Conceptual
Low Impact Development (LID)
Plan

For:

Hacienda Industrial
333 Hacienda Boulevard
Industry, CA 91744

CITY PERMIT NO. _____

Prepared for:
Chamber Equity Group
7901 Crossway Drive
Pico Rivera, CA 90660
Phone (562) 948-4850
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Prepared by:
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November 5, 2014

SAMPLE

OWNER'S CERTIFICATION

LOW IMPACT DEVELOPMENT PLAN

FOR PERMIT/PLANNING APPLICATION NUMBER _____

& TRACT/PARCEL MAP NUMBER _____

This Low Impact Development (LID) Plan has been prepared for Chamber Equity Group (CEG) by CNC Engineering. The LID is intended to comply with the requirements of the City of Industry, Planning Division, Conditional Use Permit (CUP _____) requiring the preparation of a Low Impact Development 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 County of Los Angeles requirements and the intent of the non-point source NPDES Permit for Waste Discharge Requirements for the County of Los Angeles, Los Angeles County Flood Control District and the incorporated Cities of Los Angeles County within the Los Angeles Region Stormwater Runoff Management Program. Once the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement and amend the LID. An appropriate number of approved and signed copies of this document shall be available on the subject site in perpetuity.

Signed:	***See Attachment E for Signed Master Covenant and Agreement***
Name:	TBD
Title:	Owner
Company:	Chamber Equity Group
Address:	7901 Crossway Drive, Pico Rivera, CA 90660
Telephone #:	(562) 948-4850
Date:	_____

Contents

Section I Discretionary Permit(s) and Water Quality Conditions

The following is a list of the Discretionary Permit (s) related to this project:

City of Industry Building Department Permit Number _____

The City of Industry requires the preparation and implementation of a Low Impact Development (LID) Plan.

Master Covenant and Agreement Regarding On-site Stormwater Treatment Devices Maintenance (See Attachment E for copy of this agreement)

Section II Project Description

Location:
The Chamber Equity Group (CEG) proposes to construct a warehouse and office facility on approximately 9.43 acres of property located at 333 Hacienda Boulevard, in the City of Industry. The site is bounded by Valley Boulevard to the north, existing commercial/industrial facilities on private property on the west and south, and Hacienda Boulevard on the east. Figures 1 and 2 show the location and vicinity maps of the project.

Project Components:
The proposed development, Hacienda Industry, primary function is a warehouse and office concrete tilt-up building. The project site will consists of one (1) main building, that is separated into two (2) units, with a total area of 206,000 SF. Unit A consists of a 2,600 SF mezzanine/office area with a 47,500 SF warehouse area. Unit B consists of a 12,000 SF mezzanine/office area and a 144,500 Sf warehouse area. A loading dock area will be located along wth west side of the building and will serve both units. In addition, each unit will have separate parking areas for employees and visitors.

This project is a Designated Project, as defined by theCounty of Los Angeles Department of Public Works Low Impact Development Standards Manual, dated February 2014 for the following reasons:

- All development projects equal to one acre or greater of disturbed area and adding more than 10,000 square feet of impervious surface area;

- Parking lots with 5,000 square feet or more of impervious surface area, or with 25 or more parking spaces and

- Redevelopment projects, which are developments that result in creation or addition or replacement of 5,000 square feet or more of impervious surface on a site that was previously developed as described in the above bullets.

Site Activities:
Activities at Hacienda Industy will consists mainly of transporting goods to and from the project site via semi-trailer trucks, along with storage of good within the warehouse area. It is not know at this time the nature of busniess, nor the type of goods that will be warehoused onsite. Table 1 below list the potential pollutants of concern for thise project and associated activities.

Table 1-Activity and Associated Pollutants of Concern

Anticipated Activity	Associated Pollutants	Location on Site Map
Import and Export of Goods	Oil, Grease, Metals, Trash	Loading Dock on the West side of building
Employee Arrival and Departures from site	Oil, Grease, Metals, Trash	Entrances and parking lots on east and north along Hacienda Blvd and Valley Blvd, respectively.
Landscape and Irrigation Maintenance	Fertilizers, Pesticides and Herbicides	Located along the perimeter of the site and adjacent to the building.
Trash Enclosure	Trash	TBD

Table 1 above describes the associated pollutants of concern in relation to the various industrial activities anticipated to occur on this project site. This project is subject to the provisions in Los Angeles Regional Water Quality Control Board (LARWQCB) Order R4-2012-0175, Attachment P for the San Gabriel River Watershed Metals and Selenium TMDLs for Lead and Selenium. Order R4-2012-0175 and associated reference documents can be found at the following website: http://www.waterboards.ca.gov/rwqcb4/water_issues/programs/stormwater/municipal/index.shtml

The drainage from the project site ultimately drains to the San Jose Creek and then to San Gabriel River, Reach 2. Per in Los Angeles Regional Water Quality Control Board (LARWQCB) Order R4-2012-0175, Attachment K and P for the San Gabriel River Watershed Metals and Selenium TMDLs for Lead and Selenium.

Section III Site Description

Site Characteristics:

The proposed Hacienda Industry site is located at 333 Hacienda Boulevard, in the City of Industry. The site is bounded by Valley Boulevard to the north, existing commercial/industrial facilities on private property on the west and south, and Hacienda Boulevard on the east. The project site is generally rectangular in shape except for a small rectangular shaped parcel located on the northeast corner of the site. This is a separate parcel and not part of this project. The site is approximately 9.43 acres. The site has a frontage of 435' along Valley Boulevard and 350' along Hacienda Boulevard. The site will be accessed by two (2) proposed driveways on Valley Boulevard and one (1) off of Hacienda Boulevard. Figures 1 and 2 show the location and vicinity maps of the project.

The property currently is zoned M and has a land use designation of 'General Industrial'.

The project site consists mainly of building, paved and landscaped areas. The impervious areas, such as buildings and paved areas comprised 86% of the site, while the remaining 14% is pervious or landscaped area. A majority of the landscape area is located along the property lines and acts as a setback or buffer with adjacent properties. Table 2 below describes the breakdown of impervious area per Tributary Drainage Area

Table 2 - Impervious Area Hardscape Materials

Tributary Drainage	Total Area	Percent Impervious	Type/Material of Hardscape

Areas	(AC)		
A-1	0.90	96%	Curbs, Gutters and PCC Pavement
A-2	0.94	32%	Curbs, Gutters and PCC Pavement
A-3	0.06	100%	Building Roof
A-4	0.03	57%	Curbs, Gutters and PCC Pavement
A-5	0.88	100%	Building Roof
A-6	0.22	49%	Curbs, Gutters and PCC Pavement
A-7	0.64	100%	Building Roof
A-8	1.04	100%	Building Roof
A-9	0.62	65%	Curbs, Gutters and PCC Pavement
A-10	0.61	100%	Building Roof
A-11	0.72	90%	Curbs, Gutters and PCC Pavement
A-12	0.51	75%	Curbs, Gutters and PCC Pavement
A-13	0.86	97%	Curbs, Gutters and PCC Pavement
A-14	1.03	100%	Building Roof
A-15	0.34	1%	Misc Concrete

Drainage Characteristics:

Currently, a majority (85%) of the site drains to an existing onsite storm drain system that is connected to an existing 48" RCP storm drain located in Hacienda Boulevard. The remaining portion (15%) of the site sheet flows toward the northeast corner of the property and onto Valley Boulevard.

The 48" RCP storm drain in Hacienda Boulevard run south and connects to San Jose Creek. While the runoff that sheet flows onto Valley Boulevard travels west via a curb and gutter, then westerly along Proctor Avenue before entering a catch basin located at the southwest corner of Proctor Avenue and Turnbull Canyon Road. The catch basin is connected to an existing 69" RCP storm drain that runs south and connects to San Jose Creek.

The proposed drainage generally follows the existing drainage patterns with 70% draining to the existing onsite system that connects to the existing 48" RCP in Hacienda and the remaining 30% will sheet flow onto Valley and follow the same flow route as the existing condition. LID Plans (Figure No. 4) shows the proposed drainage patterns. Table 3 below shows the proposed BMP's in relation to the Tributary Drainage Areas.

Table 3 - BMP Designation Table

BMP Designation No.	BMP Description	Tributary Drainage Management Areas (DMA's)
1	Biofiltration Basin	A-1, A-8 & A-15
2 & 3	Catch Basin/Media Filtration Device (2 Total)	A-11
4 & 5	Planter Filtration Box (2 Total)	A-10 (Partial)

6	Vegetated Swale	A-12(Includes portion of A-10)
7 & 8	Planter Filtration Box (2 Total)	A-7 (Partial)
9	Vegetated Swale	A-9 (Includes portion of A-7)
10, 11 & 12	Planter Filtration Box (3 Total)	A-5
13	Vegetated Swale	A-4 & A-6
14	Vegetated Swale	A-2, A-3, A-13 & A-14

The BMP's described in the table above are to be designed to capture and retain the Stormwater Quality Design Volume (SWQDv). The SWQDv is defined as:

- The 0.75-inch, 24-hour rain event or
- The 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map, whichever is greater.

See Attachment A for the calculation associated with each of the BMPs listed above.

SWQDv's were calculated using the County of Los Angeles Department of Public Works HydroCalc software. A copy of the input spreadsheet and output has been included in Attachment A. The values generated by HydroCalc are for infiltration. Treatment values were calculated to be 1.5 times the infiltration values.

Section IV Best Management Practices (BMPs)

A. Source Control BMPs

The following table shows source control BMPs (routine non-structural and routine structural) included in this project and those that were not included.

Routine Non-Structural BMPs

Identifier	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
N1	Education for Property Owners, Tenants and Occupants	X		
N2	Activity Restrictions	X		
N3	Common Area Landscape Management	X		
N4	BMP Maintenance	X		
N5	Title 22 CCR Compliance (How development will comply)		X	It is not anticipated that hazardous materials will be maintained on-site
N6	Local Industrial Permit Compliance		X	Warehouse does not require an industrial permit.
N7	Spill Contingency Plan	X		
N8	Underground Storage Tank Compliance		X	No underground storage tanks are part of project.
N9	Hazardous Materials Disclosure Compliance		X	It is not anticipated that hazardous materials will be maintained on-site
N10	Uniform Fire Code Implementation		X	It is not anticipated that hazardous materials will be maintained on-site
N11	Common Area Litter Control	X		
N12	Employee Training	X		
N13	Housekeeping of Loading Docks	X		
N14	Common Area Catch Basin Inspection	X		
N15	Street Sweeping Private Streets and Parking Lots	X		
N16	Commercial Vehicle Washing		X	The project is for warehouse space, no facilities will be included.
N17	Commercial Vehicle Fueling		X	The project is for warehouse space, no facilities will be included.
N18	Commercial Vehicle Maintenance		X	The project is for warehouse space, no facilities will be included.

Best Management Practices (BMPs) are construction and post-construction devices and procedures which when implemented and followed, should reduce or eliminate the infiltration of the pollutant into the storm water system.

Non-Structural BMP's:

N1 – Education for Property Owners
N2 – Activity Restrictions
N3 – Common Area Landscape Management Plan
N4 – BMP Maintenance
(N5) – Title 22 CCR Compliance
(N6) – Local Industrial Permit Compliance
N7 – Spill Contingency Plan
(N8) – Underground Storage Tank Compliance
(N9) – Haz-Mat Disclosure Compliance
(N10) – Uniform Fire Code Implementation
N11 – Common Area Litter Control
N12 – Employee Training
N13 – Housekeeping of Loading Docks
N14 – Catch Basin Inspection
N15 – Street Sweeping Private Streets and Parking Lots
(N16) – Commercial Vehicle Washing
(N17)- Commercial Vehicle Fueling
(N18) – Commercial Vehicle Maintenance

( ) BMPs not applicable to this project

Structural BMPs:

S1 – Filtration
S2 – Common Area Efficient Irrigation
S3 – Common Area Runoff-Minimizing Landscape Design
(S4) – Community Car Wash Racks
(S5) – Wash Water Controls for Food Preparation Areas
S6 – Waste Management (Trash Dumpster) Areas
(S7) – Self Contained Washing
(S8) – Outdoor Storage
(S9)-Motor Fuel Concrete Dispensing Areas
(S10)- Motor Fuel Dispensing Area Canopy
(S11)- Motor Fuel Dispensing Area Interruptible Drainage
(S12) – Energy Dissipaters
S13 – Catch Basin Stenciling
(S14) – Diversion of Loading Dock Drainage
S15 – Inlet Trash Racks
S16 – Water Quality Inlets
S17 – Stormwater Filters
S18 – Vegetated Swale
S19 – Planter Boxes
S20 – Biofiltration Basin
S21 – Porous/Permiable Pavement

( ) BMPs not applicable to this project

All BMPs selected should be implemented properly and maintained in good working condition for the duration of the life of the BMP (during construction or post-construction).

Non-structural Measures

N1 - Education for Property Owners, Members and Employees
Practical informational materials will be provided to employees on general good housekeeping practices that contribute to protection of storm water quality. Among other things, these materials will describe the use of chemicals (including household type) that should be limited to the property, with no discharge of specified wastes via hosing or other direct discharge to gutters, catch basins and storm drains. CEG will provide these materials through an education program. This program must be maintained, enforced, and updated periodically by CEG. Educational materials including, but not limited to, the materials included in Section VII of this plan will be made available to the employees, members and occupants periodically thereafter.

N2 - Activity Restrictions
Activities on this site will be limited to activities related to the transfer of solid waste.

N3 - Common Area Landscape Management
Management programs will be designed and established by CEG who will maintain the common areas within the project site. These programs will include how to mitigate the potential dangers of fertilizer and pesticide usage (refer to the Maintenance and Frequency Table). Ongoing maintenance will be consistent with the State of California Model Water-Efficient Landscape Ordinance.

N4 - BMP Maintenance
CEG will be responsible for implementing each of the BMPs detailed in this plan. CEG will also be responsible for cleaning and maintaining the BMPs on a regular basis.

N7 – Spill Contingency Plan
CEG will prepare and maintain onsite a spill contingency plan to be implemented in the event of a spill of hazardous materials onsite.

N11 - Common Area Litter Control
CEG will be required to implement waste management and litter control procedures in the common areas aimed at reducing pollution of surface runoff. CEG may also contract with their landscape maintenance firm to provide this service during regularly scheduled maintenance, which should consist of litter patrol, to prevent emptying of waste receptacles in common areas, and noting waste disposal violations and reporting the violations to CEG for investigation.

N12 – Employee Training
An employee training program will be established as it would apply to future employees and contractors of CEG to inform and train all engaged in maintenance activities regarding the impact of dumping oil, paints, solvents, or other potentially harmful chemicals into storm drains; the proper

use of fertilizers and pesticides in landscaping maintenance practices; and the impacts of littering and improper waste disposal.

N13 – Housekeeping of Loading Docks
Runoff from the loading dock area will be directed toward either the biofiltration basin near the SW corner of the property or the vegetated swale along the northerly frontage of the property.

N14 - Catch Basin Inspection
CEG will be required to have at least 80 percent of the catch basins and inlets inspected, cleaned and maintained on an annual basis and 100 percent of the basins and inlets included in a two-year period. Cleaning should take place in the late summer/early fall prior to the start of the rainy season.

N15 - Street Sweeping Private Streets and Parking Lots
CEG shall have parking lots swept prior to the storm season, in late summer and early fall, prior to the start of the rainy season, as defined by the city of Industry.

Structural BMPs

Structural BMPs shall be installed by CEG, through the construction and development of the project. The structural BMPs used for this project are summarized below:

S1 - Filtration
As part of the design of all common areas, surface runoff shall be directed toward landscaped areas wherever practicable and as shown on the approved grading plans. The roof drains on the transfer and office buildings will be collected in an underground storm drain pipe and discharged into an infiltration trench. The roof drains for the maintenance building will be allowed to discharge onto the adjacent landscape area and subsequently be treated in a vegetated swale, located along the eastern property line. See Attachment B for additional information. Such common areas will be maintained by CEG.

S2 - Common Area Efficient Irrigation (SD-12)
As part of the design of all common area landscape irrigation, implementation of, but not limited to, such provisions as water sensors, programmable irrigation times (for short cycles), etc., will be used. Such common areas will be maintained by CEG. For additional BMP description, see Section IV.B, *SD-12: Effective Irrigation*.

S3 - Common Area Runoff-Minimizing Landscape Design (SD-10)
As part of the design of all common area landscape areas, similar planting material with similar water requirements will be used in order to reduce excess irrigation runoff and promote surface filtration. Such common areas will be maintained by CEG. For additional BMP description, see Section IV.C, *SD-10: Site Design and Landscape Planning*.

S6 – Waste Management (Trash Dumpster) Areas (SD-32)
The proposed Waste Management Area will have a screen wall surrounding three (3) sides and an access gate along the front. The waste collection containers will be kept covered. The floor slab of the enclosure will slope, at a minimum of 1%, so no water will collect within the enclosure. See

architectural plans for details of Waste Management Area enclosure. For additional BMP description, see Section IV.B, *SD-32: Trash Enclosures*.

S13 - Catch Basin Stenciling (SD-13)
All proposed catch basins and inlets will have either a stencil and/or placard with verbiage conforming to city of Los Angeles requirements and as shown in Section IV.B. CEG will maintain the stenciling and labels. For additional BMP description, see Section IV.B, *SD-13: Storm Drain System Signs*.

S15 - Inlet trash racks
All proposed catch basins will have catch basin inserts installed in addition to protection bars to collect debris and litter prior to entering the on-site storm drain system.

S16 – Water Quality Inlets
As part of this project, stormwater filtration devices will be installed at two (2) locations. The locations will correspond to the downstream end of the run-off from area A-11 to treat the stormwater run-off for the 'first flush' amount and collect any debris. For additional information on the stormwater filtration devices, see Attachment C.

S17 – Stormwater Filters (MP-40)
The purpose of this BMP is to provide for treatment of low-flow or 'first flush' runoff prior to discharge into existing off-site storm drain facilities. A proprietary system (Modular Wetlands or approved equal) is being proposed for treating runoff from this site. See Attachment C for additional information. For additional BMP description, see Attachment B, *MP-40: Media Filters*.

S18 – Vegetated Swale
The project proposed to construct three (3) vegetated swales to treat the runoff from the site. Two of the swales are located along the easterly frontage of the project and the other is along the northerly frontage. Each swale shall be design to conform to the requirements in Attachment H of Los Angeles Regional Water Quality Control Board (LARWQCB) Order R4-2012-0175. In addition, each swale shall be inspected for vector issues. See Figure No. 6 for frequency of inspections for vector issues.

S19 – Planter Boxes (Flow-Thru Planters)
The purpose of this BMP is to collect a portion of the run-off from the surface and the roof area and treat it prior to discharge into the on-site storm drain. The Flow-Thru Planters allow run-off to be collected in a contained manner, filtered through a series of materials and collected in a perforated pipe to be connected to the on-site storm drain. These planters will have an impermeable liner or structure to avoid groundwater to seep into the planter. See LID Layout Plans for the location and typical section detail.

S20 – Biofiltration Basin (TC-32)
As part of the project, one (1) biofiltration basin will be constructed to allow runoff from a portion of the roof and surrounding paved area to be filtered through a series of materials and collected in a perforated pipe to be connected to the on-site storm drain. As part of the trench, an riser pipe with constructed to allow for overflow. The riser pipe will be connected to the on-site storm drain system.

S21 - Pervious/Porous Pavements (SD-20)
The purpose of this BMP is to integrate and incorporate porous pavement/pavers as both a decorative element while providing an opportunity to allow a portion of runoff to be treated. The design of the porous pavement/pavers will be so that run-off will filter through a series of materials before being collected in a perforated pipe and then connected to the on-site storm drain. An impermeable barrier will be placed at the bottom of the pavement section to avoid groundwater from seeping up into the pavement structure and being collected in the perforated pipe. See LID Layout Plans for the location and typical section detail. For additional BMP description, see Attachment B, *SD-20: Pervious Pavement.*

B. Addition Source Control BMP's Information

SD-12: Effective Irrigation
Design of an effective irrigation system will reduce the amount of runoff from excess irrigation water into the storm drain system.

The system design will incorporate the use of a centralized evapotranspiration based irrigation controllers, rain shutdown devices, master valves, and low precipitation spray heads. The system will have the ability to run multiple programs with cycle and soak to prevent run-off, and emergency shut-off devices for excessive flow conditions to minimize water waste. The design will comply with the State Ordinance AB325 and city of Industry requirements for water conservation.

SD-13: Storm Drain System Signs
The use of stencil's and signs to alert the public to the destination of pollutants allowed to flow into the storm drain system.

This project will use catch basins and grate inlets to collect surface runoff from the parking lot areas and direct it in pipes to the existing storm drain system located south of the project site. At each of these grate inlets, a placard will be placed with the message "NO DUMPING – DRAINS TO OCEANS" on it, see Section IV.B for sample.

C. Site Design BMPs

Site design BMPs must be considered in all Priority Projects and should be considered for all projects. Indicate in the following table the type of site design BMPs included in the project. The following table shows site design BMPs that are included in this project. A description of each BMPs follows:

Site Design BMPs

Technique	Included?	Brief Description of Method

	Yes	No	
Minimize Impervious Area/Maximize Permeability (C-Factor Reduction)	X		The proposed vegetated swale will also be used to treat a portion of the surface runoff.
Minimize Directly Connected Impervious Areas (DCIAs) (C-Factor Reduction)		X	
Create Reduced or "Zero Discharge" Areas (Runoff Volume Reduction)	X		The vegetated swales located along the frontage of the property will also be used to treat storm water.
Conserve Natural Areas (C-Factor Reduction)		X	

SD-10: Site Design and Landscape Planning
The purpose of this BMP is to integrate and incorporate landscaping elements in an effective manor to reduce the amount of surface runoff of storm water to underground storm drain facilities.

D. Additional Site Design Objectives

The following guidelines address specific concerns highlighted by the Regional Water Quality Control Boards and should be implemented if applicable to the proposed project:

- Run-off from the roof will be collected in either planter boxes, biofiltration basins or vegetated swales to be treated prior to discharge into an on-site underground storm drain system.

E. Treatment Control BMPs

The following table shows treatment BMPs that are included in this project. A description of each BMP follows:

Treatment Control BMPs

Name	Included?		If not applicable, state brief reason
	Yes	No	
Vegetated (Grass) Strips		X	Project site not large enough to justify BMP due to parking demand.

Vegetated (Grass) Swales	X		
Proprietary Control Measures	X		
Dry Detention Basin		X	Project site not large enough to justify BMP due to parking demand.
Wet Detention Basin		X	Could not be sustained
Constructed Wetland		X	Could not be sustained
Detention Basin/Sand Filter		X	Project site not large enough to justify BMP due to parking demand.
Porous Pavement Detention	X		
Porous Landscape Detention	X		
Infiltration Basin		X	Existing soils condition does not allow for infiltration.
Infiltration Trench		X	Existing soils condition does not allow for infiltration.
Media Filter	X		
Proprietary Control Measures	X		

Vegetated Swale (TC-30)/Bioretention (TC-32)
The purpose of this BMP is to provide for treatment of low-flow or 'first flush' runoff prior to discharge off-site. The Vegetated Swales will also be used as a bioretention BMP. This project is proposing to install three (3) of these BMP's Two (2) will be located along the eastern frontage of the site. The other will be located along the northern frontage of the project site in the landscape setback area. See LID Layout Plans for the location and typical section detail. The design is based on both the Stormwater Quantity Design Flow (SQDF) and Stormwater Quantity Design Volume (SQDV).

Media Filtration Device
The purpose of this BMP is to collect a portion of the run-off within the industrial activities areas and pre-treat the run-off prior to being allowed to infiltrate into the ground. The project proposes to install two (2) proprietary system devices (Modular Wetlands or approved equal). See Attachment C for additional information. See LID Layout Plans for the locations for these devices. The design is based on both the Stormwater Quantity Design Flow (SQDF) and Stormwater Quantity Design Volume (SQDV).

Section V Inspection/Maintenance Responsibility for BMPs

Chambers Equity Group (CEG) at 7901 Crossway Drive, Pico Rivera, CA 90660 (562) 948-4860 will be responsible for the inspection, employ/implementation of maintenance of the BMPs detailed herein, this includes;

Non-Structural Measures:

- N1 – Education for Property Owners
- N2 – Activity Restrictions
- N3 – Common Area Landscape Management Plan
- N4 – BMP Maintenance
- N7 – Spill Contingency Plan
- N11 – Common Area Litter Control
- N12 – Employee Training
- N13 – Housekeeping of Loading Docks
- N14 – Catch Basin Inspection
- N15 – Street Sweeping Private Streets and Parking Lots

Structural BMPs:

- S1 – Filtration
- S2 – Common Area Efficient Irrigation
- S3 – Common Area Runoff-Minimizing Landscape Design
- S6 – Waste Management (Trash Dumpster) Area
- S13 – Catch Basin Stenciling
- S15 – Inlet Trash Racks
- S16 – Water Quality Inlets
- S17 – Stormwater Filters
- S18 – Vegetated Swale
- S19 – Planter Boxes
- S20 – Biofiltration Basin
- S21 – Porous/Permiable Pavement

Figures No. 5 and 6 detailing the maintenance and frequency of maintenance are included at the end of this text. CEG will be providing ongoing funding for operation and maintenance of the BMP's described herein.

Section VI Location Map, Plot Plan & BMP Details

The following is a list of the figures used as part of this SUSMP:

Figure No. 1: Location Map
Figure No. 2: Project Site and Vicinity Map
Figure No. 3: Site Plan
Figure No. 4: LID Layout Plans (2 Sheets)
Figure No. 5: Non-structural BMP Maintenance Responsibility/Frequency Matrix
Figure No. 6: Structural BMP Maintenance Responsibility/Frequency Matrix

Section VII Educational Materials Included

The following is a list of educational materials included in this SUSMP.

- The Ocean begins at your front door
- A Guide to the Disposal of Water-Based Cleaners
- Additional Educational Material can be found at the following City of Los Angeles website: http://www.lacity.org/SAN/wpd/Siteorg/education/edumat.htm

Section VIII
Attachments

Figure NO. 1:
Location Map

J:\Industry K Clone\MiscProj\JN-7446 EWMP Preparation\Documents\Reports\K-mart Site LID Report\LID Figures 1 and 2.dwg

CNC ENGINEERING
255 N. HACIENDA BLVD, SUITE 222
INDUSTRY, CA 91744
PHONE (626) 333-0336
FAX (626) 336-7076
Consulting Civil Engineers and Land Surveyors

LOCATION MAP
LID PLAN
HACIENDA INDUSTRIAL
INDUSTRY, CA

SHEET:	FIG NO. 1
SCALE:	N.T.S.
DATE:	08/12/14
DWG BY:	JC

Figure NO. 2:
Project Site and Vicinity Map

CNC ENGINEERING
255 N. HACIENDA BLVD, SUITE 222
INDUSTRY, CA 91744
PHONE (626) 333-0336
FAX (626) 336-7076
Consulting Civil Engineers and Land Surveyors

VICINITY MAP
LID PLAN
HACIENDA INDUSTRIAL
INDUSTRY, CA

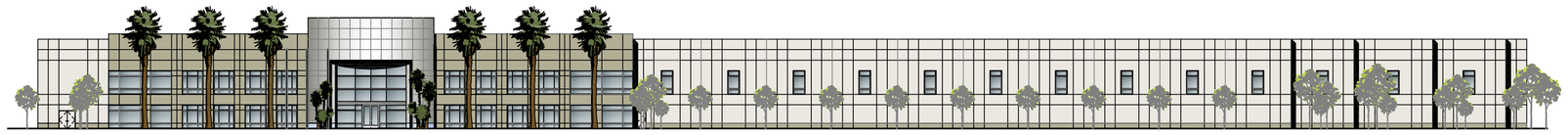
SHEET:	FIG NO. 2
SCALE:	N.T.S.
DATE:	08/12/14
DWG BY:	JC

Figure NO. 3:
Site Plan

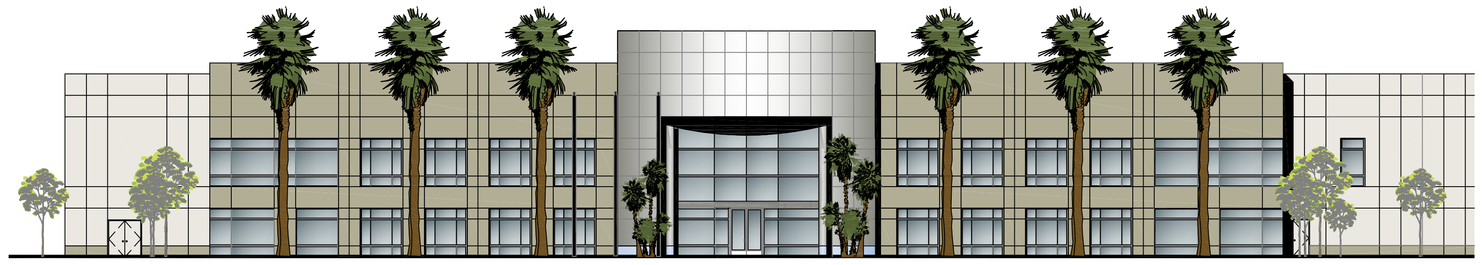
HACIENDA INDUSTRIAL

WAREHOUSE AND OFFICE CONCRETE TILT UP BUILDINGS

333 HACIENDA, CITY OF INDUSTRY, CA



EAST ELEVATION SCALE 1/32" = 1'-0"



PARTIAL EAST ELEVATION SCALE 1/16" = 1'-0"

SITE PLAN SCALE 1/32" = 1'-0"

PROJECT DATA

DESCRIPTION	AREAS
ZONING	M (GENERAL INDUSTRY)
LEGAL DESCRIPTION	POR LOT 1 TR#25279 AND POR RO LA PUENTE P 1-43-44
ASSESSOR'S PARCEL NO:	8208-027-913
BUILDING CODE	CBC 2010
BLDG. OCCUPANCY	B, S-1, F-1
BUILDING TYPE	III-B, FULLY SPRINKLERED
LAND AREA : PARCEL AREA	APROX. 413,678 S.F. (9.50AC)
COVERAGE :	51.22%
ALLOWABLE AREA	50% INCREASED PER REDUCTION OF PROPERTY SIZE
LANDSCAPED AREA	57,800 S.F.
12% MINIMUM REQUIRED	(12.00% - 49,641 S.F.)

BUILDING	BUILDING	LAND AREA
	206,500 S.F.	401,398 S.F.
FIRST FLOOR: WAREHOUSE / OFFICE MEZZANINE: OFFICE	192,000 S.F. 14,500 S.F.	
TRASH ENCL. AREA PROVIDED	525 S.F.	
PARKING REQUIRED : FIRST 25,000 SQ. FEET UP TO 100,000 SQ. FEET OVER 100,000 SQ. FEET	25,000/500 = 50 CARS 75,000/ 750 = 100 CARS 106,500/ 1,000 = 107 CARS	
TOTAL	257 CARS (260 STALLS)	
PARKING PROVIDED: ACCESSIBLE 14' X 19' ACCESSIBLE (VAN) 17' X 19' STANDARD STALLS 9' X 19' COMPACT STALLS 8' X 16' MAX 20% (OF REQ.)	 4 - STALLS 4 - STALLS 257 - STALLS 0 - STALLS	
TOTAL	265- STALLS	
BICYCLE RACK	2	
AREA JUSTIFICATION	UNLIMITED AREA PER SECTION 507BUILDING SURROUNDED BY PUBLIC WAYS OR YARDS WITH A MINIMUM WIDTH OF 60'	

NOT A PART

VICINITY MAP
NOT TO SCALE

ADDRESS:
333 HACIENDA
CITY OF INDUSTRY,CA
PROJECT NO. : A-10-006

OWNER / DEVELOPER:

CHALMERS EQUITY GROUP
7901 CROSSWAY DR.
PICO RIVERA, CA 90660
TEL (562) 948-4850
FAX (562) 948-1735

GENERAL CONTRACTOR:

C.E.G. CONSTRUCTION
7901 CROSSWAY DR. PICO RIVERA, CA 90660
TEL (562)942-9804 FAX (562)948-1735

DESIGN:

O.C. DESIGN & ENGINEERING
7901 CROSSWAY DR. PICO RIVERA, CA 90660
TEL (562)942-9804 FAX (562)948-1735

SITE PLAN
A-1

Figure NO. 4:
LID Layout Plans

VALLEY BOULEVARD

VALLEY BLVD.

HACIENDA BLVD.

HACIENDA

NOT A PART

UNIT A

FOOTPRINT	47,500 S.F.
MEZZANINE	2,500 S.F.
TOTAL AREA	50,000 S.F.

UNIT B

FOOTPRINT	144,500 S.F.
MEZZANINE	12,000 S.F.
TOTAL AREA	156,500 S.F.

BUILDING	206,500 S.F.
FIRST FLOOR: WAREHOUSE / OFFICE	192,000 S.F.
MEZZANINE: OFFICE	14,500 S.F.

PROPOSED BLDG PAD=320.65

MEZZANINE 2,500 S.F.

F.F. OFFICE W/ 12,000 S.F. MEZZANINE

2,000 S.F. STORAGE

14,200 S.F. OPTIONAL

A-1 0.90 AC

A-2 0.94 AC

A-3 0.06 AC

A-4 0.03 AC

A-5 0.88 AC

A-6 0.22 AC

A-7 0.64 AC

A-8 1.04 AC

A-9 0.62 AC

A-10 0.61 AC

A-11 0.72 AC

A-12 0.52 AC

A-13 0.86 AC

A-14 1.06 AC

A-15 0.14 AC

259'-0" PROPERTY LINE

569'-0" PROPERTY LINE

208'-0" PROPERTY LINE

560'-0" BUILDING DIMENSION

354'-8" BUILDING DIMENSION

DEMISING WALL

WROUGTH IRON GATE

EMPLOYEE WELFARE AND BATHROOMS

DRIVER'S BATHROOM

12' X 14' GROUND LEVEL T.D.

22' x 16' ROLL UP DOORS GROUND LEVEL

FORKLIFT RAMP

STEEL COLUMN TYPICAL

REMOVE SEGMENT OF EX STORM DRAIN

EX STORM DRAIN

VAULT

8,400 SF

9" T.D. 13'-0" O.C. TYPICAL 31 TOTAL

20'-0" SETBACK

CONSTRUCTION NOTES:

1. INSTALL MODULAR WETLANDS SYSTEM (MWS) LINEAR PER TYPICAL DETAIL NO. 2
2. CONSTRUCT PLANTER BOX PER TYPICAL DETAIL NO. 1
3. CONSTRUCT VEGETATED SWALE PER TYPICAL DETAIL NO. 3
4. CONSTRUCT POROUS AND/OR PERMIABLE PAVING PER TYPICAL DETAIL NOS. 4 AND 5
5. CONSTRUCT BIOFILTRATION BASIN PER TYPICAL DETAIL NO. 6
6. INSTALL DRAIN PIPE
7. INSTALL RISER PIPE
8. CONSTRUCT SLOTTED PCC CURB PER DETAIL NO. 7.

1" = 30'

Prepared by:

CNC ENGINEERING

255 N. Hacienda Blvd., Ste. 222
City of Industry, Ca. 91744
Phone (626) 333-0336
Fax (626) 336-7076

Consulting Civil Engineers - Surveyors

CITY OF INDUSTRY

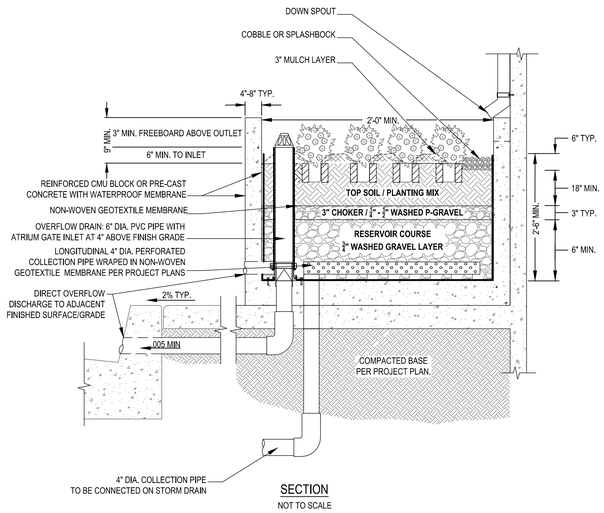
APPROVED BY:

JOHN D. BALLAS, R.C.E. 34311, AGENCY ENGINEER — DATE

FORMER K-MART SITE
SW CORNER OF HACIENDA AND VALLEY
CONCEPTUAL LID SITE PLAN
CONCETUAL GRADING AND LAYOUT PLAN

DESIGNED BY: J.C.	CHECKED BY: J.L.N.	JOB NO. JN-07446	SHT. 1 OF 3
DRAWN BY: J.C.	DATE: AUG 2014		

K:\MiscProj\JN-7446 EWMP Preparation\Drawings\Exhibits\K-Mart Site Example\K-mart Rough Grading_Alt.dwg

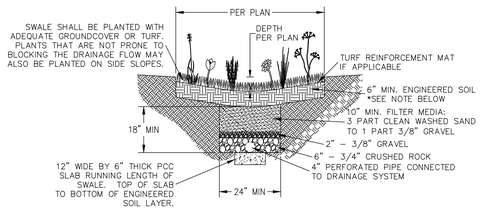


SECTION

NOT TO SCALE

1 ABOVE GRADE PLANTER BOX

SCALE: N.T.S.



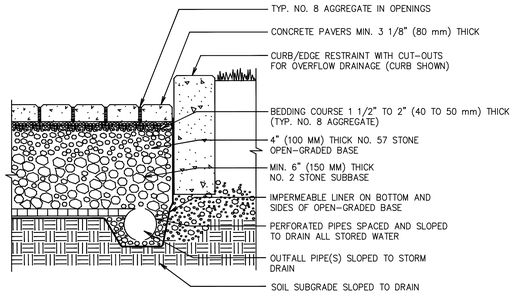
*"ENGINEERED SOIL" LAYER SHALL BE MINIMUM 6" DEEP "SANDY LOAM" SOIL MIX WITH NO MORE THAN 5% CLAY CONTENT. THE MIX SHALL CONTAIN 50–60% SAND, 20–30% COMPOST OR HARDWOOD MULCH, AND 20–30% TOPSOIL.

NOTE: VEGETATED SWALES ON GRADES OF MORE THAN 2.5% MUST INSTALL CHECK DAMS TO LIMIT THE SLOPE OF THE SWALE TO 2.5% UNLESS OTHERWISE APPROVED BY THE DIRECTOR OF ENGINEERING SERVICES.

NOTE: NO FILTER FABRIC IS TO BE USED IN THIS SECTION.

3 TYPICAL VEGETATED SWALE

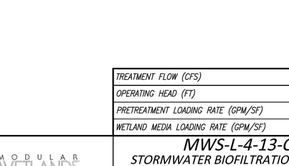
SCALE: N.T.S.



NOTES:
1. 2 3/8" (60 MM) THICK PAVERS MAY BE USED IN PEDESTRIAN APPLICATIONS.
2. NO. 2 STONE SUBBASE THICKNESS VARIES WITH DESIGN. CONSULT ICPI PERMEABLE INTERLOCKING CONCRETE PAVEMENT MANUAL.

5 TYPICAL PERMIRABLE PAVERS SECTION

SCALE: N.T.S.

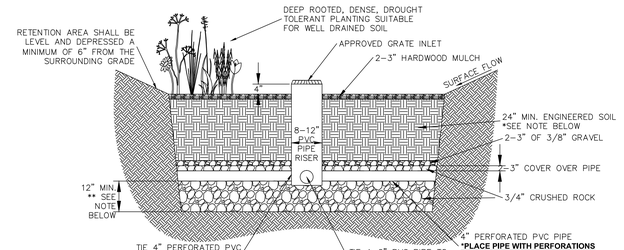


–A NATIONAL READY MIX CONCRETE ASSOCIATION (NRMCA) PERVIOUS CONCRETE CERTIFIED CONTRACTOR MUST INSTALL THE PERVIOUS CONCRETE. CONTRACTOR IS TO PROVIDE PROOF OF CERTIFICATION TO THE ENGINEERING FIELD INSPECTOR PRIOR TO START OF WORK.

–THE CITY ENGINEER MAY REQUIRE A CORE SAMPLE OF THE INSTALLED PERVIOUS CONCRETE TO ENSURE THAT THERE IS A MINIMUM VOID CONTENT OF 20%. IF A MINIMUM VOID CONTENT OF 20% IS NOT SATISFIED, THE REMOVAL AND REPLACEMENT OF THE PERVIOUS CONCRETE WILL BE REQUIRED TO THE SATISFACTION OF THE CITY ENGINEER.

4 TYPICAL POROUS PAVEMENT DETAIL

SCALE: N.T.S.



*BIORETENTION "ENGINEERED SOIL" LAYER SHALL BE MINIMUM 24" DEEP "SANDY LOAM" SOIL MIX WITH NO MORE THAN 5% CLAY CONTENT. THE MIX SHALL CONTAIN 50–60% SAND, 20–30% COMPOST OR HARDWOOD MULCH, AND 20–30% TOPSOIL.

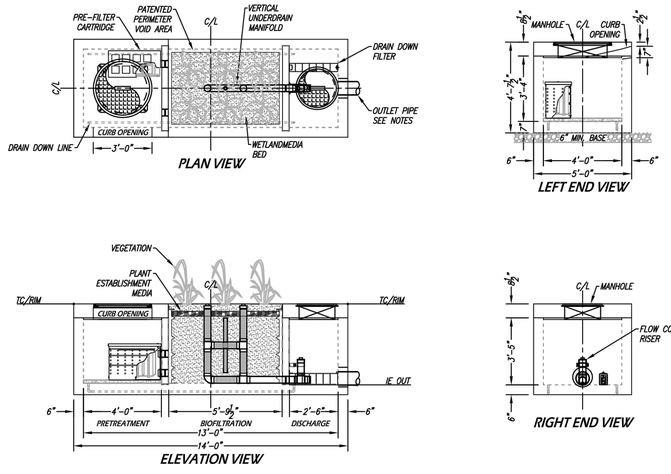
**3/4" CRUSHED ROCK LAYER SHALL BE A MINIMUM OF 12" BUT MAY BE DEEPENED TO INCREASE THE INFILTRATION AND STORAGE ABILITY OF THE BASIN.

THE EFFECTIVE AREA OF THE BASIN SHALL BE LEVEL AND SHALL BE SIZED BASED ON ENCINITAS STORMWATER MANUAL CALCULATIONS. TYPICALLY, THE SURFACE AREA OF THE BIORETENTION BASIN IS 4% OF THE IMPERVIOUS AREA DRAINING TO IT.

6 TYPICAL BIOFILTRATION BASIN DETAIL

SCALE: N.T.S.

SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			3.05
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø1.71"
MAXIMUM PICK WEIGHT (LBS)			27000
NOTES:			



INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.

TREATMENT FLOW (CFS)	0.144
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

THE PRODUCT DESCRIBED MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 7,425,260; 7,470,360; 7,674,378; & 8,303,816; RELATED FOREIGN PATENTS OR OTHER PATENTS PENDING

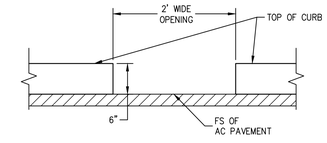
PROPRIETARY AND CONFIDENTIAL: THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MODULAR WETLANDS SYSTEMS. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MODULAR WETLANDS SYSTEMS IS PROHIBITED.

MODULAR WETLANDS — www.ModularWetlands.com | (833) 3MOD-WET

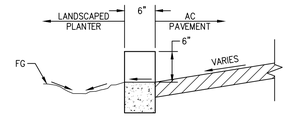
MWS-L-4-13-C
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

2 TYPICAL MODULAR WETLANDS DETAIL

SCALE: N.T.S.



SECTION A–A



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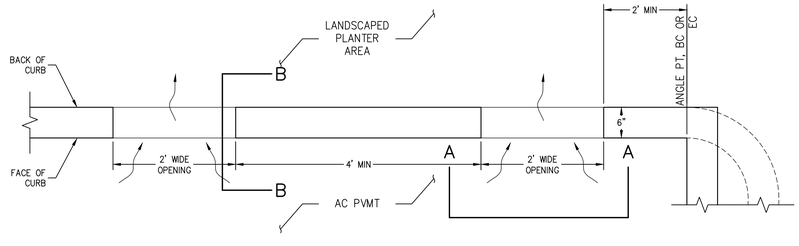

7 SLOTTED CURB DETAIL

SCALE: N.T.S.

Prepared by:
CNC ENGINEERING
255 N. Hacienda Blvd., Ste. 222
City of Industry, Ca. 91744
Phone (626) 333-0336
Fax (626) 336-7076
Consulting Civil Engineers • Surveyors

CITY OF INDUSTRY

APPROVED BY:

JOHN D. BALLAS, R.C.E. 34311, AGENCY ENGINEER DATE

FORMER K-MART SITE
SW CORNER OF HACIENDA AND VALLEY
CONCEPTUAL LID SITE PLAN
TYPICAL DETAILS

DESIGNED BY: J.C.	CHECKED BY: J.L.N.	JOB NO. JN-07446	SHT. 2 OF 3
DRAWN BY: J.C.	DATE: AUG 2014		

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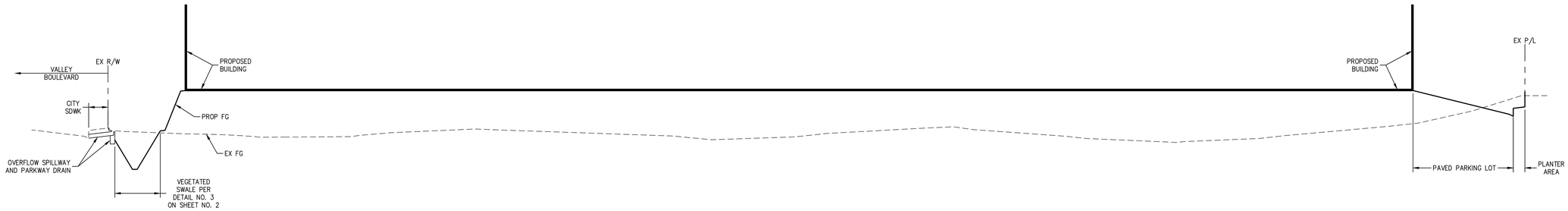
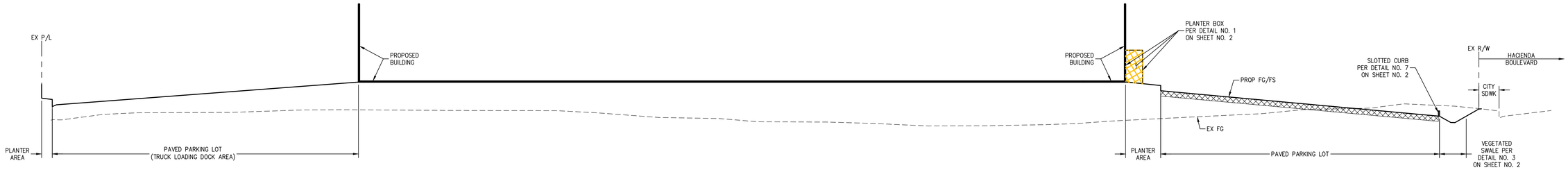


1 — CROSS SECTION — NORTH SIDE OF BUILDING

SCALE: N.T.S.



2 — CROSS SECTION — EAST SIDE OF BUILDING

SCALE: N.T.S.

K:\MiscProjJN - 7446 EMMP Preparation\Drawings\Exhibits\K-Mart Site Example\K-mart Rough Grading_Alt.dwg

Prepared by:
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CITY OF INDUSTRY

APPROVED BY:

JOHN D. BALLAS, R.C.E. 34311, AGENCY ENGINEER DATE

FORMER K-MART SITE
SW CORNER OF HACIENDA AND VALLEY

CONCEPTUAL LID SITE PLAN

SECTIONS

DESIGNED BY: J.C.	CHECKED BY: J.L.N.	JOB NO. JN-07446	SHT. 3 OF 3
DRAWN BY: J.C.	DATE: AUG 2014		

Figure NO. 5:
Non-structural BMP Maintenance Responsibility/Frequency Matrix

Figure No. 5

NON-STRUCTURAL BMP MAINTENANCE RESPOSIBILITY/FREQUENCY MATRIX

	BMP	RESPONSIBILITY	FREQUENCY
N1,N2	Education of Property Owners, Activity Restrictions	The Owner will provide educational materials.	Continuous. Information to be provided to employees. Activities restricted to facility operations.
N3	Common Area Landscape Management	Construction Manager during construction, The Owner through it's landscape maintenance firm	Monthly during regular maintenance; manage landscaping in accordance with the City and County management guidelines for use of fertilizers and pesticides.
N4	BMP Maintenance	Owner	Refer to Attachments B for specific BMP maintenance requirements
N7	Spill Contingency Plan	Owner	Continuous. Plan to be prepared and updated on an ongoing basis.
N11	Litter Control	Owner and Employees	Continuous
N12	Employee Training	The Owner will train staff and landscape maintenance firm after construction.	Monthly for maintenance personnel and employees to include the educational materials contained in the approved SUSMP.
N13	Housekeeping for Loading Dock	Owner	Refer to Attachment B for specific BMP maintenance requirements
N14	Catch Basin Inspection	Owner	Inspect, cleaned and maintained at 100% of the catch basins and inlets on an annual basis. Cleaning to take place in late summer/early fall.
N15	Parking Lot Sweeping	Owner	Parking lots to be swept prior to the beginning of the storm season, in late summer/early fall, as defined by the city of Industry.

Figure NO. 6:
Structural BMP Maintenance Responsibility/Frequency Matrix

Figure No. 6

STRUCTURAL BMP MAINTENANCE RESPOSIBILITY/FREQUENCY MATRIX

	BMP	RESPONSIBILITY	FREQUENCY
S1	Filtration	Owner	Continuous. Maintenance of the vegetated swales, planter boxes, and biofiltration basin shall be continuous in conjunction with maintenance of site landscape.
S2 (SD-12)	Common Area Efficient Irrigation	Contractor during construction; Owner through its landscape maintenance firm after construction	Once a week, in conjunction with maintenance activities. Verify that runoff minimizing landscape design continues to function by checking that water sensors are functioning properly, that irrigation heads are adjusted properly to eliminate overspray to hardscape areas, and to verify that irrigation timing and cycle lengths are adjusted in accordance with water demands, given time of year, weather and day or night time temperatures.
S3 (SD-10)	Common Area Runoff Efficient Landscape Design	Owner through its landscaping maintenance firm	Once a week in conjunction with maintenance activities and prior to finalizing any replanting schemes. Verify that plants continue to be grouped according to similar water requirements in order to reduce excess irrigation runoff.
S6 (SD-32	Waste Management (Trash Dumpster) Areas	Owner	As needed
S13 (SD-13)	Catch Basin Stenciling	Contractor during construction and Owner after construction	As needed
S15	Inlet Trash Racks	Contractor during construction and Owner after construction	As needed and per manufacturers recommendations for frequency of maintenance. (See Attachment C).
S16	Water Quality Inlets	Owner	Water Quality Inlets shall be inspected and replaced per manufacturers recommendations for frequency of maintenance. (See Attachment C).
S17 (MP-40)	Stormwater Filters	Owner	As needed and per manufacturers recommendations for frequency of maintenance. (See Attachment B & C).
S18 (TC-30)	Vegetated Swale	Owner through its landscaping maintenance firm	Once a week in conjunction with maintenance activities and prior to finalizing any replanting schemes. In addition, the swale shall be inspected within 48 hours after a storm event for vector issues.
S19	Planter Boxes	Owner through its landscaping maintenance firm	Once a week in conjunction with maintenance activities and prior to finalizing any replanting schemes
S20 (TC-32)	Biofiltration Basin	Owner	As needed to prevent clogging of filtration media. Monitoring wells shall be inspected on a monthly basis and/or after a storm event.
S21 (SD-20)	Porous/Permiable Pavement	Owner	Refer to Attachment B for specific BMP maintenance requirements

Attachment A
Flow Calculations

project	subarea	area	length	slope	depth	impervious	soil	frequency	fire	
K-Mart Site	A-1	0.9	243.59	0.01	1.1	0.962	17	85th perce		0
K-Mart Site	A-2	0.94	246.41	0.005	1.1	0.322	17	85th perce		0
K-Mart Site	A-3	0.06	103.62	0.0042	1.1	1	17	85th perce		0
K-Mart Site	A-4	0.03	53.69	0.0546	1.1	0.566	17	85th perce		0
K-Mart Site	A-5	0.88	257.32	0.0042	1.1	1	17	85th perce		0
K-Mart Site	A-6	0.22	195.57	0.0149	1.1	0.492	17	85th perce		0
K-Mart Site	A-7	0.64	245.73	0.0042	1.1	1	17	85th perce		0
K-Mart Site	A-8	1.04	311.71	0.0042	1.1	1	17	85th perce		0
K-Mart Site	A-9	0.62	220.97	0.0136	1.1	0.654	17	85th perce		0
K-Mart Site	A-10	0.61	238.4	0.0042	1.1	1	17	85th perce		0
K-Mart Site	A-11	0.72	628.73	0.0041	1.1	0.896	17	85th perce		0
K-Mart Site	A-12	0.51	212.68	0.0141	1.1	0.747	17	85th perce		0
K-Mart Site	A-13	0.86	239.24	0.0114	1.1	0.966	17	85th perce		0
K-Mart Site	A-14	1.06	311.92	0.0042	1.1	1	17	85th perce		0
K-Mart Site	A-15	0.34	98.66	0.0185	1.1	0.01	17	85th perce		0

Flow and Volume Calculations for Capture/Infiltration

Project Site	Subarea	Area	Flow Length	Slope	85th % Depth (in)	Impervious Area	Design Frequency	Design Flow (cfs)	Design Volume (CF)
K-Mart Site	A-1	0.90	243.59	0.01	1.1	0.962	85th %	0.3192	3100.64
K-Mart Site	A-2	0.94	246.41	0.005	1.1	0.322	85th %	0.0950	1331.15
K-Mart Site	A-3	0.06	103.62	0.0042	1.1	1.000	85th %	0.0269	213.84
K-Mart Site	A-4	0.03	53.69	0.0546	1.1	0.566	85th %	0.0148	66.78
K-Mart Site	A-5	0.88	257.32	0.0042	1.1	1.000	85th %	0.2924	3136.33
K-Mart Site	A-6	0.22	195.57	0.0149	1.1	0.492	85th %	0.0498	433.97
K-Mart Site	A-7	0.64	245.73	0.0042	1.1	1.000	85th %	0.2188	2280.97
K-Mart Site	A-8	1.04	311.71	0.0042	1.1	1.000	85th %	0.3280	3706.58
K-Mart Site	A-9	0.62	220.97	0.0136	1.1	0.654	85th %	0.1653	1537.65
K-Mart Site	A-10	0.61	238.40	0.0042	1.1	1.000	85th %	0.2086	2174.05
K-Mart Site	A-11	0.72	628.73	0.0041	1.1	0.896	85th %	0.1613	2328.89
K-Mart Site	A-12	0.51	212.68	0.0141	1.1	0.747	85th %	0.1539	1414.07
K-Mart Site	A-13	0.86	239.24	0.0114	1.1	0.966	85th %	0.3059	2973.59
K-Mart Site	A-14	1.06	311.92	0.0042	1.1	1.000	85th %	0.3343	3777.86
K-Mart Site	A-15	0.34	98.66	0.0185	1.1	0.010	85th %	0.0104	145.41
	Totals:	**9.43**						**2.6846**	**28621.78**

Flow and Volume Calculations for Treatment

Project Site	Subarea	Infiltration Design Flow (cfs)	Infiltration Design Volume (CF)	Increase due to Treatment	Treatment Design Flow (cfs)	Treatment Design Volume (CF)
K-Mart Site	A-1	0.3192	3100.64	1.50	0.4788	4650.96
K-Mart Site	A-2	0.0950	1331.15	1.50	0.1425	1996.73
K-Mart Site	A-3	0.0269	213.84	1.50	0.0404	320.76
K-Mart Site	A-4	0.0148	66.78	1.50	0.0222	100.17
K-Mart Site	A-5	0.2924	3136.33	1.50	0.4386	4704.50
K-Mart Site	A-6	0.0498	433.97	1.50	0.0747	650.96
K-Mart Site	A-7	0.2188	2280.97	1.50	0.3282	3421.46
K-Mart Site	A-8	0.3280	3706.58	1.50	0.4920	5559.87
K-Mart Site	A-9	0.1653	1537.65	1.50	0.2480	2306.48
K-Mart Site	A-10	0.2086	2174.05	1.50	0.3129	3261.08
K-Mart Site	A-11	0.1613	2328.89	1.50	0.2420	3493.34
K-Mart Site	A-12	0.1539	1414.07	1.50	0.2309	2121.11
K-Mart Site	A-13	0.3059	2973.59	1.50	0.4589	4460.39
K-Mart Site	A-14	0.3343	3777.86	1.50	0.5015	5666.79
K-Mart Site	A-15	0.0104	145.41	1.50	0.0156	218.12
	Totals:	**2.6846**	**28621.78**		**4.0269**	**42932.67**

Peak Flow Hydrologic Analysis

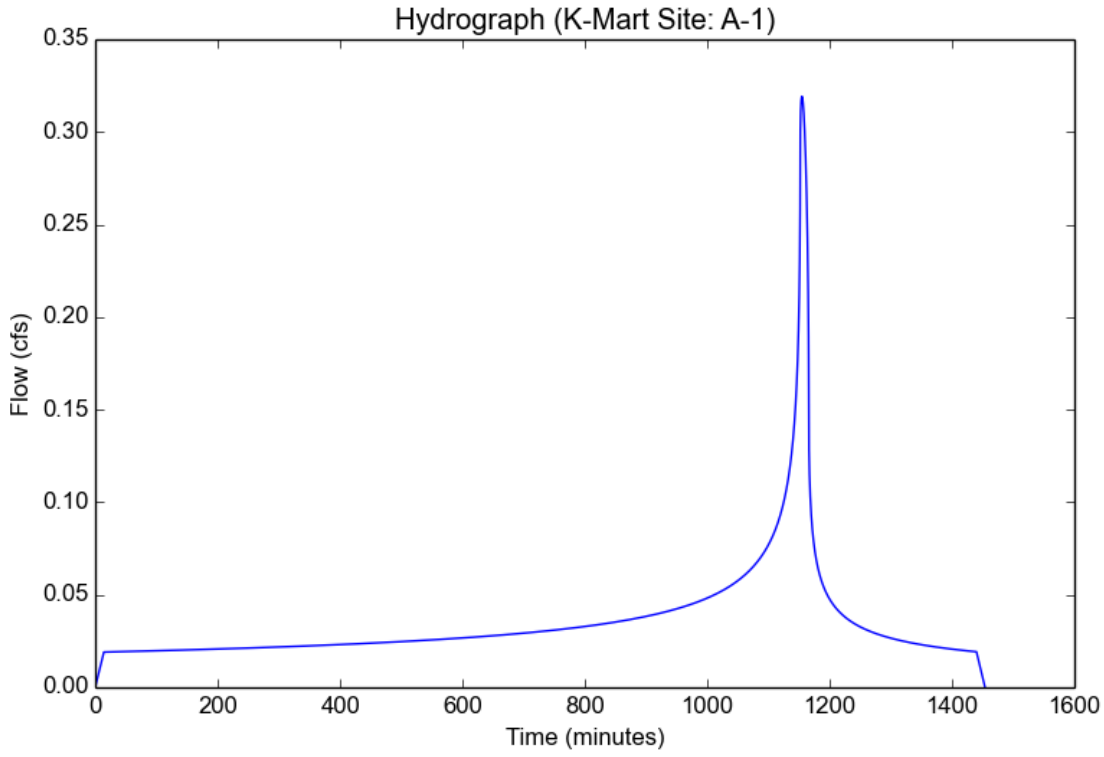
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-1
Area (ac)	0.9
Flow Path Length (ft)	243.59
Flow Path Slope (vft/hft)	0.01
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.962
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.4045
Undeveloped Runoff Coefficient (Cu)	0.2906
Developed Runoff Coefficient (Cd)	0.8768
Time of Concentration (min)	14.0
Clear Peak Flow Rate (cfs)	0.3192
Burned Peak Flow Rate (cfs)	0.3192
24-Hr Clear Runoff Volume (ac-ft)	0.0712
24-Hr Clear Runoff Volume (cu-ft)	3100.6382



Peak Flow Hydrologic Analysis

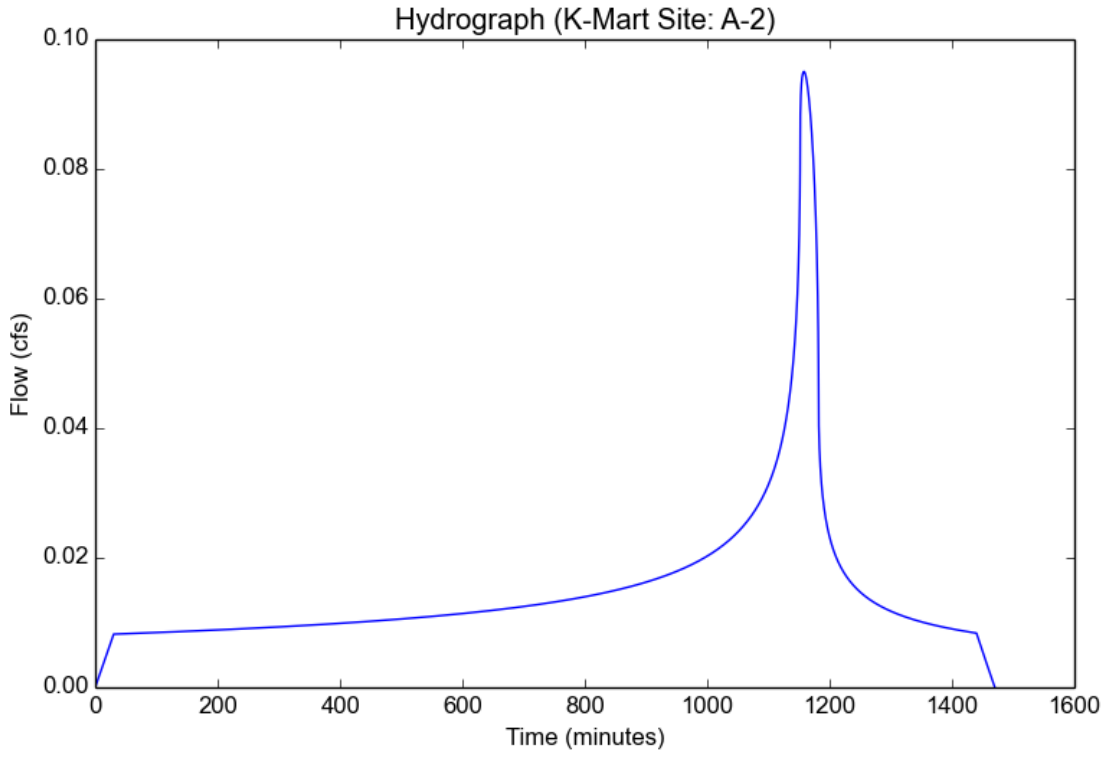
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-2
Area (ac)	0.94
Flow Path Length (ft)	246.41
Flow Path Slope (vft/hft)	0.005
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.322
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.2827
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.3576
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	0.095
Burned Peak Flow Rate (cfs)	0.095
24-Hr Clear Runoff Volume (ac-ft)	0.0306
24-Hr Clear Runoff Volume (cu-ft)	1331.1455



Peak Flow Hydrologic Analysis

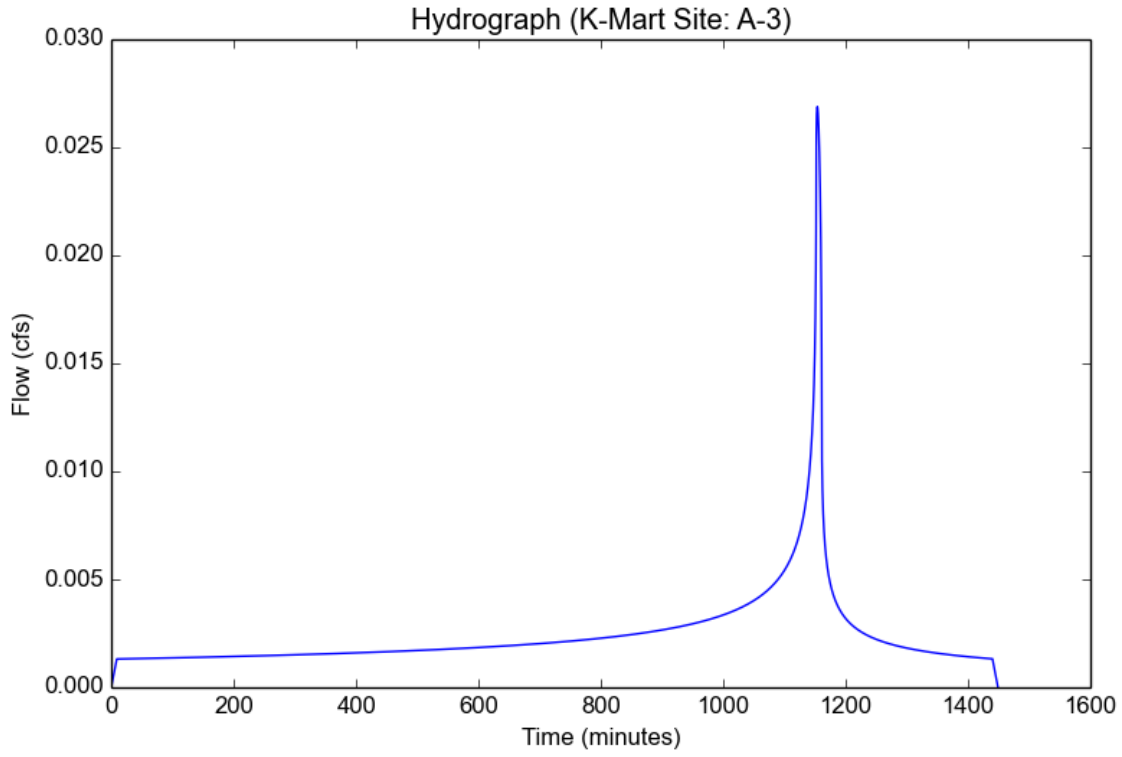
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-3
Area (ac)	0.06
Flow Path Length (ft)	103.62
Flow Path Slope (vft/hft)	0.0042
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	1.0
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.4979
Undeveloped Runoff Coefficient (Cu)	0.4608
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	9.0
Clear Peak Flow Rate (cfs)	0.0269
Burned Peak Flow Rate (cfs)	0.0269
24-Hr Clear Runoff Volume (ac-ft)	0.0049
24-Hr Clear Runoff Volume (cu-ft)	213.8402



Peak Flow Hydrologic Analysis

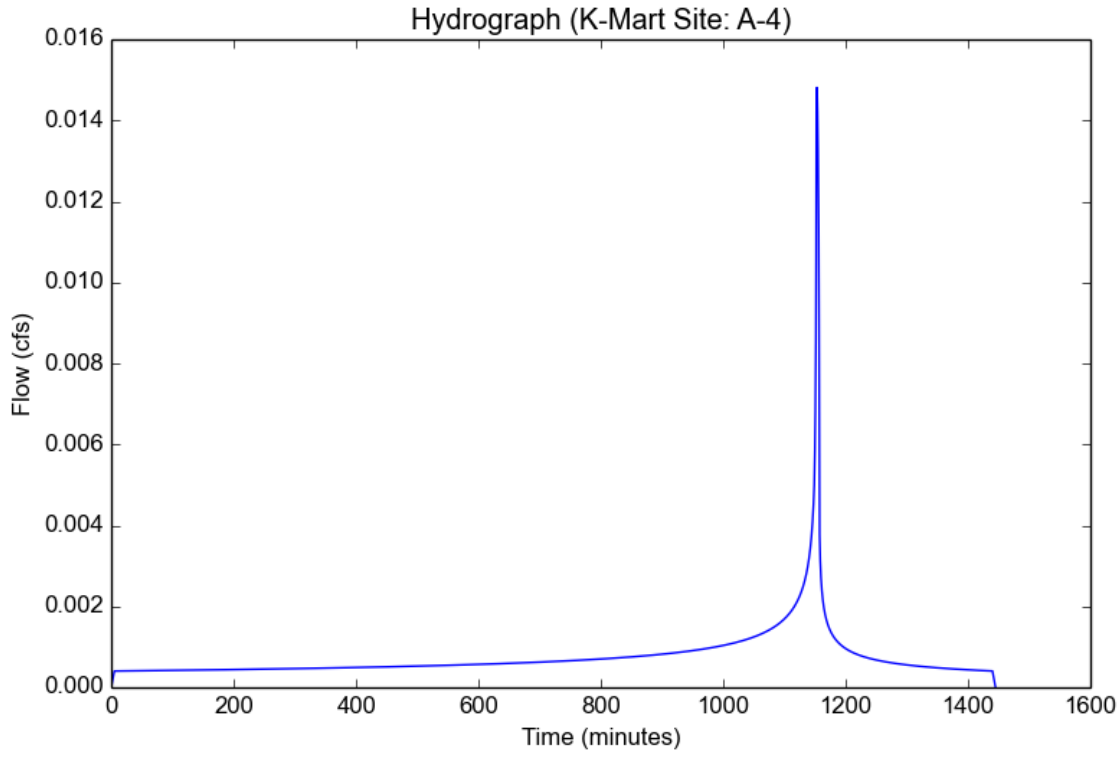
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-4
Area (ac)	0.03
Flow Path Length (ft)	53.69
Flow Path Slope (vft/hft)	0.0546
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.566
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.6563
Undeveloped Runoff Coefficient (Cu)	0.5595
Developed Runoff Coefficient (Cd)	0.7522
Time of Concentration (min)	5.0
Clear Peak Flow Rate (cfs)	0.0148
Burned Peak Flow Rate (cfs)	0.0148
24-Hr Clear Runoff Volume (ac-ft)	0.0015
24-Hr Clear Runoff Volume (cu-ft)	66.7766



Peak Flow Hydrologic Analysis

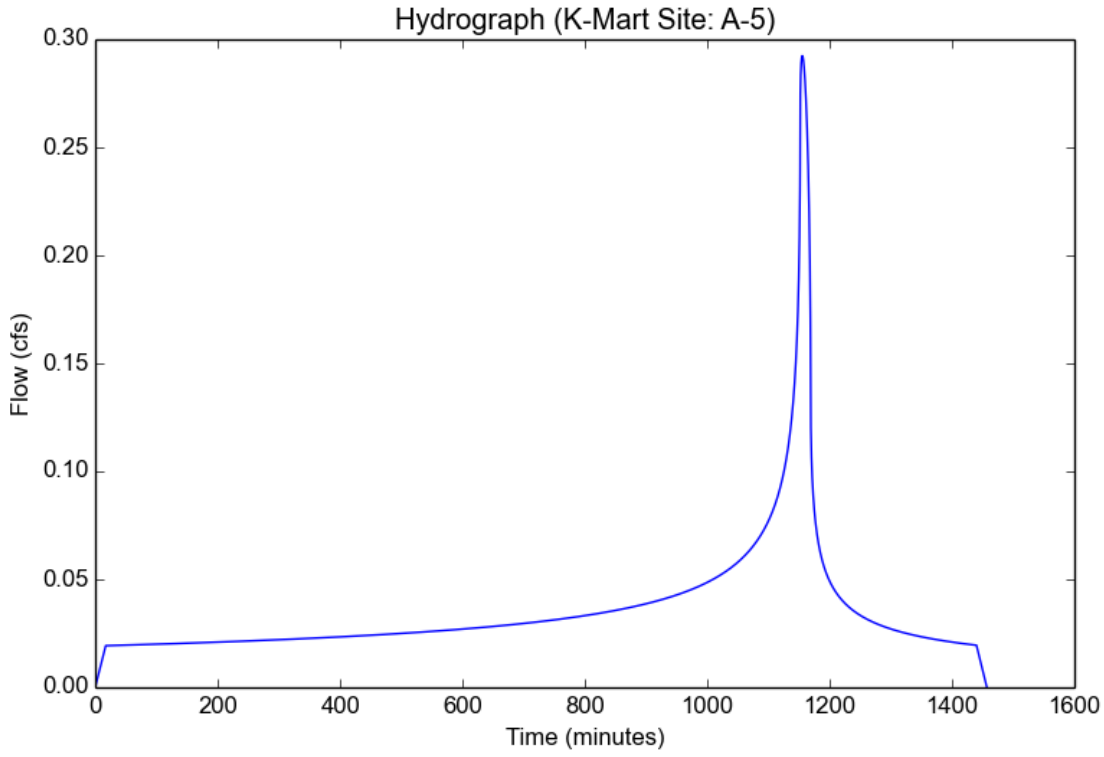
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-5
Area (ac)	0.88
Flow Path Length (ft)	257.32
Flow Path Slope (vft/hft)	0.0042
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	1.0
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.3692
Undeveloped Runoff Coefficient (Cu)	0.2262
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	17.0
Clear Peak Flow Rate (cfs)	0.2924
Burned Peak Flow Rate (cfs)	0.2924
24-Hr Clear Runoff Volume (ac-ft)	0.072
24-Hr Clear Runoff Volume (cu-ft)	3136.3315



Peak Flow Hydrologic Analysis

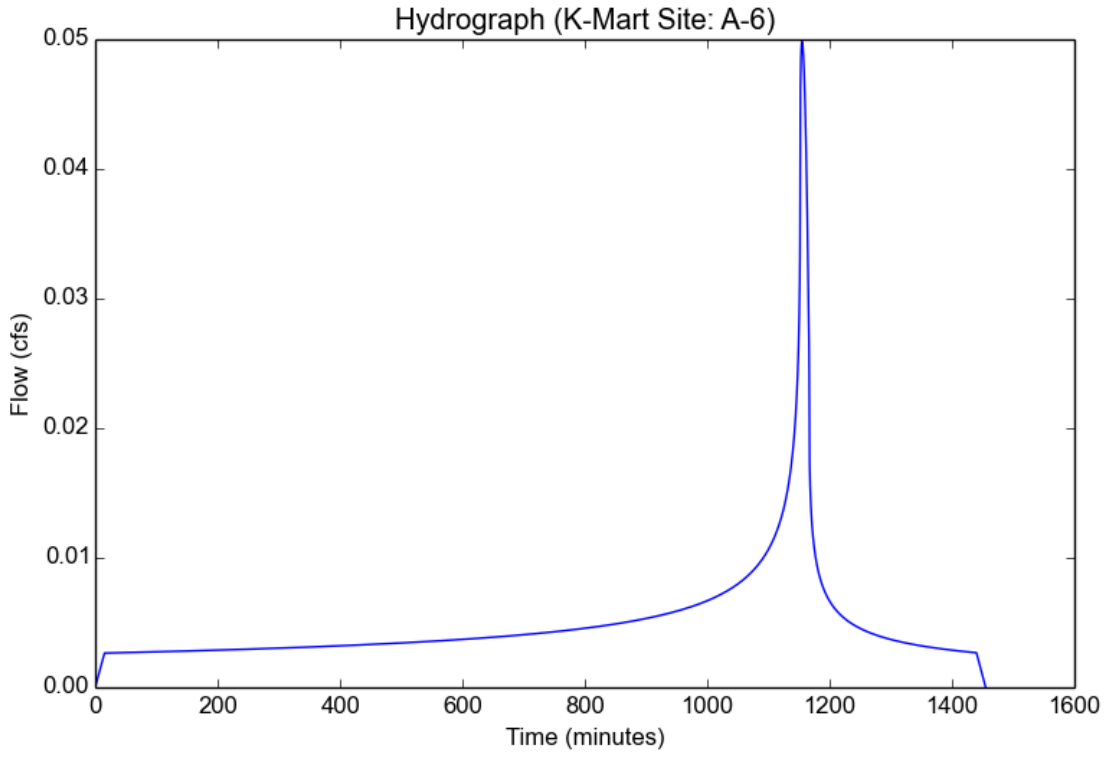
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-6
Area (ac)	0.22
Flow Path Length (ft)	195.57
Flow Path Slope (vft/hft)	0.0149
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.492
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.3916
Undeveloped Runoff Coefficient (Cu)	0.267
Developed Runoff Coefficient (Cd)	0.5785
Time of Concentration (min)	15.0
Clear Peak Flow Rate (cfs)	0.0498
Burned Peak Flow Rate (cfs)	0.0498
24-Hr Clear Runoff Volume (ac-ft)	0.01
24-Hr Clear Runoff Volume (cu-ft)	433.9678



Peak Flow Hydrologic Analysis

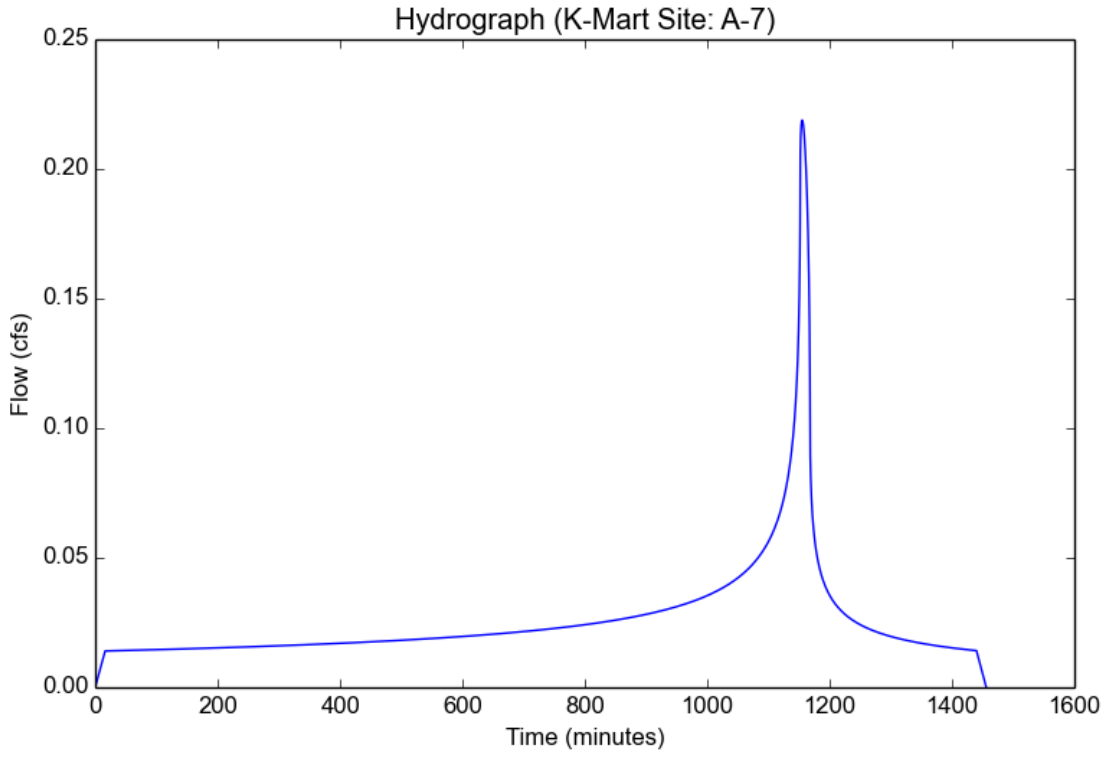
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-7
Area (ac)	0.64
Flow Path Length (ft)	245.73
Flow Path Slope (vft/hft)	0.0042
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	1.0
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.3799
Undeveloped Runoff Coefficient (Cu)	0.2457
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	16.0
Clear Peak Flow Rate (cfs)	0.2188
Burned Peak Flow Rate (cfs)	0.2188
24-Hr Clear Runoff Volume (ac-ft)	0.0524
24-Hr Clear Runoff Volume (cu-ft)	2280.9674



Peak Flow Hydrologic Analysis

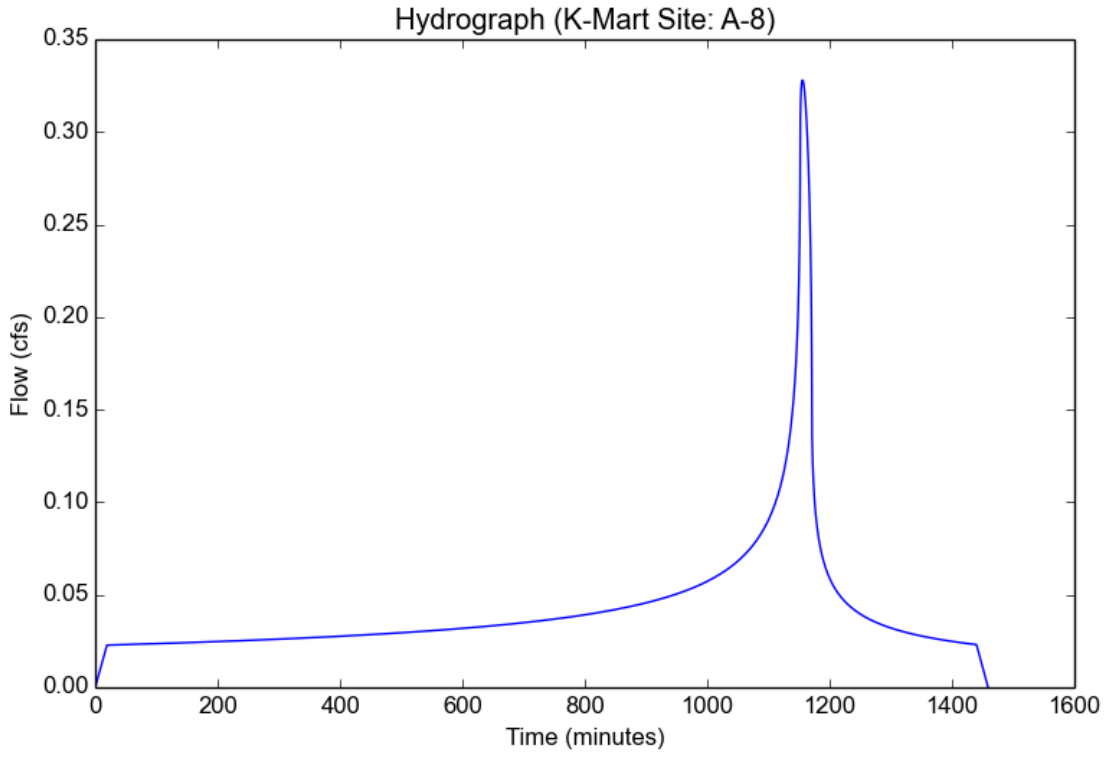
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-8
Area (ac)	1.04
Flow Path Length (ft)	311.71
Flow Path Slope (vft/hft)	0.0042
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	1.0
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.3504
Undeveloped Runoff Coefficient (Cu)	0.192
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	19.0
Clear Peak Flow Rate (cfs)	0.328
Burned Peak Flow Rate (cfs)	0.328
24-Hr Clear Runoff Volume (ac-ft)	0.0851
24-Hr Clear Runoff Volume (cu-ft)	3706.5769



Peak Flow Hydrologic Analysis

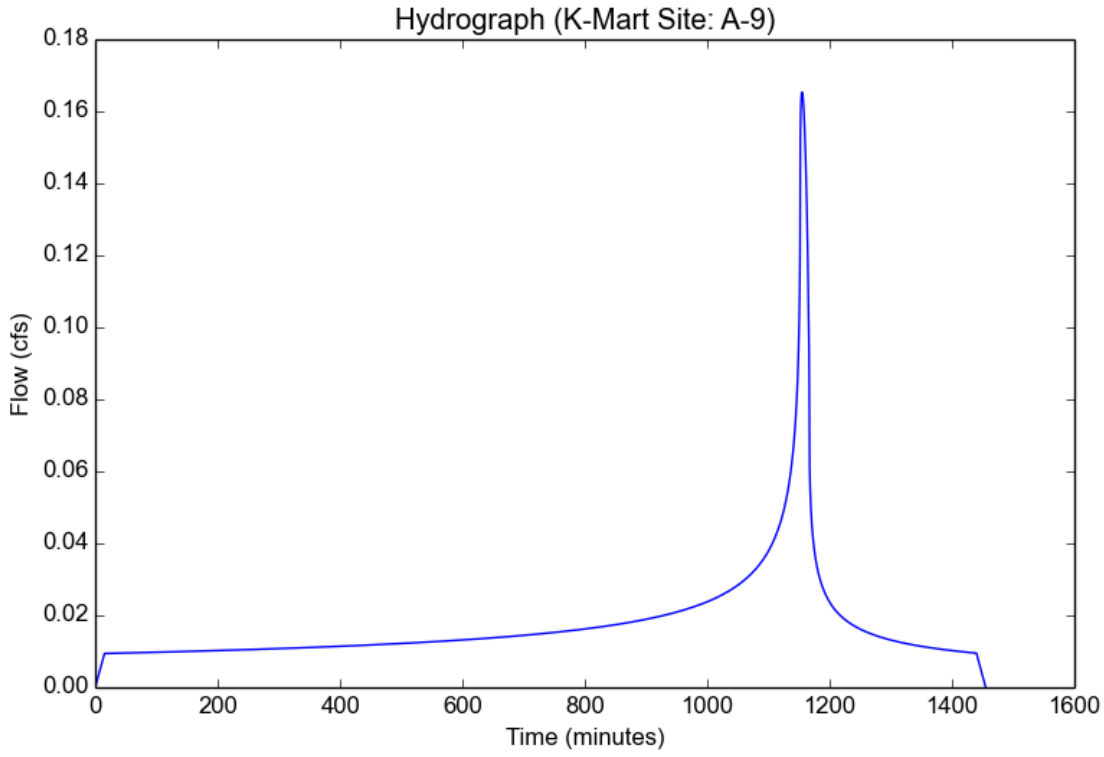
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-9
Area (ac)	0.62
Flow Path Length (ft)	220.97
Flow Path Slope (vft/hft)	0.0136
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.654
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.3916
Undeveloped Runoff Coefficient (Cu)	0.267
Developed Runoff Coefficient (Cd)	0.681
Time of Concentration (min)	15.0
Clear Peak Flow Rate (cfs)	0.1653
Burned Peak Flow Rate (cfs)	0.1653
24-Hr Clear Runoff Volume (ac-ft)	0.0353
24-Hr Clear Runoff Volume (cu-ft)	1537.652



Peak Flow Hydrologic Analysis

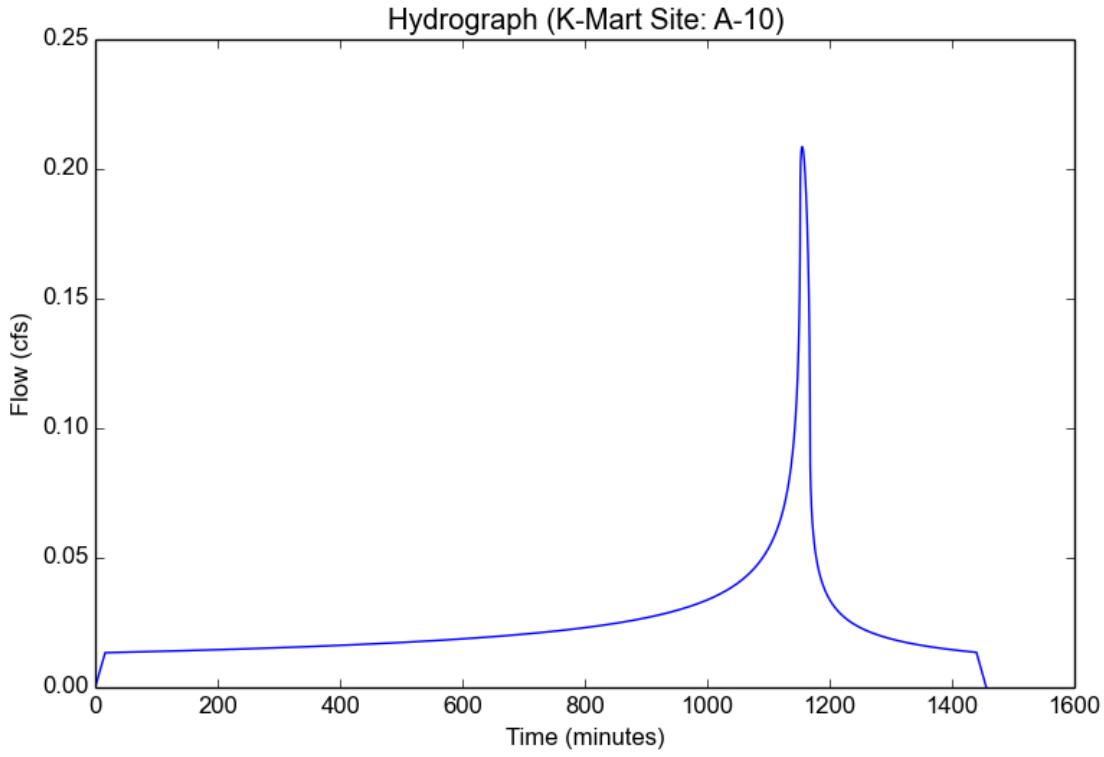
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-10
Area (ac)	0.61
Flow Path Length (ft)	238.4
Flow Path Slope (vft/hft)	0.0042
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	1.0
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.3799
Undeveloped Runoff Coefficient (Cu)	0.2457
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	16.0
Clear Peak Flow Rate (cfs)	0.2086
Burned Peak Flow Rate (cfs)	0.2086
24-Hr Clear Runoff Volume (ac-ft)	0.0499
24-Hr Clear Runoff Volume (cu-ft)	2174.047



Peak Flow Hydrologic Analysis

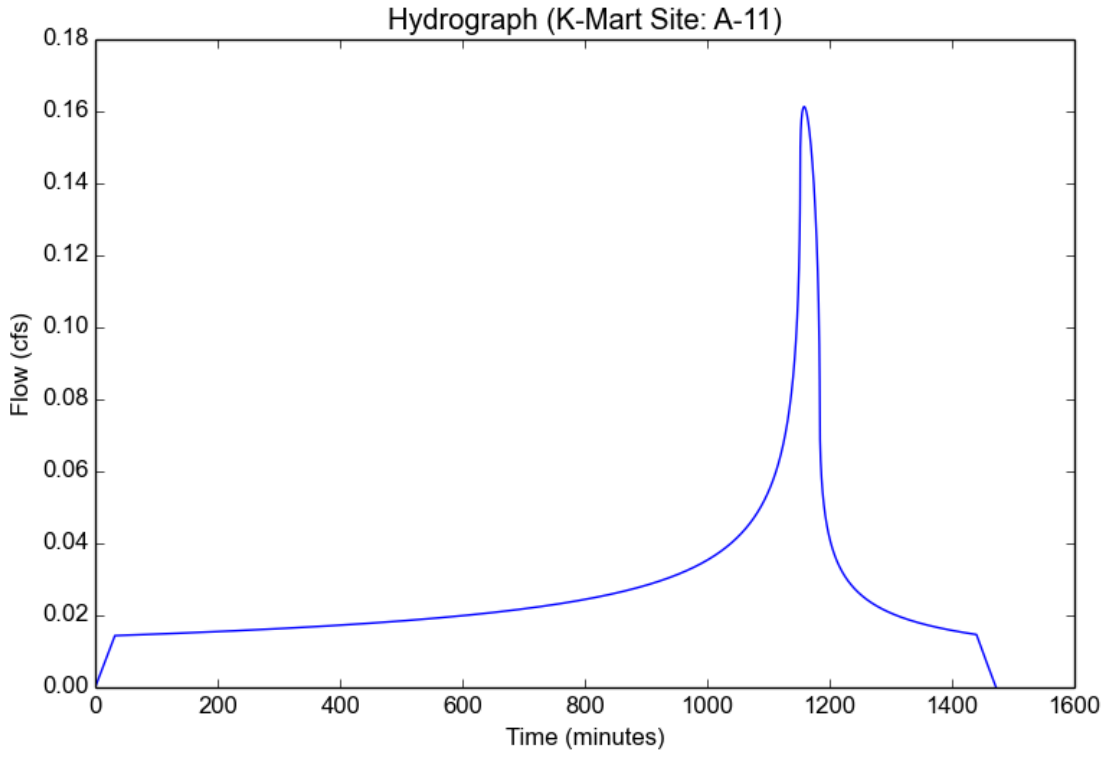
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-11
Area (ac)	0.72
Flow Path Length (ft)	628.73
Flow Path Slope (vft/hft)	0.0041
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.896
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.2743
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.8168
Time of Concentration (min)	32.0
Clear Peak Flow Rate (cfs)	0.1613
Burned Peak Flow Rate (cfs)	0.1613
24-Hr Clear Runoff Volume (ac-ft)	0.0535
24-Hr Clear Runoff Volume (cu-ft)	2328.8906



Peak Flow Hydrologic Analysis

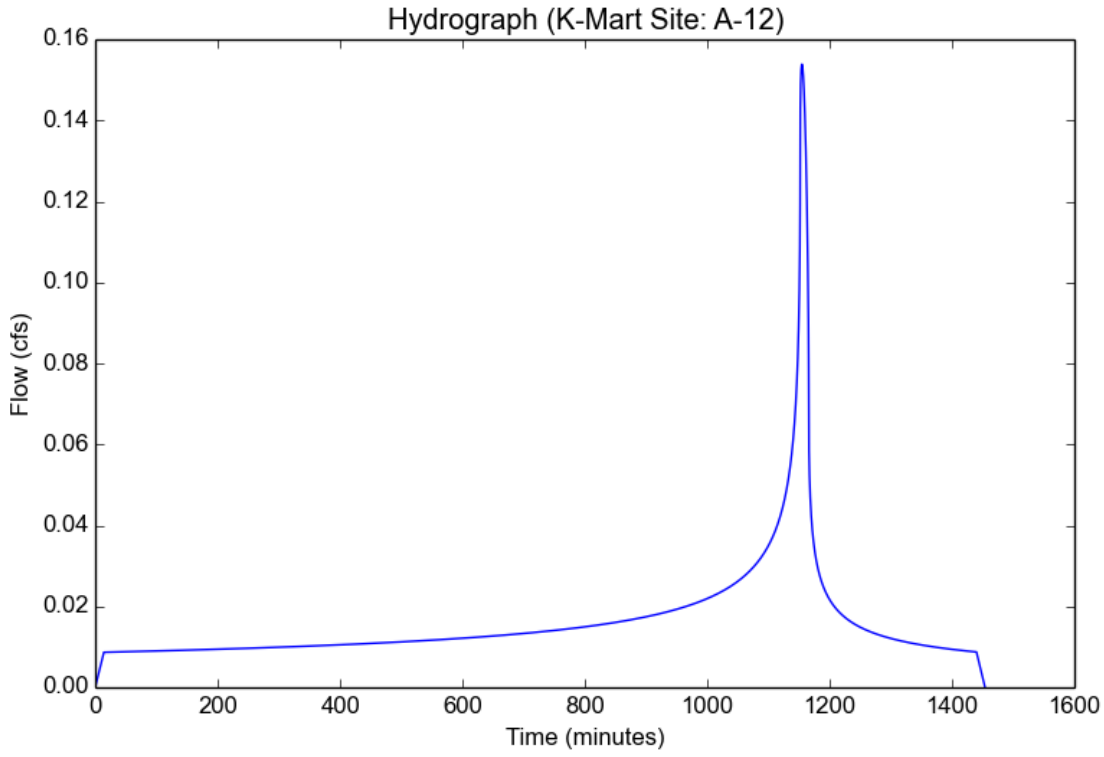
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-12
Area (ac)	0.51
Flow Path Length (ft)	212.68
Flow Path Slope (vft/hft)	0.0141
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.747
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.4045
Undeveloped Runoff Coefficient (Cu)	0.2906
Developed Runoff Coefficient (Cd)	0.7458
Time of Concentration (min)	14.0
Clear Peak Flow Rate (cfs)	0.1539
Burned Peak Flow Rate (cfs)	0.1539
24-Hr Clear Runoff Volume (ac-ft)	0.0325
24-Hr Clear Runoff Volume (cu-ft)	1414.0682



Peak Flow Hydrologic Analysis

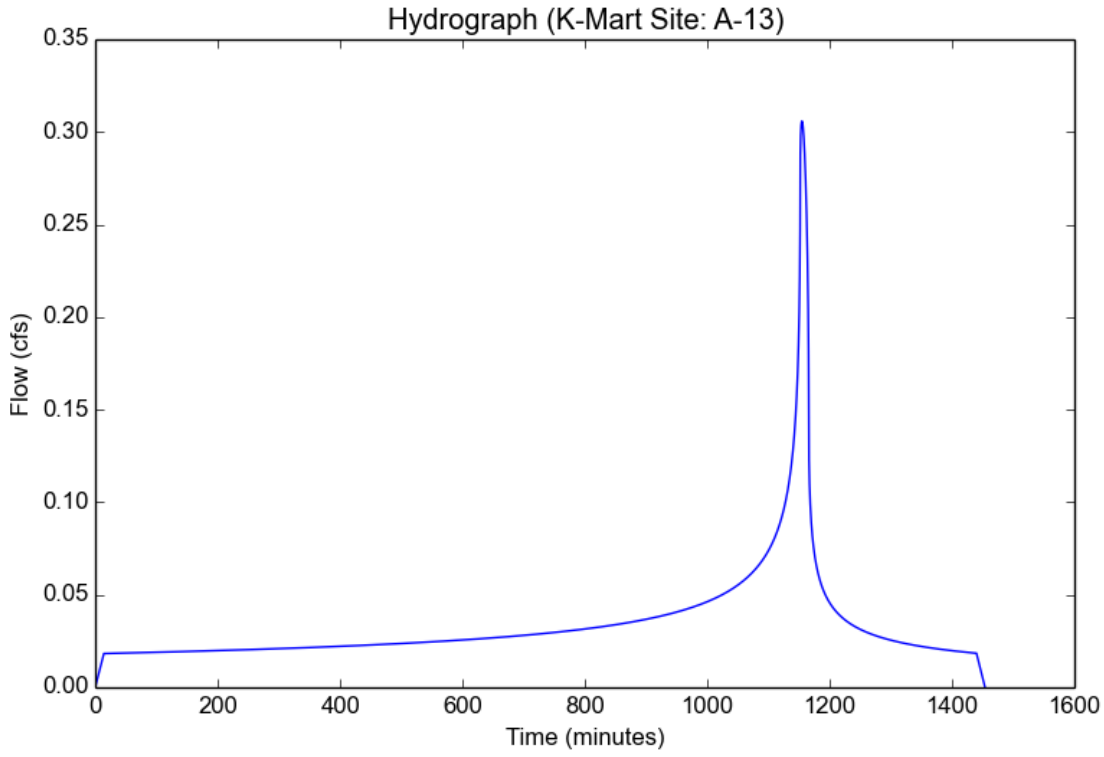
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-13
Area (ac)	0.86
Flow Path Length (ft)	239.24
Flow Path Slope (vft/hft)	0.0114
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.966
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.4045
Undeveloped Runoff Coefficient (Cu)	0.2906
Developed Runoff Coefficient (Cd)	0.8793
Time of Concentration (min)	14.0
Clear Peak Flow Rate (cfs)	0.3059
Burned Peak Flow Rate (cfs)	0.3059
24-Hr Clear Runoff Volume (ac-ft)	0.0683
24-Hr Clear Runoff Volume (cu-ft)	2973.5916



Peak Flow Hydrologic Analysis

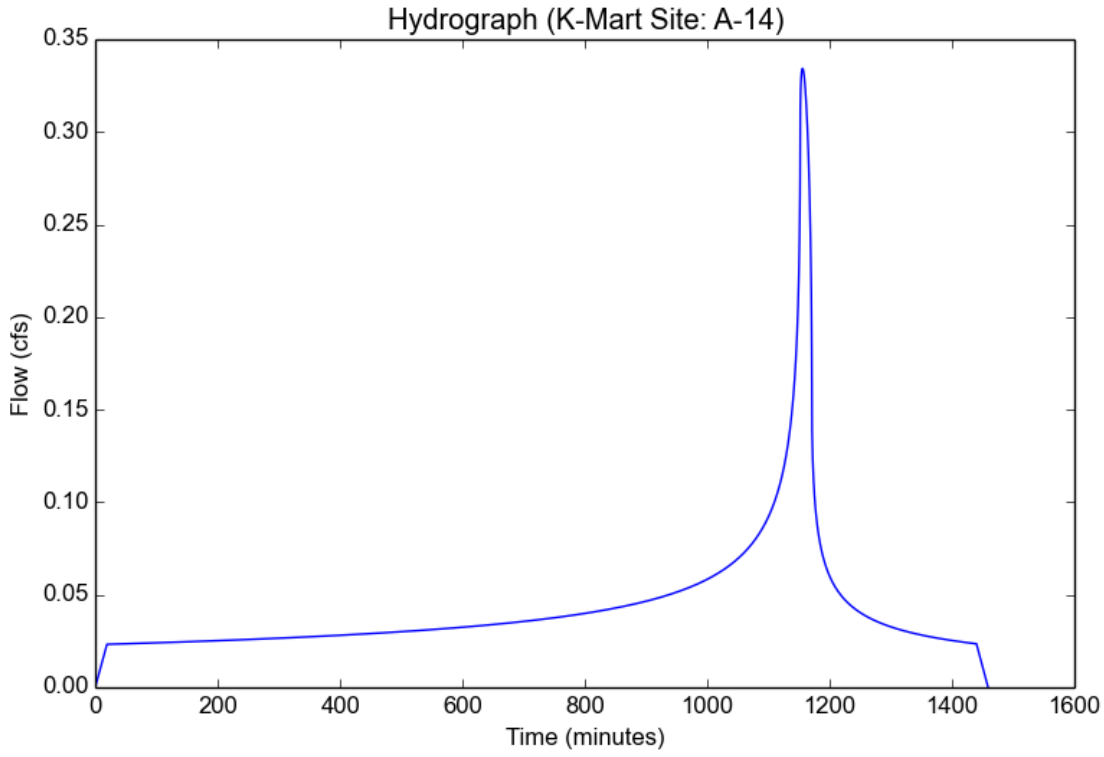
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-14
Area (ac)	1.06
Flow Path Length (ft)	311.92
Flow Path Slope (vft/hft)	0.0042
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	1.0
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.3504
Undeveloped Runoff Coefficient (Cu)	0.192
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	19.0
Clear Peak Flow Rate (cfs)	0.3343
Burned Peak Flow Rate (cfs)	0.3343
24-Hr Clear Runoff Volume (ac-ft)	0.0867
24-Hr Clear Runoff Volume (cu-ft)	3777.8573



Peak Flow Hydrologic Analysis

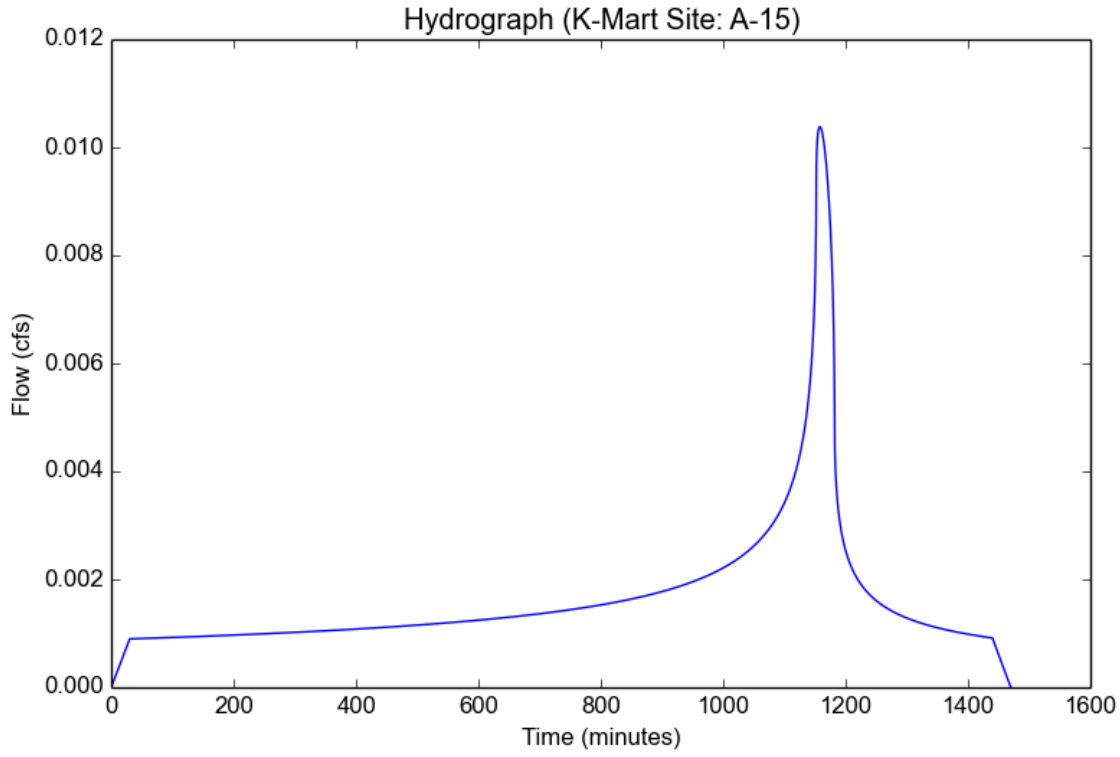
File location: K:/MiscProj/JN-7446 EWMP Preparation/Drawings/Exhibits/K-Mart Site Example/K-Mart Site HydroCalc Report_Alt_08-08-2014.pdf
Version: HydroCalc 0.2.0-beta

Input Parameters

Project Name	K-Mart Site
Subarea ID	A-15
Area (ac)	0.34
Flow Path Length (ft)	98.66
Flow Path Slope (vft/hft)	0.0185
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.01
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.2827
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.108
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	0.0104
Burned Peak Flow Rate (cfs)	0.0104
24-Hr Clear Runoff Volume (ac-ft)	0.0033
24-Hr Clear Runoff Volume (cu-ft)	145.4129



Vegetated Swale
Sizing Calculations

Grass Swale Calculations - Trapezoid Channel

Variables:

Bottom Width (w_b)=	**2.00**	ft	*(2' Minimum, 10' Maximum)*
Depth of Swale (H)=	**1.00**	ft	*(12" Minimum)*
Sideslope (z)=	**3**	(value represents # : 1)	*(Maximum 3:1 H:V)*
Slope (s)=	**0.010**	ft/ft	
Top Width (w_t)=	**8.00**	ft	
Cross-Sectional Area (A_x)=	**5.00**	sf	
Manning's (n)=	**0.020**		*(**0.020** for frequnet and **0.024** for infrequent mowing)*
Residence Time (t_r)=	**10.00**	minutes	*(10 Minutes Minimum)*

Calculations: (Solving for Flow using Depth)

Channel Flow (Q):

$$Q = \frac{w_b + (z*H)*(y^{1.67})*(s^{0.5})}{n}$$

Velocity of Swale Flow (v):

$$v = \frac{Q}{A_x}$$

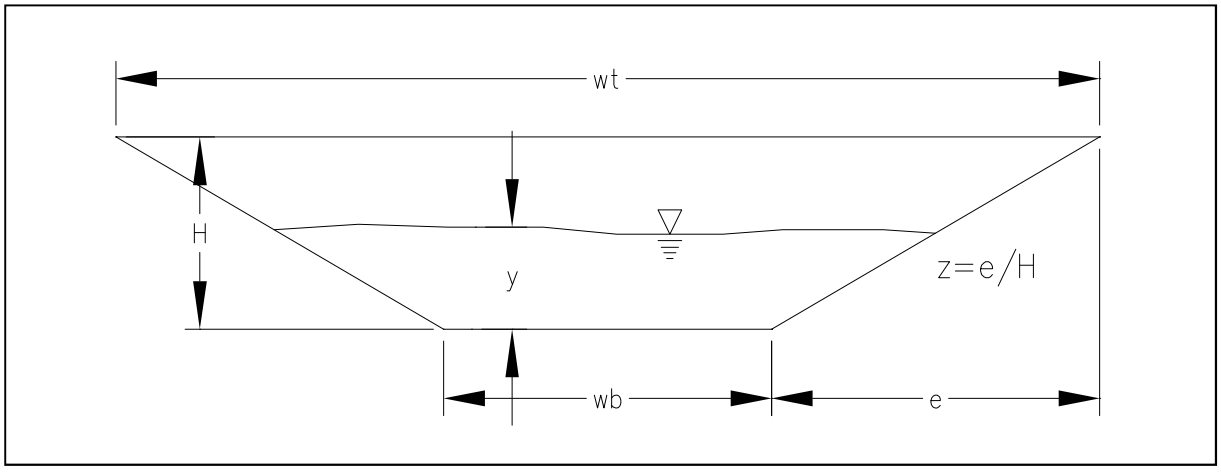
(v must be less than 1 ft/s)

Swale Length (L):

$$L = v*t_r*(60\ s/min)$$

(Minimum length is 100 ft)

y=Depth (inches)	y=Depth (ft)	Q=Flow (cfs)	v=Velocity (fps)	L=Length (ft)
1	**0.083**	**0.394**	**0.0788**	**47.30**
2	**0.167**	**1.254**	**0.2509**	**150.53**
3	**0.250**	**2.469**	**0.4938**	**296.27**
4	**0.333**	**3.992**	**0.7983**	**478.99**
5	**0.417**	**5.794**	**1.1588**	**695.29**
6	**0.500**	**7.856**	**1.5713**	**942.76**



Note: The above calculation are based on LA Co. 2014 LID Design Criteria for Vegetated Swales

Grass Swale Calculations - Trapezoid Channel

Location: BMP No. 14 (Area A-2, A-3, A-13 and A-14)

Variables:

Design Flow (Q)=	**1.143**	cfs	
Manning's (n)=	**0.020**		*(**0.020** for frequnet and **0.024** for infrequent mowing)*
Slope (s)=	**0.010**	ft/ft	
Depth of Swale (H)=	**1.00**	ft	*(12" Minimum)*
Depth of Flow (y)=	**0.167**	ft	*(4" Maximum)*
Residence Time (t_r)=	**10.00**	minutes	*(10 Minutes Minimum)*
Sideslope (z)=	**3**	(value represents # : 1)	*(Maximum 3:1 H:V)*

Calculations: (Solving for Channel Geometrics)

1) Bottom Width of Trapezoid Channel (w_b):

$$w_b = \frac{Q*n}{(y^{1.67})*(s^{0.5})} - z*H$$

w_b= **1.54** ft

Use w_b= **2.00** ft

2) Top Width of Trapzoid Channel (w_t):

$w_t = w_b + 2*z*H$

w_t= **7.54** ft

3) Cross-Sectional Area (A_x):

$A_x = (w_b + z*H)*(H)$

A_x= **4.54** sf

4) Velocity of Swale Flow (v):

$$v = \frac{Q}{A_x}$$

v= **0.252** ft/s

(v must be less than 1 ft/s) **Yes**

5) Swale Length (L):

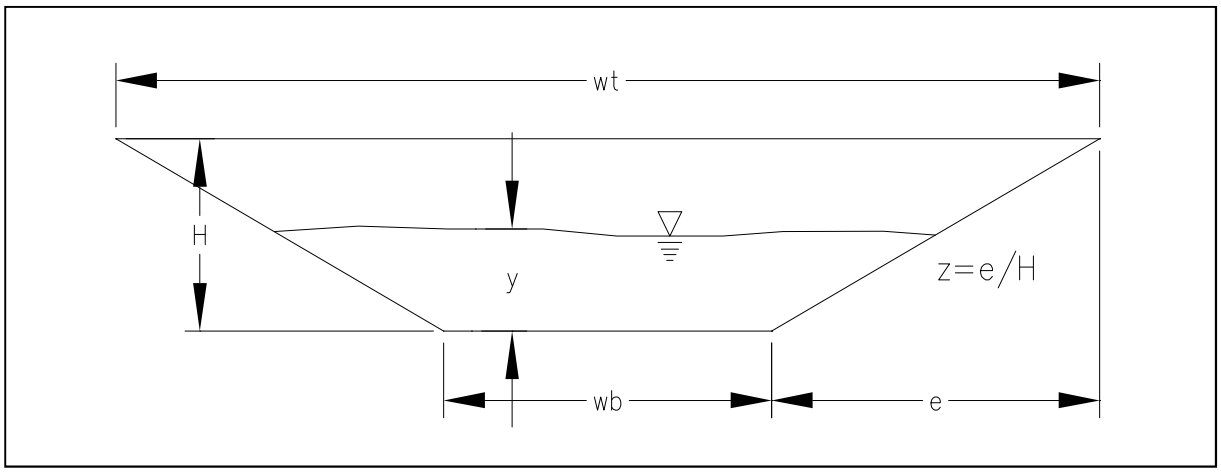
$L = v*t_r*(60\ s/min)$

L= **151.03** ft

(Minimum length is 100 ft)

Available Length= **200.00** ft

Sufficient length? (Yes/No): **Yes**



Note: The above calculation are based on LA Co. 2014 LID Design Criteria for Vegetated Swales

Grass Swale Calculations - Trapezoid Channel

Location: BMP No. 6 (Area A-10 and A-12)

Variables:

Design Flow (Q)=	**0.544**	cfs	
Manning's (n)=	**0.020**		*(**0.020** for frequnet and **0.024** for infrequent mowing)*
Slope (s)=	**0.010**	ft/ft	
Depth of Swale (H)=	**1.00**	ft	*(12" Minimum)*
Depth of Flow (y)=	**0.125**	ft	*(4" Maximum)*
Residence Time (t_r)=	**10.00**	minutes	*(10 Minutes Minimum)*
Sideslope (z)=	**3**	(value represents # : 1)	*(Maximum 3:1 H:V)*

Calculations: (Solving for Channel Geometrics)

1) Bottom Width of Trapezoid Channel (w_b):

$$w_b = \frac{Q*n}{(y^{1.67})*(s^{0.5})} - z*H$$

w_b= **0.50** ft

Use w_b= **2.00** ft

2) Top Width of Trapzoid Channel (w_t):

$w_t = w_b + 2*z*H$

w_t= **6.50** ft

3) Cross-Sectional Area (A_x):

$A_x = (w_b + z*H)*(H)$

A_x= **3.50** sf

4) Velocity of Swale Flow (v):

$$v = \frac{Q}{A_x}$$

v= **0.155** ft/s

(v must be less than 1 ft/s) **Yes**

5) Swale Length (L):

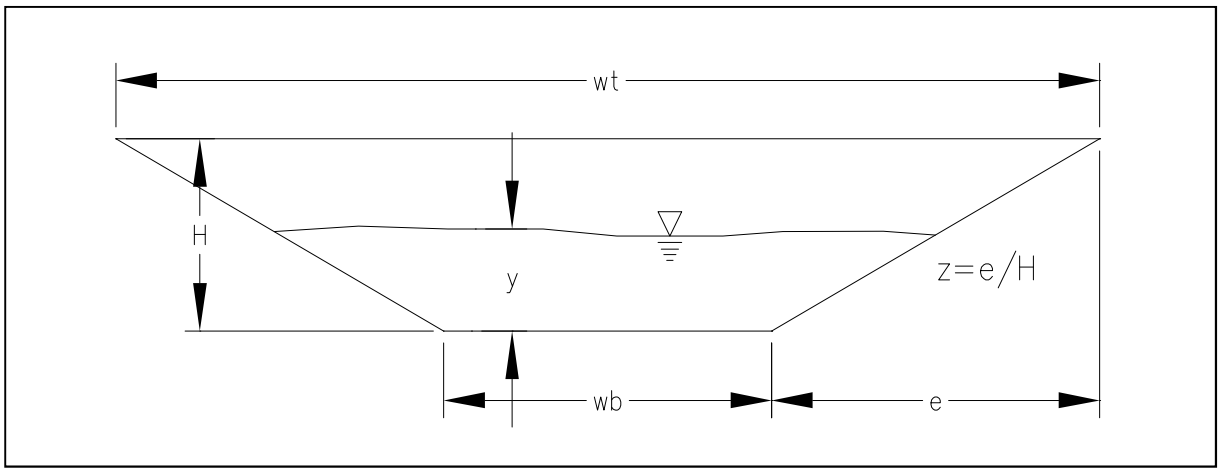
$L = v*t_r*(60\ s/min)$

L= **93.10** ft

(Minimum length is 100 ft)

Available Length= **120.00** ft

Sufficient length? (Yes/No): **Yes**



Note: The above calculation are based on LA Co. 2014 LID Design Criteria for Vegetated Swales

Grass Swale Calculations - Trapezoid Channel

Location: BMP No. 9 (Area A-7 and A-9)

Variables:

Design Flow (Q)=	**0.576**	cfs	
Manning's (n)=	**0.020**		*(**0.020** for frequnet and **0.024** for infrequent mowing)*
Slope (s)=	**0.010**	ft/ft	
Depth of Swale (H)=	**1.00**	ft	*(12" Minimum)*
Depth of Flow (y)=	**0.125**	ft	*(4" Maximum)*
Residence Time (t_r)=	**10.00**	minutes	*(10 Minutes Minimum)*
Sideslope (z)=	**3**	(value represents # : 1)	*(Maximum 3:1 H:V)*

Calculations: (Solving for Channel Geometrics)

1) Bottom Width of Trapezoid Channel (w_b):

$$w_b = \frac{Q*n}{(y^{1.67})*(s^{0.5})} - z*H$$

w_b= **0.71** ft

Use w_b= **2.00** ft

2) Top Width of Trapzoid Channel (w_t):

$w_t = w_b + 2*z*H$

w_t= **6.71** ft

3) Cross-Sectional Area (A_x):

$A_x = (w_b + z*H)*(H)$

A_x= **3.71** sf

4) Velocity of Swale Flow (v):

$$v = \frac{Q}{A_x}$$

v= **0.155** ft/s

(v must be less than 1 ft/s) **Yes**

5) Swale Length (L):

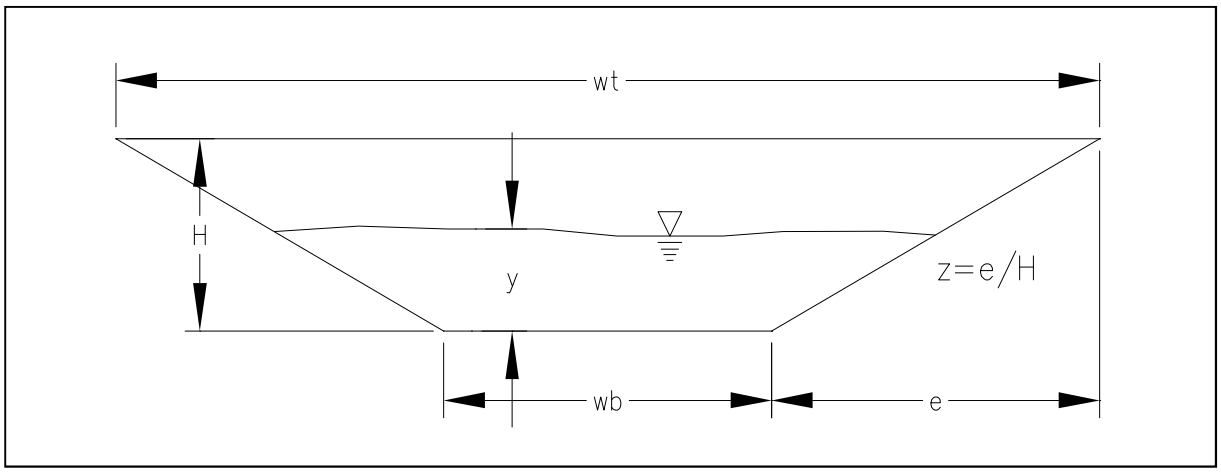
$L = v*t_r*(60\ s/min)$

L= **93.10** ft

(Minimum length is 100 ft)

Available Length= **140.00** ft

Sufficient length? (Yes/No): **Yes**



Note: The above calculation are based on LA Co. 2014 LID Design Criteria for Vegetated Swales

Biofiltration Basin
Sizing Calculations

Biofiltration Basin Calculations

Location: BMP No 1 (Areas A-1, A-8 and A-15)

Variables:

Soil Infiltration Rate (f)=	**2.00**	in/hr	*(Determined by Soils Report)*
Factor of Safety (FS)=	**2.00**		
Maximum Detention Time (t_{max})=	**48.00**	hr	*(96 hr Maximum)*
Porosity/Void Ratio (r)=	**0.35**		*(Ranges from 30-40%)*
Design Volume (V)=	**9574.00**	cf	
Ponding Depth (d_p)=	**1.250**	ft	*(Max. 1.5 ft)*

Calculations: (Solving for Depth of Reservoir Layer - d)

Design Infiltration Rate (f_{design})

$$f_{design} = \frac{f}{FS}$$

f_{design}= **1.00** in/hr

Maximum Depth of Stormwater Runoff (d_{max}):

$$d_{max} = \frac{f_{design} * t_{max}}{12}$$

d_{max}= **4.00** ft

Ponding Depth (d_p):

If $d_{max} >= d_p$, then use: **1.25** ft

If $d_{max} <= d_p$, then use: **4.00** ft

Use: **1.25** ft

Calculations: (Solving for Trench Bottom Surface Area - A)

Bottom Surface Area (A_s):

$$A_s = \frac{Q}{d_p}$$

A_s= **7659.20** square feet

Available Area= **8000.00** square feet

Sufficient area for Biofiltration? (Yes/No): **Yes**

Note: The above calculation are based on LA Co. 2014 LID Design Criteria for Bioretention and/or Biofiltration

Planter Box
Sizing Calculations

Planter Box Calculations

Location: BMP Nos 10 thru 12 (Area A-5)

Variables:

Soil Infiltration Rate (f)=	**5.00**	in/hr	*(Determined by Soils Report)*
Factor of Safety (FS)=	**2.00**		
Maximum Detention Time (t_{max})=	**48.00**	hr	*(96 hr Maximum)*
Porosity/Void Ratio (r)=	**0.35**		*(Ranges from 30-40%)*
Design Volume (V)=	**4704.50**	cf	
Ponding Depth (d_p)=	**1.500**	ft	*(Max. 1.5 ft)*

Calculations: (Solving for Depth of Reservoir Layer - d)

Design Infiltration Rate (f_{design})

$$f_{design} = \frac{f}{FS}$$

f_{design}= **2.5** in/hr

Maximum Depth of Stormwater Runoff (d_{max}):

$$d_{max} = \frac{f_{design} * t_{max}}{12}$$

d_{max}= **10.0** ft

Ponding Depth (d_p):

If $d_{max} >= d_p$, then use: **1.5** ft

If $d_{max} <= d_p$, then use: **10.0** ft

Use: **1.5** ft

Calculations: (Solving for Trench Bottom Surface Area - A)

Bottom Surface Area (A_s):

$$A_s = \frac{Q}{d_p}$$

A_s= **3136.33** square feet

Total Available Area= **576.00** square feet

Sufficient area of Planter Boxes? (Yes/No): **No**

Note: Overflow from planter boxes shall be directed toward vegetated swale.

Note: The above calculation are based on LA Co. 2014 LID Design Criteria for Bioretention and/or Biofiltration

Planter Box Calculations

Location: BMP Nos 4 and 5 (Area A-10)

Variables:

Soil Infiltration Rate (f)=	**5.00**	in/hr	*(Determined by Soils Report)*
Factor of Safety (FS)=	**2.00**		
Maximum Detention Time (t_{max})=	**48.00**	hr	*(96 hr Maximum)*
Porosity/Void Ratio (r)=	**0.35**		*(Ranges from 30-40%)*
Design Volume (V)=	**3261.08**	cf	
Ponding Depth (d_p)=	**1.500**	ft	*(Max. 1.5 ft)*

Calculations: (Solving for Depth of Reservoir Layer - d)

Design Infiltration Rate (f_{design})

$$f_{design} = \frac{f}{FS}$$

f_{design}= **2.5** in/hr

Maximum Depth of Stormwater Runoff (d_{max}):

$$d_{max} = \frac{f_{design} * t_{max}}{12}$$

d_{max}= **10.0** ft

Ponding Depth (d_p):

If $d_{max} >= d_p$, then use: **1.5** ft

If $d_{max} <= d_p$, then use: **10.0** ft

Use: **1.5** ft

Calculations: (Solving for Trench Bottom Surface Area - A)

Bottom Surface Area (A_s):

$$A_s = \frac{Q}{d_p}$$

A_s= **2174.05** square feet

Total Available Area= **400.00** square feet

Sufficient area of Planter Boxes? (Yes/No): **No**

Note: Overflow from planter boxes shall be directed toward vegetated swale.

Note: The above calculation are based on LA Co. 2014 LID Design Criteria for Bioretention and/or Biofiltration

Planter Box Calculations

Location: BMP Nos 7 and 8 (Area A-7)

Variables:

Soil Infiltration Rate (f)=	**5.00**	in/hr	*(Determined by Soils Report)*
Factor of Safety (FS)=	**2.00**		
Maximum Detention Time (t_{max})=	**48.00**	hr	*(96 hr Maximum)*
Porosity/Void Ratio (r)=	**0.35**		*(Ranges from 30-40%)*
Design Volume (V)=	**3421.46**	cf	
Ponding Depth (d_p)=	**1.500**	ft	*(Max. 1.5 ft)*

Calculations: (Solving for Depth of Reservoir Layer - d)

Design Infiltration Rate (f_{design})

$$f_{design} = \frac{f}{FS}$$

f_{design}= **2.5** in/hr

Maximum Depth of Stormwater Runoff (d_{max}):

$$d_{max} = \frac{f_{design} * t_{max}}{12}$$

d_{max}= **10.0** ft

Ponding Depth (d_p):

If $d_{max} >= d_p$, then use: **1.5** ft

If $d_{max} <= d_p$, then use: **10.0** ft

Use: **1.5** ft

Calculations: (Solving for Trench Bottom Surface Area - A)

Bottom Surface Area (A_s):

$$A_s = \frac{Q}{d_p}$$

A_s= **2280.97** square feet

Total Available Area= **400.00** square feet

Sufficient area of Planter Boxes? (Yes/No): **No**

Note: Overflow from planter boxes shall be directed toward vegetated swale.

Note: The above calculation are based on LA Co. 2014 LID Design Criteria for Bioretention and/or Biofiltration

Modular Wetlands Inlet Device
Sizing Calculations

Flow Based Sizing

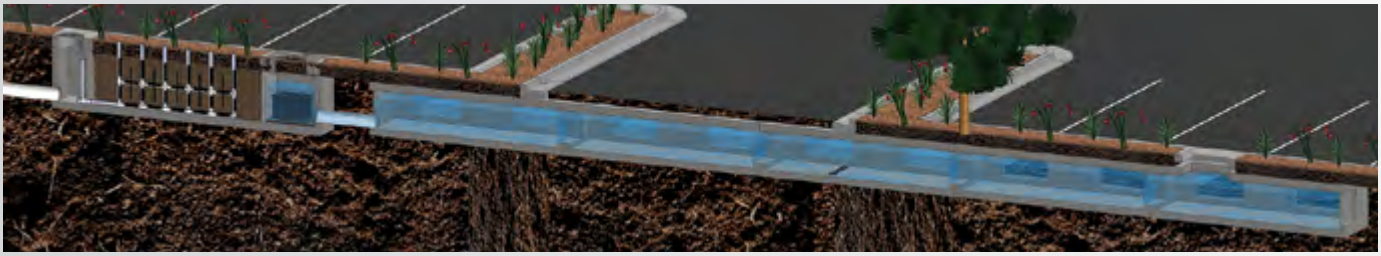
The MWS Linear can be used in stand alone applications to meet treatment flow requirements. Since the MWS Linear is the only biofiltration system that can accept inflow pipes several feet below the surface it can be used not only in decentralized design applications but also as a large central end-of-the-line application for maximum feasibility.

Treatment Flow Sizing Table

Model #	Dimensions	WetlandMedia Surface Area	Treatment Flow Rate (cfs)
MWS-L-4-4	4' x 4'	23 ft^2	0.052
MWS-L-4-6	4' x 6'	32 ft^2	0.073
MWS-L-4-8	4' x 8'	50 ft^2	0.115
MWS-L-4-13	4' x 13'	63 ft^2	0.144
MWS-L-4-15	4' x 15'	76 ft^2	0.175
MWS-L-4-17	4' x 17'	90 ft^2	0.206
MWS-L-4-19	4' x 19'	103 ft^2	0.237
MWS-L-4-21	4' x 21'	117 ft^2	0.268
MWS-L-8-8	8' x 8'	100 ft^2	0.230
MWS-L-8-12	8' x 12'	151 ft^2	0.346
MWS-L-8-16	8' x 16'	201 ft^2	0.462

Volume Based Sizing

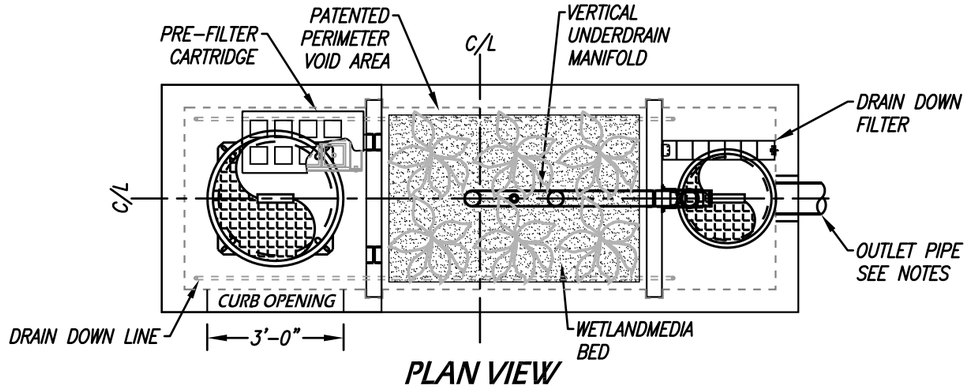
Many states require treatment of a water quality volume and do not offer the option of flow based design. The MWS Linear and its unique horizontal flow makes it the only biofilter that can be used in volume based design installed downstream of ponds, detention basins, and underground storage systems.



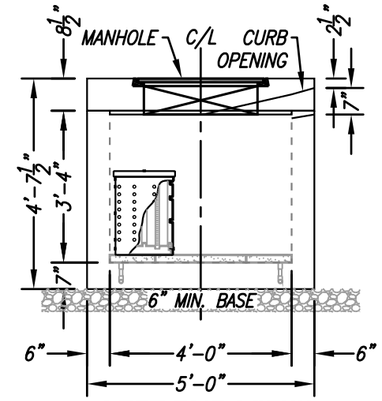
Treatment Volume Sizing Table

Model #	Treatment Capacity (cu. ft.) @ 24-Hour Drain Down	Treatment Capacity (cu. ft.) @ 48-Hour Drain Down
MWS-L-4-4	1140	2280
MWS-L-4-6	1600	3200
MWS-L-4-8	2518	5036
MWS-L-4-13	3131	6261
MWS-L-4-15	3811	7623
MWS-L-4-17	4492	8984
MWS-L-4-19	5172	10345
MWS-L-4-21	5853	11706
MWS-L-8-8	5036	10072
MWS-L-8-12	7554	15109
MWS-L-8-16	10073	20145

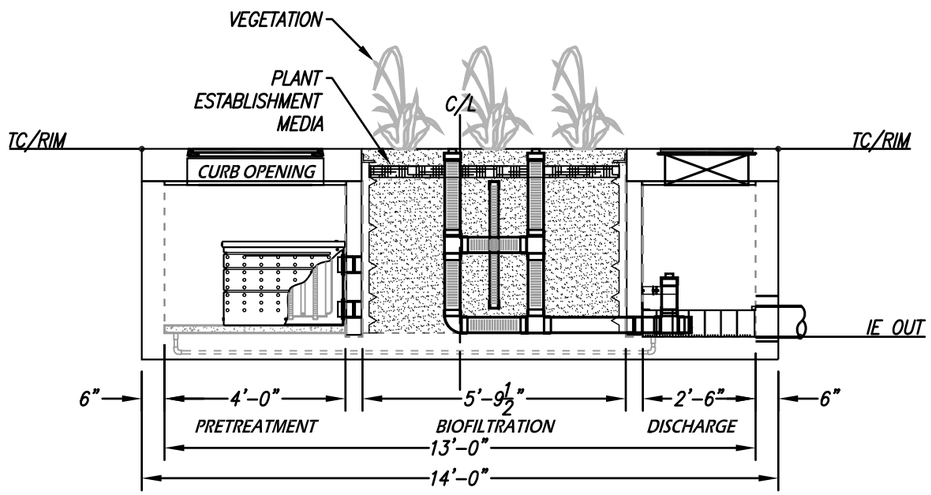
SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			3.05
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø1.71"
MAXIMUM PICK WEIGHT (LBS)			27000
NOTES:			



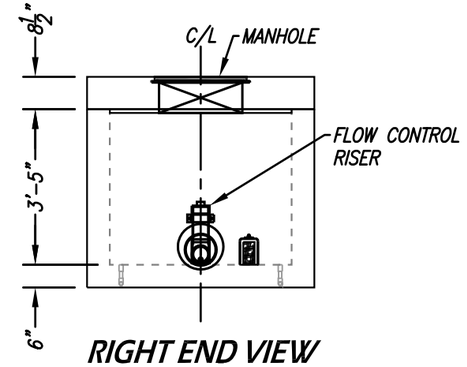
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON–SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.

TREATMENT FLOW (CFS)	0.144
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

THE PRODUCT DESCRIBED MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 7,425,262; 7,470,362; 7,674,378; 8,303,816; RELATED FOREIGN PATENTS OR OTHER PATENTS PENDING

PROPRIETARY AND CONFIDENTIAL:

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MWS-L-4-13-C
STORMWATER BIOFILTRATION SYSTEM STANDARD DETAIL

Attachment B
Best Management Practices (BMPs) Fact Sheets

Media Filter MP-40

General Description

Stormwater media filters are usually two-chambered including a pretreatment settling basin and a filter bed filled with sand or other absorptive filtering media. As stormwater flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as stormwater flows through the filtering media in the second chamber.

There are currently three manufacturers of stormwater filter systems. Two are similar in that they use cartridges of a standard size. The cartridges are placed in vaults; the number of cartridges a function of the design flow rate. The water flows laterally (horizontally) into the cartridge to a centerwell, then downward to an underdrain system. The third product is a flatbed filter, similar in appearance to sand filters.

Inspection/Maintenance Considerations

Media filters may exhibit decreased effectiveness after a few years of operation, depending on the activities occurring in the drainage area. Media filters clog easily when subjected to high sediment loads. Sediment reducing pretreatment practices, such as vegetated buffer strips or vegetated swales, placed upstream of the filter should be maintained properly to reduce sediment loads into filter. Media filters can become a nuisance due to mosquito or midge breeding if not properly designed and maintained. Installations should dewater completely (recommended 72 hour or less residence time) to prevent creating mosquito and other vector habitats. Maintenance efforts will need to focus on basic housekeeping practices such as removal of debris accumulations and vegetation management (in filter media) to prevent clogs and/or pods of standing water. To minimize the potential for clogging, frequent maintenance and inspection practices are required. Waste sand, gravel, filter cloth, or filter media must be disposed of properly and in accordance with all applicable laws.

Maintenance Concerns, Objectives, and Goals

- Pollutant Breakthrough
- Clogged of Sand Media
- Trash and Debris Accumulation

Targeted Constituents

- ✓ Sediment
- ✓ Nutrients
- ✓ Trash
- ✓ Metals
- Bacteria
- ✓ Oil and Grease
- ✓ Organics

Removal Effectiveness

See New Development and Redevelopment Handbook-Section 5.

CASQA California Stormwater Quality Association

Inspection Activities	Suggested Frequency
■ During the first year of operation, inspect chambers quarterly to ensure that the system is functioning properly. ■ Inspect sand filters after every major storm in the first few months after construction to ensure that the system is functioning properly.	Post construction
■ Ensure that filter surface, inlets, and outlets are clear of debris. ■ Ensure that the contributing area is stabilized and mowed, with clippings removed. ■ Check to ensure that the filter surface is not clogging. ■ Ensure that activities in the drainage area minimize oil/grease and sediment entry to the system. ■ Inspect the facility once during the wet season after a large rain event to determine whether the facility is draining completely within 72 hr.	Quarterly, and after major storms
■ Inspect for standing water, sediment, trash and debris, structural damage, and to identify potential problems.	Semi-annual
■ Check to see that the filter bed is clean of sediments and the sediment chamber contains no more than six inches of sediment. ■ Make sure that there is no evidence of deterioration of concrete structures. ■ Inspect grates (if used). ■ Inspect inlets, outlets, and overflow spillway to ensure good condition and no evidence of erosion. ■ Ensure that flow is not bypassing the facility. ■ Ensure that no noticeable odors are detected outside the facility.	Annual
Maintenance Activities	**Suggested Frequency**
■ Remove trash and debris from the sedimentation basin (Austin design), the riser pipe, and the filter bed as needed. ■ Prevent grass clippings from washing into the filter. ■ Remove trash from inlet grates to maintain the inflow capacity of the media filter. ■ Upstream vegetation should be maintained as needed.	Frequently (as needed)
■ Clean filter surface semiannually; or more often if watershed is excessively erosive. ■ Replace sorbent pillows (Multi-Chamber Treatment Train only).	Semi-annual
■ Repair or replace any damaged structural parts. ■ Stabilize any eroded areas.	Annual
■ Remove accumulated sediment in the sedimentation chamber every 10 years or when the sediment occupies 10-20% of the basin volume or accumulates to a depth of six inches, whichever is less. ■ Remove top 2 in. of media filter and landfill if facility drain time exceeds 72 hr. Restore media depth to 18 in. when overall media depth drops to 12 in.).	As needed

References

Metropolitan Council, Urban Small Sites Best Management Practices Manual. Available at: http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm

U.S. Environmental Protection Agency, Post-Construction Stormwater Management in New Development & Redevelopment BMP Factsheets. Available at: http://www.cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_files.cfm

Ventura Countywide Stormwater Quality Management Program, Technical Guidance Manual for Stormwater Quality Control Measures. July, 2002.

Site Design & Landscape Planning SD-10

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.

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Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Roof Runoff Controls SD-11

Rain Garden

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Description

Various roof runoff controls are available to address stormwater that drains off rooftops. The objective is to reduce the total volume and rate of runoff from individual lots, and retain the pollutants on site that may be picked up from roofing materials and atmospheric deposition. Roof runoff controls consist of directing the roof runoff away from paved areas and mitigating flow to the storm drain system through one of several general approaches: cisterns or rain barrels; dry wells or infiltration trenches; pop-up emitters, and foundation planting. The first three approaches require the roof runoff to be contained in a gutter and downspout system. Foundation planting provides a vegetated strip under the drip line of the roof.

Approach

Design of individual lots for single-family homes as well as lots for higher density residential and commercial structures should consider site design provisions for containing and infiltrating roof runoff or directing roof runoff to vegetative swales or buffer areas. Retained water can be reused for watering gardens, lawns, and trees. Benefits to the environment include reduced demand for potable water used for irrigation, improved stormwater quality, increased groundwater recharge, decreased runoff volume and peak flows, and decreased flooding potential.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

One method of addressing roof runoff is to direct roof downspouts to cisterns or rain barrels. A cistern is an above ground storage vessel with either a manually operated valve or a permanently open outlet. Roof runoff is temporarily stored and then released for irrigation or infiltration between storms. The number of rain

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barrels needed is a function of the rooftop area. Some low impact developers recommend that every house have at least 2 rain barrels, with a minimum storage capacity of 1000 liters. Roof barrels serve several purposes including mitigating the first flush from the roof which has a high volume, amount of contaminants, and thermal load. Several types of rain barrels are commercially available. Consideration must be given to selecting rain barrels that are vector proof and childproof. In addition, some barrels are designed with a bypass valve that filters out grit and other contaminants and routes overflow to a soak-away pit or rain garden.

If the cistern has an operable valve, the valve can be closed to store stormwater for irrigation or infiltration between storms. This system requires continual monitoring by the resident or grounds crews, but provides greater flexibility in water storage and metering. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern must be covered to prevent mosquitoes from breeding.

A cistern system with a permanently open outlet can also provide for metering stormwater runoff. If the cistern outlet is significantly smaller than the size of the downspout inlet (say ¼ to ½ inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. This is a feasible way to mitigate the peak flow increases caused by rooftop impervious land coverage, especially for the frequent, small storms.

Dry wells and Infiltration Trenches

Roof downspouts can be directed to dry wells or infiltration trenches. A dry well is constructed by excavating a hole in the ground and filling it with an open graded aggregate, and allowing the water to fill the dry well and infiltrate after the storm event. An underground connection from the downspout conveys water into the dry well, allowing it to be stored in the voids. To minimize sedimentation from lateral soil movement, the sides and top of the stone storage matrix can be wrapped in a permeable filter fabric, though the bottom may remain open. A perforated observation pipe can be inserted vertically into the dry well to allow for inspection and maintenance.

In practice, dry wells receiving runoff from single roof downspouts have been successful over long periods because they contain very little sediment. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top (maximum depth of 10 feet).

To protect the foundation, dry wells must be set away from the building at least 10 feet. They must be installed in solids that accommodate infiltration. In poorly drained soils, dry wells have very limited feasibility.

Infiltration trenches function in a similar manner and would be particularly effective for larger roof areas. An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. These are described under Treatment Controls.

Pop-up Drainage Emitter

Roof downspouts can be directed to an underground pipe that daylights some distance from the building foundation, releasing the roof runoff through a pop-up emitter. Similar to a pop-up irrigation head, the emitter only opens when there is flow from the roof. The emitter remains flush to the ground during dry periods, for ease of lawn or landscape maintenance.

Foundation Planting

Landscape planting can be provided around the base to allow increased opportunities for stormwater infiltration and protect the soil from erosion caused by concentrated sheet flow coming off the roof. Foundation plantings can reduce the physical impact of water on the soil and provide a subsurface matrix of roots that encourage infiltration. These plantings must be sturdy enough to tolerate the heavy runoff sheet flows, and periodic soil saturation.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Supplemental Information

Examples

- City of Ottawa's Water Links Surface –Water Quality Protection Program
- City of Toronto Downspout Disconnection Program
- City of Boston, MA, Rain Barrel Demonstration Program

Other Resources

Hager, Marty Catherine, Stormwater, "Low-Impact Development", January/February 2003. www.stormh2o.com

Low Impact Urban Design Tools, Low Impact Development Design Center, Beltsville, MD. www.lid-stormwater.net

Start at the Source, Bay Area Stormwater Management Agencies Association, 1999 Edition

Efficient Irrigation SD-12

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Irrigation water provided to landscaped areas may result in excess irrigation water being conveyed into stormwater drainage systems.

Approach

Project plan designs for development and redevelopment should include application methods of irrigation water that minimize runoff of excess irrigation water into the stormwater conveyance system.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Designing New Installations

The following methods to reduce excessive irrigation runoff should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

- Employ rain-triggered shutoff devices to prevent irrigation after precipitation.
- Design irrigation systems to each landscape area's specific water requirements.
- Include design featuring flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- Implement landscape plans consistent with County or City water conservation resolutions, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

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- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:
  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff
  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect
  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible
  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth
- Employ other comparable, equally effective methods to reduce irrigation water runoff.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Storm Drain Signage SD-13

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include "NO DUMPING

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– DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.

- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

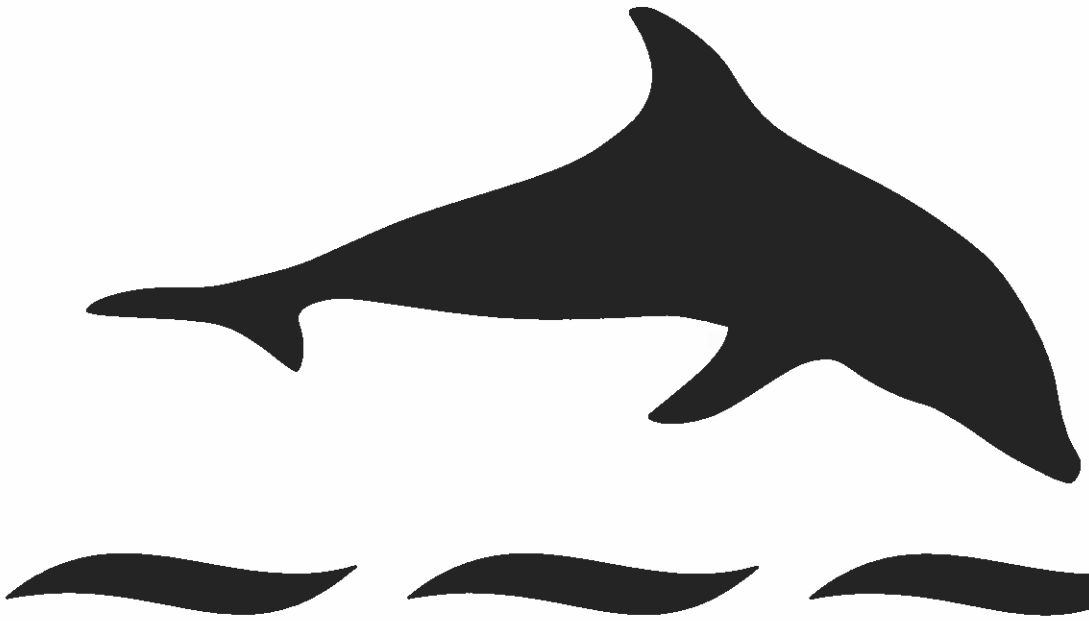
Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Sample Stencil 1

NO DUMPING



DRAINS TO OCEAN

Sample Stencil 2

Pervious Pavements SD-20

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Pervious paving is used for light vehicle loading in parking areas. The term describes a system comprising a load-bearing, durable surface together with an underlying layered structure that temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface can itself be porous such that water infiltrates across the entire surface of the material (e.g., grass and gravel surfaces, porous concrete and porous asphalt), or can be built up of impermeable blocks separated by spaces and joints, through which the water can drain. This latter system is termed 'permeable' paving. Advantages of pervious pavements is that they reduce runoff volume while providing treatment, and are unobtrusive resulting in a high level of acceptability.

Approach

Attenuation of flow is provided by the storage within the underlying structure or sub base, together with appropriate flow controls. An underlying geotextile may permit groundwater recharge, thus contributing to the restoration of the natural water cycle. Alternatively, where infiltration is inappropriate (e.g., if the groundwater vulnerability is high, or the soil type is unsuitable), the surface can be constructed above an impermeable membrane. The system offers a valuable solution for drainage of spatially constrained urban areas.

Significant attenuation and improvement in water quality can be achieved by permeable pavements, whichever method is used. The surface and subsurface infrastructure can remove both the soluble and fine particulate pollutants that occur within urban runoff. Roof water can be piped into the storage area directly, adding areas from which the flow can be attenuated. Also, within lined systems, there is the opportunity for stored runoff to be piped out for reuse.

Suitable Applications

Residential, commercial and industrial applications are possible. The use of permeable pavement may be restricted in cold regions, arid regions or regions with high wind erosion. There are some specific disadvantages associated with permeable pavement, which are as follows:

- Permeable pavement can become clogged if improperly installed or maintained. However, this is countered by the ease with which small areas of paving can be cleaned or replaced when blocked or damaged.
- Their application should be limited to highways with low traffic volumes, axle loads and speeds (less than 30 mph limit), car parking areas and other lightly trafficked or non-trafficked areas. Permeable surfaces are currently not considered suitable for adoptable roads due to the risks associated with failure on high speed roads, the safety implications of ponding, and disruption arising from reconstruction.
- When using un-lined, infiltration systems, there is some risk of contaminating groundwater, depending on soil conditions and aquifer susceptibility. However, this risk is likely to be small because the areas drained tend to have inherently low pollutant loadings.
- The use of permeable pavement is restricted to gentle slopes.
- Porous block paving has a higher risk of abrasion and damage than solid blocks.

Design Considerations

Designing New Installations

If the grades, subsoils, drainage characteristics, and groundwater conditions are suitable, permeable paving may be substituted for conventional pavement on parking areas, cul de sacs and other areas with light traffic. Slopes should be flat or very gentle. Scottish experience has shown that permeable paving systems can be installed in a wide range of ground conditions, and the flow attenuation performance is excellent even when the systems are lined.

The suitability of a pervious system at a particular pavement site will, however, depend on the loading criteria required of the pavement.

Where the system is to be used for infiltrating drainage waters into the ground, the vulnerability of local groundwater sources to pollution from the site should be low, and the seasonal high water table should be at least 4 feet below the surface.

Ideally, the pervious surface should be horizontal in order to intercept local rainfall at source. On sloping sites, pervious surfaces may be terraced to accommodate differences in levels.

Design Guidelines

The design of each layer of the pavement must be determined by the likely traffic loadings and their required operational life. To provide satisfactory performance, the following criteria should be considered:

- The subgrade should be able to sustain traffic loading without excessive deformation.
- The granular capping and sub-base layers should give sufficient load-bearing to provide an adequate construction platform and base for the overlying pavement layers.
- The pavement materials should not crack of suffer excessive rutting under the influence of traffic. This is controlled by the horizontal tensile stress at the base of these layers.

There is no current structural design method specifically for pervious pavements. Allowances should be considered the following factors in the design and specification of materials:

- Pervious pavements use materials with high permeability and void space. All the current UK pavement design methods are based on the use of conventional materials that are dense and relatively impermeable. The stiffness of the materials must therefore be assessed.
- Water is present within the construction and can soften and weaken materials, and this must be allowed for.
- Existing design methods assume full friction between layers. Any geotextiles or geomembranes must be carefully specified to minimize loss of friction between layers.
- Porous asphalt loses adhesion and becomes brittle as air passes through the voids. Its durability is therefore lower than conventional materials.

The single sized grading of materials used means that care should be taken to ensure that loss of finer particles between unbound layers does not occur.

Positioning a geotextile near the surface of the pervious construction should enable pollutants to be trapped and retained close to the surface of the construction. This has both advantages and disadvantages. The main disadvantage is that the filtering of sediments and their associated pollutants at this level may hamper percolation of waters and can eventually lead to surface ponding. One advantage is that even if eventual maintenance is required to reinstate infiltration, only a limited amount of the construction needs to be disturbed, since the sub-base below the geotextile is protected. In addition, the pollutant concentration at a high level in the structure allows for its release over time. It is slowly transported in the stormwater to lower levels where chemical and biological processes may be operating to retain or degrade pollutants.

The design should ensure that sufficient void space exists for the storage of sediments to limit the period between remedial works.

- Pervious pavements require a single size grading to give open voids. The choice of materials is therefore a compromise between stiffness, permeability and storage capacity.
- Because the sub-base and capping will be in contact with water for a large part of the time, the strength and durability of the aggregate particles when saturated and subjected to wetting and drying should be assessed.
- A uniformly graded single size material cannot be compacted and is liable to move when construction traffic passes over it. This effect can be reduced by the use of angular crushed rock material with a high surface friction.

In pollution control terms, these layers represent the site of long term chemical and biological pollutant retention and degradation processes. The construction materials should be selected, in addition to their structural strength properties, for their ability to sustain such processes. In general, this means that materials should create neutral or slightly alkaline conditions and they should provide favorable sites for colonization by microbial populations.

Construction/Inspection Considerations

- Permeable surfaces can be laid without cross-falls or longitudinal gradients.
- The blocks should be lain level
- They should not be used for storage of site materials, unless the surface is well protected from deposition of silt and other spillages.
- The pavement should be constructed in a single operation, as one of the last items to be built, on a development site. Landscape development should be completed before pavement construction to avoid contamination by silt or soil from this source.
- Surfaces draining to the pavement should be stabilized before construction of the pavement.
- Inappropriate construction equipment should be kept away from the pavement to prevent damage to the surface, sub-base or sub-grade.

Maintenance Requirements

The maintenance requirements of a pervious surface should be reviewed at the time of design and should be clearly specified. Maintenance is required to prevent clogging of the pervious surface. The factors to be considered when defining maintenance requirements must include:

- Type of use
- Ownership
- Level of trafficking
- The local environment and any contributing catchments

Studies in the UK have shown satisfactory operation of porous pavement systems without maintenance for over 10 years and recent work by Imbe et al. at 9th ICUD, Portland, 2002 describes systems operating for over 20 years without maintenance. However, performance under such regimes could not be guaranteed, Table 1 shows typical recommended maintenance regimes:

Table 1 Typical Recommended Maintenance Regimes	
Activity	**Schedule**
■ Minimize use of salt or grit for de-icing ■ Keep landscaped areas well maintained ■ Prevent soil being washed onto pavement	Ongoing
■ Vacuum clean surface using commercially available sweeping machines at the following times: - End of winter (April) - Mid-summer (July / August) - After Autumn leaf-fall (November)	2/3 x per year
■ Inspect outlets	Annual
■ If routine cleaning does not restore infiltration rates, then reconstruction of part of the whole of a pervious surface may be required. ■ The surface area affected by hydraulic failure should be lifted for inspection of the internal materials to identify the location and extent of the blockage. ■ Surface materials should be lifted and replaced after brush cleaning. Geotextiles may need complete replacement. ■ Sub-surface layers may need cleaning and replacing. ■ Removed silts may need to be disposed of as controlled waste.	As needed (infrequent) Maximum 15-20 years

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 1 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Cost Considerations

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 2 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

Table 2 Engineer's Estimate for Porous Pavement

Porous Pavement													
Item	Units	Price	Cycles/ Year	Quant. 1 Acre WS	Total	Quant. 2 Acre WS	Total	Quant. 3 Acre WS	Total	Quant. 4 Acre WS	Total	Quant. 5 Acre WS	Total
Grading	SY	$2.00		604	$1,208	1209	$2,418	1812	$3,624	2419	$4,838	3020	$6,040
Paving	SY	$19.00		212	$4,028	424	$8,056	636	$12,084	848	$16,112	1060	$20,140
Excavation	CY	$3.60		201	$724	403	$1,451	604	$2,174	806	$2,902	1008	$3,629
Filter Fabric	SY	$1.15		700	$805	1400	$1,610	2000	$2,300	2800	$3,220	3600	$4,140
Stone Fill	CY	$16.00		201	$3,216	403	$6,448	604	$9,664	806	$12,896	1008	$16,128
Sand	CY	$7.00		100	$700	200	$1,400	300	$2,100	400	$2,800	500	$3,500
Sight Well	EA	$300.00		2	$600	3	$900	4	$1,200	7	$2,100	7	$2,100
Seeding	LF	$0.05		644	$32	1288	$64	1932	$97	2576	$129	3220	$161
Check Dam	CY	$35.00		0	$0	0	$0	0	$0	0	$0	0	$0
Total Construction Costs					**$10,105**		**$19,929**		**$29,619**		**$40,158**		**$49,798**
Construction Costs Amortized for 20 Years					**$505**		**$996**		**$1,481**		**$2,008**		**$2,490**
Annual Maintenance Expense													
Item	Units	Price	Cycles/ Year	Quant. 1 Acre WS	Total	Quant. 2 Acre WS	Total	Quant. 3 Acre WS	Total	Quant. 4 Acre WS	Total	Quant. 5 Acre WS	Total
Sweeping	AC	$250.00	6	1	$1,500	2	$3,000	3	$4,500	4	$6,000	5	$7,500
Washing	AC	$250.00	6	1	$1,500	2	$3,000	3	$4,500	4	$6,000	5	$7,500
Inspection	MH	$20.00	5	5	$100	5	$100	5	$100	5	$100	5	$100
Deep Clean	AC	$450.00	0.5	1	$225	2	$450	3	$675	3.9	$878	5	$1,125
Total Annual Maintenance Expense					**$3,960**		**$7,792**		**$11,651**		**$15,483**		**$19,370**

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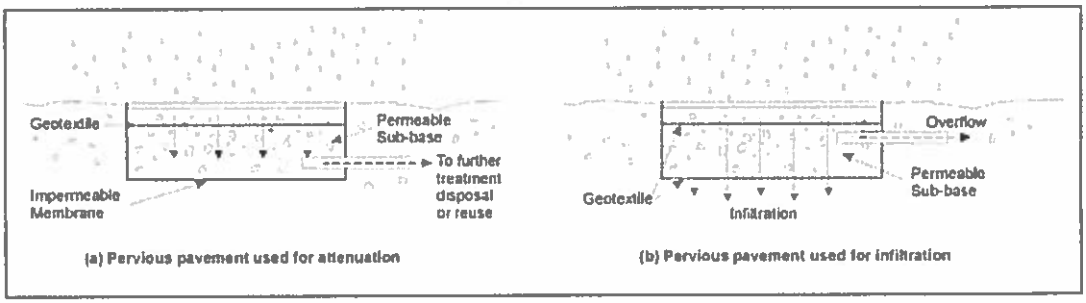

Schematics of a Pervious Pavement System

Maintenance Bays & Docks SD-31

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Description

Several measures can be taken to prevent operations at maintenance bays and loading docks from contributing a variety of toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to the stormwater conveyance system.

Approach

In designs for maintenance bays and loading docks, containment is encouraged. Preventative measures include overflow containment structures and dead-end sumps. However, in the case of loading docks from grocery stores and warehouse/distribution centers, engineered infiltration systems may be considered.

Suitable Applications

Appropriate applications include commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for vehicle maintenance and repair are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code requirements.

Designing New Installations

Designs of maintenance bays should consider the following:

- Repair/maintenance bays and vehicle parts with fluids should be indoors; or designed to preclude urban run-on and runoff.
- Repair/maintenance floor areas should be paved with Portland cement concrete (or equivalent smooth impervious surface).

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- Repair/maintenance bays should be designed to capture all wash water leaks and spills. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around repair bays to prevent spilled materials and wash-down waters form entering the storm drain system. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.
- Other features may be comparable and equally effective.

The following designs of loading/unloading dock areas should be considered:

- Loading dock areas should be covered, or drainage should be designed to preclude urban run-on and runoff.
- Direct connections into storm drains from depressed loading docks (truck wells) are prohibited.
- Below-grade loading docks from grocery stores and warehouse/distribution centers of fresh food items should drain through water quality inlets, or to an engineered infiltration system, or an equally effective alternative. Pre-treatment may also be required.
- Other features may be comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Trash Storage Areas SD-32

Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

Designing New Installations

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Maintenance Considerations

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Vegetated Swale TC-30

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	●
☑	Metals	▲
☑	Bacteria	●
☑	Oil and Grease	▲
☑	Organics	▲

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

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- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

Table 1 Grassed swale pollutant removal efficiency data							
	Removal Efficiencies (% Removal)						
Study	TSS	TP	TN	NO_3	Metals	Bacteria	Type
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.
- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.
- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.
- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.
- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately $0.25 per ft². This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately $0.50 per ft², which compares favorably with other stormwater management practices.

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b]	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c]	Acre	0.25	$3,800	$5,200	$6,600	$950	$1,300	$1,650
General Excavation[d]	Yd^3	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e]	Yd^2	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil Seed, and Mulch[f]	Yd^2	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Sod[g]	Yd^2	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Subtotal	--	–	--	–	--	$5,116	$9,388	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	–	--	–	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $\left(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}\right) \times$ swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Table 3 Estimated Maintenance Costs (SEWRPC. 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	$0.85 / 1,000 ft²/ mowing	$0.14 / linear foot	$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	$9.00 / 1,000 ft²/ year	$0.18 / linear foot	$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	$0.10 / linear foot / year	$0.10 / linear foot	$0.10 / linear foot	--
Grass Reseeding with Mulch and Fertilizer	$0.30 / yd²	$0.01 / linear foot	$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	$0.15 / linear foot / year, plus $25 / inspection	$0.15 / linear foot	$0.15 / linear foot	Inspect four times per year
Total	--	$0.58 / linear foot	$ 0.75 / linear foot	--

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

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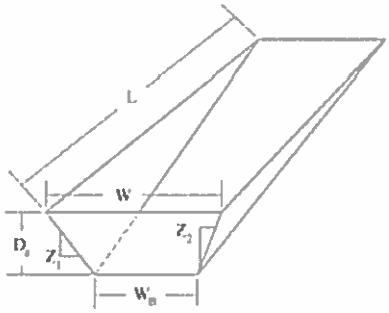
Provide for scour protection.

(a) Cross section of swale with check dam.



(b) Dimensional view of swale impoundment area.

Notation:
L = Length of swale impoundment area per check dam (ft)
D_s = Depth of check dam (ft)
S_s = Bottom slope of swale (ft/ft)
W = Top width of check dam (ft)
W_B = Bottom width of check dam (ft)
$Z_{1&2}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

Bioretention TC-32

Maintenance Concerns, Objectives, and Goals

- Clogged Soil or Outlet Structures
- Invasive Species
- Vegetation/Landscape Maintenance
- Erosion
- Channelization of Flow
- Aesthetics

General Description

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through a sand bed and is subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

Targeted Constituents

✓ Sediment	■
✓ Nutrients	▲
✓ Trash	■
✓ Metals	■
✓ Bacteria	■
✓ Oil and Grease	■
✓ Organics	■

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

Inspection/Maintenance Considerations

Bioretention requires frequent landscaping maintenance, including measures to ensure that the area is functioning properly, as well as maintenance of the landscaping on the practice. In many cases, bioretention areas initially require intense maintenance, but less maintenance is needed over time. In many cases, maintenance tasks can be completed by a landscaping contractor, who may already be hired at the site. In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

CASQA California Stormwater Quality Association

Inspection Activities	Suggested Frequency
■ Inspect soil and repair eroded areas.	Monthly
■ Inspect for erosion or damage to vegetation, preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the strips are ready for winter. However, additional inspection after periods of heavy runoff is desirable.	Semi-annual inspection
■ Inspect to ensure grass is well established. If not, either prepare soil and reseed or replace with alternative species. Install erosion control blanket.	
■ Check for debris and litter, and areas of sediment accumulation.	
■ Inspect health of trees and shrubs.	
Maintenance Activities	**Suggested Frequency**
■ Water plants daily for 2 weeks.	At project completion
■ Remove litter and debris.	Monthly
■ Remove sediment.	As needed
■ Remulch void areas.	
■ Treat diseased trees and shrubs.	
■ Mow turf areas.	
■ Repair erosion at inflow points.	
■ Repair outflow structures.	
■ Unclog underdrain.	
■ Regulate soil pH regulation.	
■ Remove and replace dead and diseased vegetation.	Semi-annual
■ Add mulch.	Annual
■ Replace tree stakes and wires.	
■ Mulch should be replaced every 2 to 3 years or when bare spots appear. Remulch prior to the wet season.	Every 2-3 years, or as needed

Additional Information

Landscaping is critical to the function and aesthetic value of bioretention areas. It is preferable to plant the area with native vegetation, or plants that provide habitat value, where possible. Another important design feature is to select species that can withstand the hydrologic regime they will experience. At the bottom of the bioretention facility, plants that tolerate both wet and dry conditions are preferable. At the edges, which will remain primarily dry, upland species will be the most resilient. It is best to select a combination of trees, shrubs, and herbaceous materials.

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Media Filter TC-40

Maintenance Concerns, Objectives, and Goals

- Pollutant Breakthrough
- Clogged of Sand Media
- Trash and Debris Accumulation

General Description

Stormwater media filters are usually two-chambered including a pretreatment settling basin and a filter bed filled with sand or other absorptive filtering media. As stormwater flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as stormwater flows through the filtering media in the second chamber. There are a number of design variations including the Austin sand filter, Delaware sand filter, and multi-chambered treatment train (MCTT).

Targeted Constituents

✓	Sediment	■
✓	Nutrients	●
✓	Trash	■
✓	Metals	■
✓	Bacteria	▲
✓	Oil and Grease	■
✓	Organics	■

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

Inspection/Maintenance Considerations

Media filters may exhibit decreased effectiveness after a few years of operation, depending on the activities occurring in the drainage area. Media filters clog easily when subjected to high sediment loads. Sediment reducing pretreatment practices, such as vegetated buffer strips or vegetated swales, placed upstream of the filter should be maintained properly to reduce sediment loads into filter. Media filters can become a nuisance due to mosquito or midge breeding if not properly designed and maintained. Installations should dewater completely (recommended 72 hour or less residence time) to prevent creating mosquito and other vector habitats. Maintenance efforts will need to focus on basic housekeeping practices such as removal of debris accumulations and vegetation management (in filter media) to prevent clogs and/or pods of standing water. To minimize the potential for clogging, frequent maintenance and inspection practices are required. Waste sand, gravel, filter cloth, or filter media must be disposed of properly and in accordance with all applicable laws.

CASQA California Stormwater Quality Association

Inspection Activities	Suggested Frequency
■ During the first year of operation, inspect chambers quarterly to ensure that the system is functioning properly. ■ Inspect sand filters after every major storm in the first few months after construction to ensure that the system is functioning properly.	Post construction
■ Ensure that filter surface, inlets, and outlets are clear of debris. ■ Ensure that the contributing area is stabilized and mowed, with clippings removed. ■ Check to ensure that the filter surface is not clogging. ■ Ensure that activities in the drainage area minimize oil/grease and sediment entry to the system. ■ Inspect the facility once during the wet season after a large rain event to determine whether the facility is draining completely within 72 hr.	Quarterly, and after major storms
■ Inspect for standing water, sediment, trash and debris, structural damage, and to identify potential problems.	Semi-annual
■ Check to see that the filter bed is clean of sediments and the sediment chamber contains no more than six inches of sediment. ■ Make sure that there is no evidence of deterioration of concrete structures. ■ Inspect grates (if used). ■ Inspect inlets, outlets, and overflow spillway to ensure good condition and no evidence of erosion. ■ Ensure that flow is not bypassing the facility. ■ Ensure that no noticeable odors are detected outside the facility.	Annual
Maintenance Activities	**Suggested Frequency**
■ Remove trash and debris from the sedimentation basin (Austin design), the riser pipe, and the filter bed as needed. ■ Prevent grass clippings from washing into the filter. ■ Remove trash from inlet grates to maintain the inflow capacity of the media filter. ■ Upstream vegetation should be maintained as needed.	Frequently (as needed)
■ Clean filter surface semiannually; or more often if watershed is excessively erosive. ■ Replace sorbent pillows (Multi-Chamber Treatment Train only).	Semi-annual
■ Repair or replace any damaged structural parts. ■ Stabilize any eroded areas.	Annual
■ Remove accumulated sediment in the sedimentation chamber every 10 years or when the sediment occupies 10-20% of the basin volume or accumulates to a depth of six inches, whichever is less. ■ Remove top 2 in. of media filter and landfill if facility drain time exceeds 72 hr. Restore media depth to 18 in. when overall media depth drops to 12 in.).	As needed

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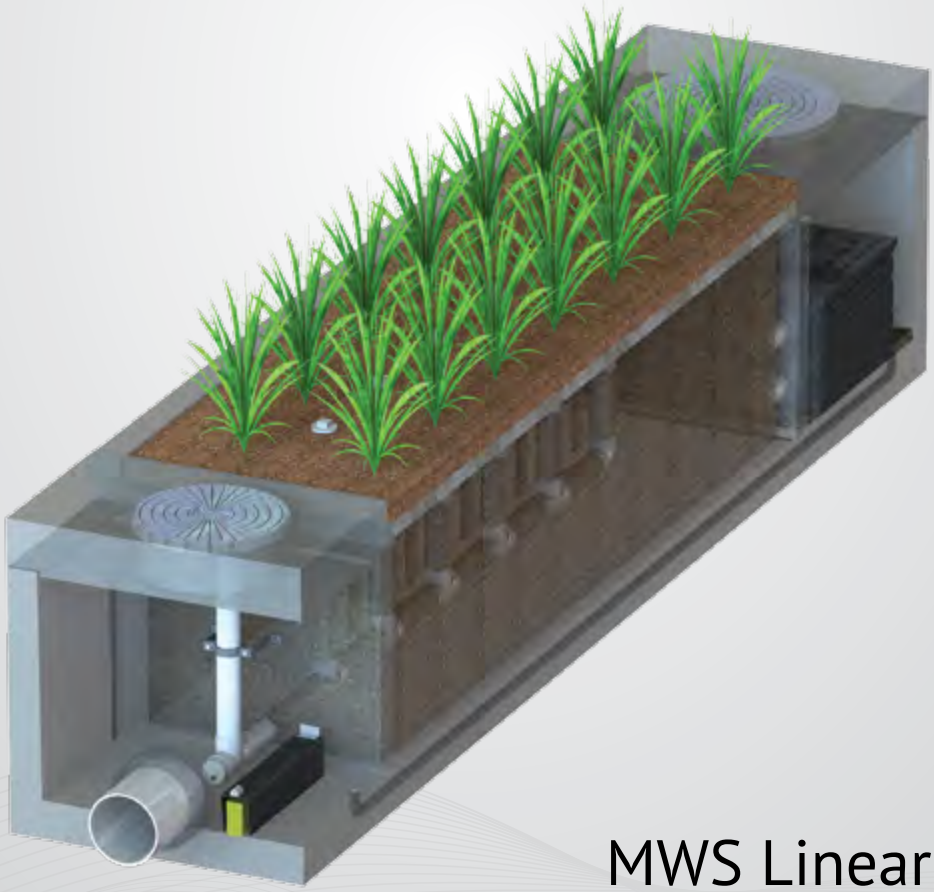
Attachment C
Modular Wetlands Information

MODULAR WETLANDS™

*Advanced **Stormwater** Biofiltration*



MWS Linear

Contents

The Urban Impact

For hundreds of years natural wetlands surrounding our shores have played an integral role as nature's stormwater treatment system. But as our cities grow and develop, these natural wetlands have perished under countless roads, rooftops, and parking lots.

Plant A Wetland

Without natural wetlands our cities are deprived of water purification, flood control, and land stability. Modular Wetlands and the MWS Linear re-establish nature's presence and rejuvenate water ways in urban areas.

MWS Linear

The Modular Wetland System Linear represents a pioneering breakthrough in stormwater technology as the only biofiltration system to utilize patented horizontal flow, allowing for a smaller footprint and higher treatment capacity. While most biofilters use little or no pre-treatment, the MWS Linear incorporates an advanced pre-treatment chamber that includes separation and pre-filter cartridges. In this chamber sediment and hydrocarbons are removed from runoff before it enters the biofiltration chamber, in turn reducing maintenance costs and improving performance.

Applications

The MWS Linear has been successfully used on numerous new construction and retrofit projects. The system's superior versatility makes it beneficial for a wide range of stormwater and waste water applications - treating rooftops, streetscapes, parking lots, and industrial sites.

Industrial

Many states enforce strict regulations for discharges from industrial sites. The MWS Linear has helped various sites meet difficult EPA mandated effluent limits for dissolved metals and other pollutants.

Residential

Low to high density developments can benefit from the versatile design of the MWS Linear. The system can be used in both decentralized LID design and cost-effective end-of-the-line configurations.

Streets

Street applications can be challenging due to limited space. The MWS Linear is very adaptable, and offers the smallest footprint to work around the constraints of existing utilities on retrofit projects.

Parking Lots

Parking lots are designed to maximize space and the MWS Linear's 4 ft. standard planter width allows for easy integration into parking lot islands and other landscape medians.

Commercial

Compared to bioretention systems, the MWS Linear can treat far more area in less space - meeting treatment and volume control requirements.

Mixed Use

The MWS Linear can be installed as a raised planter to treat runoff from rooftops or patios, making it perfect for sustainable "live-work" spaces.

More applications are available on our website: www.ModularWetlands.com/Applications

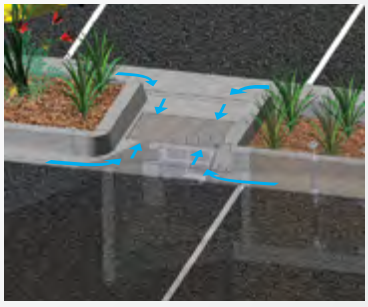
- Agriculture
- Reuse
- Low Impact Development
- Waste Water

Configurations

The MWS Linear is the preferred biofiltration system of Civil Engineers across the country due to its versatile design. This highly versatile system has available "pipe-in" options on most models, along with built-in curb or grated inlets for simple integration into your stormdrain design.

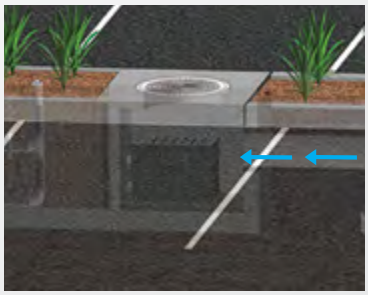
Curb Type

The *Curb Type* configuration accepts sheet flow through a curb opening and is commonly used along road ways and parking lots. It can be used in sump or flow by conditions. Length of curb opening varies based on model and size.



Grate Type

The *Grate Type* configuration offers the same features and benefits as the *Curb Type* but with a grated/drop inlet above the systems pre-treatment chamber. It has the added benefit of allowing for pedestrian access over the inlet. ADA compliant grates are available to assure easy and safe access. The *Grate Type* can also be used in scenarios where runoff needs to be intercepted on both sides of landscape islands.



Vault Type

The system's patented horizontal flow biofilter is able to accept inflow pipes directly into the pre-treatment chamber, meaning the MWS Linear can be used in end-of-the-line installations. This greatly improves feasibility over typical decentralized designs that are required with other biofiltration/bioretention systems. Another benefit of the "pipe in" design is the ability to install the system downstream of underground detention systems to meet water quality volume requirements.

Downspout Type

The *Downspout Type* is a variation of the *Vault Type* and is designed to accept a vertical downspout pipe from roof top and podium areas. Some models have the option of utilizing an internal bypass, simplifying the overall design. The system can be installed as a raised planter and the exterior can be stuccoed or covered with other finishes to match the look of adjacent buildings.

Advantages & Operation

The MWS Linear is the most efficient and versatile biofiltration system on the market, and the only system with horizontal flow which improves performance, reduces footprint, and minimizes maintenance. Figure-1 and Figure-2 illustrate the invaluable benefits of horizontal flow and the multiple treatment stages.

Featured Advantages

- Horizontal Flow Biofiltration
- Greater Filter Surface Area
- Pre-Treatment Chamber
- Patented Perimeter Void Area
- Flow Control
- No Depressed Planter Area

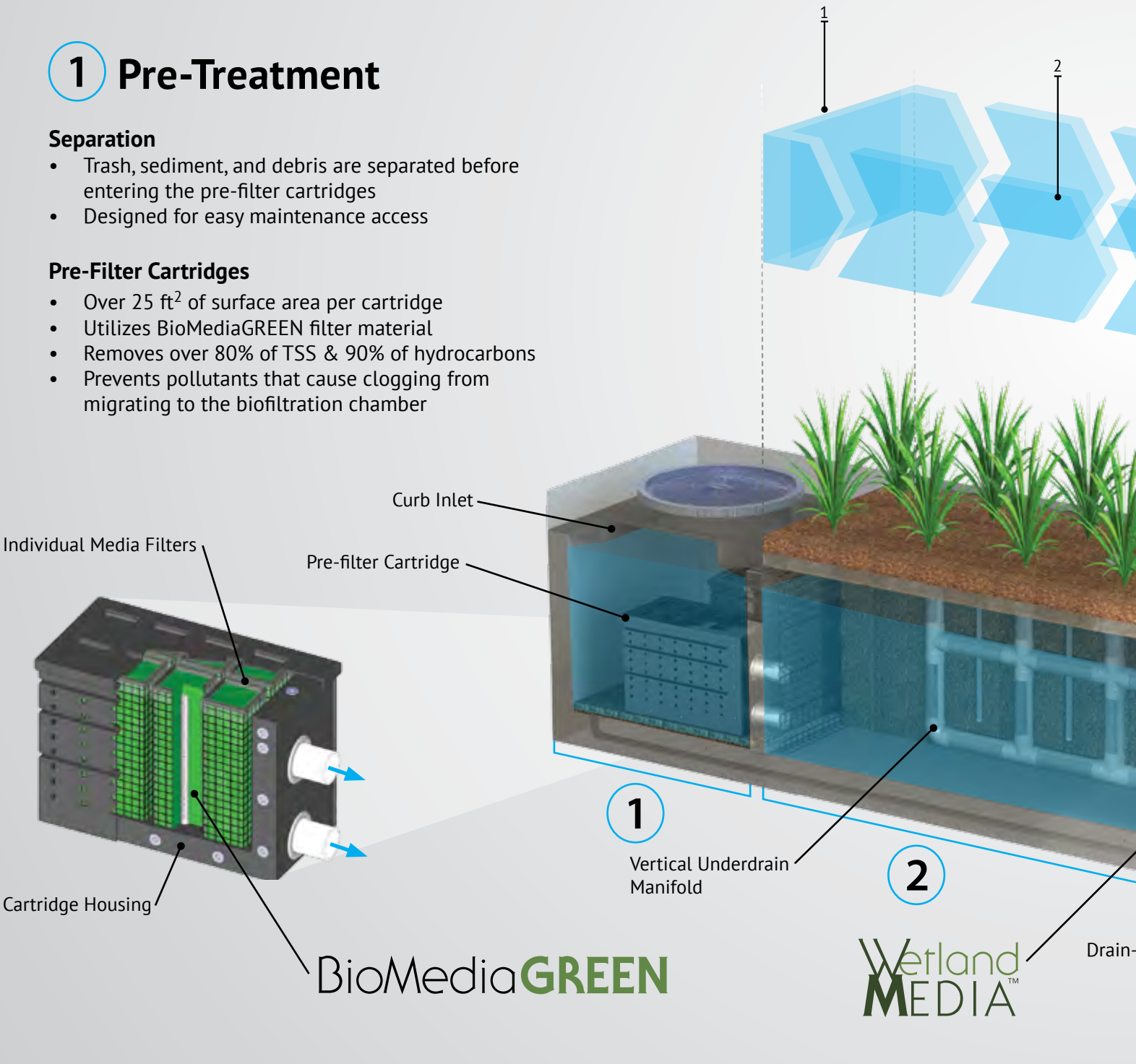
1 Pre-Treatment

Separation

- Trash, sediment, and debris are separated before entering the pre-filter cartridges
- Designed for easy maintenance access

Pre-Filter Cartridges

- Over 25 ft^2 of surface area per cartridge
- Utilizes BioMediaGREEN filter material
- Removes over 80% of TSS & 90% of hydrocarbons
- Prevents pollutants that cause clogging from migrating to the biofiltration chamber



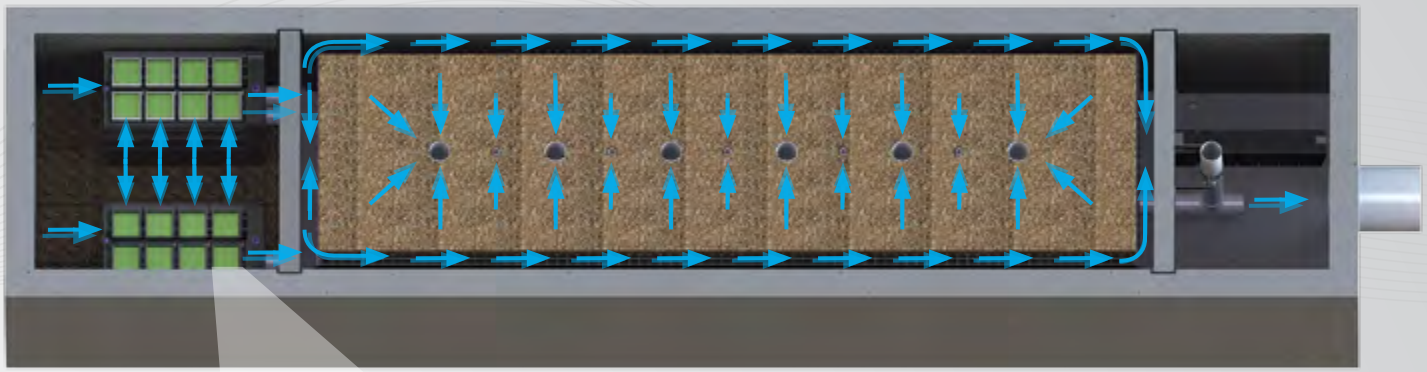


Fig. 2 - Top View

2x to 3x More Surface Area Than Traditional Downward Flow Bioretention Systems.

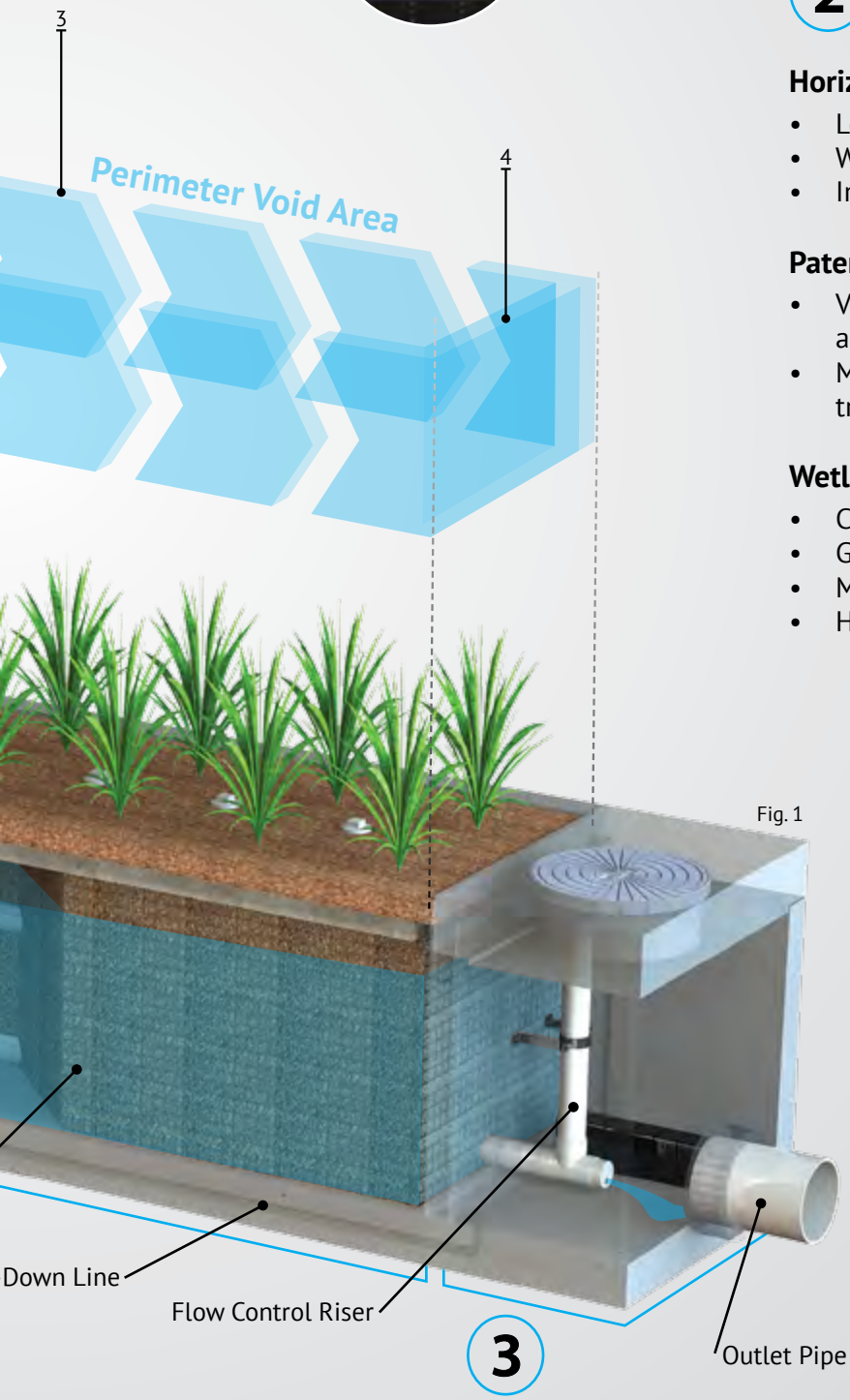


Fig. 1

2 Biofiltration

Horizontal Flow

- Less clogging than downward flow biofilters
- Water flow is subsurface
- Improves biological filtration

Patented Perimeter Void Area

- Vertically extends void area between the walls and the WetlandMEDIA on all four sides.
- Maximizes surface area of the media for higher treatment capacity

WetlandMEDIA

- Contains no organics and removes phosphorus
- Greater surface area and 48% void space
- Maximum evapotranspiration
- High ion exchange capacity and light weight

3 Discharge

Flow Control

- Orifice plate controls flow of water through WetlandMEDIA to a level lower than the media's capacity.
- Extends the life of the media and improves performance

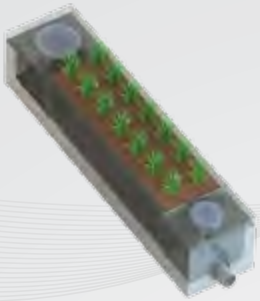
Drain-Down Filter

- The Drain-Down is an optional feature that completely drains the pre-treatment chamber
- Water that drains from the pre-treatment chamber between storm events will be treated

Orientations

Side-By-Side

The *Side-By-Side* orientation places the pre-treatment and discharge chamber adjacent to one another with the biofiltration chamber running parallel on either side. This minimizes the system length, providing a highly compact footprint. It has been proven useful in situations such as streets with directly adjacent sidewalks, as half of the system can be placed under that sidewalk. This orientation also offers internal bypass options as discussed below.



End-To-End

The *End-To-End* orientation places the pre-treatment and discharge chambers on opposite ends of the biofiltration chamber therefore minimizing the width of the system to 5 ft (outside dimension). This orientation is perfect for linear projects and street retrofits where existing utilities and sidewalks limit the amount of space available for installation. One limitation of this orientation is bypass must be external.

Bypass

Internal Bypass Weir (Side-by-Side Only)

The *Side-By-Side* orientation places the pre-treatment and discharge chambers adjacent to one another allowing for integration of internal bypass. The wall between these chambers can act as a bypass weir when flows exceed the system's treatment capacity, thus allowing bypass from the pre-treatment chamber directly to the discharge chamber.

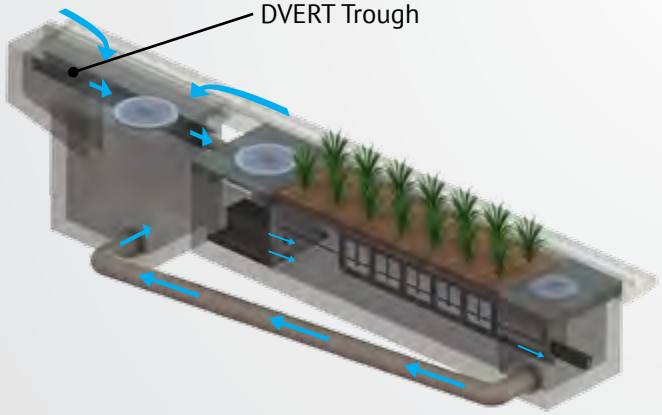
External Diversion Weir Structure

This traditional offline diversion method can be used with the MWS Linear in scenarios where runoff is being piped to the system. These simple and effective structures are generally configured with two outflow pipes. The first is a smaller pipe on the upstream side of the diversion weir - to divert low flows over to the MWS Linear for treatment. The second is the main pipe that receives water once the system has exceeded treatment capacity and water flows over the weir.

Flow By Design

This method is one in which the system is placed just upstream of a standard curb or grate inlet to intercept the first flush. Higher flows simply pass by the MWS Linear and into the standard inlet downstream.

DVERT Low Flow Diversion



This simple yet innovative diversion trough can be installed in existing or new curb and grate inlets to divert the first flush to the MWS Linear via pipe. It works similar to a rain gutter and is installed just below the opening into the inlet. It captures the low flows and channels them over to a connecting pipe exiting out the wall of the inlet and leading to the MWS Linear. The DVERT is perfect for retrofit and green street applications that allows the MWS Linear to be installed anywhere space is available.

Performance

The MWS Linear continues to outperform other treatment methods with superior pollutant removal for TSS, heavy metals, nutrients, hydrocarbons and bacteria. Since 2007 the MWS Linear has been field tested on numerous sites across the country. With it's advanced pre-treatment chamber and innovative horizontal flow biofilter, the system is able to effectively remove pollutants through a combination of physical, chemical, and biological filtration processes. With the same biological processes found in natural wetlands, the MWS Linear harnesses natures ability to process, transform, and remove even the most harmful pollutants.

Approvals

The MWS Linear has successfully met years of challenging technical reviews and testing from some of the most prestigious and demanding agencies in the nation, and perhaps the world.

Washington State DOE Approved

The MWS Linear is approved for General Use Level Designation (GULD) for Basic, Enhanced, and Phosphorus treatment at 1 gpm/ft^2 loading rate. The highest performing BMP on the market for all main pollutant categories.

TSS	Total Phosphorus	Ortho Phosphorus	Nitrogen	Dissolved Zinc	Dissolved Copper	Total Zinc	Total Copper	Motor Oil
85%	64%	67%	45%	66%	38%	69%	50%	95%

DEQ Assignment

The Virginia Department of Environmental Quality assigned the MWS Linear, the highest phosphorus removal rating for manufactured treatment devices to meet the new Virginia Stormwater Management Program (VSMP) Technical Criteria.

MASTEP Evaluation

The University of Massachusetts at Amherst – Water Resources Research Center, issued a technical evaluation report noting removal rates up to 84% TSS, 70% Total Phosphorus, 68.5% Total Zinc, and more.

Rhode Island DEM Approved

Approved as an authorized BMP and noted to achieve the following minimum removal efficiencies: 85% TSS, 60% Pathogens, 30% Total Phosphorus for discharges to freshwater systems, and 30% Total Nitrogen for discharges to saltwater or tidal systems.

Flow Based Sizing

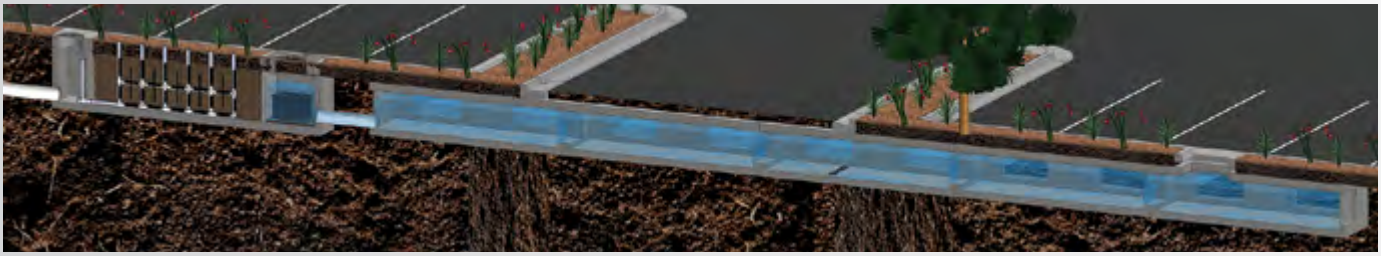
The MWS Linear can be used in stand alone applications to meet treatment flow requirements. Since the MWS Linear is the only biofiltration system that can accept inflow pipes several feet below the surface it can be used not only in decentralized design applications but also as a large central end-of-the-line application for maximum feasibility.

Treatment Flow Sizing Table

Model #	Dimensions	WetlandMedia Surface Area	Treatment Flow Rate (cfs)
MWS-L-4-4	4' x 4'	23 ft^2	0.052
MWS-L-4-6	4' x 6'	32 ft^2	0.073
MWS-L-4-8	4' x 8'	50 ft^2	0.115
MWS-L-4-13	4' x 13'	63 ft^2	0.144
MWS-L-4-15	4' x 15'	76 ft^2	0.175
MWS-L-4-17	4' x 17'	90 ft^2	0.206
MWS-L-4-19	4' x 19'	103 ft^2	0.237
MWS-L-4-21	4' x 21'	117 ft^2	0.268
MWS-L-8-8	8' x 8'	100 ft^2	0.230
MWS-L-8-12	8' x 12'	151 ft^2	0.346
MWS-L-8-16	8' x 16'	201 ft^2	0.462

Volume Based Sizing

Many states require treatment of a water quality volume and do not offer the option of flow based design. The MWS Linear and its unique horizontal flow makes it the only biofilter that can be used in volume based design installed downstream of ponds, detention basins, and underground storage systems.



Treatment Volume Sizing Table

Model #	Treatment Capacity (cu. ft.) @ 24-Hour Drain Down	Treatment Capacity (cu. ft.) @ 48-Hour Drain Down
MWS-L-4-4	1140	2280
MWS-L-4-6	1600	3200
MWS-L-4-8	2518	5036
MWS-L-4-13	3131	6261
MWS-L-4-15	3811	7623
MWS-L-4-17	4492	8984
MWS-L-4-19	5172	10345
MWS-L-4-21	5853	11706
MWS-L-8-8	5036	10072
MWS-L-8-12	7554	15109
MWS-L-8-16	10073	20145

Installation

The MWS Linear is simple, easy to install, and has a space efficient design that offers lower excavation and installation costs compared to traditional tree-box type systems. The structure of the system resembles pre-cast catch basin or utility vaults and is installed in a similar fashion.

The system is delivered fully assembled for quick installation. Generally, the structure can be unloaded and set in place in 15 minutes. Our experienced team of field technicians are available to supervise installations and provide technical support.

Maintenance

Reduce your maintenance costs, man hours, and materials with the MWS Linear. Unlike other biofiltration systems that provide no pre-treatment, the MWS Linear is a self-contained treatment train which incorporates simple and effective pre-treatment.

Maintenance requirements for the biofilter itself are almost completely eliminated, as the pre-treatment chamber removes and isolates trash, sediments, and hydrocarbons. What's left is the simple maintenance of an easily accessible pre-treatment chamber that can be cleaned by hand or with a standard vac truck. Only periodic replacement of low-cost media in the pre-filter cartridges is required for long term operation and there is absolutely no need to replace expensive biofiltration media.

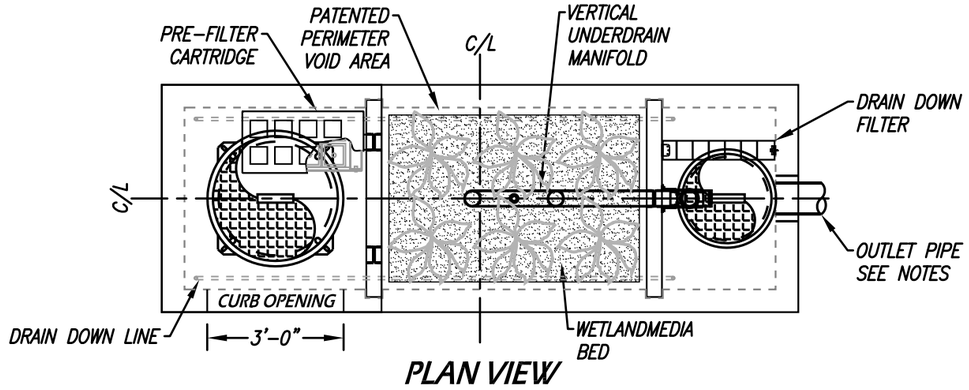
Plant Selection

Abundant plants, trees, and grasses bring value and an aesthetic benefit to any urban setting, but those in the MWS Linear do even more - they increase pollutant removal. What's not seen, but very important, is that below grade the stormwater runoff/flow is being subjected to nature's secret weapon: a dynamic physical, chemical, and biological process working to break down and remove non-point source pollutants. The flow rate is controlled in the MWS Linear, giving the plants more "contact time" so that pollutants are more successfully decomposed, volatilized and incorporated into the biomass of The MWS Linear's micro/macro flora and fauna.

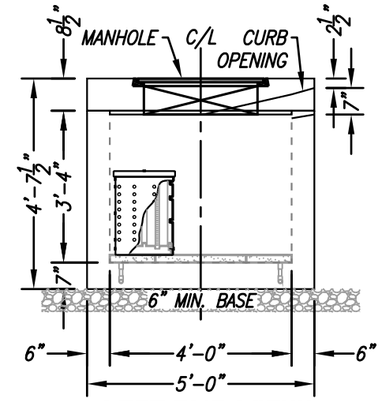
A wide range of plants are suitable for use in the MWS Linear, but selections vary by location and climate. View suitable plants by selecting the list relative to your project location's hardy zone.

Please visit www.ModularWetlands.com/Plants for more information and various plant lists.

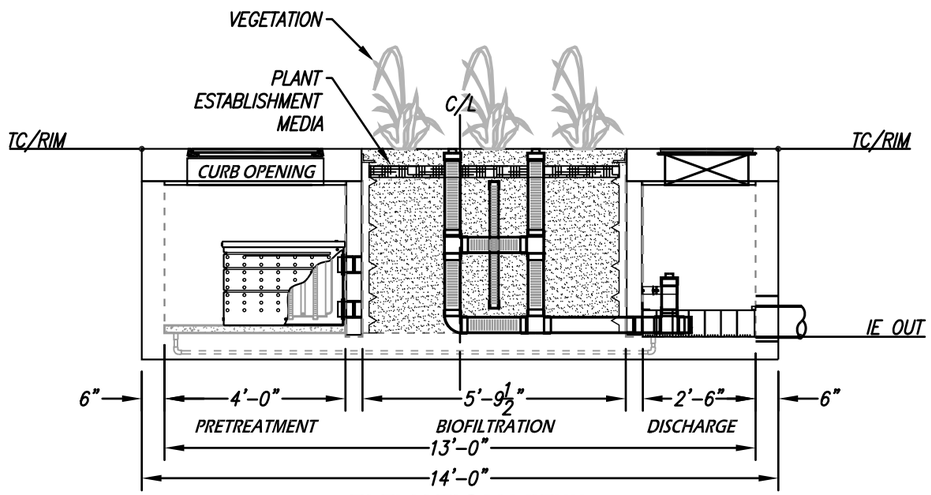
SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			3.05
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø1.71"
MAXIMUM PICK WEIGHT (LBS)			27000
NOTES:			



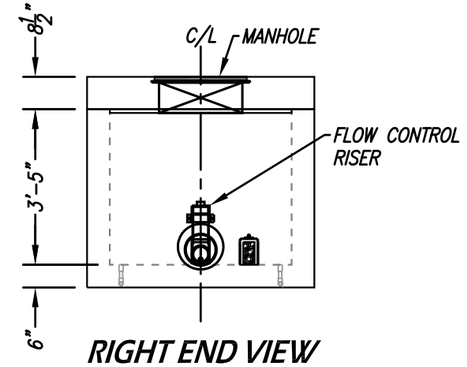
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON–SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.

TREATMENT FLOW (CFS)	0.144
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

THE PRODUCT DESCRIBED MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 7,425,262; 7,470,362; 7,674,378; 8,303,816; RELATED FOREIGN PATENTS OR OTHER PATENTS PENDING

PROPRIETARY AND CONFIDENTIAL:

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MODULAR WETLANDS SYSTEMS. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MODULAR WETLANDS SYSTEMS IS PROHIBITED.

MODULAR WETLANDS
www.ModularWetlands.com | (855) 5MOD-WET

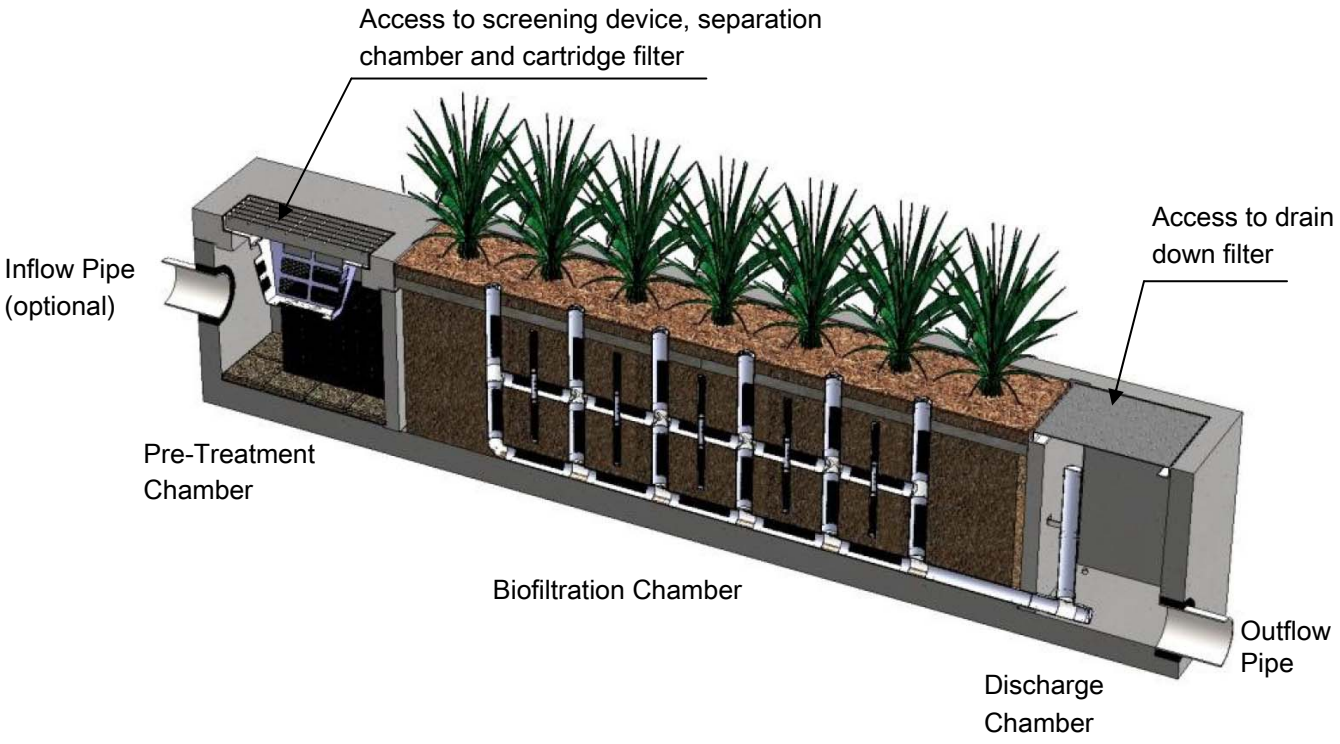
MWS-L-4-13-C
STORMWATER BIOFILTRATION SYSTEM STANDARD DETAIL

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

- Remove Trash from Screening Device – average maintenance interval is 6 to 12 months.
  - (*5 minute average service time*).
- Remove Sediment from Separation Chamber – average maintenance interval is 12 to 24 months.
  - (*10 minute average service time*).
- Replace Cartridge Filter Media – average maintenance interval 12 to 24 months.
  - (*10-15 minute per cartridge average service time*).
- Replace Drain Down Filter Media – average maintenance interval is 12 to 24 months.
  - (*5 minute average service time*).
- Trim Vegetation – average maintenance interval is 6 to 12 months.
  - (*Service time varies*).

System Diagram



Maintenance Procedures

Screening Device

1. Remove grate or manhole cover to gain access to the screening device in the Pre-Treatment Chamber. Vault type units do not have screening device. Maintenance can be performed without entry.
2. Remove all pollutants collected by the screening device. Removal can be done manually or with the use of a vacuum truck. The hose of the vacuum truck will not damage the screening device.
3. Screening device can easily be removed from the Pre-Treatment Chamber to gain access to separation chamber and media filters below. Replace grate or manhole cover when completed.

Separation Chamber

1. Perform maintenance procedures of screening device listed above before maintaining the separation chamber.
2. With a pressure washer spray down pollutants accumulated on walls and cartridge filters.
3. Vacuum out Separation Chamber and remove all accumulated pollutants. Replace screening device, grate or manhole cover when completed.

Cartridge Filters

1. Perform maintenance procedures on screening device and separation chamber before maintaining cartridge filters.
2. Enter separation chamber.
3. Unscrew the two bolts holding the lid on each cartridge filter and remove lid.
4. Remove each of 4 to 8 media cages holding the media in place.
5. Spray down the cartridge filter to remove any accumulated pollutants.
6. Vacuum out old media and accumulated pollutants.
7. Reinstall media cages and fill with new media from manufacturer or outside supplier. Manufacturer will provide specification of media and sources to purchase.
8. Replace the lid and tighten down bolts. Replace screening device, grate or manhole cover when completed.

Drain Down Filter

1. Remove hatch or manhole cover over discharge chamber and enter chamber.
2. Unlock and lift drain down filter housing and remove old media block. Replace with new media block. Lower drain down filter housing and lock into place.
3. Exit chamber and replace hatch or manhole cover.

Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.

2. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.

3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.

4. Entry into chambers may require confined space training based on state and local regulations.

5. No fertilizer shall be used in the Biofiltration Chamber.

6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

Maintenance Procedure Illustration

Screening Device

The screening device is located directly under the manhole or grate over the Pre-Treatment Chamber. It's mounted directly underneath for easy access and cleaning. Device can be cleaned by hand or with a vacuum truck.

Separation Chamber

The separation chamber is located directly beneath the screening device. It can be quickly cleaned using a vacuum truck or by hand. A pressure washer is useful to assist in the cleaning process.

Cartridge Filters

The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.

Drain Down Filter

The drain down filter is located in the Discharge Chamber. The drain filter unlocks from the wall mount and hinges up. Remove filter block and replace with new block.

Trim Vegetation

Vegetation should be maintained in the same manner as surrounding vegetation and trimmed as needed. No fertilizer shall be used on the plants. Irrigation per the recommendation of the manufacturer and or landscape architect. Different types of vegetation requires different amounts of irrigation.

Inspection Form

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

Inspection Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ____/____/____ Time _____ AM / PM

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

Inspection Checklist

Modular Wetland System Type (Curb, Grate or UG Vault): _____ Size (22', 14' or etc.): _____

Structural Integrity:	**Yes**	**No**	**Comments**
Damage to pre-treatment access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Damage to discharge chamber access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Does the MWS unit show signs of structural deterioration (cracks in the wall, damage to frame)?			
Is the inlet/outlet pipe or drain down pipe damaged or otherwise not functioning properly?			
Working Condition:			
Is there evidence of illicit discharge or excessive oil, grease, or other automobile fluids entering and clogging the unit?			
Is there standing water in inappropriate areas after a dry period?			
Is the filter insert (if applicable) at capacity and/or is there an accumulation of debris/trash on the shelf system?			
Does the depth of sediment/trash/debris suggest a blockage of the inflow pipe, bypass or cartridge filter? If yes, specify which one in the comments section. Note depth of accumulation in in pre-treatment chamber.			Depth:
Does the cartridge filter media need replacement in pre-treatment chamber and/or discharge chamber?			Chamber:
Any signs of improper functioning in the discharge chamber? Note issues in comments section.			
Other Inspection Items:			
Is there an accumulation of sediment/trash/debris in the wetland media (if applicable)?			
Is it evident that the plants are alive and healthy (if applicable)? Please note Plant Information below.			
Is there a septic or foul odor coming from inside the system?			

Waste:	**Yes**	**No**
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

Recommended Maintenance	
No Cleaning Needed	
Schedule Maintenance as Planned	
Needs Immediate Maintenance	

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes:

2972 San Luis Rey Road, Oceanside, CA 92058 P (760) 433-7640 F (760) 433-3176

Maintenance Report

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

Cleaning and Maintenance Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ____/____/____ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Site Map #	GPS Coordinates of Insert	Manufacturer / Description / Sizing	Trash Accumulation	Foliage Accumulation	Sediment Accumulation	Total Debris Accumulation	Condition of Media 25/50/75/100 (will be changed @ 75%)	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:	MWS Catch Basins						
		MWS Sedimentation Basin						
		Media Filter Condition						
		Plant Condition						
		Drain Down Media Condition						
		Discharge Chamber Condition						
		Drain Down Pipe Condition						
		Inlet and Outlet Pipe Condition						

Comments:

2972 San Luis Rey Road, Oceanside, CA 92058 P. 760.433.7640 F. 760.433.3176

Attachment D
Educational Materials

Keeping Our Air and Water Clean ...

Beginning January 1, 1999, Rule 1171 of the South Coast Air Quality Management District (SCAQMD) will require repair and maintenance cleaning operations, including cleaning operations in the auto repair industry, to use water-based cleaners instead of the solvents which are used today.

Making the switch to water-based cleaners is expected to remove *over 20 tons* of smog-forming compounds from the air we breathe.

While use of water-based cleaners leads to better air quality, we must not forget that our water resources must also be kept clean. Improper disposal of water-based cleaners can lead to contamination of the ocean, rivers, and groundwater below us...water we depend on for drinking and survival.

This guide will provide you with valuable information on proper disposal practices to help keep our environment clean.

A Guide to the Disposal of

USED Water-Based Cleaners

Auto Repair & Maintenance Shops

Keeping Our Environment Clean!

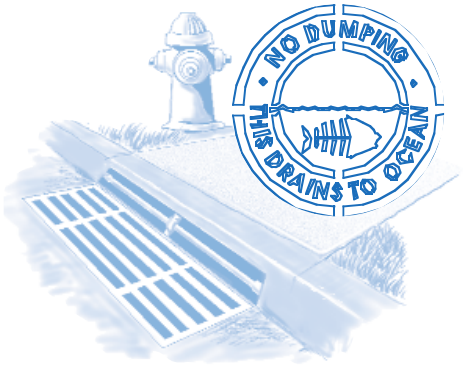
City of Los Angeles • Bureau of Sanitation
Industrial Waste Management Division

Did You Know? ...

- Just as solvent cleaners require proper disposal, so do water-based cleaners. In order to protect our environment, used water-based cleaners must be disposed of in a responsible manner.
- Many water-based cleaners are labeled as non-toxic and bio-degradable as packaged, but once these cleaners have been used, they will contain high levels of oils, grease, metals and solvents.
- Most used water-based cleaners qualify as hazardous waste.
- Because of the high levels of pollutants, it is illegal to discharge used water-based cleaners into storm drains, gutters, or in the street.
- It is illegal to dispose of water-based cleaners into the sewer system unless you have approval from your local sewerage agency.

Remember ...

It is illegal to discharge used water-based cleaners into storm drains, gutters, or in the street !



Disposal of Used Water-Based Cleaners

The recommended method of disposal for used water-based cleaners is hauling by a registered hazardous waste transporter. It is your shop's responsibility to verify if your waste hauler is a legally registered transporter. Remember to always maintain waste disposal records in your shop.

If Disposing to the Sewer ...

It is best to legally haul used cleaner off-site. However, If you are interested in discharging used cleaner into the sewer, contact your local sewerage agency for specific requirements.

In general, you will need to ...

- Remove the oil, grease, metals and solvents from the used cleaner by established techniques.
- After treatment, have a lab test the cleaner to determine if it will meet your sewerage agency's requirements for disposal.
- Contact your sewerage agency for permission to discharge.

Your sewerage agency may also require that an Industrial Wastewater Permit be obtained and associated permit fees be paid. Since the used cleaner may be a hazardous waste, you may also be required to obtain a tiered permit from the state if you wish to treat your used cleaner for sewer disposal.

You Can Reduce Costs ...

- You can extend the life of your water-based cleaner by using oil skimmers, filters and absorbents.
- Keep used water-based cleaners separate from other wastewater in your shop. It is easier to dispose of hazardous waste when they are not mixed with other wastes.
- Operate at the optimal concentration and temperature for your water-based cleaner. Contact trade organizations and vendors on how to get the most from your cleaner.
- Avoid spot cleaning parts with solvent-based spray cleaners as these cleaners contain very high levels of toxic organics.

Questions?

Rule 1171 and how to convert to water-based cleaning:

SCAQMD Small Business Hotline
(800) 388-2121

Tiered Permitting or Treatment of Hazardous Waste:

Department of Toxic Substances Control
Southern California Office
(562) 590-4868

Industrial Wastewater Discharge Requirements, Contact the Sewerage Agency in Your Area:

City of Los Angeles
Bureau of Sanitation
Industrial Waste Management Division
(213) 237-0806

Los Angeles County Sanitation Districts
Industrial Waste Section
(562) 699-7411 ext. 2900

Orange County Sanitation Districts
Source Control Division
(714) 962-2411 ext. 3800

Riverside and San Bernardino County Areas
Inland Empire Permit Assistance Center
(909) 391-0723 or (800) 468-1786

How can you help in your community?

Como puedes ayudar en tu comunidad?

Home & Garden

Casa y Jardines

- Properly use and store all hazardous household products, including cleaners, solvents and paints.

  Use y almacene de manera adecuada productos domésticos peligrosos, incluyendo limpiadores, solventes, y pinturas.

- Be an environmentally aware consumer. Buy non-toxic products for use in your home and garden whenever possible.

  Sea un consumidor consciente del medio ambiente. Compre productos que no sean tóxicos para su casa o jardin.

- Use pesticides, herbicides and fertilizers carefully and sparingly.

  Use pesticidas, herbicidas y fertilizantes cuidadosamente y a la medida justa.

- Conserve water and reduce the amount of runoff by not over-watering your lawn and garden.

  Conserve el agua y reduzca la cantidad de derrame no sobre-regando el y jardin.

- Use a broom rather than a hose to clean up garden clippings, dirt and litter from sidewalks, patios and driveways.

  Use una escoba en vez de la manguera al limpiar tierra y basura de las aceras, patios y caminos de entrada.

- Compost yard trimmings and leaves. Do not sweep them into the streets or catch basins.

  Convierta ramas y hojas en abono. No las barra a la calle o drenajes.

- Divert rain spouts and other sources of runoff onto grass or vegetation.

  Desvie los caños y otros recursos de derrame hacia el césped o la vegetación.

- Dispose of pet waste in trash cans. Leaving it on the lawn sends harmful bacteria into the storm drains whenever you water or when it rains.

  Deseche el excremento de los animales en botes de basura. Si se dejan en el césped, estos crearan bacterias dañinas que iran hacia los drenajes cuando se riege o cuando llueva.

- Donate unwanted paint, fertilizer, etc. to friends or community organizations.

  Regale pintura, fertilizante, etc. a sus amistades u organizaciones comunitarias.

Automotive

Automóviles

- When changing car fluids, use a drip pan to collect any spills. If a spill occurs, soak it up using an absorbent material such as kitty litter or sawdust and dispose of it properly.

  Cuando cambie lubricantes, use un envase debajo del goteo para contener cualquier derrame. Si un derrame ocurriera, limpielo usando cualquier material absorbente, como aserrín o "kitty litter", luego deseche de manera apropiada.

- Wash your car with biodegradable soap using as little water as possible. Shut off the hose while washing your car and then rinse.

  Lave su vehículo con jabón biodegradable usando la menor cantidad de agua posible. Cierre la llave del agua mientras lo lave y luego enjuágelo.

- Keep a trash bag in the car and use it! Do not throw anything out the window.

  ¡Mantenga una bolsa de basura dentro del carro y úsela! No arroje nada por la ventana.

- Keep up car maintenance to reduce leakage of oil, anti-freeze and other fluids.

  Dé un buen mantenimiento a su carro para reducir derrames de aceite, anticongelante u otros lubricantes.

- Buy batteries, anti-freeze and motor oil from stores that will recycle used products, or

  Take these items to a local Household Hazardous Waste roundup.

  Compre baterías, anticongelantes y aceites para motores en tiendas que reciclen los productos que ha usado, ó

  lleve estos productos a su centro de colección local de desechos domésticos peligrosos.

SPILL RESPONSE AGENCIES
AGENCIAS PARA EL CONTROL DE DERRAMES

City of Los Angeles
Stormwater Program Hotline
(800) 974-9794

Los Angeles County
(888) CLEAN-LA / 253-2652

RECYCLING & HAZARDOUS WASTE DISPOSAL
RECICLAGE Y DESECHO DE DESPERDICIOS PELIGROSOS

City of Los Angeles
Small Business Hazardous Waste Hotline
(800) 98-TOXIC / 988-6942

City of L.A. Recycling
(800) 773-CITY

Los Angeles County
Department of Public Works
(888) CLEAN-LA / 253-2652

TO REPORT ILLEGAL DUMPING
PARA REPORTAR ARROJOS ILEGALES

City of Los Angeles
Stormwater Program Hotline
(800) 974-9794

Los Angeles County
Department of Public Works
Illegal Dumping Hotline
(888) CLEAN-LA / 253-2652

TO REPORT CLOGGED CATCH BASINS
PARA REPORTAR DRENAJES TAPADOS

City of Los Angeles
Stormwater Program Hotline
(800) 974-9794

Los Angeles County
Department of Public Works
(888) CLEAN-LA / 253-2652

WATERSHED PROTECTION
CITY OF LOS ANGELES

www.LAstormwater.org

Illustration and Design: Oscar Amaro

Printed on ♻ Recycled Paper

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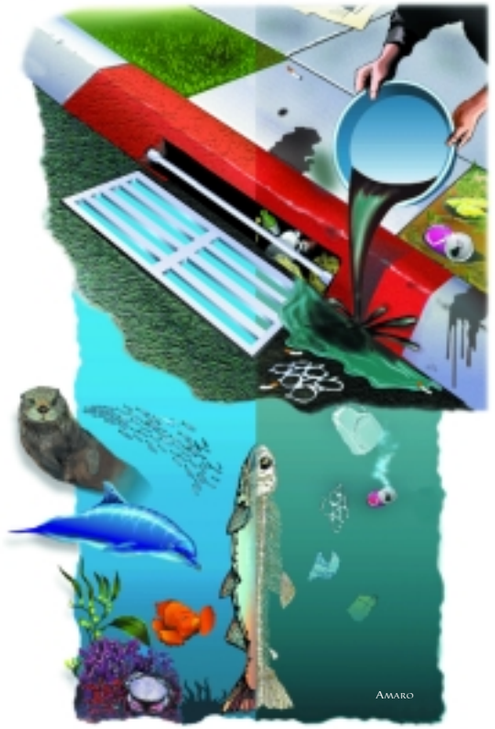
The Ocean Begins

El Oceano Empieza



In Your Neighborhood

En Su Vecindad

How So?

Water running off your yard, sidewalk or street flows down gutters to curbside openings called **catch basins**.

Curbside catch basin

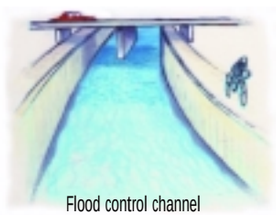
Underground storm drain tunnel

Anything carried by this runoff — pesticides, pet waste, oil and anti-freeze from leaky cars and trucks, foam containers and plastic bags — ends up trashing the beaches, polluting the ocean, and harming wildlife... and humans. This contaminated flow is the reason some of our most scenic beaches are closed to the public after a heavy rainstorm.

Just one quart of used motor oil dumped into a catch basin can pollute *250,000 gallons of ocean water!*

Unlike the wastewater from inside homes and businesses that flows to sewers and treatment plants, outside runoff water flows to the ocean untreated. That's because the storm drain system was designed to prevent flooding during heavy rains by quickly diverting billions of gallons of rainwater to the ocean.

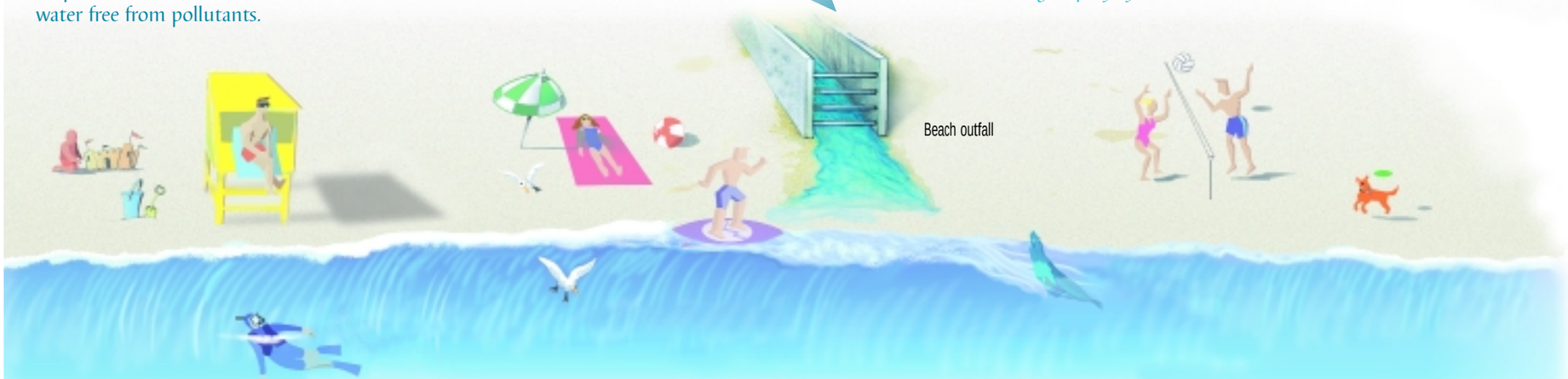
The open portions of this system are called flood control channels.



Flood control channel

Even during the driest day in Southern California, we produce tens of millions of gallons of runoff, the result of activities such as car washing, lawn watering and yard cleanup.

For our own protection, and for a cleaner ocean, we need to keep trash off the streets, out of catch basins, and runoff water free from pollutants.



Beach outfall

¿Cómo Puede Ser?

El agua que se desborda en jardines, aceras y calles se vierte a las cunetas, las cuales la transportan hacia las aperturas en las calzadas llamadas alcantarillas.

De allí, es vaciada al sistema del alcantarillado pluvial, el cual es una gran red de tuberías y canales que eventualmente terminan en el océano.

Cualquier cosa acarreada por este flujo, como por ejemplo pesticidas, excremento de animales, aceite o anticongelante derramados de carros y envases plásticos terminan ensuciando las playas, contaminando el océano, dañando a la fauna y al mismo tiempo a los humanos. Este flujo contaminado es la razón del cierre al público de algunas de nuestras playas más hermosas luego de una tormenta severa.

¡Basta un cuarto de galón de aceite de automóvil arrojado dentro del drenaje para contaminar 250,000 galones de agua marina!

A diferencia de las aguas que fluyen de las casas y negocios por medio del sistema de desagüe hacia las plantas de tratamiento, el agua que fluye por las calles va al océano sin ser tratada. El sistema de drenaje de lluvias es diseñado para prevenir inundaciones durante tormentas severas. Este sistema recoge rápidamente billones de galones de agua de las calles llevándolos directamente al océano.

Aún durante el día más seco en el sur de California se producen decenas de millones de galones de agua que fluyen por las calles como resultado de actividades tales como el lavado de carros, o riego y limpieza de jardines y patios.

Por nuestra propia protección debemos impedir que la basura llegue a nuestras calles y colectores de lluvia, así como asegurar que el agua que fluye hacias las calles, esté libre de contaminantes.

BIO-DEGRADATION TIMELINE

Depending upon their composition, products take different lengths of time to break down (bio-degrade) in the environment. Here are average times for these products.

Según la composición de los productos, estos varian en la cantidad de tiempo para descomponerse en el medio ambiente. Los siguientes son los periodos promedios para esos productos.

Paper towel/toalla de papel
2-4 weeks/*semanas*

Newspaper/*periódico*
6 weeks

Cardboard/*cartón*
2 months/*meses*

Tin can/*lata*
50 years/*años*

Polysterene cup
vaso de espuma plástico
50 years

Plastic bottle
botella de plástico
450 years

Disposable diaper
pañal desechable
450 years

- Every year, over 40 tons of trash washes up on our beaches.
- Approximately 80% of that trash could have been recycled.
- An average of 870,000 cigarette butts are tossed into the streets **every month.** These eventually wash into the storm drain system and onto the beaches and ocean. Fish and birds swallow cigarette butts often mistaking them for food, and die.
- The County of Los Angeles spends an average of $1.3 million cleaning the beaches after rainstorms every year.

Attachment E
Master Covenant and Agreement

RECORDING REQUESTED BY
AND MAIL TO:

COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
BUILDING AND SAFETY DIVISION
900 S. FREMONT AVENUE, 3RD FLOOR
ALHAMBRA, CA 91803-1331

Space above this line is for Recorder's use

COVENANT AND AGREEMENT
REGARDING THE MAINTENANCE OF LOW IMPACT DEVELOPMENT (LID) & NATIONAL POLLUTANTS DISCHARGE ELIMINATION SYSTEM (NPDES) BMPs

The undersigned, _____ ("Owner"), hereby certifies that it owns the real property described as follows ("Subject Property"), located in the County of Los Angeles, State of California:

LEGAL DESCRIPTION

ASSESSOR'S ID #_____TRACT NO._____LOT NO._____

ADDRESS: _____

_____

Owner is aware of the requirements of the County of Los Angeles' Green Building Standards Code, Title 31, Section 4.106.4 and Section 5.106.2 (LID), and National Pollutant Discharge Elimination System (NPDES) permit. The following post-construction BMP features have been installed on the Subject Property:

- □ Porous pavement
- □ Cistern/rain barrel
- □ Infiltration trench/pit
- □ Bioretention or biofiltration
- □ Rain garden/planter box
- □ Disconnect impervious surfaces
- □ Dry Well
- □ Storage containers
- □ Landscaping and landscape irrigation
- □ Green roof
- □ Other _____

_____

The location, including GPS x-y coordinates, and type of each post-construction BMP feature installed on the Subject Property is identified on the site diagram attached hereto as Exhibit 1.

Owner hereby covenants and agrees to maintain the above-described post-construction BMP features in a good and operable condition at all times, and in accordance with the LID/NPDES Maintenance Guidelines, attached hereto as Exhibit 2.

Owner further covenants and agrees that the above-described post-construction BMP features shall not be removed from the Subject Property unless and until they have been replaced with other post-construction BMP features in accordance with County of Los Angeles' Green Building Standards Code, Title 31 and NPDES permit.

Owner further covenants and agrees that if Owner hereafter sells the Subject Property, Owner shall provide printed educational materials to the buyer regarding the post-construction BMP features that are located on the Subject Property, including the type(s) and location(s) of all such features, and instructions for properly maintaining all such features.

Owner makes this Covenant and Agreement on behalf of itself and its successors and assigns. This Covenant and Agreement shall run with the Subject Property and shall be binding upon owner, future owners, and their heirs, successors and assignees, and shall continue in effect until the release of this Covenant and Agreement by the County of Los Angeles, in its sole discretion.

Owner(s):

By:_____ Date:_____

By:_____ Date:_____

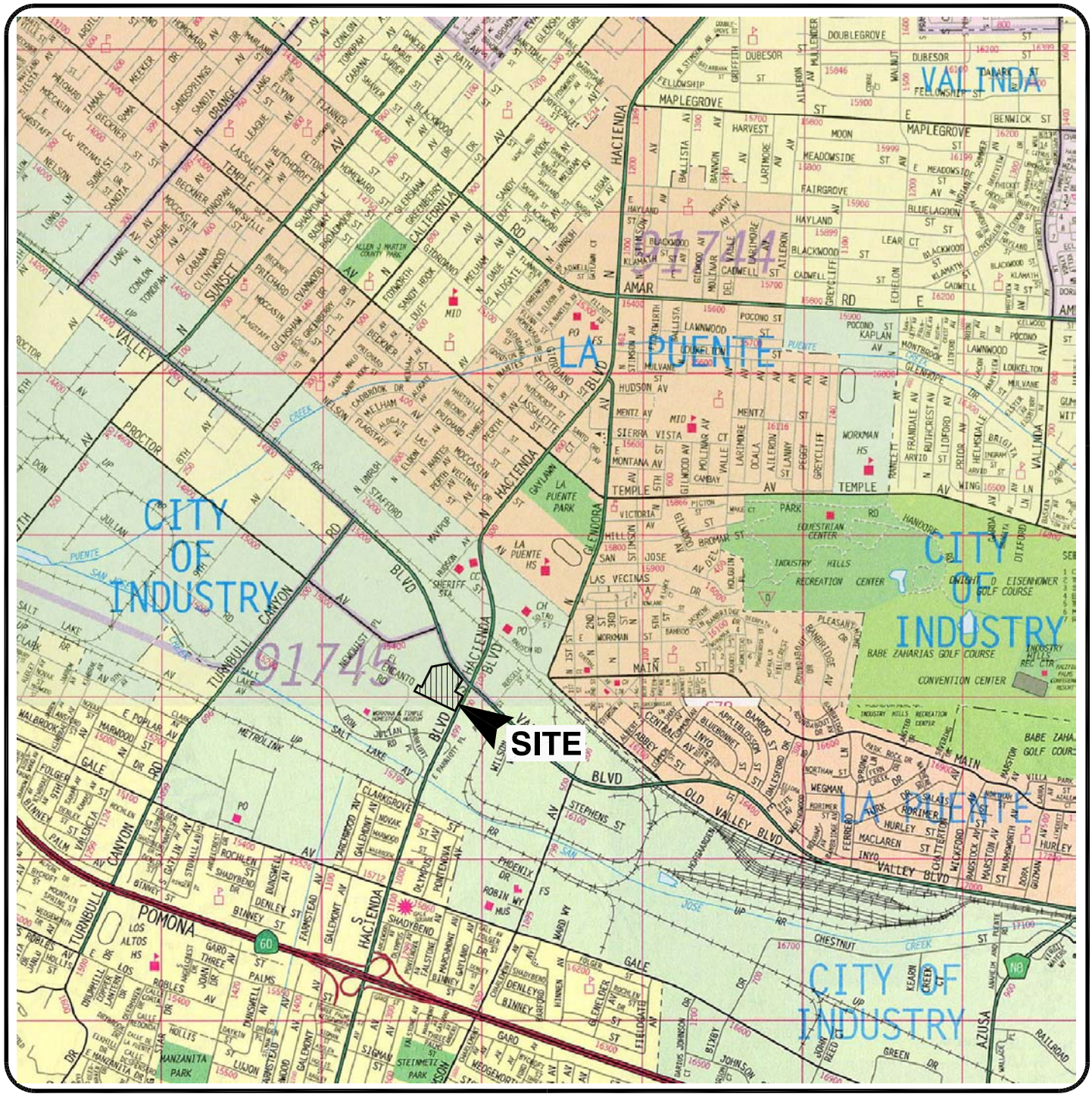
(PLEASE ATTACH NOTARY)

REFERENCE

PLAN CHECK NO.: _____ DISTRICT OFFICE NO.:_____

ATTACHMENTS

Attachment F
Soils Report and Percolation Data



REFERENCE: 2004 THOMAS GUIDE FOR LOS ANGELES/ORANGE COUNTIES, STREET GUIDE AND DIRECTORY

NORTH

0 2400 4800

APPROXIMATE SCALE IN FEET

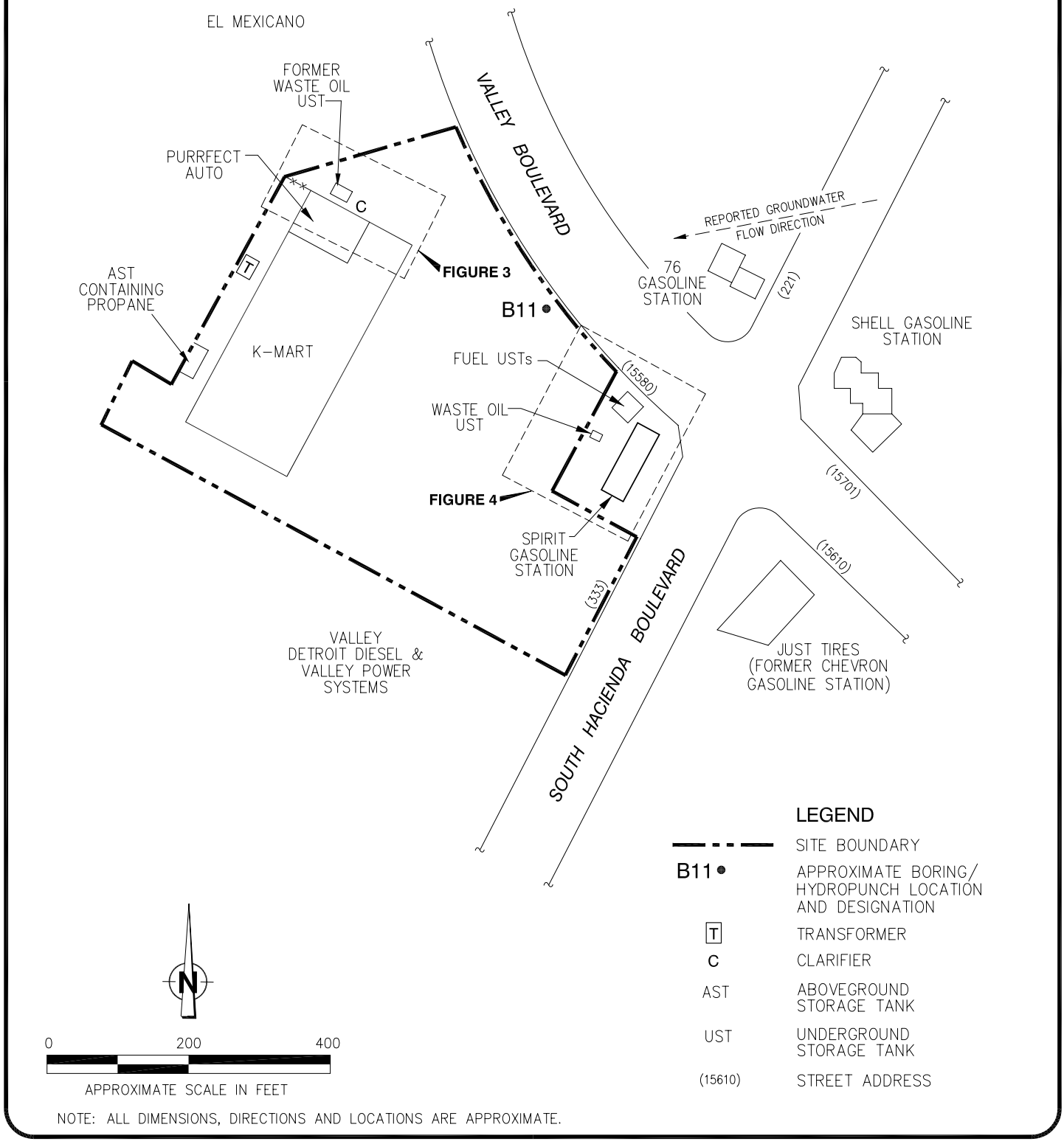
Ninyo & Moore

206512-A1.DWG

SITE LOCATION MAP

333 HACIENDA BOULEVARD
CITY OF INDUSTRY, CALIFORNIA

PROJECT NO.	DATE	FIGURE
206512001	10/2005	1



NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

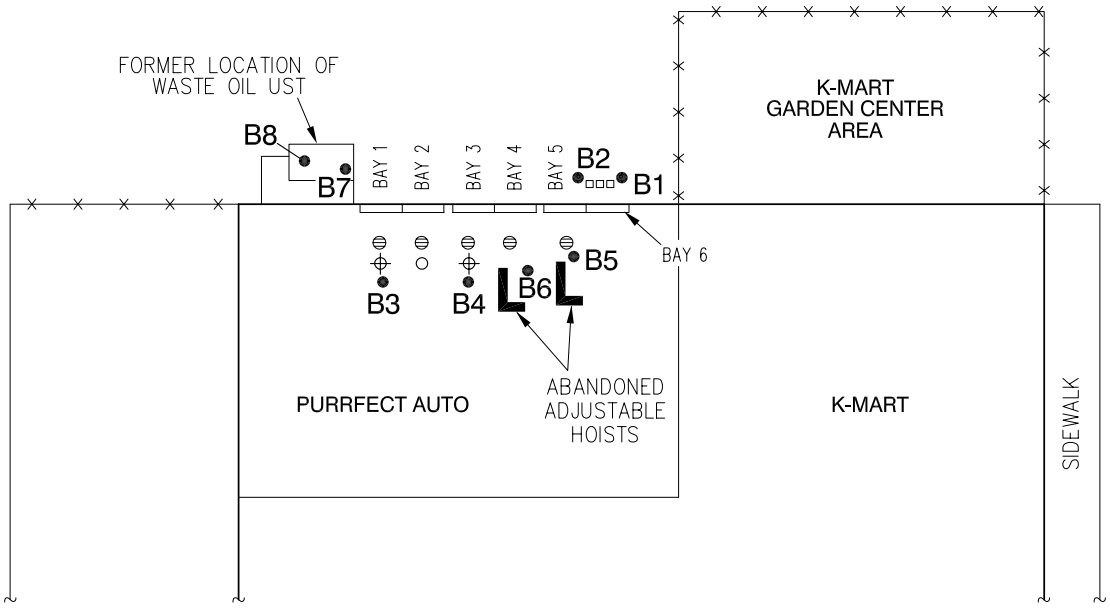
206512-A2.DWG

Ninyo & Moore

SITE VICINITY MAP

333 HACIENDA BOULEVARD
CITY OF INDUSTRY, CALIFORNIA

PROJECT NO.	DATE	FIGURE
206512001	10/2005	2



LEGEND

×—×—×	CHAIN–LINK FENCE
B8 ●	APPROXIMATE BORING LOCATION AND DESIGNATION
⊕	ABANDONED HYDRAULIC HOIST
○	ACTIVE HYDRAULIC HOIST
⊖	FLOOR DRAIN
UST	UNDERGROUND STORAGE TANK
▫▫▫	CLARIFIER

0 50 100

APPROXIMATE SCALE IN FEET

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

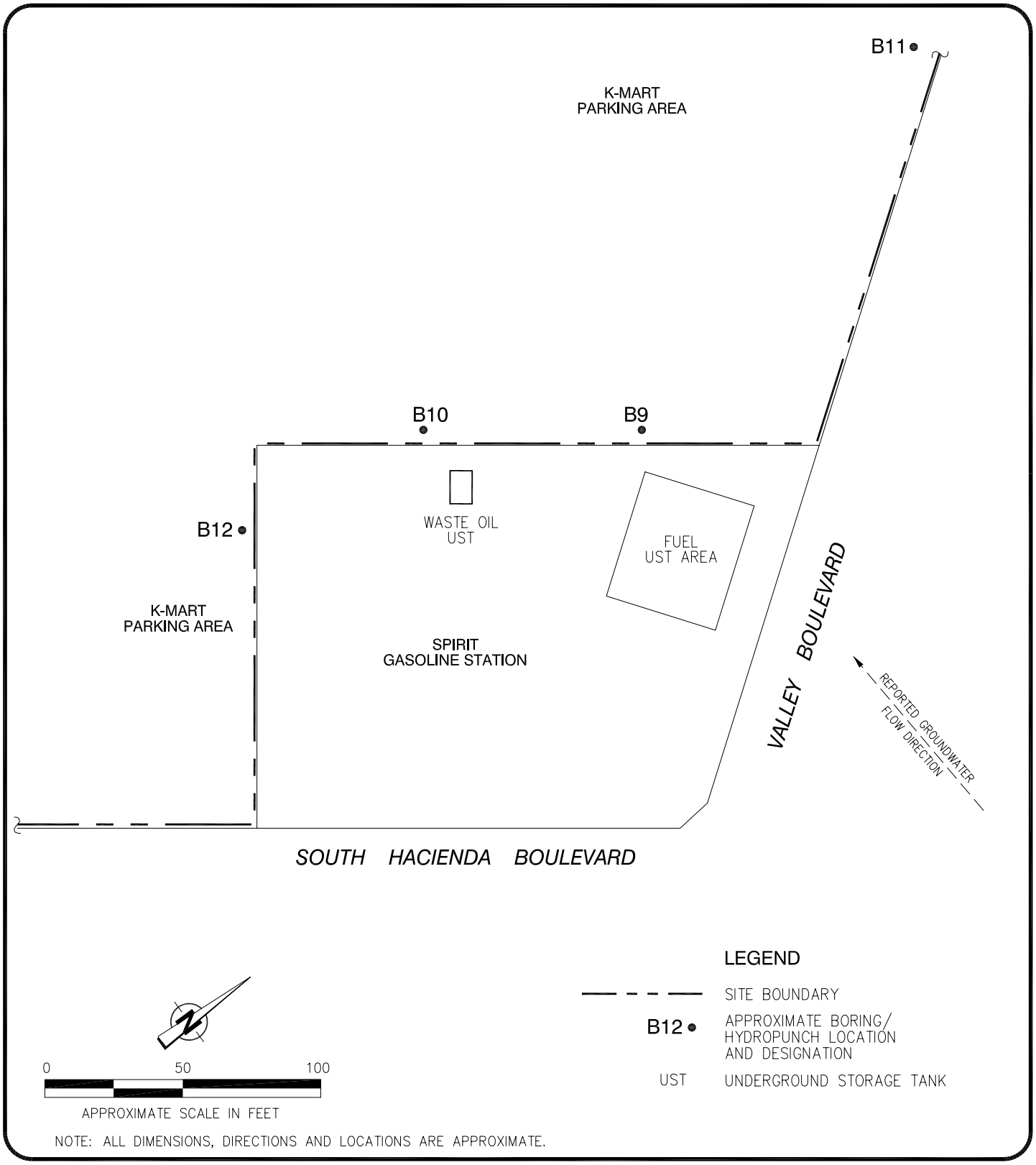
206512–A4.DWG

Ninyo & Moore

BORING LOCATION MAP, PURRFECT AUTO

333 HACIENDA BOULEVARD
CITY OF INDUSTRY, CALIFORNIA

PROJECT NO.	DATE	FIGURE
206512001	10/2005	3



206512-A3.DWG

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore

**BORING LOCATION MAP,
ADJACENT GASOLINE STATIONS**

333 HACIENDA BOULEVARD
CITY OF INDUSTRY, CALIFORNIA

PROJECT NO.	DATE	FIGURE
206512001	10/2005	4

APPENDIX E

BORING LOGS

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES: Bulk	SAMPLES: Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0	■							Bulk sample.
		■						Modified split-barrel drive sampler.
		⊠						No recovery with modified split-barrel drive sampler.
		▬						Sample retained by others.
		◪						Standard Penetration Test (SPT).
5		◪						No recovery with a SPT.
		▭	XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
		◪						No recovery with Shelby tube sampler.
		▭						Continuous Push Sample.
				♀				Seepage.
10				▽				Groundwater encountered during drilling.
				▼				Groundwater measured after drilling.
						▩	SM	ALLUVIUM: Solid line denotes unit change.
								Dashed line denotes material change.
15								Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Sheared Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

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BORING LOG

EXPLANATION OF BORING LOG SYMBOLS

PROJECT NO.	DATE	FIGURE
	Rev. 01/03	

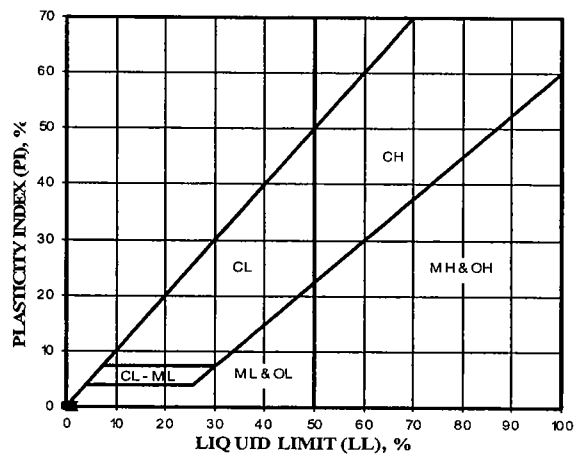
U.S.C.S. METHOD OF SOIL CLASSIFICATION

MAJOR DIVISIONS		SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (More than 1/2 of soil >No. 200 sieve size)	GRAVELS (More than 1/2 of coarse fraction > No. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction <No. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (More than 1/2 of soil <No. 200 sieve size)	SILTS & CLAYS Liquid Limit <50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean
		OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS Liquid Limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

GRAIN SIZE CHART

CLASSIFICATION	RANGE OF GRAIN SIZE	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.76
Coarse	3" to 3/4"	76.2 to 19.1
Fine	3/4" to No. 4	19.1 to 4.76
SAND	No. 4 to No. 200	4.76 to 0.075
Coarse	No. 4 to No. 10	4.76 to 2.00
Medium	No. 10 to No. 40	2.00 to 0.420
Fine	No. 40 to No. 200	0.420 to 0.075
SILT & CLAY	Below No. 200	Below 0.075

PLASTICITY CHART



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U.S.C.S. METHOD OF SOIL CLASSIFICATION

DATE DRILLED 10/12/05 BORING NO. B1

GROUND ELEVATION NA SHEET 1 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL	ASPHALT: Approximately 1 inch thick. ALLUVIUM: Dark brown to black, moist, silty CLAY.
5	Driven		B1-5	16.1				
							SM	Dusky yellowish brown (10 YR 2/2), moist, silty fine SAND.
10	Driven		B1-10	36.4				
15	Driven		B1-15	6.9				Dark yellowish brown (10 YR 4/2).
20	Driven		B1-20	1.6				

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BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-1

DATE DRILLED 10/12/05 BORING NO. B1

GROUND ELEVATION NA SHEET 2 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20									Total Depth = 20 feet. No groundwater encountered during drilling. No petroleum hydrocarbon odors or staining noted in samples. Backfilled with granular bentonite on 10/12/05.
25									
30									
35									
40									

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BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-2

DATE DRILLED 10/12/05 BORING NO. B2

GROUND ELEVATION NA SHEET 1 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES: Bulk	SAMPLES: Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0								CL	ASPHALT: Approximately 1 inch thick. ALLUVIUM: Dark brown to black, moist, silty CLAY.
5		■		B2-5	34.6				
								SM	Dusky yellowish brown (10 YR 2/2), moist, silty fine SAND.
10		■		B2-10	18.8				
15		■		B2-15	4.5				Dark yellowish brown (10 YR 4/2).
20		■		B2-20	1.5				

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BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-3

DATE DRILLED 10/12/05 BORING NO. B2

GROUND ELEVATION NA SHEET 2 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20									Total Depth = 20 feet. No groundwater encountered during drilling. No petroleum hydrocarbon odors or staining noted in samples. Backfilled with granular bentonite on 10/12/05.
25									
30									
35									
40									

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BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-4

DATE DRILLED 10/12/05 BORING NO. B3

GROUND ELEVATION NA SHEET 1 OF 1

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL	CONCRETE: Approximately 3 inches thick. ALLUVIUM: Black, moist, silty CLAY.
5			B3-5	9.2				
10			B3-10	3.2			SM	Dusky yellowish brown (10 YR 2/2), moist, silty fine SAND.
15			B3-15	2.7				Dusky brown (5 YR 2/2).
20								Total Depth = 15 feet. No groundwater encountered during drilling. No petroleum hydrocarbon odors or staining noted in samples. Backfilled with granular bentonite on 10/12/05.

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BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-5

DATE DRILLED 10/12/05 BORING NO. B4

GROUND ELEVATION NA SHEET 1 OF 1

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL	CONCRETE: Approximately 3 inches thick. ALLUVIUM: Black, moist, silty CLAY.
5	Driven		B4-5	12.4				
							SM	Dusky yellowish brown (10 YR 2/2), moist, silty fine SAND.
10	Driven		B4-10	11.4				
15	Driven		B4-15	2.1				Dark yellowish brown (10 YR 4/2). Total Depth = 15 feet. No groundwater encountered during drilling. No petroleum hydrocarbon odors or staining noted in samples. Backfilled with granular bentonite on 10/12/05.
20								

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BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-6

DATE DRILLED 10/12/05 BORING NO. B5

GROUND ELEVATION NA SHEET 1 OF 1

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL	CONCRETE: Approximately 3 inches thick. ALLUVIUM: Dusky yellowish brown (10 YR 2/2) interbedded with dark yellowish brown (10 YR 4/2), moist, silty CLAY.
5	Driven		B5-5					
10								Total Depth = 7 feet. Refusal encountered at 7 feet (concrete). No groundwater encountered during drilling. Backfilled with granular bentonite on 10/12/05.
15								
20								

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BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-7

DATE DRILLED 10/12/05 BORING NO. B6

GROUND ELEVATION NA SHEET 1 OF 1

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ML	CONCRETE: Approximately 3 inches thick. ALLUVIUM: Black, moist, clayey SILT.
5			B6-5	7.1				
							SM	Dusky yellowish brown (10 YR 2/2), moist, silty fine SAND.
10			B6-10	12.3				
			B6-15	3.4				Dark yellowish brown (10 YR 4/2).
15								Total Depth = 15 feet. No groundwater encountered during drilling. No petroleum hydrocarbon odors or staining noted in samples. Backfilled with granular bentonite on 10/12/05.
20								

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-8

DATE DRILLED 10/12/05 BORING NO. B7

GROUND ELEVATION NA SHEET 1 OF 1

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL	ASPHALT: Approximately 3 inches thick. FILL: Black, moist, silty CLAY.
5	Driven		B7-5	0.3				
10	Driven		B7-10	6.7			SM	ALLUVIUM: Dusky yellowish brown (10 YR 2/2), moist, silty SAND.
15	Driven		B7-15	2.7				Dark yellowish brown (10 YR 4/2).
								Total Depth = 15 feet. No groundwater encountered during drilling. No petroleum hydrocarbon odors or staining noted in samples. Backfilled with granular bentonite on 10/12/05.
20								

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-9

DATE DRILLED 10/12/05 BORING NO. B8

GROUND ELEVATION NA SHEET 1 OF 1

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ML	ASPHALT: Approximately 3 inches thick. FILL: Black, moist, clayey SILT.
5	Driven		B8-5	11.8				
10	Driven		B8-10	8.4			SM	ALLUVIUM: Dark yellowish brown (10 YR 4/2), moist, silty SAND.
15	Driven		B8-15	3.2				Total Depth = 15 feet. No groundwater encountered during drilling. No petroleum hydrocarbon odors or staining noted in samples. Backfilled with granular bentonite on 10/12/05.
20								

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-10

DATE DRILLED 10/12/05 BORING NO. B9

GROUND ELEVATION NA SHEET 1 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ML	ASPHALT: Approximately 3 inches thick. ALLUVIUM: Dark brown to black, moist, clayey SILT.
5	Driven		B9-5	3.4				
							SM	Dark yellowish brown (10 YR 4/2), moist, silty SAND.
10	Driven		B9-10	18.9				
15	Driven		B9-15	4.5				Dusky yellowish brown (10 YR 2/2); groundwater seepage encountered.
20	Driven		B9-20	9.3				Dark yellowish brown (10 YR 4/2).

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-11

DATE DRILLED 10/12/05 BORING NO. B9

GROUND ELEVATION NA SHEET 2 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES: Bulk	SAMPLES: Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20								SM	ALLUVIUM: (Continued) Dark yellowish brown (10 YR 4/2), moist, silty SAND
								SP	Dusky yellowish brown (10 YR 2/2), wet, medium to coarse SAND.
		■		B9-25	47.8	▽			
25									Groundwater encountered during drilling at 25 feet.
30									
									Total Depth = 31 feet. Groundwater samples collected using hydropunch equipment from 27 to 31 feet. No petroleum hydrocarbon odors or staining noted in samples. Backfilled with granular bentonite on 10/12/05.
35									
40									

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-12

DATE DRILLED 10/12/05 BORING NO. B10

GROUND ELEVATION NA SHEET 1 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0									ASPHALT: Approximately 3 inches thick. No samples collected.
5									
10									
15									
20									

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-13

DATE DRILLED 10/12/05 BORING NO. B10

GROUND ELEVATION NA SHEET 2 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20									
25									
30									
									Total Depth = 31 feet. No petroleum hydrocarbon odors or shean noted in ground. Groundwater samples collected using hydropunch equipment from 27 to 31 feet. Backfilled with granular bentonite on 10/12/05.
35									
40									

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-14

DATE DRILLED 10/13/05 BORING NO. B11

GROUND ELEVATION NA SHEET 1 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0									ASPHALT: Approximately 3 inches thick. No samples collected.
5									
10									
15									
20									

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-15

DATE DRILLED 10/13/05 BORING NO. B11

GROUND ELEVATION NA SHEET 2 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES: Bulk	SAMPLES: Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20									
25									
30									
									Total Depth = 31 feet. No petroleum hydrocarbon odors or shean noted in ground. Groundwater samples collected using hydropunch equipment from 27 to 31 feet. Backfilled with granular bentonite on 10/13/05.
35									
40									

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-16

DATE DRILLED 10/13/05 BORING NO. B12

GROUND ELEVATION NA SHEET 1 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0									ASPHALT: Approximately 3 inches thick. No samples collected.
5									
10									
15									
20									

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-17

DATE DRILLED 10/13/05 BORING NO. B12

GROUND ELEVATION NA SHEET 2 OF 2

METHOD OF DRILLING Direct Push

DRIVE WEIGHT NA DROP NA

SAMPLED BY BAP LOGGED BY BAP REVIEWED BY PAR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	SAMPLE ID	ORGANIC VAPORS (ppm)	MOISTURE	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20									
25									
30									
									Total Depth = 31 feet. No petroleum hydrocarbon odors or shean noted in ground. Groundwater samples collected using hydropunch equipment from 27 to 31 feet. Backfilled with granular bentonite on 10/13/05.
35									
40									

Ninyo & Moore

BORING LOG

K-Mart Property
333 South Hacienda Boulevard, California

PROJECT NO.	DATE	FIGURE
206512002	11/2005	A-18

R404.5 Precast concrete foundation walls.

R404.5.1 Design. Precast concrete foundation walls shall be designed in accordance with accepted engineering practice. The design and manufacture of precast concrete foundation wall panels shall comply with the materials requirements of Section R402.3 or ACI 318. The panel design drawings shall be prepared by a registered design professional.

R404.5.2 Precast concrete foundation design drawings. Precast concrete foundation wall design drawings shall be submitted to the building official and approved prior to installation. Drawings shall include, at a minimum, the information specified below:

1. Design loading as applicable;
2. Footing design and material;
3. Concentrated loads and their points of application;
4. Soil bearing capacity;
5. Maximum allowable total uniform load;
6. Seismic design category; and
7. Basic wind speed.

R404.5.3 Identification. Precast concrete foundation wall panels shall be identified by a certificate of inspection label issued by an approved third party inspection agency.

SECTION R405
FOUNDATION DRAINAGE

R405.1 Concrete or masonry foundations. Drains shall be provided around all concrete or masonry foundations that retain earth and enclose habitable or usable spaces located below grade. Drainage tiles, gravel or crushed stone drains, perforated pipe or other approved systems or materials shall be installed at or below the area to be protected and shall discharge by gravity or mechanical means into an approved drainage system. Gravel or crushed stone drains shall extend at least 1 foot (305 mm) beyond the outside edge of the footing and 6 inches (152 mm) above the top of the footing and be covered with an approved filter membrane material. The top of open joints of drain tiles shall be protected with strips of building paper. Perforated drains shall be surrounded with an approved filter membrane or the filter membrane shall cover the washed gravel or crushed rock covering the drain. Drainage tiles or perforated pipe shall be placed on a minimum of 2 inches (51 mm) of washed gravel or crushed rock at least one sieve size larger than the tile joint opening or perforation and covered with not less than 6 inches (152 mm) of the same material.

Exception: A drainage system is not required when the foundation is installed on well-drained ground or sand-gravel mixture soils according to the Unified Soil Classification System, Group I Soils, as detailed in Table R405.1.

TABLE R405.1
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS[a]	FROST HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION[b]
Group I	GW	Well-graded gravels, gravel sand mixtures, little or no fines	Good	Low	Low
	GP	Poorly graded gravels or gravel sand mixtures, little or no fines	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures	Good	Medium	Low
Group II	GC	Clayey gravels, gravel-sand-clay mixtures	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixture	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium	Medium	Medium to Low
Group III	CH	Inorganic clays of high plasticity, fat clays	Poor	Medium	High
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts	Unsatisfactory	Medium	High
	Pt	Peat and other highly organic soils	Unsatisfactory	Medium	High

For SI: 1 inch = 25.4 mm.

a. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 inches to 4 inches per hour, and poor is less than 2 inches per hour.

b. Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with a high potential expansion have a PI greater than 20.