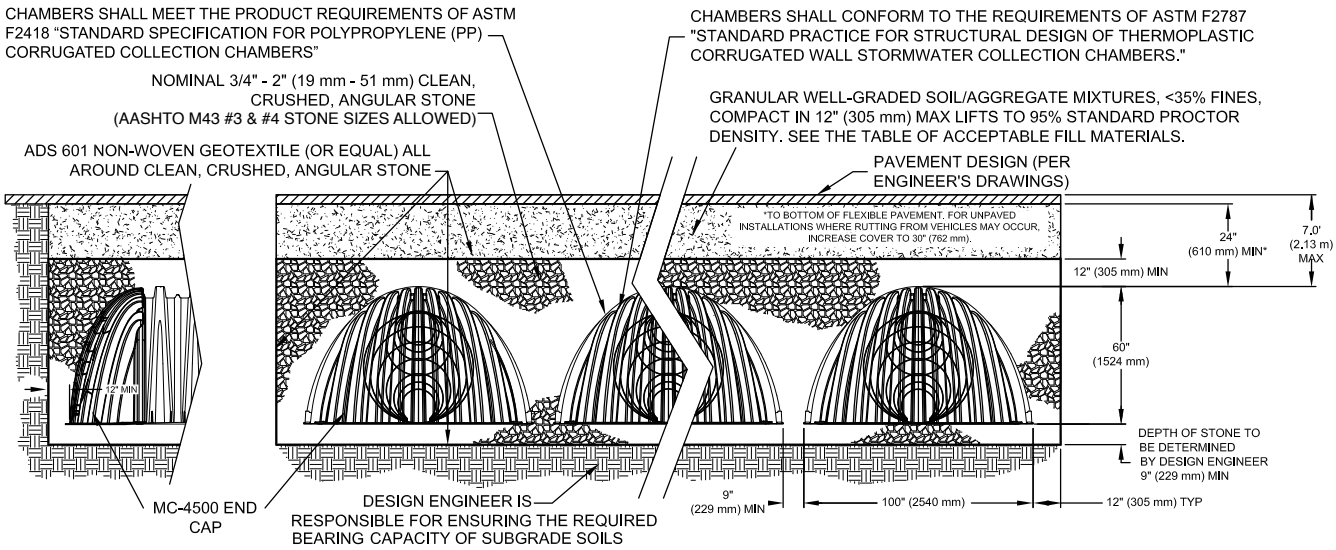
MC-3500 STORMWATER CHAMBER SPECIFICATIONS:

1. Chambers shall be StormTech MC-3500 or approved equal.
2. Chambers shall be made from virgin, impact-modified polypropylene copolymers.
3. Chamber rows shall provide continuous, unobstructed internal space with no internal panels that would impede flow.
4. The structural design of the chambers, the structural backfill and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met for: 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO Design Truck with consideration for impact and multiple vehicle presences.
5. Chambers shall meet the requirements of ASTM F 2418, "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers."
6. Chambers shall conform to the requirements of ASTM F 2787, "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers."
7. Only chambers that are approved by the engineer will be allowed. The contractor shall submit (3 sets) of the following to the engineer for approval before delivering chambers to the project site:
   - A structural evaluation by a registered structural engineer that demonstrates that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met. The 50-year creep modulus data specified in ASTM F 2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.
   - Structural cross section detail on which the structural cross section is based.
8. The installation of chambers shall be in accordance with the manufacturer's latest Construction Guide.

Detail drawings available in Cad Rev. 2000 format at www.stormtech.com.

7.0 Structural Cross Sections and Specifications

Figure 16 – MC-4500 Structural Cross Section Detail – (not to scale)



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2. Chambers shall be made from virgin, impact-modified polypropylene copolymers.
3. Chamber rows shall provide continuous, unobstructed internal space with no internal panels that would impede flow.
4. The structural design of the chambers, the structural backfill and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met for: 1) long-duration dead loads and 2) short duration live loads, based on the AASHTO Design Truck with consideration for impact and multiple vehicle presences.
5. Chambers shall meet the requirements of ASTM F 2418, "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers."
6. Chambers shall conform to the requirements of ASTM F 2787, "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers."
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   - A structural evaluation by a registered structural engineer that demonstrates that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met. The 50-year creep modulus data specified in ASTM F 2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.
   - Structural cross section detail on which the structural cross section is based.
8. The installation of chambers shall be in accordance with the manufacturer's latest Construction Guide.

Detail drawings available in Cad Rev. 2000 format at www.stormtech.com.

8.0 General Notes

1. StormTech ("StormTech") requires installing contractors to use and understand the latest **StormTech MC-3500 and MC-4500 Construction Guide** prior to beginning system installation.
2. StormTech offers installation consultations to installing contractors. Contact our Technical Service Department or local StormTech representative at least 30 days prior to system installation to arrange a pre-installation consultation. Our representatives can then answer questions or address comments on the StormTech chamber system and inform the Installing contractor of the minimum installation requirements before beginning the system's construction. Call 860-529-8188 to speak to a Technical Service Representative or visit www.stormtech.com to receive a copy of our Construction Guide.
3. StormTech requirements for systems with pavement design (asphalt, concrete pavers, etc.): Minimum cover is 24" (610 mm) not including pavement; MC-3500 maximum cover is 6.5' (1.98 m) and MC-4500 maximum cover is 7.0' (2.13 m) both including pavement. For installations that do not include pavement, where rutting from vehicles may occur, minimum required cover is increased to 30" (762 mm).
4. The contractor must report any discrepancies with the bearing capacity of the subgrade materials to the design engineer.
5. AASHTO M288 Class 2 non-woven geotextile (ADS601 or equal) (filter fabric) must be used as indicated in the project plans.
6. Stone placement between chamber rows and around perimeter must follow instructions as indicated in the most current version of StormTech MC-3500 / MC-4500 Construction Guide.
7. Backfilling over the chambers must follow requirements as indicated in the most current version of StormTech MC-3500 / MC-4500 Construction Guide.
8. The contractor must refer to StormTech MC-3500 / MC-4500 Construction Guide for a Table of Acceptable Vehicle Loads at various depths of cover. This information is also available at the StormTech website: www.stormtech.com. The contractor is responsible for preventing vehicles that exceed StormTech requirements from traveling across or parking over the stormwater system. Temporary fencing, warning tape and appropriately located signs are commonly used to prevent unauthorized vehicles from entering sensitive construction areas.
9. The contractor must apply erosion and sediment control measures to protect the stormwater system during all phases of site construction per local codes and design engineer's specifications.
10. STORMTECH PRODUCT WARRANTY IS LIMITED. Contact StormTech for warranty information.

9.1 ISOLATOR ROW INSPECTION

Regular inspection and maintenance are essential to assure a properly functioning stormwater system. Inspection is easily accomplished through the manhole or optional inspection ports of an Isolator Row. Please follow local and OSHA rules for a confined space entry.

Inspection ports can allow inspection to be accomplished completely from the surface without the need for a confined space entry. Inspection ports provide visual access to the system with the use of a flashlight. A stadia rod may be inserted to determine the depth of sediment. If upon visual inspection it is found that sediment has accumulated to an average depth exceeding 3" (76 mm), cleanout is required.

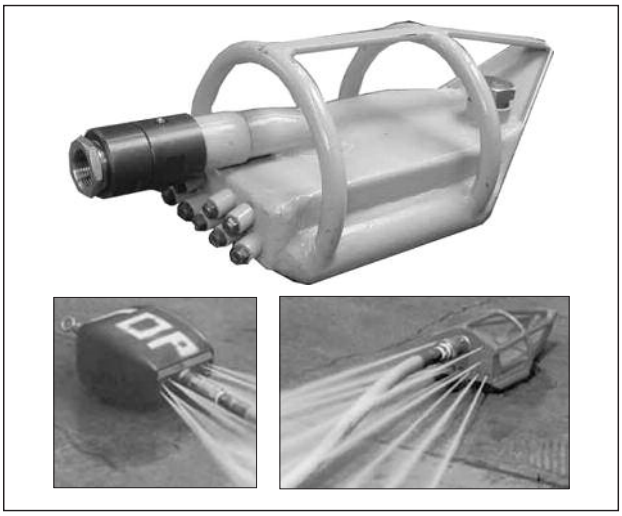
A StormTech Isolator Row should initially be inspected immediately after completion of the site's construction. While every effort should be made to prevent sediment from entering the system during construction, it is during this time that excess amounts of sediments are most likely to enter any stormwater system. Inspection and maintenance, if necessary, should be performed prior to passing responsibility over to the site's owner. Once in normal service, a StormTech Isolator Row should be inspected bi-annually until an understanding of the sites characteristics is developed. The site's maintenance manager can then revise the inspection schedule based on experience or local requirements.

9.2 ISOLATOR ROW MAINTENANCE

JetVac maintenance is recommended if sediment has been collected to an average depth of 3" (76 mm) inside the Isolator Row. More frequent maintenance may be required to maintain minimum flow rates through the Isolator Row. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, a wave of suspended sediments is flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/ JetVac combination vehicles. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" (1143 mm) are best. The JetVac process shall only be performed on StormTech Rows that have AASHTO class 1 woven geotextile over their foundation stone (ADS 315WTM or equal).

Looking down the Isolator Row.

A typical JetVac truck. (This is not a StormTech product.)



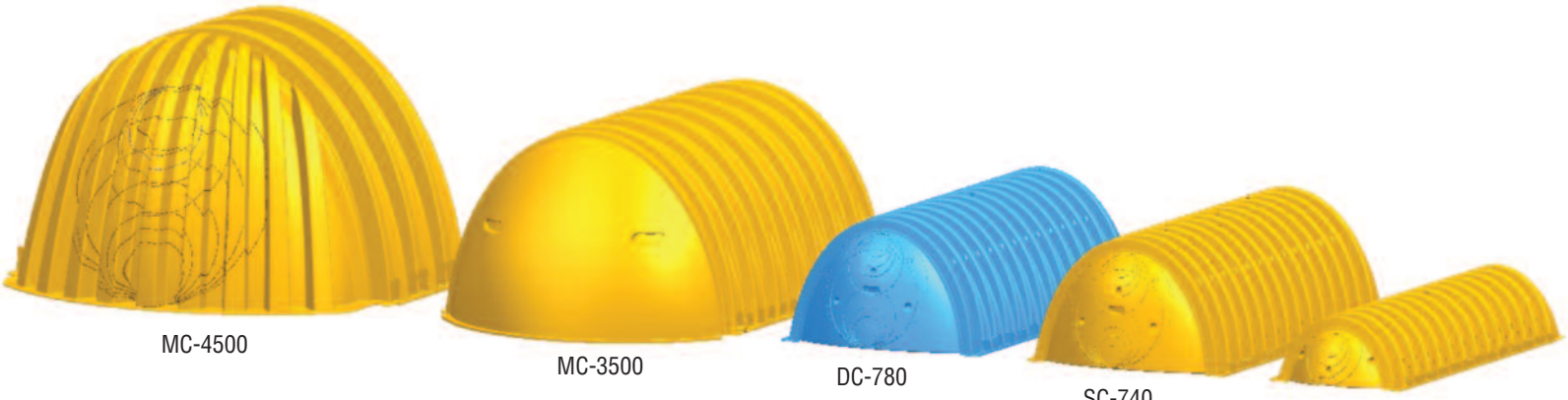
Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

A Family of Products and Services for the Stormwater Industry:

- MC-3500 and MC-4500 Chambers and End Caps
- SC-310 and SC-740 Chambers and End Caps
- DC-780 Chambers and End Caps
- Fabricated End Caps
- Fabricated Manifold Fittings
- Patented Isolator Row for Maintenance and Water Quality
- Chamber Separation Spacers
- In-House System Layout Assistance
- On-Site Educational Seminars
- Worldwide Technical Sales Group
- Centralized Product Applications Department
- Research and Development Team
- Technical Literature, O&M Manuals and Detailed CAD drawings all downloadable via our Web Site

StormTech provides state of the art products and services that meet or exceed industry performance standards and expectations. We offer designers, regulators, owners and contractors the highest quality products and services for stormwater management that "Saves Valuable Land and Protects Water Resources."

Please contact one of our inside project application professionals or Engineered Product Managers (EPMs) to discuss your particular application. A wide variety of technical support material is available in print, electronic media or from our website at www.stormtech.com. For any questions, please call StormTech at 888-892-2694.



MC-4500 MC-3500 DC-780 SC-740 SC-310

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ADS "Terms and Conditions of Sale" are available on the ADS website, www.ads-pipe.com.
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StormTech® and the Isolator® Row are registered trademarks of StormTech, Inc.
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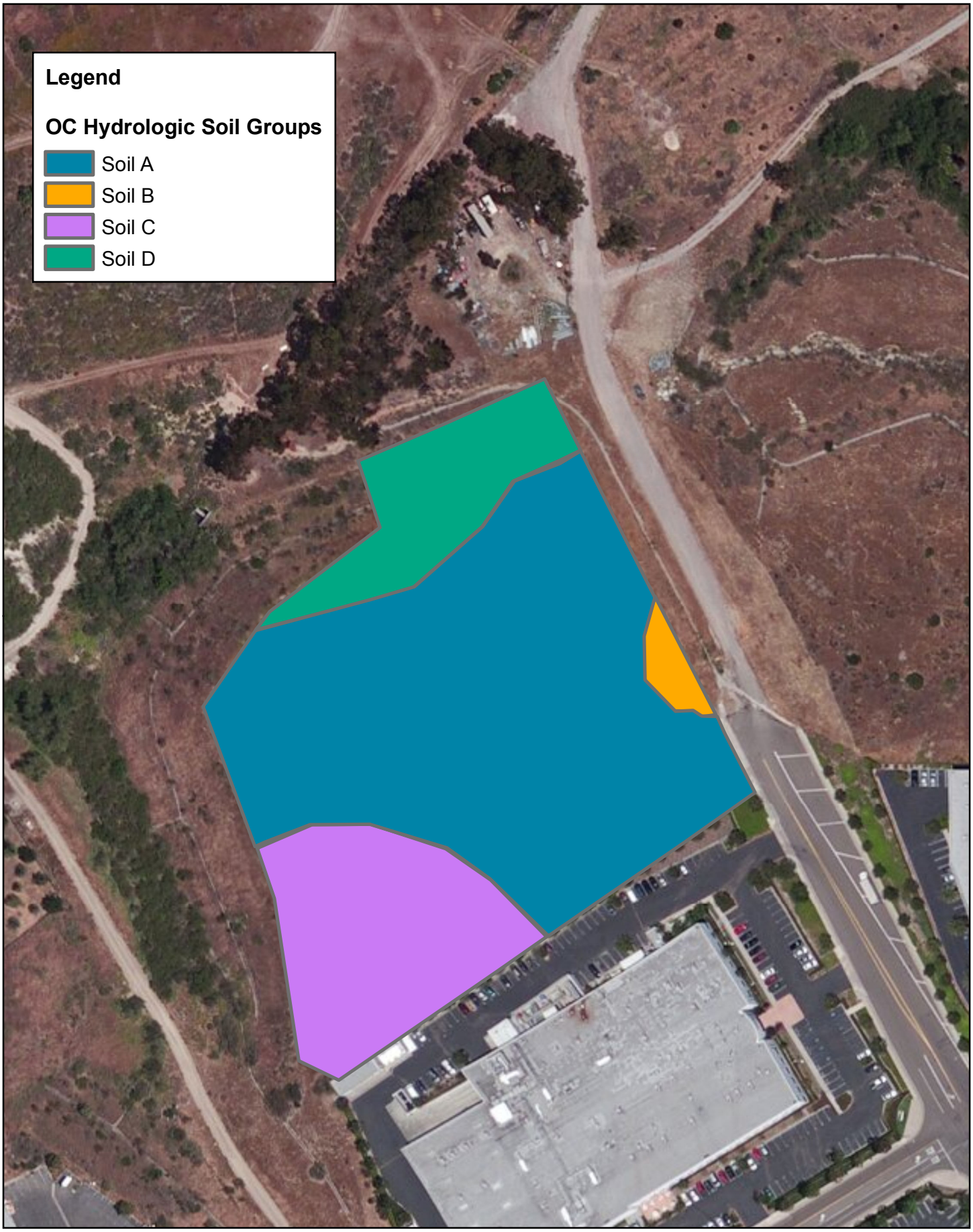
Appendix C:

Conditions of Approval

(to be submitted with Final WQMP)

Appendix D:

Soils Information



RBF CONSULTING A Baker Company

N 0 75 150 Feet

Source:

Commercentre Drive Drainage Study

Soils Map

Figure 5

Appendix E:

Storm Drain Stencil

NO DUMPING
THIS DRAINS TO OCEAN

Appendix F:

Operations and Maintenance

StormTech®

Detention • Retention • Water Quality

Subsurface Stormwater Management℠

Save Valuable Land and Protect Water Resources

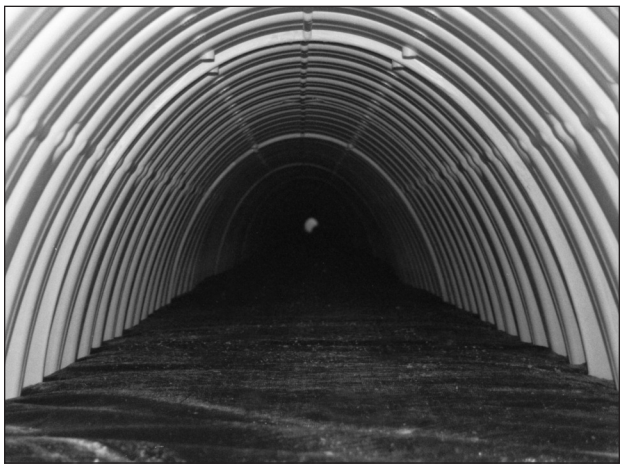
Isolator™ Row O&M Manual

StormTech® Chamber System for Stormwater Management

1.0 The Isolator™ Row

1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.



Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

1.2 THE ISOLATOR™ ROW

The Isolator Row is a row of StormTech chambers, either SC-310, SC-740, DC-780 or MC-3500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

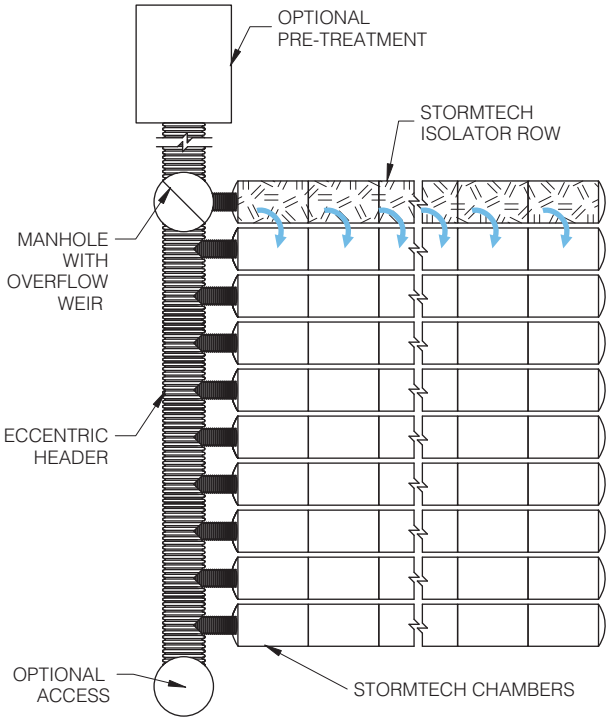
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



2.0 Isolator Row Inspection/Maintenance

2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

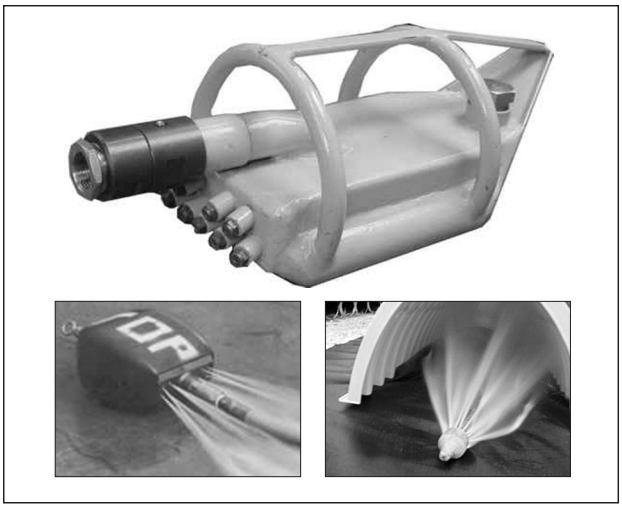
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

2.2 MAINTENANCE

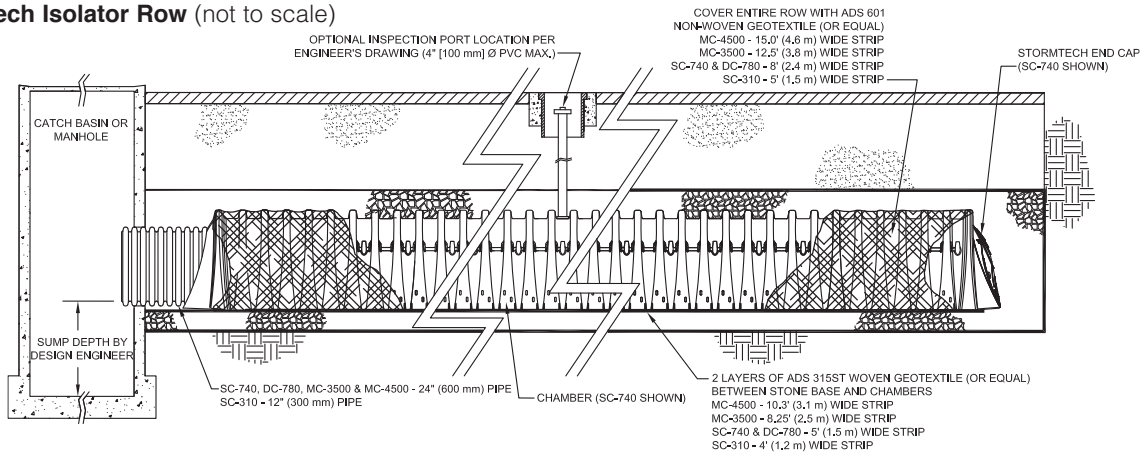
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



Note: For many applications, the non-woven geotextile over the DC-780, MC-3500 and MC-4500 Isolator Row chambers can be eliminated or substituted with the AASHTO Class 1 woven geotextile. Contact your StormTech representative for assistance.

3.0 Isolator Row Step By Step Maintenance Procedures

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.

iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.

B) All Isolator Rows

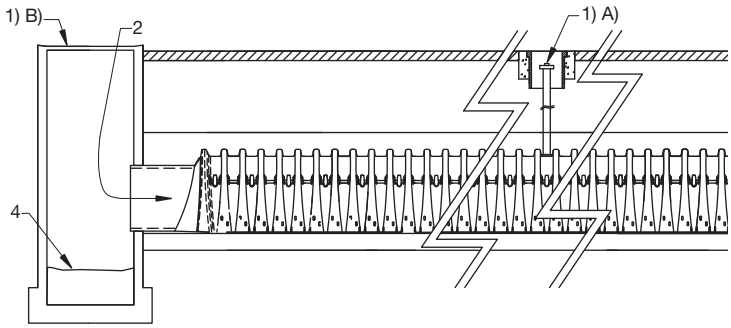
i. Remove cover from manhole at upstream end of Isolator Row

ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Mirrors on poles or cameras may be used to avoid a confined space entry
2. Follow OSHA regulations for confined space entry if entering manhole

iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

StormTech Isolator Row (not to scale)



Step 2) Clean out Isolator Row using the JetVac process

A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable

B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers, record observations and actions

Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

Sample Maintenance Log

Date	Stadia Rod Readings		Sediment Depth (1) - (2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/01	6.3 ft.	none		New installation. Fixed point is CI frame at grade	djm
9/24/01		6.2	0.1 ft.	Some grit felt	sm
6/20/03		5.8	0.5 ft.	Mucky feel, debris visible in manhole and in Isolator row, maintenance due	rv
7/7/03	6.3 ft.		0	System jetted and vacuumed	djm

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StormTech products are covered by one or more of the following patents: U.S. Patents: 5,401,459; 5,511,903; 5,716,163; 5,588,778; 5,839,844; Canadian Patents: 2,158,418 Other U.S. and Foreign Patents Pending Printed in U.S.A.

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OPERATION & MAINTENANCE PLAN
FOR UNDERGROUND INFILTRATION SYSTEMS

1. REMOVAL OF DEBRIS:

Sediment and debris (litter, leaves, papers and cans, etc.) within the area, especially around the drainage inlet, shall be collected and removed monthly at a minimum and whenever landscaping takes place. Surface drains and pipes/leach lines will be cleaned out annually at a minimum, typically before the rainy season begins, which will efficiently and effectively remove pollutants from entering the receiving waters.

Removal of debris from within the infiltration chamber shall be done every 2 to 3 years or as needed. If ponding persists beyond 72 hours after a storm event then the invert shall be cleaned and all debris shall be removed to allow for proper drainage.

2. REGULAR INSPECTIONS:

Surface inlets and chambers will be inspected twice a year to determine the frequency of sediment and debris removal. The sump chamber will also be checked for hydrocarbon and oil contamination or clogging as well as the need to re-paint stencils during the biannual inspections.

Post storm event inspections are necessary to avoid vector breeding. If water remains ponded for more than 72 hours after a storm event corrective action shall take place immediately. A list of corrective actions includes but is not limited to: removal of sediment and debris from invert of the system, pump and drain ponded water, remediate subsurface soil, improve invert of system to allow for more drainage, or contact vector control.

3. CONDUCT VISUAL INSPECTION:

If ponded water or excessive trash, debris, or sediment persists, surface inlets, clean outs, pipes, and aqueducts should be visually inspected as deemed necessary in order to keep the system and the surrounding area clear of all sediment and trash.

4. MAINTENANCE LOG:

Keep a log of all inspections and maintenance performed on the system and its components. Keep this log on-site or with the owner. A blank log has been provided at the end of this Appendix to facilitate this process.

5. FOR MORE INFORMATION:

If the device fails to infiltrate within 72 hours the invert should be drained, cleaned, and inspected to determine what needs to be repaired and replaced. For technical questions and maintenance procedures contact device manufacturer or geotechnical engineer.

Overflow risers or structures should be inspected monthly during the wet season and repaired as needed.

BMP Inspection Log

BMP: _____

Date	Maintenance Performed	Re-Inspection Date	Comments