

Preliminary

Water Quality Management Plan

For:

Keystone – Rialto Townhouses

PPD 2020-0007

TRACT MAP NO 20356

APN: 128-071-02, 03 & 09

Prepared for:

Keystone DCS

9140 Trask Avenue, Suite 202

Garden Grove, CA 92843

714-791-3772

Prepared by:

Huitt-Zollars, Inc

3990 Concourses, Suite 330

Ontario, CA 91764

909-941-7799

Submittal Date: 01/10/2022

Revision Date: _____

Approval Date: _____

Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for Keystone DCS by Huitt-Zollars, Inc. The WQMP is intended to comply with the requirements of the City of Rialto and the NPDES Areawide Stormwater Program requiring the preparation of a WQMP. 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 San Bernardino County's Municipal Storm Water Management Program and the intent of the NPDES Permit for San Bernardino County and the incorporated cities of San Bernardino County within the Santa Ana Region. Once the undersigned transfers its interest in the property, its successors in interest and the city/county shall be notified of the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity.

"I certify under a penalty of law that the provisions (implementation, operation, maintenance, and funding) of the WQMP have been accepted and that the plan will be transferred to future successors."

Project Data			
Permit/Application Number(s):	PPD 2020-0007	Grading Permit Number(s):	TBD
Tract/Parcel Map Number(s):	20356	Building Permit Number(s):	TBD
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN: 128-071-02, 03 & 09
Owner's Signature			
Owner Name: Timothy Nguyen			
Title			
Company	Keystone DCS		
Address	9140 Trask Avenue, Suite 202. Garden Grove, CA 92843		
Email	timothy@keystonedcs.com		
Telephone #	714-791-3772		
Signature			Date

Preparer's Certification

Project Data			
Permit/Application Number(s):	PPD 2020-0007	Grading Permit Number(s):	TBD
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"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan were prepared under my oversight and meet the requirements of Regional Water Quality Control Board Order No. R8-2010-0036."

Engineer: David White, PE		PE Stamp Below
Title	Vice President	
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Date		

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Section 1 Discretionary Permit(s)

Form 1-1 Project Information					
Project Name		Keystone Rialto Townhouses			
Project Owner Contact Name:		Timothy Nguyen			
Mailing Address:	9140 Trask Avenue, Suite 202. Garden Grove, CA 92843	E-mail Address:	timothy@keystonedcs.com	Telephone:	714-791-3772
Permit/Application Number(s):		PPD 2020-0007	Tract/Parcel Map Number(s):	20356	
Additional Information/ Comments:		N/A			
Description of Project:		This project is a new development of townhouses located along the southeast corner of Foothill Boulevard and Larch Avenue in the City of Rialto, CA. The site is currently with scattered weeds and native grass. The proposed project will have approximately 70 townhomes, common drive aisle and recreation areas within a gated tract on approximately 4.5 acres of land. The project site will be designed to one (1) DA area, and all on-site runoff will be collected by catch basins with Bioclean catch basin filters (or approved equal) installed and conveyed to an on-site detention/infiltration underground system beneath the proposed swimming pool area. Excess flow from the underground system will discharge through a trench drain to an existing v-gutter along the south side of the project site. Ultimately, the overflow will be discharged to Rialto Channel and continue to Santa Ana Reach 3, Prado Control basin, Santa Ana River Reach 2, 1 & Pacific Ocean.			
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.		N/A			

Section 2 Project Description

2.1 Project Information

This section of the WQMP should provide the information listed below. The information provided for Conceptual/ Preliminary WQMP should give sufficient detail to identify the major proposed site design and LID BMPs and other anticipated water quality features that impact site planning. Final Project WQMP must specifically identify all BMP incorporated into the final site design and provide other detailed information as described herein.

The purpose of this information is to help determine the applicable development category, pollutants of concern, watershed description, and long term maintenance responsibilities for the project, and any applicable water quality credits. This information will be used in conjunction with the information in Section 3, Site Description, to establish the performance criteria and to select the LID BMP or other BMP for the project or other alternative programs that the project will participate in, which are described in Section 4.

Form 2.1-1 Description of Proposed Project					
1 Development Category (Select all that apply):					
☐ Significant re-development involving the addition or replacement of 5,000 ft ² or more of impervious surface on an already developed site	☒ New development involving the creation of 10,000 ft ² or more of impervious surface collectively over entire site	☐ Automotive repair shops with standard industrial classification (SIC) codes 5013, 5014, 5541, 7532- 7534, 7536-7539	☐ Restaurants (with SIC code 5812) where the land area of development is 5,000 ft ² or more		
☐ Hillside developments of 5,000 ft ² or more which are located on areas with known erosive soil conditions or where the natural slope is 25 percent or more	☐ Developments of 2,500 ft ² of impervious surface or more adjacent to (within 200 ft) or discharging directly into environmentally sensitive areas or waterbodies listed on the CWA Section 303(d) list of impaired waters.	☐ Parking lots of 5,000 ft ² or more exposed to storm water	☐ Retail gasoline outlets that are either 5,000 ft ² or more, or have a projected average daily traffic of 100 or more vehicles per day		
☐ Non-Priority / Non-Category Project <i>May require source control LID BMPs and other LIP requirements. Please consult with local jurisdiction on specific requirements.</i>					
2 Project Area (ft ²):	193,880	3 Number of Dwelling Units:	N/A	4 SIC Code:	6531211
5 Is Project going to be phased? Yes ☐ No ☒ <i>If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.</i>					
6 Does Project include roads? Yes ☐ No ☒ <i>If yes, ensure that applicable requirements for transportation projects are addressed (see Appendix A of TGD for WQMP)</i>					

2.2 Property Ownership/Management

Describe the ownership/management of all portions of the project and site. State whether any infrastructure will transfer to public agencies (City, County, Caltrans, etc.) after project completion. State if a homeowners or property owners association will be formed and be responsible for the long-term maintenance of project stormwater facilities. Describe any lot-level stormwater features that will be the responsibility of individual property owners.

Form 2.2-1 Property Ownership/Management

Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities:

The property is being developed by Keystone DCS. Keystone DCS or subsequent ownership entity will be the entity responsible for long term maintenance of WQMP Storm Water Facilities throughout the site.

Name: Keystone DCS

Address: 9140 Trask Avenue, Suite 202. Garden Grove, CA 92843

Contact Person: Timothy Nguyen

Phone: 714-791-3772

2.3 Potential Stormwater Pollutants

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-3 in the TGD for WQMP).

Form 2.3-1 Pollutants of Concern			
Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E ☒	N ☐	Pathogens are typically caused by the transport of animal or human fecal wastes from the watershed.
Nutrients - Phosphorous	E ☒	N ☐	Primary sources of nutrients in urban runoff are fertilizers and eroded soils.
Nutrients - Nitrogen	E ☒	N ☐	Primary sources of nutrients in urban runoff are fertilizers and eroded soils.
Noxious Aquatic Plants	E ☒	N ☐	Noxious aquatic plants are typically from animals or vehicle transport that grow aggressively, multiply quickly without natural controls (native herbivores, soil chemistry, etc.), and adversely affect native habitats.
Sediment	E ☒	N ☐	Sediments are solid materials that are eroded from the land surface.
Metals	E ☒	N ☐	The primary source of metal pollution in stormwater is typically commercially available metals and metal products, as well as emissions from brake pad and tire tread wear associated with driving.
Oil and Grease	E ☒	N ☐	Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids.
Trash/Debris	E ☒	N ☐	Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste from human or animals
Pesticides / Herbicides	E ☒	N ☐	Pesticides and herbicides can be washed off urban landscapes during storm events.
Organic Compounds	E ☒	N ☐	Sources of organic compounds may include waste handling areas and vehicle or landscape maintenance areas.
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

2.4 Water Quality Credits

A water quality credit program is applicable for certain types of development projects if it is not feasible to meet the requirements for on-site LID. Proponents for eligible projects, as described below, can apply for water quality credits that would reduce project obligations for selecting and sizing other treatment BMP or participating in other alternative compliance programs. Refer to Section 6.2 in the TGD for WQMP to determine if water quality credits are applicable for the project.

Form 2.4-1 Water Quality Credits			
1 Project Types that Qualify for Water Quality Credits: <i>Select all that apply</i>			
☐ Redevelopment projects that reduce the overall impervious footprint of the project site. [Credit = % impervious reduced]	Higher density development projects ☐ Vertical density [20%] ☐ 7 units/ acre [5%]	☐ Mixed use development, (combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that demonstrate environmental benefits not realized through single use projects) [20%]	☐ Brownfield redevelopment (redevelop real property complicated by presence or potential of hazardous contaminants) [25%]
☐ Redevelopment projects in established historic district, historic preservation area, or similar significant core city center areas [10%]	☐ Transit-oriented developments (mixed use residential or commercial area designed to maximize access to public transportation) [20%]	☐ In-fill projects (conversion of empty lots & other underused spaces < 5 acres, substantially surrounded by urban land uses, into more beneficially used spaces, such as residential or commercial areas) [10%]	☐ Live-Work developments (variety of developments designed to support residential and vocational needs) [20%]
2 Total Credit % 0 (Total all credit percentages up to a maximum allowable credit of 50 percent)			
Description of Water Quality Credit Eligibility (if applicable)	NOT APPLICABLE		

Section 3 Site and Watershed Description

Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and sub-watershed DMAs) is conveyed to the site outlet(s). Refer to Section 3.2 in the TGD for WQMP. The form below is provided as an example.

Then complete Forms 3.2 and 3.3 for each DA on the project site. ***If the project has more than one drainage area for stormwater management, then complete additional versions of these forms for each DA / outlet.***

Form 3-1 Site Location and Hydrologic Features			
Site coordinates take GPS measurement at approximate center of site	Latitude 34° 6'22.22"N	Longitude 117°23'25.52"W	Thomas Bros Map page 605
1 San Bernardino County climatic region: ☒ Valley ☐ Mountain			
2 Does the site have more than one drainage area (DA): Yes ☐ No ☒ <i>If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached</i>			
<pre> graph BT DA1[DA1] --> Outlet1[Outlet 1] </pre>			
Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA		
DA1 DMA C flows to DA1 DMA A	Runoff from the area DA1 will be directed to the proposed underground infiltration chamber system beneath the proposed pool area. When the basin reaches capacity, it will overflow and discharge through a trench drain to an existing v-gutter along the south side of the project site.		
DA1 DMA A to Outlet 1			
DA1 DMA B to Outlet 1			
DA2 to Outlet 2			

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1				
For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft ²)	193,880	N/A	N/A	N/A
2 Existing site impervious area (ft ²)	0	N/A	N/A	N/A
3 Antecedent moisture condition <i>For desert areas, use</i> http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf	AMC II	N/A	N/A	N/A
4 Hydrologic soil group <i>Refer to Watershed Mapping Tool –</i> http://permittrack.sbcounty.gov/wap/	A	N/A	N/A	N/A
5 Longest flowpath length (ft)	367	N/A	N/A	N/A
6 Longest flowpath slope (ft/ft)	~0.020	N/A	N/A	N/A
7 Current land cover type(s) <i>Select from Fig C-3 of Hydrology Manual</i>	Barren	N/A	N/A	N/A
8 Pre-developed pervious area condition: <i>Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating</i>	Poor	N/A	N/A	N/A

Form 3-3 Watershed Description for Drainage Area	
Receiving waters <i>Refer to Watershed Mapping Tool -</i> http://permitrack.sbcounty.gov/wap/ <i>See "Drainage Facilities" link at this website</i>	Rialto Channel, Santa Ana Reach 3, Prado Control basin, Santa Ana Reach 2, 1, and Pacific Ocean.
Applicable TMDLs <i>Refer to Local Implementation Plan</i>	Per 2010 303(d) list, Santa Ana River Reach 3: TMDL still required. Prado Flood Control Basin: TMDL still required.
303(d) listed impairments <i>Refer to Local Implementation Plan and Watershed Mapping Tool –</i> http://permitrack.sbcounty.gov/wap/ and State Water Resources Control Board website – http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml	The project expects to generate Pathogens, Nutrients and Metals (Copper & Lead) which are listed for downstream receiving waters on the latest CWA 303(d) list.
Environmentally Sensitive Areas (ESA) <i>Refer to Watershed Mapping Tool –</i> http://permitrack.sbcounty.gov/wap/	None
Unlined Downstream Water Bodies <i>Refer to Watershed Mapping Tool –</i> http://permitrack.sbcounty.gov/wap/	Santa Ana River
Hydrologic Conditions of Concern	☒ Yes Complete Hydrologic Conditions of Concern (HCOC) Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-10 in submittal ☐ No
Watershed-based BMP included in a RWQCB approved WAP	☐ Yes Attach verification of regional BMP evaluation criteria in WAP • More Effective than On-site LID • Remaining Capacity for Project DCV • Upstream of any Water of the US • Operational at Project Completion • Long-Term Maintenance Plan ☒ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMP

4.1.1 Pollution Prevention

Non-structural and structural source control BMP are required to be incorporated into all new development and significant redevelopment projects. Form 4.1-1 and 4.1-2 are used to describe specific source control BMPs used in the WQMP or to explain why a certain BMP is not applicable. Table 7-3 of the TGD for WQMP provides a list of applicable source control BMP for projects with specific types of potential pollutant sources or activities. The source control BMP in this table must be implemented for projects with these specific types of potential pollutant sources or activities.

The preparers of this WQMP have reviewed the source control BMP requirements for new development and significant redevelopment projects. The preparers have also reviewed the specific BMP required for project as specified in Forms 4.1-1 and 4.1-2. All applicable non-structural and structural source control BMP shall be implemented in the project.

Form 4.1-1 Non-Structural Source Control BMPs				
Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☒	☐	Property owners shall review and become familiar with the site specific WQMP. Additional educational materials for day to day operations are contained in Attachment C. Additional materials can be obtained from the local water pollution prevention program. Education of property owners begin with the review/preparation of the site specific WQMP and continues through the review of additional educational material as it applies to their project.
N2	Activity Restrictions	☒	☐	Activity restriction shall be stated in the owners lease terms prior to occupancy: • Fuelling areas, air/water supply areas, maintenance bays, vehicle washing areas, outdoor material storage areas, outdoor work areas, outdoor processing areas, wash water from food preparation areas within the project site will not be allowed on the project site. • Storage of hazardous materials will not be allowed on the project site. • All pesticide applications shall be performed by a licensed contractor certified by the California Department of Pesticide Regulation. • All dumpster lids shall be kept closed at all times. • Blowing, Sweeping or hosing of debris (leaf, litter, grass clippings, trash or debris) into the streets, underground stormdrain facilities or other storm water conveyance areas shall be strictly prohibited
N3	Landscape Management BMPs	☒	☐	A landscape architect will provide design plans for the on-site landscaping and irrigation system. The design shall incorporate the use of native and drought tolerant trees and shrubs throughout the project site.
N4	BMP Maintenance	☒	☐	Property owners shall maintain the designated on-site BMP areas, see Section 5 for self inspection and maintenance form
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	Residential property does not apply to Title 22 CCR.
N6	Local Water Quality Ordinances	☒	☐	Local Water Quality Ordinances will be addressed by implementation of this WQMP

Form 4.1-1 Non-Structural Source Control BMPs				
N7	Spill Contingency Plan	☐	☒	Spill Contingency is not applicable for this site.
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tanks are proposed for this site.
N9	Hazardous Materials Disclosure Compliance	☐	☒	No hazardous materials are planned to be stored on this site.

Form 4.1-1 Non-Structural Source Control BMPs				
Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N10	Uniform Fire Code Implementation	☒	☐	Underground fire protection service and fire sprinklers will be provided per the uniform fire code and the requirements of the County of San Bernardino Fire Department.
N11	Litter/Debris Control Program	☒	☐	Trash storage areas will be designed to have adjacent areas drain away from the trash storage areas. The trash storage areas shall be inspected and maintained on a monthly basis. Collection of trash from the trash storage areas shall occur on a regular basis to ensure that the trash receptacles are not overflowing. Documentation of such inspection/maintenance and trash collection shall be kept by the owner in perpetuity. See the WQMP site map in Attachment A for anticipated location of trash storage areas.
N12	Employee Training	☒	☐	The following requirements shall be stated in the owners lease terms; an Employee Training/Education program shall be provided annually to help educate employees about storm water quality management and practices that help prevent storm water pollution. Documentation of such training/education program implementation shall be kept by the owner for a minimum of ten years. Sample education materials have been provided in Attachment C. Additional educational materials can be obtained from the City of Rialto or the County of San Bernardino storm water program.
N13	Housekeeping of Loading Docks	☐	☒	No loading docks for this project site.
N14	Catch Basin Inspection Program	☒	☐	The onsite catch basins shall be inspected on a quarterly basis. Inspection of the on-site catch basins shall consist of visual inspection of any sediment, trash or debris collected in the bottom of each catch basin. Any sediment, trash or debris found shall be removed from the catch basins and disposed of in a legal manner. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	The on-site parking lots and drive aisles areas shall be swept on a monthly basis. Documentation of such sweeping shall be kept by the owner in perpetuity. Frequency of sweeping shall be adjusted as needed to maintain a clean site.

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N16	Other Non-structural Measures for Public Agency Projects	☐	☒	Not Applicable
N17	Comply with all other applicable NPDES permits	☒	☐	General construction permit "SWRCB Orders No. 2009-009-DWQ as amended by Order 2010-0014-DWQ"

Form 4.1-2 Structural Source Control BMPs				
Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	The on-site storm drain catch basins shall be stenciled with the phrase "Drains to River" or other approved language. The signage shall be inspected on an annual basis. Missing or faded signage shall be replaced. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	No outdoor material storage areas are proposed for this site.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	Trash storage areas will be designed to have adjacent areas drain away from the trash storage areas as well as have a permanent roof over them. The trash storage areas shall be inspected and maintained on a monthly basis. Collection of trash from the trash storage areas shall occur on a regular basis to ensure that the trash receptacles are not overflowing. Documentation of such inspection/maintenance and trash collection shall be kept by the owner in perpetuity. See the WQMP site map in Attachment A for anticipated location of trash storage areas.
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	The landscape architect will provide design plans for the on-site irrigation system. The irrigation system shall be inspected on a monthly basis to ensure proper operation. Any broken sprinkler heads shall be repaired immediately to ensure that the system continues to operate efficiently. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	The landscape architect will provide design plans for the on-site landscaping and irrigation system. The design shall incorporate a finish grade of landscaping areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement throughout the project site.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☐	☒	No designed slope and channel are planned for this site.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	No docks for this project site.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No maintenance bays for this site.
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No vehicle wash areas for this site.
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No outdoor processing areas for this site.
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No equipment wash areas for this site.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	No fueling areas for this site.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	No hillside landscaping are planned in this area.
S14	Wash water control for food preparation areas	☐	☒	No food preparation areas for this site.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No community car wash racks for this site.

4.1.2 Preventative LID Site Design Practices

Site design practices associated with new LID requirements in the MS4 Permit should be considered in the earliest phases of a project. Preventative site design practices can result in smaller DCV for LID BMP and hydromodification control BMP by reducing runoff generation. Describe site design and drainage plan including:

- A narrative of site design practices utilized or rationale for not using practices
- A narrative of how site plan incorporates preventive site design practices
- Include an attached Site Plan layout which shows how preventative site design practices are included in WQMP

Refer to Section 5.2 of the TGD for WQMP for more details.

Form 4.1-3 Preventative LID Site Design Practices Checklist
Site Design Practices <i>If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets</i>
Site Design Practices <i>If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets</i>
Minimize impervious areas: Yes ☐ No ☒ Explanation: The developer has chosen to maximize the building and parking footprint. An underground infiltration system is sized accordingly.
Maximize natural infiltration capacity: Yes ☒ No ☐ Explanation: The entire site drains to the underground infiltration system thereby maximizing the natural infiltration capacity.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: The proposed condition will mimic the existing condition southeasterly drainage pattern. The proposed runoff will drain to an on-site UG Infiltration System; overflow will discharge on to an existing v-gutter along the south side of the project site. The UG. Infiltration system will lengthen the time of concentration thus mimicking the existing conditions.
Disconnect impervious areas: Yes ☐ No ☒ Explanation:
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: The site has no existing vegetation or sensitive areas to protect. The planting of new vegetation will occur throughout the site.
Re-vegetate disturbed areas: Yes ☒ No ☐ Explanation: All Landscape area will be vegetated for stabilization.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: The soils in the proposed infiltration system footprints will be uncompacted in-place native material.
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☒ Explanation: No vegetated drainage swales are planned.

4.2 Project Performance Criteria

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in the MS4 Permit. These targets include runoff volume for water quality control (referred to as LID design capture volume), and runoff volume, time of concentration, and peak runoff for protection of any downstream waterbody segments with a HCOC. ***If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.***

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), the San Bernardino County Stormwater Program requires use of the P₆ method (MS4 Permit Section XI.D.6a.ii) – Form 4.2-1
- For HCOC pre- and post-development hydrologic calculation, the San Bernardino County Stormwater Program requires the use of the Rational Method (San Bernardino County Hydrology Manual Section D). Forms 4.2-2 through Form 4.2-5 calculate hydrologic variables including runoff volume, time of concentration, and peak runoff from the project site pre- and post-development using the Hydrology Manual Rational Method approach. For projects greater than 640 acres (1.0 mi²), the Rational Method and these forms should not be used. For such projects, the Unit Hydrograph Method (San Bernardino County Hydrology Manual Section E) shall be applied for hydrologic calculations for HCOC performance criteria.

Refer to Section 4 in the TGD for WQMP for detailed guidance and instructions.

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)		
1 Project area DA 1 (ft ²): 193,880	2 Imperviousness after applying preventative site design practices (Imp%): 0.82	3 Runoff Coefficient (Rc): 0.62 $R_c = 0.858(\text{Imp}\%)^{0.3} - 0.78(\text{Imp}\%)^{0.2} + 0.774(\text{Imp}\%) + 0.04$
4 Determine 1-hour rainfall depth for a 2-year return period P _{2yr-1hr} (in): 0.620 http://hdsc.nws.noaa.gov/hdsc/pfds/so/sca_pfds.html		
5 Compute P ₆ , Mean 6-hr Precipitation (inches): 0.92 $P_6 = \text{Item 4} * C_1$, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)		
6 Drawdown Rate Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.		24-hrs ☐ 48-hrs ☒
7 Compute design capture volume, DCV (ft ³): 18,090 $DCV = 1/12 * [\text{Item 1} * \text{Item 3} * \text{Item 5} * C_2]$, where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963) Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2		



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NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: CA

Data description

Data type:

Precipitation depth

 Units:

English

 Time series type:

Partial duration

Select location

1) Manually:



aa.gov):

a) Select location

Move crosshair or do

b) Click on station icon

☐ Show stations on r

Location information

Name: Rialto, California,

Latitude: 34.1061°

Longitude: -117.3900°

Elevation: 1282.47 ft **

* Source: ESRI Maps

** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES
WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 6, Version 2

Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)¹

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	
5-min	0.125 (0.104-0.151)	0.162 (0.135-0.197)	0.213 (0.176-0.259)	0.255 (0.209-0.313)	0.313 (0.248-0.398)	0.358 (0.279-0.466)	0.406 (0.308-0.541)	0.456 (0.336-0.626)	0.527 (0.372-0.754)	(0.39-0.71)
10-min	0.179 (0.149-0.217)	0.233 (0.194-0.283)	0.305 (0.253-0.371)	0.365 (0.300-0.448)	0.448 (0.356-0.570)	0.514 (0.399-0.668)	0.582 (0.441-0.775)	0.654 (0.482-0.897)	0.755 (0.533-1.08)	(0.51-0.91)
15-min	0.216 (0.180-0.262)	0.282 (0.234-0.342)	0.369 (0.306-0.449)	0.441 (0.363-0.542)	0.542 (0.431-0.689)	0.621 (0.483-0.807)	0.704 (0.533-0.938)	0.791 (0.582-1.09)	0.913 (0.644-1.31)	(0.61-1.01)
30-min	0.322 (0.268-0.391)	0.419 (0.349-0.510)	0.549 (0.455-0.669)	0.658 (0.541-0.808)	0.808 (0.641-1.03)	0.926 (0.720-1.20)	1.05 (0.795-1.40)	1.18 (0.868-1.62)	1.36 (0.960-1.95)	(1.01-1.71)
60-min	0.476 (0.396-0.577)	0.620 (0.515-0.753)	0.811 (0.673-0.988)	0.971 (0.798-1.19)	1.19 (0.947-1.52)	1.37 (1.06-1.78)	1.55 (1.17-2.06)	1.74 (1.28-2.39)	2.01 (1.42-2.88)	(1.41-2.81)
2-hr	0.704 (0.586-0.854)	0.908 (0.755-1.10)	1.18 (0.976-1.43)	1.40 (1.15-1.72)	1.71 (1.36-2.17)	1.95 (1.51-2.53)	2.19 (1.66-2.92)	2.45 (1.81-3.36)	2.81 (1.99-4.03)	(2.01-4.01)
3-hr	0.885 (0.737-1.07)	1.14 (0.946-1.38)	1.47 (1.22-1.79)	1.75 (1.43-2.14)	2.12 (1.68-2.70)	2.41 (1.87-3.13)	2.71 (2.05-3.61)	3.02 (2.23-4.14)	3.45 (2.44-4.94)	(2.45-4.95)
6-hr	1.27 (1.06-1.55)	1.64 (1.36-1.99)	2.11 (1.75-2.57)	2.50 (2.05-3.07)	3.02 (2.40-3.84)	3.42 (2.66-4.45)	3.83 (2.91-5.11)	4.26 (3.14-5.84)	4.84 (3.41-6.92)	(3.41-6.92)
12-hr	1.72 (1.43-2.08)	2.21 (1.84-2.69)	2.85 (2.36-3.47)	3.37 (2.77-4.14)	4.06 (3.22-5.16)	4.58 (3.56-5.95)	5.11 (3.88-6.81)	5.65 (4.16-7.76)	6.39 (4.51-9.14)	(4.51-9.14)
24-hr	2.33 (2.06-2.68)	3.02 (2.67-3.49)	3.91 (3.45-4.53)	4.63 (4.05-5.39)	5.58 (4.72-6.72)	6.29 (5.22-7.74)	7.01 (5.68-8.83)	7.74 (6.10-10.0)	8.72 (6.59-11.8)	(6.59-11.8)
2-day	2.84 (2.52-3.28)	3.76 (3.33-4.34)	4.95 (4.37-5.73)	5.92 (5.18-6.90)	7.23 (6.12-8.71)	8.23 (6.83-10.1)	9.24 (7.48-11.6)	10.3 (8.10-13.3)	11.7 (8.84-15.8)	(9.14-12.5)
3-day	3.03 (2.68-3.49)	4.09 (3.61-4.71)	5.47 (4.83-6.33)	6.61 (5.79-7.71)	8.19 (6.93-9.87)	9.41 (7.81-11.6)	10.7 (8.65-13.4)	12.0 (9.45-15.5)	13.8 (10.4-18.6)	(11.8-15.8)
4-day	3.24 (2.87-3.74)	4.41 (3.90-5.09)	5.97 (5.27-6.91)	7.27 (6.36-8.47)	9.07 (7.68-10.9)	10.5 (8.70-12.9)	11.9 (9.68-15.1)	13.5 (10.6-17.5)	15.6 (11.8-21.1)	(13.5-20.1)
7-day	3.70 (3.27-4.26)	5.08 (4.50-5.87)	6.94 (6.12-8.02)	8.48 (7.42-9.89)	10.6 (9.00-12.8)	12.3 (10.2-15.2)	14.1 (11.4-17.8)	16.0 (12.6-20.7)	18.6 (14.1-25.1)	(16.0-22.1)

10-day	4.01 (3.55-4.62)	5.55 (4.91-6.41)	7.61 (6.71-8.81)	9.33 (8.17-10.9)	11.7 (9.94-14.1)	13.6 (11.3-16.8)	15.6 (12.7-19.7)	17.8 (14.0-23.0)	20.7 (15.7-27.9)	(16)
20-day	4.86 (4.30-5.60)	6.78 (5.99-7.82)	9.36 (8.26-10.8)	11.5 (10.1-13.5)	14.6 (12.4-17.6)	17.0 (14.1-21.0)	19.6 (15.9-24.7)	22.4 (17.6-29.0)	26.3 (19.9-35.4)	(21)
30-day	5.72 (5.06-6.59)	7.99 (7.07-9.22)	11.1 (9.76-12.8)	13.7 (12.0-15.9)	17.3 (14.7-20.9)	20.3 (16.8-25.0)	23.4 (19.0-29.5)	26.8 (21.1-34.7)	31.5 (23.9-42.6)	(25)
45-day	6.83 (6.05-7.87)	9.49 (8.40-11.0)	13.1 (11.6-15.2)	16.2 (14.2-18.9)	20.6 (17.4-24.8)	24.1 (20.0-29.6)	27.8 (22.6-35.1)	31.9 (25.1-41.3)	37.7 (28.5-50.9)	(31)
60-day	7.97 (7.06-9.19)	11.0 (9.72-12.7)	15.1 (13.3-17.5)	18.6 (16.3-21.7)	23.6 (20.0-28.5)	27.7 (23.0-34.0)	32.0 (25.9-40.3)	36.7 (28.9-47.5)	43.5 (32.9-58.6)	(35)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates Submit

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Form 4.2-2 Summary of HCOC Assessment (DA 1)

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☒ No ☐

Go to: <http://permittrack.sbcounty.gov/wap/>

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below
(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft ³)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	1 N/A <i>Form 4.2-3 Item 12</i>	2 N/A <i>Form 4.2-4 Item 13</i>	3 N/A <i>Form 4.2-5 Item 10</i>
Post-developed	4 N/A <i>Form 4.2-3 Item 13</i>	5 N/A <i>Form 4.2-4 Item 14</i>	6 N/A <i>Form 4.2-5 Item 14</i>
Difference	7 N/A <i>Item 4 – Item 1</i>	8 N/A <i>Item 2 – Item 5</i>	9 N/A <i>Item 6 – Item 3</i>
Difference (as % of pre-developed)	10 N/A <i>Item 7 / Item 1</i>	11 N/A <i>Item 8 / Item 2</i>	12 N/A <i>Item 9 / Item 3</i>

The proposed infiltration/detention basin has been designed to mitigate the peak flow (Q100) increase to the downstream facilities from the proposed project. The proposed site Q100 runoff will be hold in infiltration/detention basin until it reaches to trench drain's grate elev. 1277.00 and resulting discharge will be less than the existing Q100. The basin will provide 53,400 CF (1.23 AC-FT) for storm water runoff for the project site, and Q2 storm runoff (0.87 AC-FT) will be completed store in the basin without releasing water. See Attachment B for Q2 hydrologic analysis.

Form 4.2-3 HCOC Assessment for Runoff Volume (DA 1) (N/A)

Weighted Curve Number Determination for: Pre-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1a Land Cover type	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2a Hydrologic Soil Group (HSG)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3a DMA Area, ft ² sum of areas of DMA should equal area of DA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4a Curve Number (CN) use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Weighted Curve Number Determination for: Post-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1b Land Cover type	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b Hydrologic Soil Group (HSG)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3b DMA Area, ft ² sum of areas of DMA should equal area of DA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4b Curve Number (CN) use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5 Pre-Developed area-weighted CN: N/A	7 Pre-developed soil storage capacity, S (in): N/A $S = (1000 / \text{Item 5}) - 10$					9 Initial abstraction, I _a (in): N/A $I_a = 0.2 * \text{Item 7}$		
6 Post-Developed area-weighted CN: N/A	8 Post-developed soil storage capacity, S (in): N/A $S = (1000 / \text{Item 6}) - 10$					10 Initial abstraction, I _a (in): N/A $I_a = 0.2 * \text{Item 8}$		
11 Precipitation for 2 yr, 24 hr storm (in): N/A Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html								
12 Pre-developed Volume (ft ³): N/A $V_{pre} = (1 / 12) * (\text{Item sum of Item 3}) * [(\text{Item 11} - \text{Item 9})^2 / ((\text{Item 11} - \text{Item 9} + \text{Item 7}))]$								
13 Post-developed Volume (ft ³): N/A $V_{pre} = (1 / 12) * (\text{Item sum of Item 3}) * [(\text{Item 11} - \text{Item 10})^2 / ((\text{Item 11} - \text{Item 10} + \text{Item 8}))]$								
14 Volume Reduction needed to meet HCOC Requirement, (ft ³): N/A $V_{HCOC} = (\text{Item 13} * 0.95) - \text{Item 12}$								

Form 4.2-4 HCOC Assessment for Time of Concentration (DA 1) (N/A)

Compute time of concentration for pre and post developed conditions for each DA (For projects using the Hydrology Manual complete the form below)

Variables	Pre-developed DA1 <i>Use additional forms if there are more than 4 DMA</i>				Post-developed DA1 <i>Use additional forms if there are more than 4 DMA</i>			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) <i>Use Form 3-2 Item 5 for pre-developed condition</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 Change in elevation (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3 Slope (ft/ft), $S_o = \text{Item 2} / \text{Item 1}$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4 Land cover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5 Initial DMA Time of Concentration (min) <i>Appendix C-1 of the TGD for WQMP</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6 Length of conveyance from DMA outlet to project site outlet (ft) <i>May be zero if DMA outlet is at project site outlet</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7 Cross-sectional area of channel (ft ²)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8 Wetted perimeter of channel (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9 Manning's roughness of channel (n)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10 Channel flow velocity (ft/sec) $V_{fps} = (1.49 / \text{Item 9}) * (\text{Item 7} / \text{Item 8})^{0.67} * (\text{Item 3})^{0.5}$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11 Travel time to outlet (min) $T_t = \text{Item 6} / (\text{Item 10} * 60)$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12 Total time of concentration (min) $T_c = \text{Item 5} + \text{Item 11}$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13 Pre-developed time of concentration (min): N/A <i>Minimum of Item 12 pre-developed DMA</i>								
14 Post-developed time of concentration (min): N/A <i>Minimum of Item 12 post-developed DMA</i>								
15 Additional time of concentration needed to meet HCOC requirement (min): N/A $T_{C-HCOC} = (\text{Item 13} * 0.95) - \text{Item 14}$								

Form 4.2-5 HCOC Assessment for Peak Runoff (DA 1) (N/A)

Compute peak runoff for pre- and post-developed conditions

Variables	Pre-developed DA to Project Outlet (Use additional forms if more than 3 DMA)			Post-developed DA to Project Outlet (Use additional forms if more than 3 DMA)								
	DMA A	DMA B	DMA C	DMA A	DMA B	DMA C						
1 Rainfall Intensity for storm duration equal to time of concentration <i>$I_{peak} = 10^{(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 / 60)}$</i>	N/A	N/A	N/A	N/A	N/A	N/A						
2 Drainage Area of each DMA (Acres) <i>For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)</i>	N/A	N/A	N/A	N/A	N/A	N/A						
3 Ratio of pervious area to total area <i>For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)</i>	N/A	N/A	N/A	N/A	N/A	N/A						
4 Pervious area infiltration rate (in/hr) <i>Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP</i>	N/A	N/A	N/A	N/A	N/A	N/A						
5 Maximum loss rate (in/hr) <i>$F_m = Item 3 * Item 4$ Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)</i>	N/A	N/A	N/A	N/A	N/A	N/A						
6 Peak Flow from DMA (cfs) <i>$Q_p = Item 2 * 0.9 * (Item 1 - Item 5)$</i>	N/A	N/A	N/A	N/A	N/A	N/A						
7 Time of concentration adjustment factor for other DMA to site discharge point <i>Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)</i>	DMA A	n/a	N/A	n/a	N/A	N/A						
	DMA B	N/A	n/a	N/A	n/a	N/A						
	DMA C	N/A	N/A	n/a	N/A	n/a						
8 Pre-developed Q_p at T_c for DMA A: N/A <i>$Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB}) / (Item 1_{DMAB} - Item 5_{DMAB}) * Item 7_{DMAA/2}] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC}) / (Item 1_{DMAC} - Item 5_{DMAC}) * Item 7_{DMAA/3}]$</i>	9 Pre-developed Q_p at T_c for DMA B: N/A <i>$Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA}) / (Item 1_{DMAA} - Item 5_{DMAA}) * Item 7_{DMAB/1}] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC}) / (Item 1_{DMAC} - Item 5_{DMAC}) * Item 7_{DMAB/3}]$</i>			10 Pre-developed Q_p at T_c for DMA C: N/A <i>$Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA}) / (Item 1_{DMAA} - Item 5_{DMAA}) * Item 7_{DMAC/1}] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB}) / (Item 1_{DMAB} - Item 5_{DMAB}) * Item 7_{DMAC/2}]$</i>								
10 Peak runoff from pre-developed condition confluence analysis (cfs): N/A Maximum of Item 8, 9, and 10 (including additional forms as needed)												
11 Post-developed Q_p at T_c for DMA A: N/A <i>Same as Item 8 for post-developed values</i>	12 Post-developed Q_p at T_c for DMA B: N/A <i>Same as Item 9 for post-developed values</i>			13 Post-developed Q_p at T_c for DMA C: N/A <i>Same as Item 10 for post-developed values</i>								
14 Peak runoff from post-developed condition confluence analysis (cfs): N/A Maximum of Item 11, 12, and 13 (including additional forms as needed)												
15 Peak runoff reduction needed to meet HCOC Requirement (cfs): N/A <i>$Q_{p-HCOC} = (Item 14 * 0.95) - Item 10$</i>												

4.3 Project Conformance Analysis

Complete the following forms for each project site DA to document that the proposed LID BMPs conform to the project DCV developed to meet performance criteria specified in the MS4 Permit (WQMP Template Section 4.2). For the LID DCV, the forms are ordered according to hierarchy of BMP selection as required by the MS4 Permit (see Section 5.3.1 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design and Hydrologic Source Controls (Form 4.3-2)
- Retention and Infiltration (Form 4.3-3)
- Harvested and Use (Form 4.3-4) or
- Biotreatment (Form 4.3-5).

At the end of each form, additional fields facilitate the determination of the extent of mitigation provided by the specific BMP category, allowing for use of the next category of BMP in the hierarchy, if necessary.

The first step in the analysis, using Section 5.3.2.1 of the TGD for WQMP, is to complete Forms 4.3-1 and 4.3-3) to determine if retention and infiltration BMPs are infeasible for the project. For each feasibility criterion in Form 4.3-1, if the answer is “Yes,” provide all study findings that includes relevant calculations, maps, data sources, etc. used to make the determination of infeasibility.

Next, complete Forms 4.3-2 and 4.3-4 to determine the feasibility of applicable HSC and harvest and use BMPs, and, if their implementation is feasible, the extent of mitigation of the DCV.

If no site constraints exist that would limit the type of BMP to be implemented in a DA, evaluate the use of combinations of LID BMPs, including all applicable HSC BMPs to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV within the minimum effective area.

If the combination of LID HSC, retention and infiltration, and harvest and use BMPs are unable to mitigate the entire DCV, then biotreatment BMPs may be implemented by the project proponent. If biotreatment BMPs are used, then they must be sized to provide sufficient capacity for effective treatment of the remainder of the volume-based performance criteria that cannot be achieved with LID BMPs (TGD for WQMP Section 5.4.4.2).

Under no circumstances shall any portion of the DCV be released from the site without effective mitigation and/or treatment.

Form 4.3-1 Infiltration BMP Feasibility (DA 1)

Feasibility Criterion – Complete evaluation for each DA on the Project Site

¹ Would infiltration BMP pose significant risk for groundwater related concerns?

Yes ☐ No ☒

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

² Would installation of infiltration BMP significantly increase the risk of geotechnical hazards?

Yes ☐ No ☒

(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

- The location is less than 50 feet away from slopes steeper than 15 percent
- The location is less than eight feet from building foundations or an alternative setback.
- A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards.

If Yes, Provide basis: (attach)

³ Would infiltration of runoff on a Project site violate downstream water rights?

Yes ☐ No ☒

If Yes, Provide basis: (attach)

⁴ Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils?

Yes ☐ No ☒

If Yes, Provide basis: (attach)

⁵ Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)?

Yes ☐ No ☒

If Yes, Provide basis: (attach)

⁶ Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses?

Yes ☐ No ☒

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

⁷ Any answer from Item 1 through Item 3 is "Yes":

Yes ☐ No ☒

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

⁸ Any answer from Item 4 through Item 6 is "Yes":

Yes ☐ No ☒

If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP. If no, then proceed to Item 9, below.

⁹ All answers to Item 1 through Item 6 are "No":

Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP. Proceed to Form 4.3-2, Hydrologic Source Control BMP.

4.3.1 Site Design Hydrologic Source Control BMP

Section XI.E. of the Permit emphasizes the use of LID preventative measures; and the use of LID HSC BMPs reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable HSC shall be provided except where they are mutually exclusive with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of HSC, if a project cannot feasibly meet BMP sizing requirements or cannot fully address HCOCs, feasibility of all applicable HSC must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design HSC BMP. Refer to Section 5.4.1 in the TGD for more detailed guidance.

Form 4.3-2 Site Design Hydrologic Source Control BMPs (DA 1)			
1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☐ No ☒ If yes, complete Items 2-5; If no, proceed to Item 6	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
2 Total impervious area draining to pervious area (ft ²)			
3 Ratio of pervious area receiving runoff to impervious area			
4 Retention volume achieved from impervious area dispersion (ft ³) $V = \text{Item 2} * \text{Item 3} * (0.5/12)$, assuming retention of 0.5 inches of runoff			
5 Sum of retention volume achieved from impervious area dispersion (ft ³): 0 $V_{\text{retention}} = \text{Sum of Item 4 for all BMPs}$			
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
7 Ponding surface area (ft ²)			
8 Ponding depth (ft)			
9 Surface area of amended soil/gravel (ft ²)			
10 Average depth of amended soil/gravel (ft)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft ³) $V_{\text{retention}} = (\text{Item 7} * \text{Item 8}) + (\text{Item 9} * \text{Item 10} * \text{Item 11})$			
13 Runoff volume retention from on-lot infiltration (ft ³): 0 $V_{\text{retention}} = \text{Sum of Item 12 for all BMPs}$			

Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs (DA 1)

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☒ <i>If yes, complete Items 15-20. If no, proceed to Item 21</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
15 Rooftop area planned for ET BMP (ft ²)			
16 Average wet season ET demand (in/day) <i>Use local values, typical ~ 0.1</i>			
17 Daily ET demand (ft ³ /day) <i>Item 15 * (Item 16 / 12)</i>			
18 Drawdown time (hrs) <i>Copy Item 6 in Form 4.2-1</i>			
19 Retention Volume (ft ³) <i>V_{retention} = Item 17 * (Item 18 / 24)</i>			
20 Runoff volume retention from evapotranspiration BMPs (ft ³): 0 <i>V_{retention} = Sum of Item 19 for all BMPs</i>			
21 Implementation of Street Trees: Yes ☐ No ☒ <i>If yes, complete Items 22-25. If no, proceed to Item 26</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
22 Number of Street Trees			
23 Average canopy cover over impervious area (ft ²)			
24 Runoff volume retention from street trees (ft ³) <i>V_{retention} = Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches</i>			
25 Runoff volume retention from street tree BMPs (ft ³): 0 <i>V_{retention} = Sum of Item 24 for all BMPs</i>			
26 Implementation of residential rain barrel/cisterns: Yes ☐ No ☒ <i>If yes, complete Items 27-29; If no, proceed to Item 30</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft ³) <i>V_{retention} = Item 27 * 3</i>			
29 Runoff volume retention from residential rain barrels/Cisterns (ft ³): 0 <i>V_{retention} = Sum of Item 28 for all BMPs</i>			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 0 <i>Sum of Items 5, 13, 20, 25 and 29</i>			

4.3.2 Infiltration BMPs

Use Form 4.3-3 to compute on-site retention of runoff from proposed retention and infiltration BMPs. Volume retention estimates are sensitive to the percolation rate used, which determines the amount of runoff that can be infiltrated within the specified drawdown time. The infiltration safety factor reduces field measured percolation to account for potential inaccuracy associated with field measurements, declining BMP performance over time, and compaction during construction. Appendix D of the TGD for WQMP provides guidance on estimating an appropriate safety factor to use in Form 4.3-3.

If site constraints limit the use of BMPs to a single type and implementation of retention and infiltration BMPs mitigate no more than 40% of the DCV, then they are considered infeasible and the Project Proponent may evaluate the effectiveness of BMPs lower in the LID hierarchy of use (Section 5.5.1 of the TGD for WQMP)

If implementation of infiltrations BMPs is feasible as determined using Form 4.3-1, then LID infiltration BMPs shall be implemented to the MEP (section 4.1 of the TGD for WQMP).

Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA 1)

1 Remaining LID DCV not met by site design HSC BMP (ft ³): 18,090 $V_{unmet} = \text{Form 4.2-1 Item 7} - \text{Form 4.3-2 Item 30}$			
BMP Type Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs	DA 1 DMA 1 BMP Type Underground Basin	DA DMA BMP Type	DA DMA BMP Type
2 Infiltration rate of underlying soils (in/hr) See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods	6 (See Attachment D for Infiltration Report)	N/A	N/A
3 Infiltration safety factor See TGD Section 5.4.2 and Appendix D	3 (See Attachment D for Worksheet H)	N/A	N/A
4 Design percolation rate (in/hr) $P_{design} = \text{Item 2} / \text{Item 3}$	2	N/A	N/A
5 Ponded water drawdown time (hr) Copy Item 6 in Form 4.2-1	48	N/A	N/A
6 Maximum ponding depth (ft) BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details	8	N/A	N/A
7 Ponding Depth (ft) $d_{BMP} = \text{Minimum of } (1/12 * \text{Item 4} * \text{Item 5}) \text{ or Item 6}$	8	N/A	N/A
8 Infiltrating surface area, SA_{BMP} (ft ²) the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP	8,570 (See Attachment B for underground basin information)	N/A	N/A
9 Amended soil depth, d_{media} (ft) Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details	N/A	N/A	N/A
10 Amended soil porosity	N/A	N/A	N/A
11 Gravel depth, d_{media} (ft) Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details	N/A	N/A	N/A
12 Gravel porosity	N/A	N/A	N/A
13 Duration of storm as basin is filling (hrs) Typical ~ 3hrs	N/A	N/A	N/A
14 Above Ground Retention Volume (ft ³) $V_{retention} = \text{Item 8} * [\text{Item 7} + (\text{Item 9} * \text{Item 10}) + (\text{Item 11} * \text{Item 12}) + (\text{Item 13} * (\text{Item 4} / 12))]$	0	N/A	N/A
15 Underground Retention Volume (ft ³) Volume determined using manufacturer's specifications and calculations	53,660	N/A	N/A
16 Total Retention Volume from LID Infiltration BMPs: 53,660 (Sum of Items 14 and 15 for all infiltration BMP included in plan)			
17 Fraction of DCV achieved with infiltration BMP: 297% $\text{Retention\%} = \text{Item 16} / \text{Form 4.2-1 Item 7}$			
18 Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☒ No ☐ If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.			

4.3.3 Harvest and Use BMP (N/A)

Harvest and use BMP may be considered if the full LID DCV cannot be met by maximizing infiltration BMPs. Use Form 4.3-4 to compute on-site retention of runoff from proposed harvest and use BMPs.

Volume retention estimates for harvest and use BMPs are sensitive to the on-site demand for captured stormwater. Since irrigation water demand is low in the wet season, when most rainfall events occur in San Bernardino County, the volume of water that can be used within a specified drawdown period is relatively low. The bottom portion of Form 4.3-4 facilitates the necessary computations to show infeasibility if a minimum incremental benefit of 40 percent of the LID DCV would not be achievable with MEP implementation of on-site harvest and use of stormwater (Section 5.5.4 of the TGD for WQMP).

Form 4.3-4 Harvest and Use BMPs (DA 1)			
1 Remaining LID DCV not met by site design HSC or infiltration BMP (ft ³): <i>V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 - Form 4.3-3 Item 16</i>			
BMP Type(s) <i>Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP) - Use additional forms for more BMPs</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
2 Describe cistern or runoff detention facility	N/A	N/A	N/A
3 Storage volume for proposed detention type (ft ³) <i>Volume of cistern</i>	N/A	N/A	N/A
4 Landscaped area planned for use of harvested stormwater (ft ²)	N/A	N/A	N/A
5 Average wet season daily irrigation demand (in/day) <i>Use local values, typical ~ 0.1 in/day</i>	N/A	N/A	N/A
6 Daily water demand (ft ³ /day) <i>Item 4 * (Item 5 / 12)</i>	N/A	N/A	N/A
7 Drawdown time (hrs) <i>Copy Item 6 from Form 4.2-1</i>	N/A	N/A	N/A
8 Retention Volume (ft ³) <i>V_{retention} = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))</i>	N/A	N/A	N/A
9 Total Retention Volume (ft ³) from Harvest and Use BMP = 0 <i>Sum of Item 8 for all harvest and use BMP included in plan</i>			
10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest & use BMPs? Yes ☒ No ☐ <i>If yes, demonstrate conformance using Form 4.3-10. If no, then re-evaluate combinations of all LID BMP and optimize their implementation such that the maximum portion of the DCV is retained on-site (using a single BMP type or combination of BMP types). If the full DCV cannot be mitigated after this optimization process, proceed to Section 4.3.4.</i>			

4.3.4 Biotreatment BMP (N/A)

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration, and harvest and use BMPs. A key consideration when using biotreatment BMP is the effectiveness of the proposed BMP in addressing the pollutants of concern for the project (see Table 5-5 of the TGD for WQMP).

Use Form 4.3-5 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV w. Biotreatment computations are included as follows:

- Use Form 4.3-6 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-7 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-8 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

Form 4.3-5 Selection and Evaluation of Biotreatment BMP (DA 1)		
1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft ³): 0 Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9		List pollutants of concern Copy from Form 2.3-1.
2 Biotreatment BMP Selected <i>(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)</i>	Volume-based biotreatment <i>Use Forms 4.3-6 and 4.3-7 to compute treated volume</i>	Flow-based biotreatment <i>Use Form 4.3-8 to compute treated volume</i>
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft ³): Form 4.3-6 Item 15 + Form 4.3-7 Item 13	4 Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft ³): Item 1 – Item 3	5 Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % Item 4 / Item 1
6 Flow-based biotreatment BMP capacity provided (cfs): Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)		
7 Metrics for MEP determination: • Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.		

Form 4.3-6 Volume Based Biotreatment (DA 1) – Bioretention and Planter Boxes with Underdrains

Biotreatment BMP Type (Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
1 Pollutants addressed with BMP <i>List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP</i>	N/A	N/A	N/A
2 Amended soil infiltration rate <i>Typical ~ 5.0</i>	N/A	N/A	N/A
3 Amended soil infiltration safety factor <i>Typical ~ 2.0</i>	N/A	N/A	N/A
4 Amended soil design percolation rate (in/hr) $P_{design} = \text{Item 2} / \text{Item 3}$	N/A	N/A	N/A
5 Pondered water drawdown time (hr) <i>Copy Item 6 from Form 4.2-1</i>	N/A	N/A	N/A
6 Maximum ponding depth (ft) <i>see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>	N/A	N/A	N/A
7 Ponding Depth (ft) $d_{BMP} = \text{Minimum of } (1/12 * \text{Item 4} * \text{Item 5}) \text{ or Item 6}$	N/A	N/A	N/A
8 Amended soil surface area (ft ²)	N/A	N/A	N/A
9 Amended soil depth (ft) <i>see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>	N/A	N/A	N/A
10 Amended soil porosity, n	N/A	N/A	N/A
11 Gravel depth (ft) <i>see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>	N/A	N/A	N/A
12 Gravel porosity, n	N/A	N/A	N/A
13 Duration of storm as basin is filling (hrs) <i>Typical ~ 3hrs</i>	N/A	N/A	N/A
14 Biotreated Volume (ft ³) $V_{biotreated} = \text{Item 8} * [(\text{Item 7} / 2) + (\text{Item 9} * \text{Item 10}) + (\text{Item 11} * \text{Item 12}) + (\text{Item 13} * (\text{Item 4} / 12))]$	N/A	N/A	N/A
15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: 0 <i>Sum of Item 14 for all volume-based BMPs included in this form</i>			

Form 4.3-7 Volume Based Biotreatment (DA 1) – Constructed Wetlands and Extended Detention

Biotreatment BMP Type <i>Constructed wetlands, extended wet detention, extended dry detention, or other comparable proprietary BMP. If BMP includes multiple modules (e.g. forebay and main basin), provide separate estimates for storage and pollutants treated in each module.</i>	DA DMA BMP Type		DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>	
	Forebay	Basin	Forebay	Basin
1 Pollutants addressed with BMP forebay and basin <i>List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP</i>	N/A	N/A	N/A	N/A
2 Bottom width (ft)	N/A	N/A	N/A	N/A
3 Bottom length (ft)	N/A	N/A	N/A	N/A
4 Bottom area (ft ²) $A_{bottom} = \text{Item 2} * \text{Item 3}$	N/A	N/A	N/A	N/A
5 Side slope (ft/ft)	N/A	N/A	N/A	N/A
6 Depth of storage (ft)	N/A	N/A	N/A	N/A
7 Water surface area (ft ²) $A_{surface} = (\text{Item 2} + (2 * \text{Item 5} * \text{Item 6})) * (\text{Item 3} + (2 * \text{Item 5} * \text{Item 6}))$	N/A	N/A	N/A	N/A
8 Storage volume (ft ³) <i>For BMP with a forebay, ensure fraction of total storage is within ranges specified in BMP specific fact sheets, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i> $V = \text{Item 6} / 3 * [\text{Item 4} + \text{Item 7} + (\text{Item 4} * \text{Item 7})^{0.5}]$	N/A	N/A	N/A	N/A
9 Drawdown Time (hrs) <i>Copy Item 6 from Form 2.1</i>	N/A		N/A	
10 Outflow rate (cfs) $Q_{BMP} = (\text{Item 8}_{forebay} + \text{Item 8}_{basin}) / (\text{Item 9} * 3600)$	N/A		N/A	
11 Duration of design storm event (hrs)	N/A		N/A	
12 Biotreated Volume (ft ³) $V_{biotreated} = (\text{Item 8}_{forebay} + \text{Item 8}_{basin}) + (\text{Item 10} * \text{Item 11} * 3600)$	N/A		N/A	
13 Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention : 0 <i>(Sum of Item 12 for all BMP included in plan)</i>				

Form 4.3-8 Flow Based Biotreatment (DA 1)

Biotreatment BMP Type <i>Vegetated swale, vegetated filter strip, or other comparable proprietary BMP</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
1 Pollutants addressed with BMP <i>List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in TGD Table 5-5</i>	N/A	N/A	N/A
2 Flow depth for water quality treatment (ft) <i>BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>	N/A	N/A	N/A
3 Bed slope (ft/ft) <i>BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>	N/A	N/A	N/A
4 Manning's roughness coefficient	N/A	N/A	N/A
5 Bottom width (ft) $b_w = (\text{Form 4.3-5 Item 6} * \text{Item 4}) / (1.49 * \text{Item 2}^{1.67} * \text{Item 3}^{0.5})$	N/A	N/A	N/A
6 Side Slope (ft/ft) <i>BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>	N/A	N/A	N/A
7 Cross sectional area (ft ²) $A = (\text{Item 5} * \text{Item 2}) + (\text{Item 6} * \text{Item 2}^{0.2})$	N/A	N/A	N/A
8 Water quality flow velocity (ft/sec) $V = \text{Form 4.3-5 Item 6} / \text{Item 7}$	N/A	N/A	N/A
9 Hydraulic residence time (min) <i>Pollutant specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>	N/A	N/A	N/A
10 Length of flow based BMP (ft) $L = \text{Item 8} * \text{Item 9} * 60$	N/A	N/A	N/A
11 Water surface area at water quality flow depth (ft ²) $SA_{top} = (\text{Item 5} + (2 * \text{Item 2} * \text{Item 6})) * \text{Item 10}$	N/A	N/A	N/A

4.3.5 Conformance Summary

Complete Form 4.3-9 to demonstrate how on-site LID DCV is met with proposed site design hydrologic source control, infiltration, harvest and use, and/or biotreatment BMP. The bottom line of the form is used to describe the basis for infeasibility determination for on-site LID BMP to achieve full LID DCV, and provides methods for computing remaining volume to be addressed in an alternative compliance plan. If the project has more than one outlet, then complete additional versions of this form for each outlet.

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)	
1	Total LID DCV for the Project DA-1 (ft ³): 18,090 <i>Copy Item 7 in Form 4.2-1</i>
2	On-site retention with site design hydrologic source control LID BMP (ft ³): 0 <i>Copy Item 30 in Form 4.3-2</i>
3	On-site retention with LID infiltration BMP (ft ³): 53,660 <i>Copy Item 16 in Form 4.3-3</i>
4	On-site retention with LID harvest and use BMP (ft ³): 0 <i>Copy Item 9 in Form 4.3-4</i>
5	On-site biotreatment with volume based biotreatment BMP (ft ³): 0 <i>Copy Item 3 in Form 4.3-5</i>
6	Flow capacity provided by flow based biotreatment BMP (cfs): 0 <i>Copy Item 6 in Form 4.3-5</i>
7	LID BMP performance criteria are achieved if answer to any of the following is "Yes": - Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☒ No ☐ <i>If yes, sum of Items 2, 3, and 4 is greater than Item 1</i> - Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☐ <i>If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3-5 Item 6 and Items 2, 3 and 4 are maximized</i> - On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☐ No ☐ <i>If yes, Form 4.3-1 Items 7 and 8 were both checked yes</i>
8	If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance: - Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐ <i>Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, $V_{alt} = (Item\ 1 - Item\ 2 - Item\ 3 - Item\ 4 - Item\ 5) * (100 - Form\ 2.4-1\ Item\ 2)\%$</i> - An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐ <i>Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed</i>

4.3.6 Hydromodification Control BMP

Use Form 4.3-10 to compute the remaining runoff volume retention, after LID BMP are implemented, needed to address HCOC, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential HCOC. Describe hydromodification control BMP that address HCOC, which may include off-site BMP and/or in-stream controls. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-10 Hydromodification Control BMPs (DA 1)	
1 Volume reduction needed for HCOC performance criteria (ft ³): 0 <i>(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1</i>	2 On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft ³): 53,660 <i>Sum of Form 4.3-9 Items 2, 3, and 4 Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving HCOC volume reduction</i>
3 Remaining volume for HCOC volume capture (ft ³): 0 <i>Item 1 – Item 2</i>	4 Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft ³): 0 <i>Existing downstream BMP may be used to demonstrate additional volume capture (if so, attach to this WQMP a hydrologic analysis showing how the additional volume would be retained during a 2-yr storm event for the regional watershed)</i>
5 If Item 4 is less than Item 3, incorporate in-stream controls on downstream waterbody segment to prevent impacts due to hydromodification ☐ <i>Attach in-stream control BMP selection and evaluation to this WQMP</i>	
6 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☐ <i>If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:</i> - Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site or off-site retention BMP ☐ <i>BMP upstream of a waterbody segment with a potential HCOC may be used to demonstrate increased time of concentration through hydrograph attenuation (if so, show that the hydraulic residence time provided in BMP for a 2-year storm event is equal or greater than the addition time of concentration requirement in Form 4.2-4 Item 15)</i> - Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☐ - Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐	
7 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☐ <i>If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:</i> - Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site or off-site retention BMPs ☐ <i>BMPs upstream of a waterbody segment with a potential HCOC may be used to demonstrate additional peak runoff reduction through hydrograph attenuation (if so, attach to this WQMP, a hydrograph analysis showing how the peak runoff would be reduced during a 2-yr storm event)</i> - Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐	

4.4 Alternative Compliance Plan (if applicable)

Describe an alternative compliance plan (if applicable) for projects not fully able to infiltrate, harvest and use, or biotreat the DCV via on-site LID practices. A project proponent must develop an alternative compliance plan to address the remainder of the LID DCV. Depending on project type some projects may qualify for water quality credits that can be applied to reduce the DCV that must be treated prior to development of an alternative compliance plan (see Form 2.4-1, Water Quality Credits). Form 4.3-9 Item 8 includes instructions on how to apply water quality credits when computing the DCV that must be met through alternative compliance. Alternative compliance plans may include one or more of the following elements:

- On-site structural treatment control BMP - All treatment control BMP should be located as close to possible to the pollutant sources and should not be located within receiving waters;
- Off-site structural treatment control BMP - Pollutant removal should occur prior to discharge of runoff to receiving waters;
- Urban runoff fund or In-lieu program, if available

Depending upon the proposed alternative compliance plan, approval by the executive officer may or may not be required (see Section 6 of the TGD for WQMP).

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMP included as part of the project WQMP are required to be maintained through regular scheduled inspection and maintenance (refer to Section 8, Post Construction BMP Requirements, in the TGD for WQMP). Fully complete Form 5-1 summarizing all BMP included in the WQMP. Attach additional forms as needed. The WQMP shall also include a detailed Operation and Maintenance Plan for all BMP and may require a Maintenance Agreement (consult the jurisdiction's LIP). If a Maintenance Agreement is required, it must also be attached to the WQMP.

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
UG Infiltr. System	Owner	- Inspect/Maintain UG-Infiltration Basin Systems - Isolator Row for collected trash, sediments and/or debris. Remove trash, sediments and debris by jet-vac and pump and dispose of trash, sediments and debris in a legal manner. - Inspect system for standing water. If system has standing water, perform re-inspection within 48 hours. If system still has standing water then the system shall be jet-vacuumed and pumped and removed debris shall be disposed of in a legal manner.	Bi-monthly and Prior to storm event and 48 hours after storm has passed
Parking Lot and Private Street Sweeping	Owner	Sweep loading dock and parking lot and truck courts.	Monthly / As needed.
Catch Basin Filter	Owner	- Inspect and maintain catch basin filters as required. - Inspect catch basin bottom for debris / remove debris and dispose as required.	Quarterly
Planting	Owner	- Inspect health of planting and erosion of landscape area.	Monthly

Water Quality Management Plan (WQMP)

		- Trimming trees and bushes when needed.	
Efficient Irrigation	Owner	- Inspect irrigation system general operation and durations. - Repair damaged sprinkler and drip irrigation lines as needed. - Reduce durations during the winter season to prevent over irrigation.	Monthly
Trash Storage Areas and Litter Control (SD-32)	Owner	Inspect trash container, lids, screens and clean trash storage areas.	Weekly
Employee Training / Education Program	Owner	Building tenants to provide BMP training and hand out educational materials.	Annually or upon hire
Roof Runoff Controls (SD-11)	Owner	Inspect / repair roof drains	Quarterly
Storm drain system signage	Owner	Inspect Catch basin signage for faded or lost signs / repair or replace as needed.	Annually

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

Include a site plan and drainage plan sheet set containing the following minimum information:

- Project location
- Site boundary
- Land uses and land covers, as applicable
- Suitability/feasibility constraints
- Structural Source Control BMP locations
- Site Design Hydrologic Source Control BMP locations
- LID BMP details
- Drainage delineations and flow information
- Drainage connections

6.2 Electronic Data Submittal

Minimum requirements include submittal of PDF exhibits in addition to hard copies. Format must not require specialized software to open. If the local jurisdiction requires specialized electronic document formats (as described in their local Local Implementation Plan), this section will describe the contents (e.g., layering, nomenclature, geo-referencing, etc.) of these documents so that they may be interpreted efficiently and accurately.

6.3 Post Construction

Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

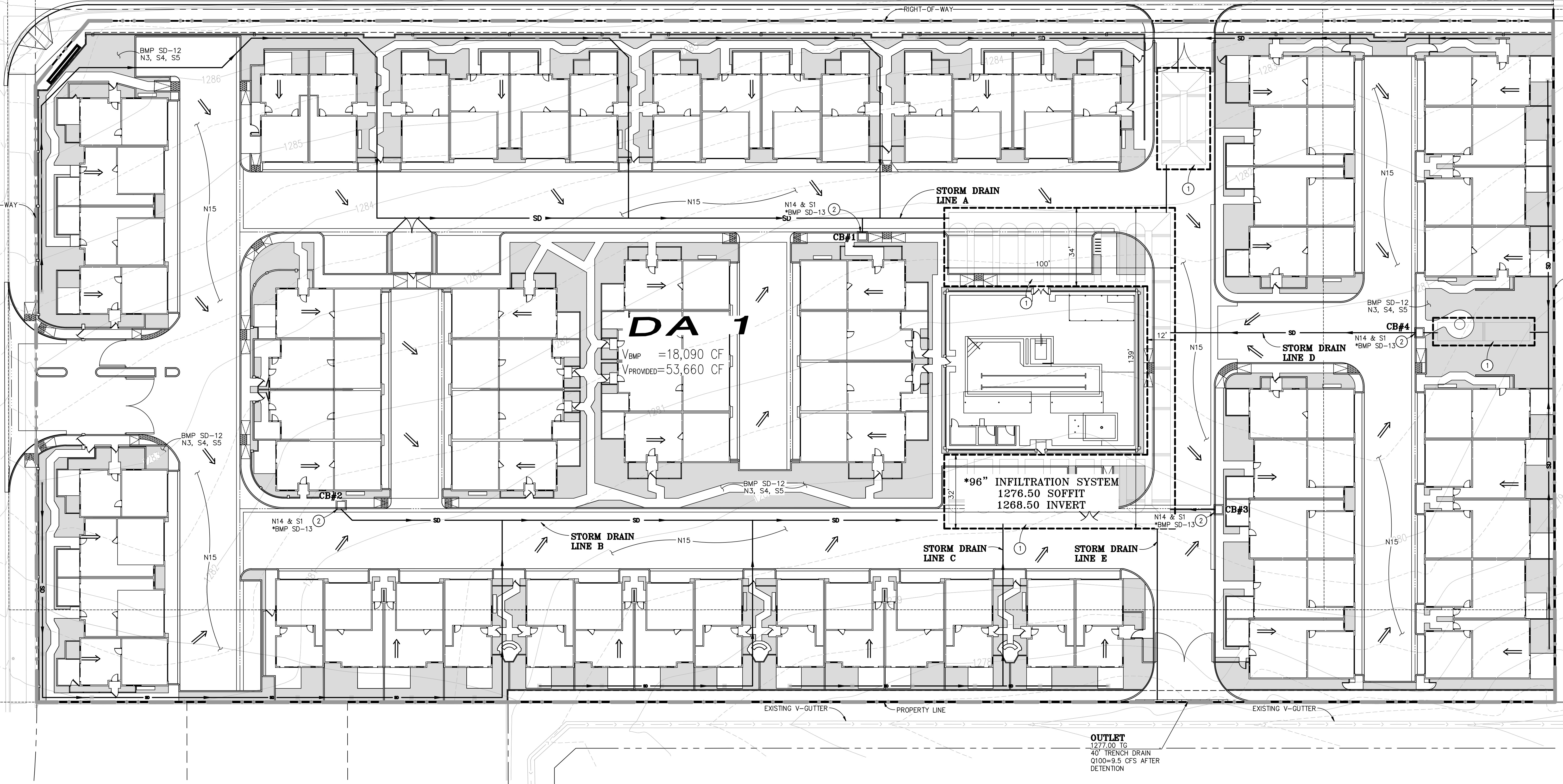
- BMP Educational Materials
- Activity Restriction – C, C&R's & Lease Agreements

Attachment A

WQMP Site Plan

N. LARCH AVE

FOOTHILL BLVD



WQMP MANAGEMENT

	DMA Area (SF)	Imperviousness (%)	Runoff Coefficient	P 2yr-1hr	P6	Drawdown Rate	Design Capture Volume (CF)	BMP	UD BMP Volume Provided (CF)
DA 1	193,880	0.82	0.63	0.62	0.92	1.963	18,090	Underground Infiltration/ Detention System	53,660

STORM WATER WILL BE HELD IN THE INFILTRATION/ DETENTION SYSTEM UNTIL THE WATER SURFACE ELEVATION RISES TO SYSTEM OUTLET ELEVATION.

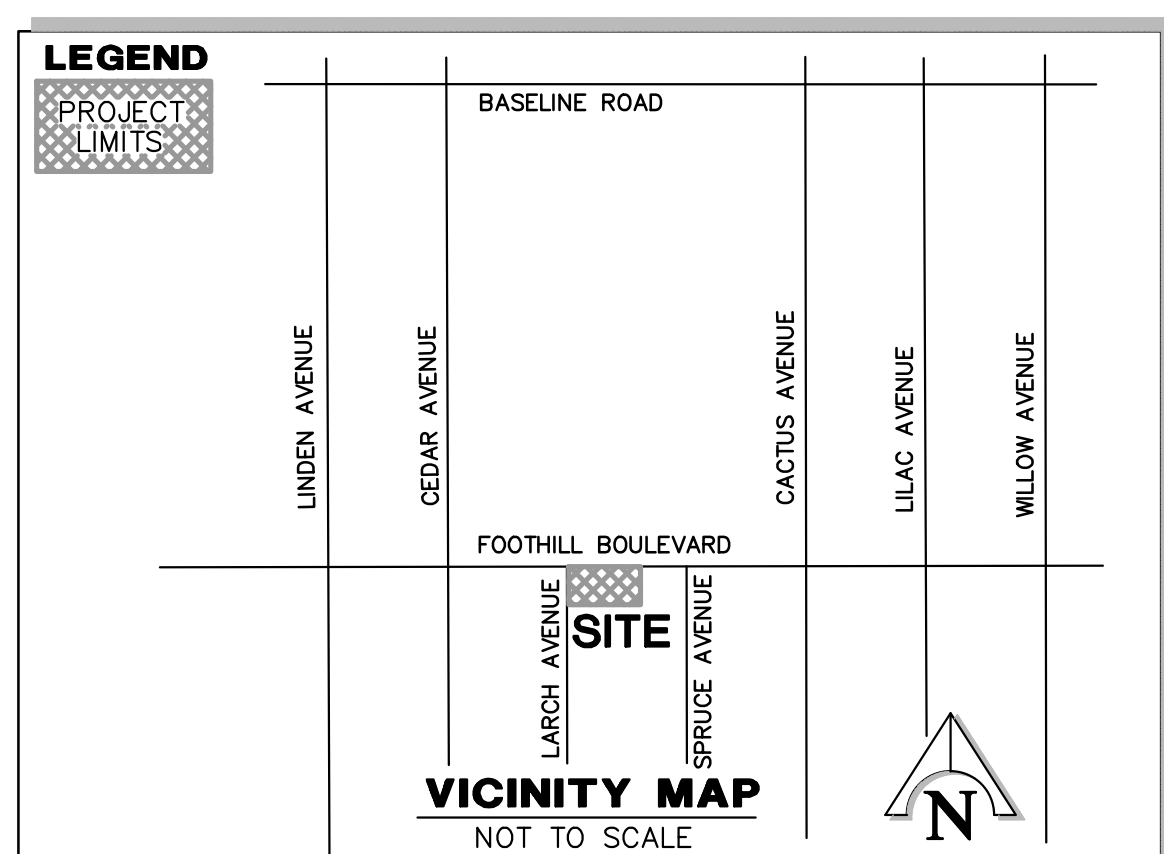
LEGEND

- SD PROPOSED STORM DRAIN
- DRAINAGE AREA BOUNDARY
- PROPOSED CATCH BASIN INLET
- PROPOSED LANDSCAPING AREA - N3, S4 & S5
- *BMP SD-10 & 12
- CB CATCH BASIN
- ← FLOW DIRECTION

WQMP BMP NOTES

- INSTALL INFILTRATION/DETENTION SYSTEM PER DETAIL ON SHEET 2
- INSTALL BIOCLEAN CURB INLET FILTER ON SHEET 2

*NOTE:
ON-SITE UNDERGROUND INFILTRATION/DETENTION SYSTEM
(53,660 CF) IS SIZED TO MITIGATE THE 100-YEAR PEAK
FLOW INCREASE TO THE DOWNSTREAM FACILITIES FROM
THE PROPOSED PROJECT.



SOURCE CONTROL BMPs INCLUDED ONSITE		
IDENTIFIER	DESCRIPTION OF BMP	RESPONSIBLE PARTY
N3	LANDSCAPE MAINTENANCE BMP'S	OWNER
N11	LITTER/DEBRIS CONTROL PROGRAM	OWNER
N14	CATCH BASIN INSPECTION PROGRAM	OWNER
N15	VACUUM SWEEPING OF PARKING LOTS	OWNER
S1	STORM DRAIN STENCILING	OWNER
S3	REDUCED WASTE STORAGE POLLUTION	OWNER
S4	EFFICIENT IRRIGATION SYSTEM	OWNER
S5	LANDSCAPING MIN. 1-2" BELOW PAVEMENT	OWNER

WATER QUALITY MANAGEMENT PLAN
FOR
KEYSTONE - RIALTO TOWNHOUSES
1075 W. FOOTHILL BLVD
CITY OF RIALTO

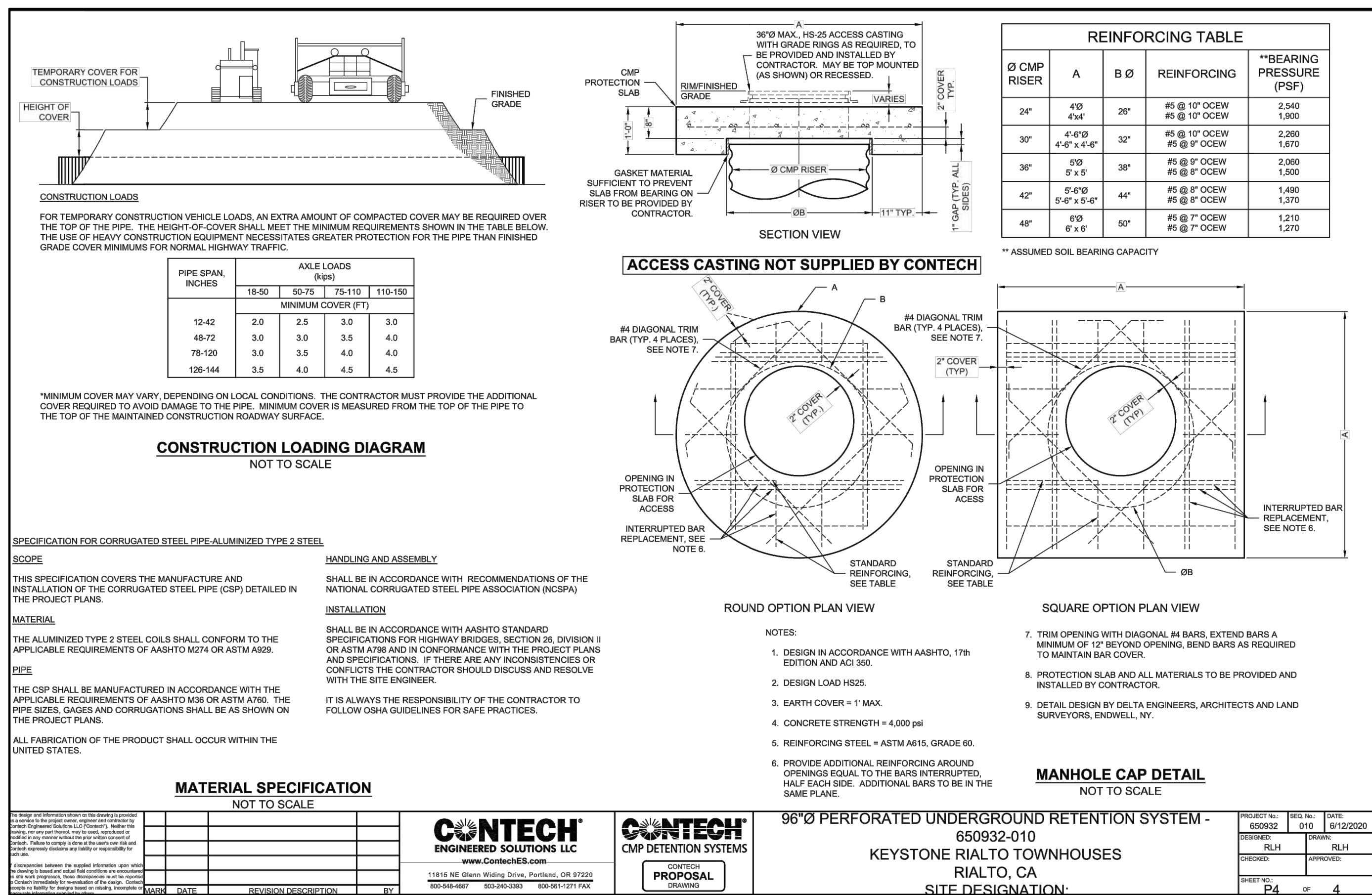
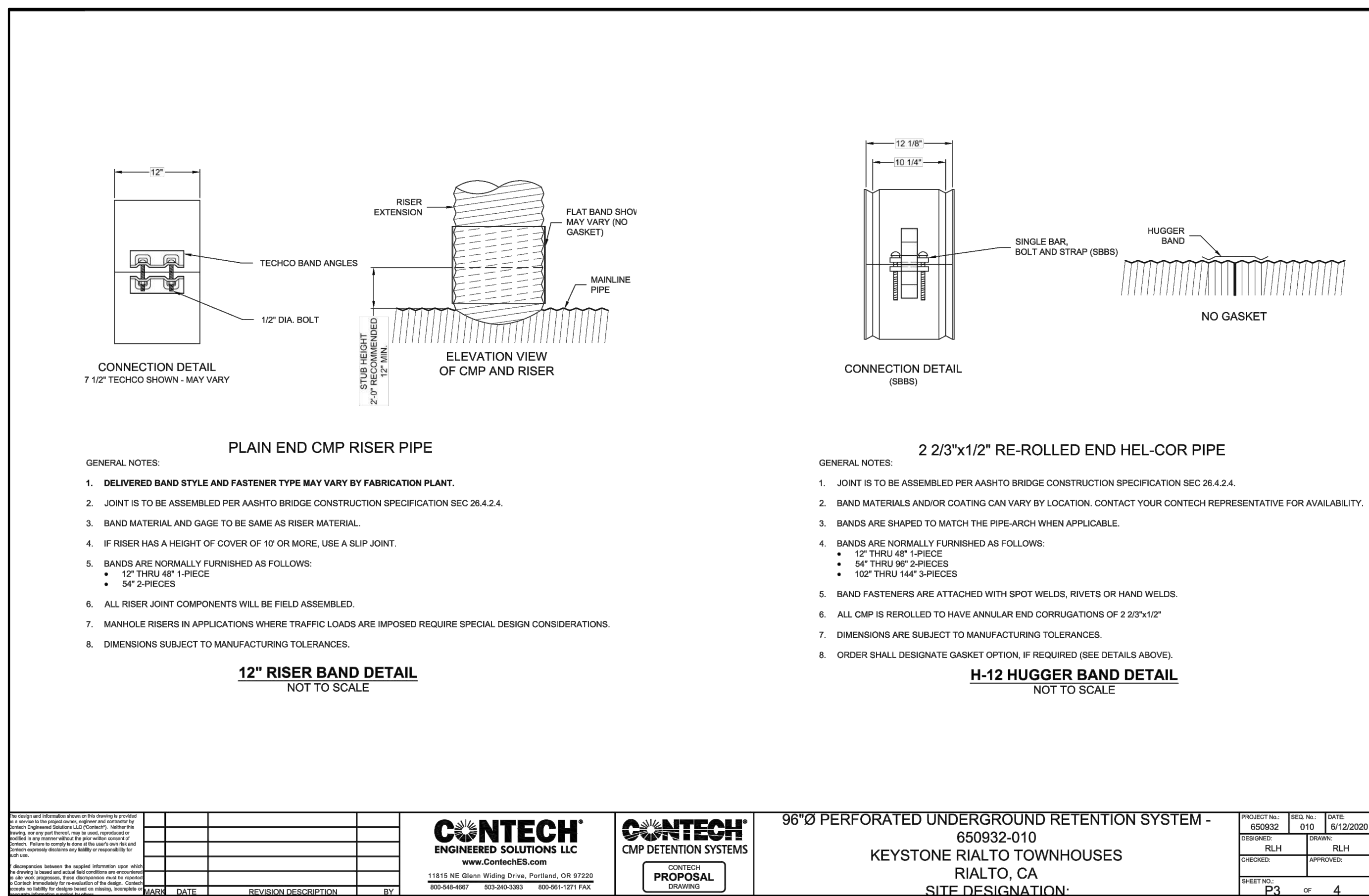
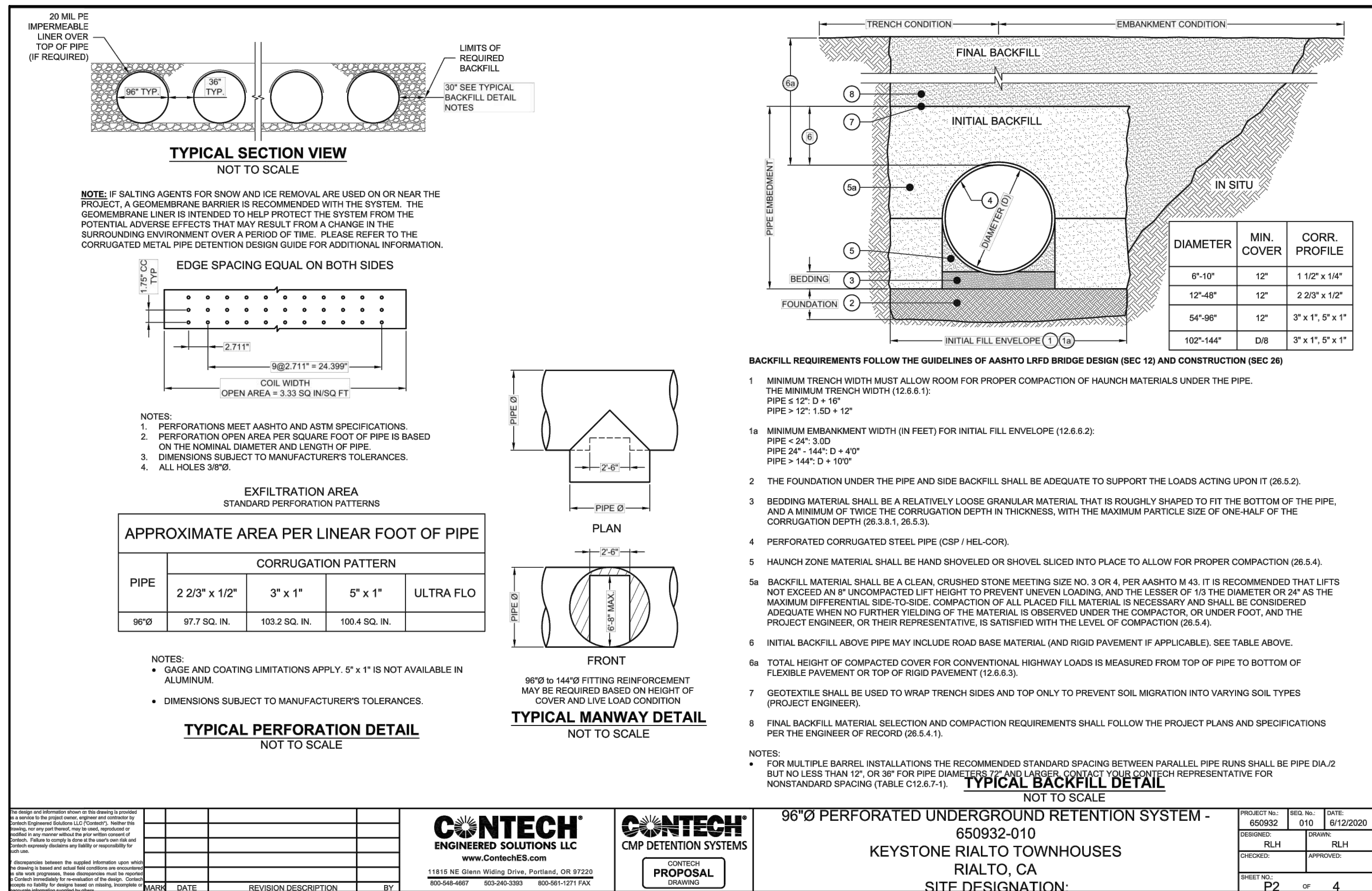
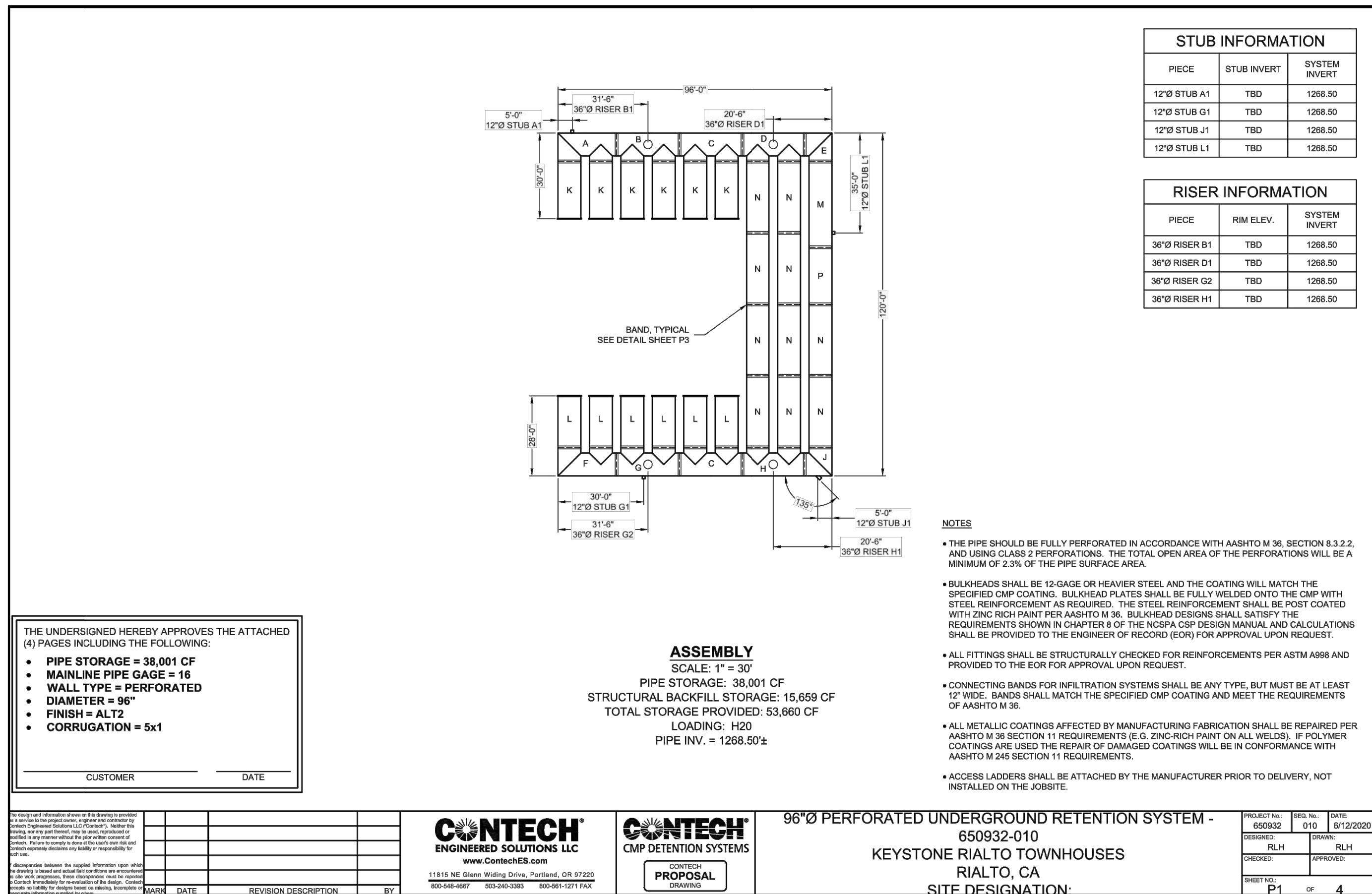
OWNER/DEVELOPER:
KEYSTONE DCS
9140 TRASK AVENUE, SUITE 202
GARDEN GROVE, CA 92843
PHONE (714) 791-3772
CONTACT PERSON: MR. TIMOTHY NGUYEN

CIVIL ENGINEER:
HUITT-ZOLLARS, INC.
3990 CONOURS, SUITE 330
ONTARIO, CA 91764
PHONE (909) 941-7799
CONTACT PERSON: DAVID WHITE



HUITT-ZOLLARS
HUITT-ZOLLARS, INC.
3990 CONCOURSE, SUITE 330 • ONTARIO, CALIFORNIA 91764 • (909) 941-7799

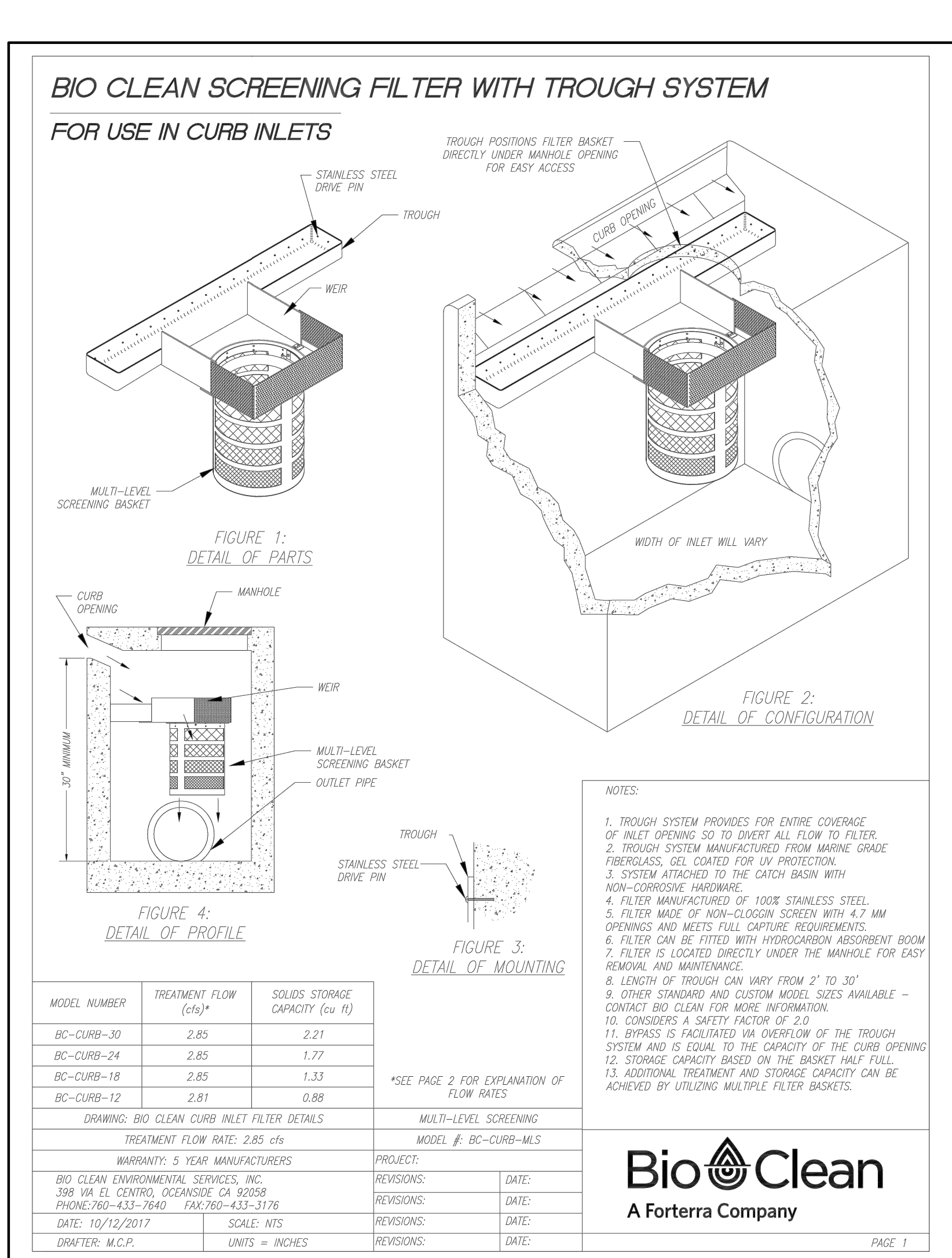
DESIGNED BY R.P.	SHEET 1
DRAWN BY R.P.	OF 2
CHECKED BY D.W.	SHEETS
FIELD BOOK	XREF NO. R312213.01



CONTECH 96" CMP SYSTEM

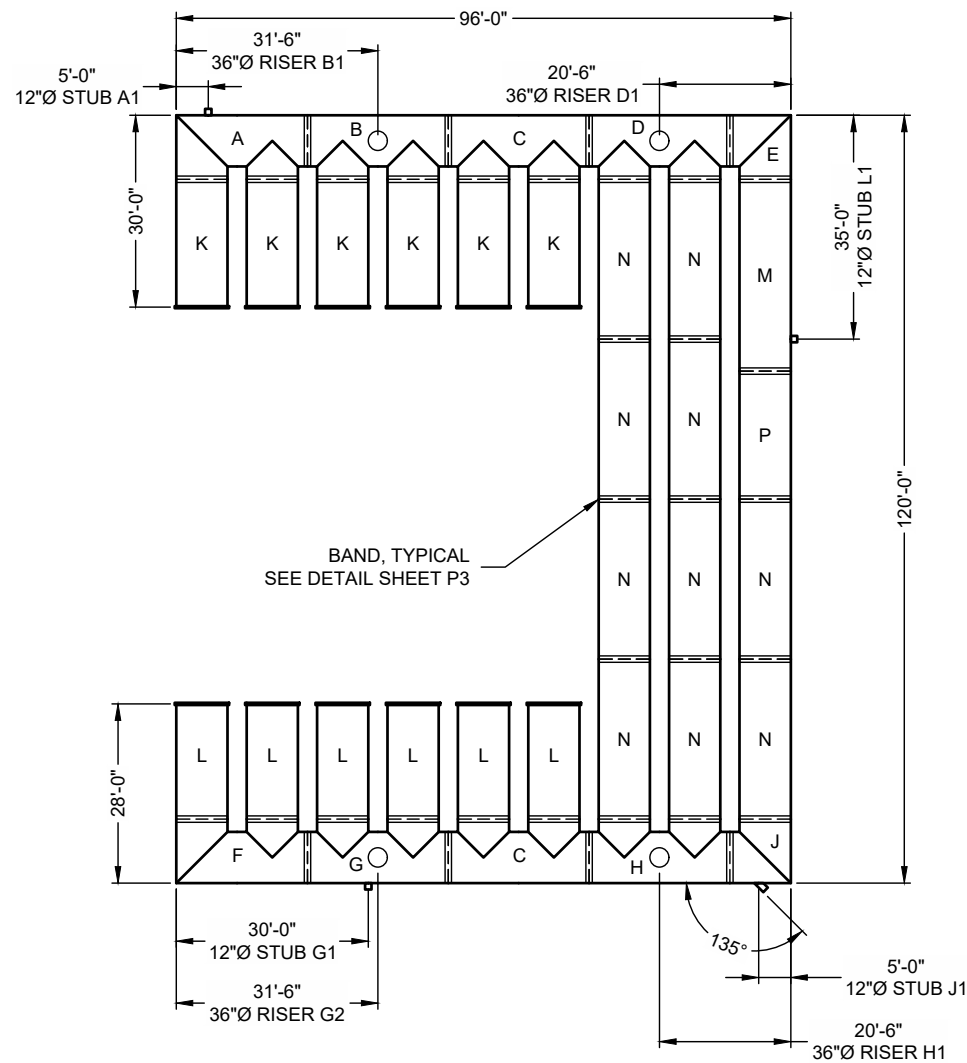
NOT TO SCALE

***NOTE:**
ON-SITE UNDERGROUND INFILTRATION/RETENTION SYSTEM (53,660 CF) IS SIZED TO MITIGATE THE 100-YEAR PEAK FLOW INCREASE TO THE DOWNSTREAM FACILITIES FROM THE PROPOSED PROJECT.



Attachment B

BMP Manufacturer's Details & Supporting Calc's, HCOC Hydrologic Analysis



STUB INFORMATION		
PIECE	STUB INVERT	SYSTEM INVERT
12"Ø STUB A1	TBD	1268.50
12"Ø STUB G1	TBD	1268.50
12"Ø STUB J1	TBD	1268.50
12"Ø STUB L1	TBD	1268.50

RISER INFORMATION		
PIECE	RIM ELEV.	SYSTEM INVERT
36"Ø RISER B1	TBD	1268.50
36"Ø RISER D1	TBD	1268.50
36"Ø RISER G2	TBD	1268.50
36"Ø RISER H1	TBD	1268.50

THE UNDERSIGNED HEREBY APPROVES THE ATTACHED
(4) PAGES INCLUDING THE FOLLOWING:

- PIPE STORAGE = 38,001 CF
- MAINLINE PIPE GAGE = 16
- WALL TYPE = PERFORATED
- DIAMETER = 96"
- FINISH = ALT2
- CORRUGATION = 5x1

CUSTOMER

DATE _____

ASSEMBLY

SCALE: 1" = 30'

PIPE STORAGE: 38,001 CF

STRUCTURAL BACKFILL STORAGE: 15,659 CF

TOTAL STORAGE PROVIDED: 53,660 CF

LOADING: H2O

PIPE INV. = 1268.50'±

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CONTECH
CMP DETENTION SYSTEMS

CONTECH
PROPOSAL
DRAWING

96"Ø PERFORATED UNDERGROUND RETENTION SYSTEM -
650932-010
KEYSTONE RIALTO TOWNHOUSES
RIALTO, CA
SITE DESIGNATION:

PROJECT No.: 650932	SEQ. No.: 010	DATE: 6/12/2020
DESIGNED: RLH	DRAWN: RLH	
CHECKED:	APPROVED:	
SHEET NO.: P1 OF 4		



EDGE SPACING EQUAL ON BOTH SIDES

1.75" CC
TYP

2.711"

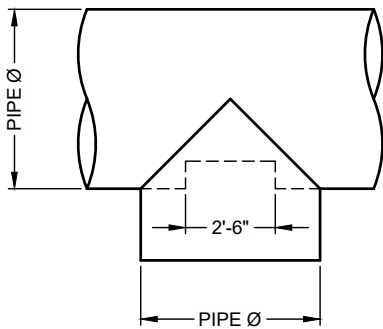
9@2.711" = 24.399"

COIL WIDTH
OPEN AREA = 3.33 SQ IN/SQ FT

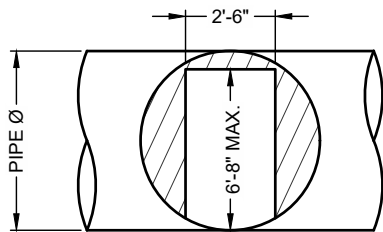
- ## EXFILTRATION AREA
- ### STANDARD PERFORATION PATTERNS

APPROXIMATE AREA PER LINEAR FOOT OF PIPE				
PIPE	CORRUGATION PATTERN			
	2 2/3" x 1/2"	3" x 1"	5" x 1"	ULTRA FLO
96"Ø	97.7 SQ. IN.	103.2 SQ. IN.	100.4 SQ. IN.	

- TYPICAL PERFORATION DETAIL**
NOT TO SCALE



PLAN

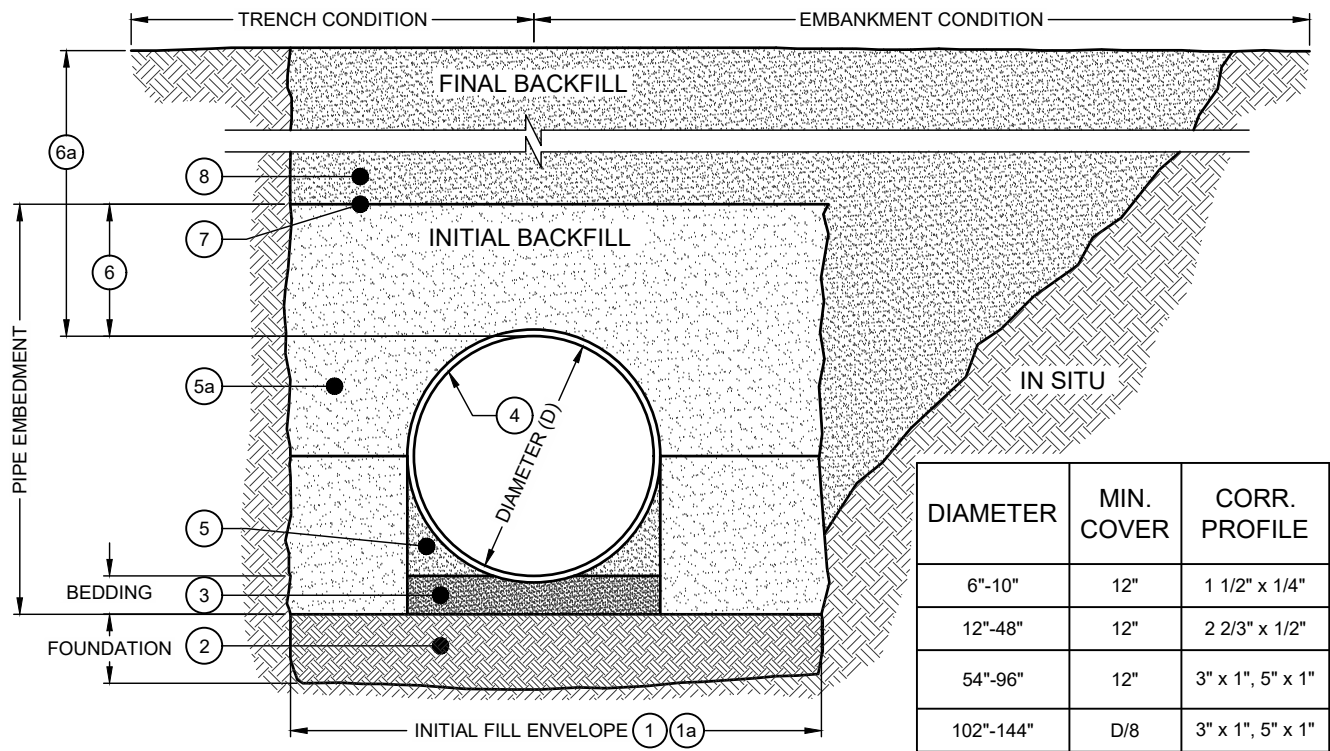


FRONT

96"Ø to 144"Ø FITTING REINFORCEMENT
MAY BE REQUIRED BASED ON HEIGHT OF
COVER AND LIVE LOAD CONDITION

TYPICAL MANWAY DETAIL

NOT TO SCALE



- 1 MINIMUM TRENCH WIDTH MUST ALLOW ROOM FOR PROPER COMPACTION OF HAUNCH MATERIALS UNDER THE PIPE.
THE MINIMUM TRENCH WIDTH (12.6.6.1):
PIPE $\leq 12"$: $D + 16"$
PIPE $> 12"$: $1.5D + 12"$
- 1a MINIMUM EMBANKMENT WIDTH (IN FEET) FOR INITIAL FILL ENVELOPE (12.6.6.2):
PIPE $< 24"$: $3.0D$
PIPE $24" - 144"$: $D + 4'0"$
PIPE $> 144"$: $D + 10'0"$
- 2 THE FOUNDATION UNDER THE PIPE AND SIDE BACKFILL SHALL BE ADEQUATE TO SUPPORT THE LOADS ACTING UPON IT (26.5.2).
- 3 BEDDING MATERIAL SHALL BE A RELATIVELY LOOSE GRANULAR MATERIAL THAT IS ROUGHLY SHAPED TO FIT THE BOTTOM OF THE PIPE, AND A MINIMUM OF TWICE THE CORRUGATION DEPTH IN THICKNESS, WITH THE MAXIMUM PARTICLE SIZE OF ONE-HALF OF THE CORRUGATION DEPTH (26.3.8.1, 26.5.3).
- 4 PERFORATED CORRUGATED STEEL PIPE (CSP / HEL-COR).
- 5 HAUNCH ZONE MATERIAL SHALL BE HAND SHOVELED OR SHOVEL SLICED INTO PLACE TO ALLOW FOR PROPER COMPACTION (26.5.4).
- 5a BACKFILL MATERIAL SHALL BE A CLEAN, CRUSHED STONE MEETING SIZE NO. 3 OR 4, PER AASHTO M 43. IT IS RECOMMENDED THAT LIFTS NOT EXCEED AN 8" UNCOMPACTED LIFT HEIGHT TO PREVENT UNEVEN LOADING, AND THE LESSER OF 1/3 THE DIAMETER OR 24" AS THE MAXIMUM DIFFERENTIAL SIDE-TO-SIDE. COMPACTION OF ALL PLACED FILL MATERIAL IS NECESSARY AND SHALL BE CONSIDERED ADEQUATE WHEN NO FURTHER YIELDING OF THE MATERIAL IS OBSERVED UNDER THE COMPACTOR, OR UNDER FOOT, AND THE PROJECT ENGINEER, OR THEIR REPRESENTATIVE, IS SATISFIED WITH THE LEVEL OF COMPACTION (26.5.4).
- 6 INITIAL BACKFILL ABOVE PIPE MAY INCLUDE ROAD BASE MATERIAL (AND RIGID PAVEMENT IF APPLICABLE). SEE TABLE ABOVE.
- 6a TOTAL HEIGHT OF COMPACTED COVER FOR CONVENTIONAL HIGHWAY LOADS IS MEASURED FROM TOP OF PIPE TO BOTTOM OF FLEXIBLE PAVEMENT OR TOP OF RIGID PAVEMENT (12.6.6.3).
- 7 GEOTEXTILE SHALL BE USED TO WRAP TRENCH SIDES AND TOP ONLY TO PREVENT SOIL MIGRATION INTO VARYING SOIL TYPES (PROJECT ENGINEER).
- 8 FINAL BACKFILL MATERIAL SELECTION AND COMPACTION REQUIREMENTS SHALL FOLLOW THE PROJECT PLANS AND SPECIFICATIONS PER THE ENGINEER OF RECORD (26.5.4.1).

- NOTES:
- FOR MULTIPLE BARREL INSTALLATIONS THE RECOMMENDED STANDARD SPACING BETWEEN PARALLEL PIPE RUNS SHALL BE PIPE DIA./2 BUT NO LESS THAN 12", OR 36" FOR PIPE DIAMETERS 72" AND LARGER. CONTACT YOUR CONTECH REPRESENTATIVE FOR NONSTANDARD SPACING (TABLE C12.6.7-1).

TYPICAL BACKFILL DETAIL

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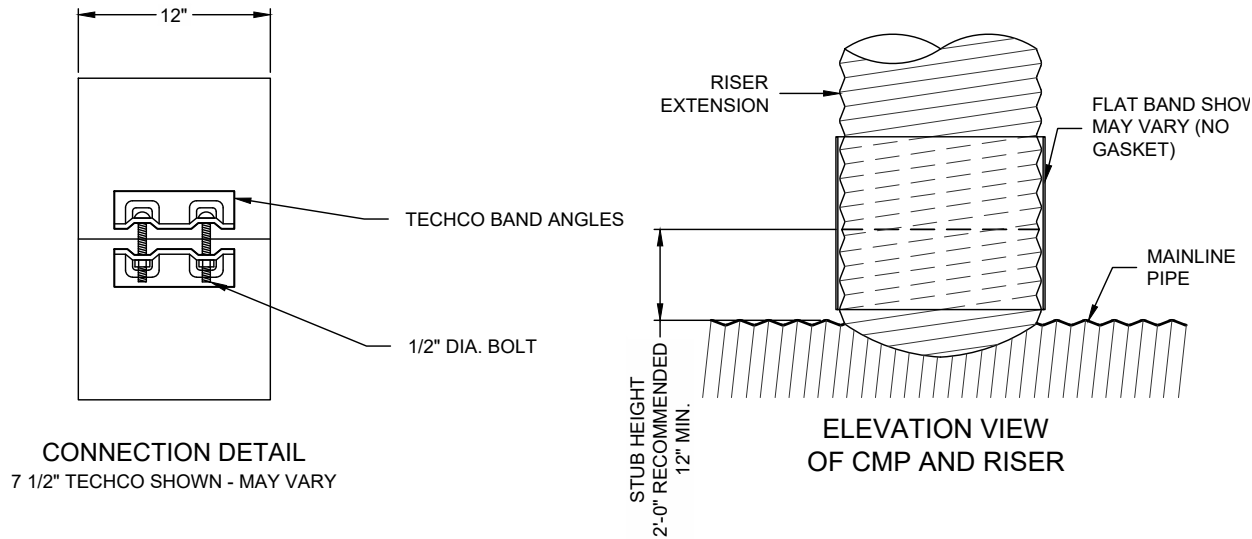
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96"Ø PERFORATED UNDERGROUND RETENTION SYSTEM -
650932-010
KEYSTONE RIALTO TOWNHOUSES
RIALTO, CA
SITE DESIGNATION:

PROJECT No.: 650932	SEQ. No.: 010	DATE: 6/12/2020
DESIGNED: RLH		DRAWN: RLH
CHECKED:		APPROVED:
SHEET NO.: P2 OF 4		

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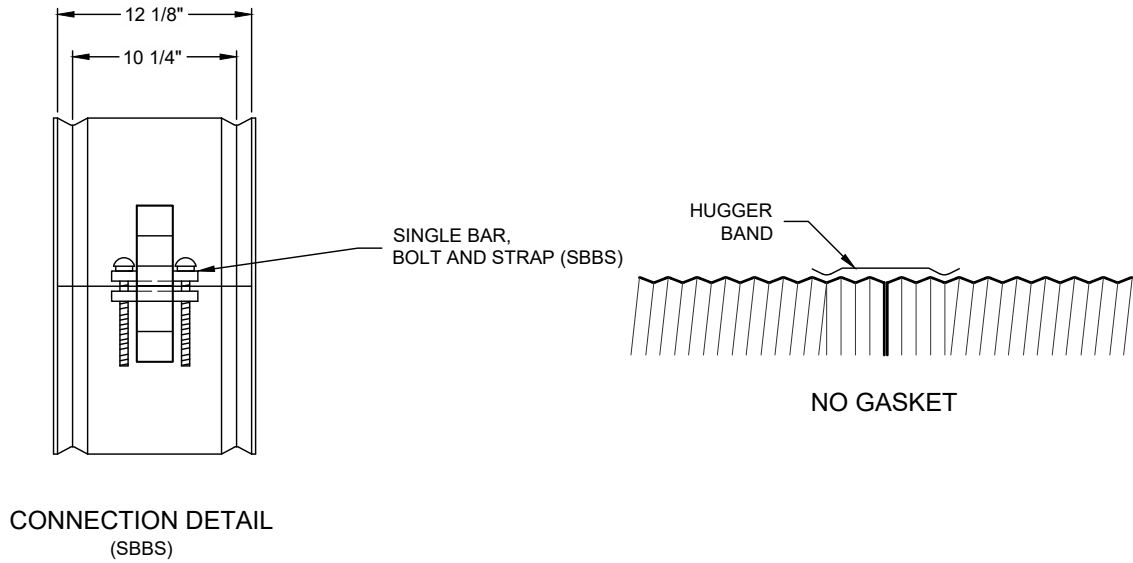


PLAIN END CMP RISER PIPE

GENERAL NOTES:

1. **DELIVERED BAND STYLE AND FASTENER TYPE MAY VARY BY FABRICATION PLANT.**
2. JOINT IS TO BE ASSEMBLED PER AASHTO BRIDGE CONSTRUCTION SPECIFICATION SEC 26.4.2.4.
3. BAND MATERIAL AND GAGE TO BE SAME AS RISER MATERIAL.
4. IF RISER HAS A HEIGHT OF COVER OF 10' OR MORE, USE A SLIP JOINT.
5. BANDS ARE NORMALLY FURNISHED AS FOLLOWS:
 - 12" THRU 48" 1-PIECE
 - 54" 2-PIECES
6. ALL RISER JOINT COMPONENTS WILL BE FIELD ASSEMBLED.
7. MANHOLE RISERS IN APPLICATIONS WHERE TRAFFIC LOADS ARE IMPOSED REQUIRE SPECIAL DESIGN CONSIDERATIONS.
8. DIMENSIONS SUBJECT TO MANUFACTURING TOLERANCES.

12" RISER BAND DETAIL NOT TO SCALE



2 2/3"x1/2" RE-ROLLED END HEL-COR PIPE

GENERAL NOTES:

1. JOINT IS TO BE ASSEMBLED PER AASHTO BRIDGE CONSTRUCTION SPECIFICATION SEC 26.4.2.4.
2. BAND MATERIALS AND/OR COATING CAN VARY BY LOCATION. CONTACT YOUR CONTECH REPRESENTATIVE FOR AVAILABILITY.
3. BANDS ARE SHAPED TO MATCH THE PIPE-ARCH WHEN APPLICABLE.
4. BANDS ARE NORMALLY FURNISHED AS FOLLOWS:
 - 12" THRU 48" 1-PIECE
 - 54" THRU 96" 2-PIECES
 - 102" THRU 144" 3-PIECES
5. BAND FASTENERS ARE ATTACHED WITH SPOT WELDS, RIVETS OR HAND WELDS.
6. ALL CMP IS REROLLED TO HAVE ANNULAR END CORRUGATIONS OF 2 2/3"x1/2"
7. DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES.
8. ORDER SHALL DESIGNATE GASKET OPTION, IF REQUIRED (SEE DETAILS ABOVE).

H-12 HUGGER BAND DETAIL NOT TO SCALE

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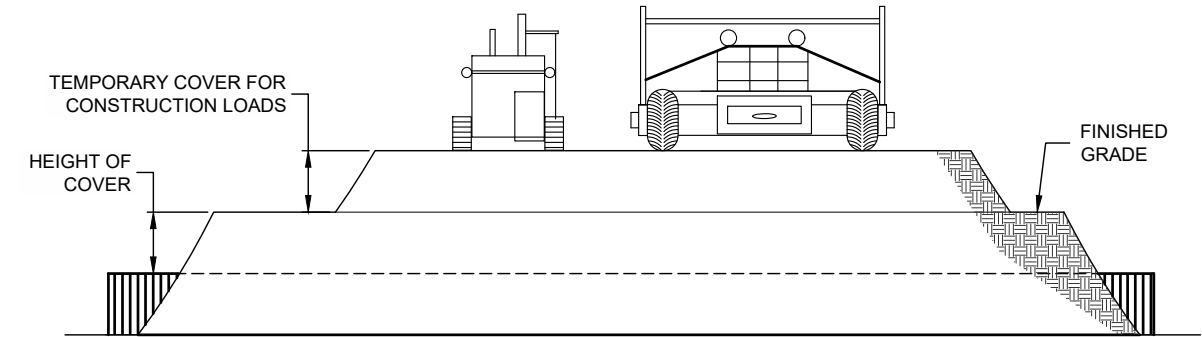
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RIALTO, CA
SITE DESIGNATION:

PROJECT No.: 650932	SEQ. No.: 010	DATE: 6/12/2020
DESIGNED: RLH	DRAWN: RLH	
CHECKED:	APPROVED:	
SHEET NO.: P3	OF 4	

\\AD-CONTECH-CPI-COMROOT\MERLIN\PROJECT\ACTIVE\650932\650932-10-CMP DETENTION\DRAWINGS\650932-010-CMP CONFAB.DWG 6/15/2020 11:48 AM



CONSTRUCTION LOADS

FOR TEMPORARY CONSTRUCTION VEHICLE LOADS, AN EXTRA AMOUNT OF COMPACTED COVER MAY BE REQUIRED OVER THE TOP OF THE PIPE. THE HEIGHT-OF-COVER SHALL MEET THE MINIMUM REQUIREMENTS SHOWN IN THE TABLE BELOW. THE USE OF HEAVY CONSTRUCTION EQUIPMENT NECESSITATES GREATER PROTECTION FOR THE PIPE THAN FINISHED GRADE COVER MINIMUMS FOR NORMAL HIGHWAY TRAFFIC.

PIPE SPAN, INCHES	AXLE LOADS (kips)			
	18-50	50-75	75-110	110-150
	MINIMUM COVER (FT)			
12-42	2.0	2.5	3.0	3.0
48-72	3.0	3.0	3.5	4.0
78-120	3.0	3.5	4.0	4.0
126-144	3.5	4.0	4.5	4.5

*MINIMUM COVER MAY VARY, DEPENDING ON LOCAL CONDITIONS. THE CONTRACTOR MUST PROVIDE THE ADDITIONAL COVER REQUIRED TO AVOID DAMAGE TO THE PIPE. MINIMUM COVER IS MEASURED FROM THE TOP OF THE PIPE TO THE TOP OF THE MAINTAINED CONSTRUCTION ROADWAY SURFACE.

CONSTRUCTION LOADING DIAGRAM
NOT TO SCALE

SPECIFICATION FOR CORRUGATED STEEL PIPE-ALUMINIZED TYPE 2 STEEL

SCOPE

THIS SPECIFICATION COVERS THE MANUFACTURE AND INSTALLATION OF THE CORRUGATED STEEL PIPE (CSP) DETAILED IN THE PROJECT PLANS.

MATERIAL

THE ALUMINIZED TYPE 2 STEEL COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M274 OR ASTM A929.

PIPE

THE CSP SHALL BE MANUFACTURED IN ACCORDANCE WITH THE APPLICABLE REQUIREMENTS OF AASHTO M36 OR ASTM A760. THE PIPE SIZES, GAGES AND CORRUGATIONS SHALL BE AS SHOWN ON THE PROJECT PLANS.

ALL FABRICATION OF THE PRODUCT SHALL OCCUR WITHIN THE UNITED STATES.

MATERIAL SPECIFICATION
NOT TO SCALE

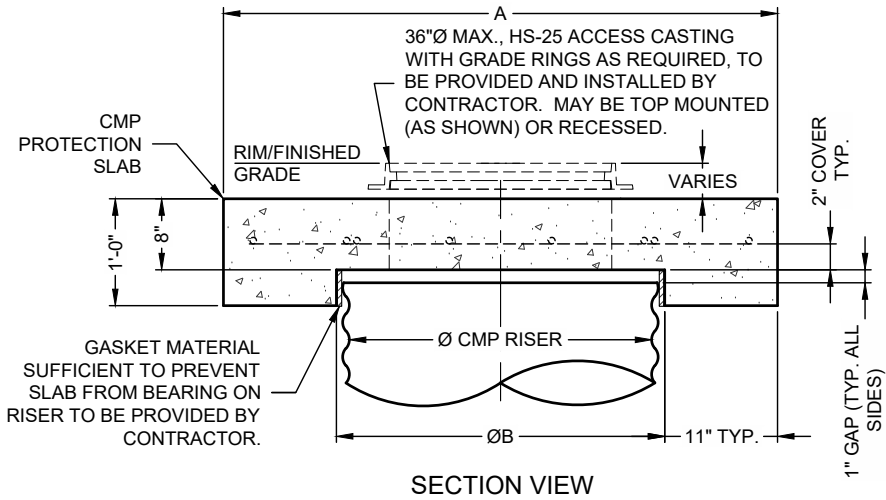
HANDLING AND ASSEMBLY

SHALL BE IN ACCORDANCE WITH RECOMMENDATIONS OF THE NATIONAL CORRUGATED STEEL PIPE ASSOCIATION (NCSPA)

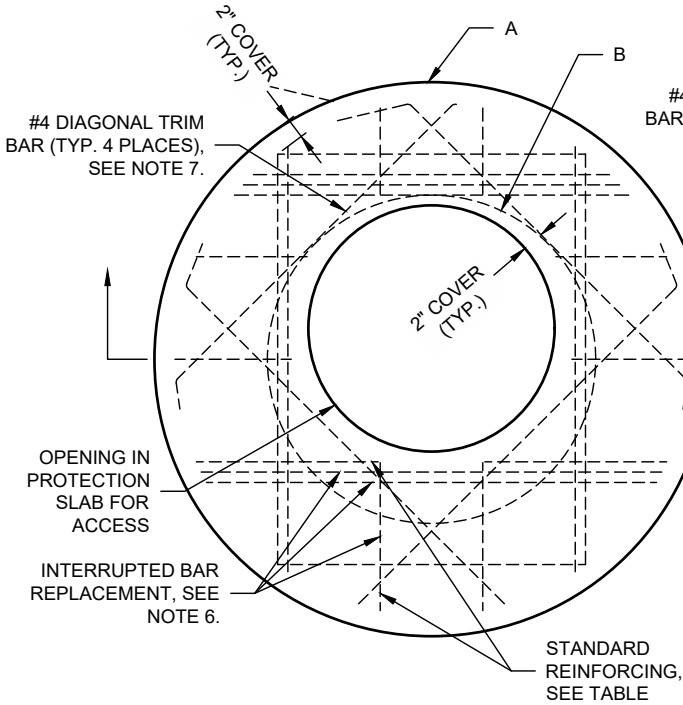
INSTALLATION

SHALL BE IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, SECTION 26, DIVISION II OR ASTM A798 AND IN CONFORMANCE WITH THE PROJECT PLANS AND SPECIFICATIONS. IF THERE ARE ANY INCONSISTENCIES OR CONFLICTS THE CONTRACTOR SHOULD DISCUSS AND RESOLVE WITH THE SITE ENGINEER.

IT IS ALWAYS THE RESPONSIBILITY OF THE CONTRACTOR TO FOLLOW OSHA GUIDELINES FOR SAFE PRACTICES.



ACCESS CASTING NOT SUPPLIED BY CONTECH



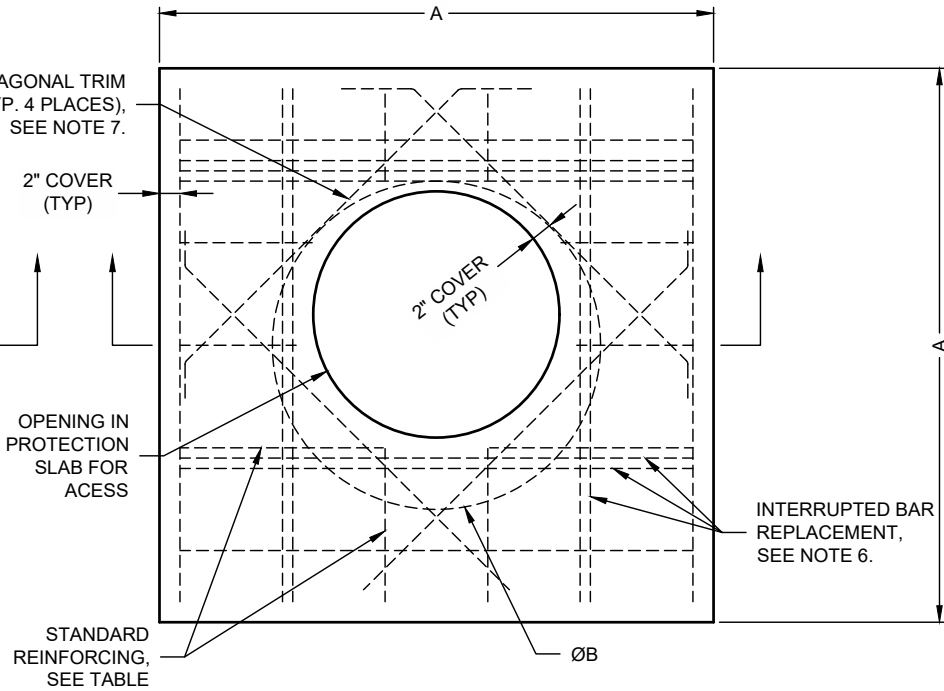
ROUND OPTION PLAN VIEW

NOTES:

- DESIGN IN ACCORDANCE WITH AASHTO, 17th EDITION AND ACI 350.
- DESIGN LOAD HS25.
- EARTH COVER = 1' MAX.
- CONCRETE STRENGTH = 4,000 psi
- REINFORCING STEEL = ASTM A615, GRADE 60.
- PROVIDE ADDITIONAL REINFORCING AROUND OPENINGS EQUAL TO THE BARS INTERRUPTED, HALF EACH SIDE. ADDITIONAL BARS TO BE IN THE SAME PLANE.

REINFORCING TABLE				
Ø CMP RISER	A	B Ø	REINFORCING	**BEARING PRESSURE (PSF)
24"	4'Ø 4'x4'	26"	#5 @ 10" OCEW #5 @ 10" OCEW	2,540 1,900
30"	4'-6"Ø 4'-6" x 4'-6"	32"	#5 @ 10" OCEW #5 @ 9" OCEW	2,260 1,670
36"	5'Ø 5' x 5'	38"	#5 @ 9" OCEW #5 @ 8" OCEW	2,060 1,500
42"	5'-6"Ø 5'-6" x 5'-6"	44"	#5 @ 8" OCEW #5 @ 8" OCEW	1,490 1,370
48"	6'Ø 6' x 6'	50"	#5 @ 7" OCEW #5 @ 7" OCEW	1,210 1,270

** ASSUMED SOIL BEARING CAPACITY



SQUARE OPTION PLAN VIEW

- TRIM OPENING WITH DIAGONAL #4 BARS, EXTEND BARS A MINIMUM OF 12" BEYOND OPENING, BEND BARS AS REQUIRED TO MAINTAIN BAR COVER.
- PROTECTION SLAB AND ALL MATERIALS TO BE PROVIDED AND INSTALLED BY CONTRACTOR.
- DETAIL DESIGN BY DELTA ENGINEERS, ARCHITECTS AND LAND SURVEYORS, ENDWELL, NY.

MANHOLE CAP DETAIL
NOT TO SCALE

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CONTECH
CMP DETENTION SYSTEMS

CONTECH
PROPOSAL
DRAWING

96"Ø PERFORATED UNDERGROUND RETENTION SYSTEM -
650932-010
KEYSTONE RIALTO TOWNHOUSES
RIALTO, CA
SITE DESIGNATION:

PROJECT No.: 650932	SEQ. No.: 010	DATE: 6/12/2020
DESIGNED: RLH	DRAWN: RLH	
CHECKED:	APPROVED:	
SHEET No.: P4	OF 4	

Total Volume	Stone Directly Above and Below Pipe			Stone Between Pipe			Pipe			
	Elevation (ft)	Volume of Stone (cf)	Storage in stone (cf)	Elevation (ft)	Volume of Stone (cf)	Storage in stone (cf)	Elevation (ft)	Area (sf)	Volume (cf)	Top Width (ft)
0	1268.00	0.0	0.0	1268.00	0.00	0.00				
	1268.08	504.0	201.6	1268.08	210.33	84.13				
	1268.17	1008.0	403.2	1268.17	420.67	168.27				
	1268.25	1512.0	604.8	1268.25	631.00	252.40				
	1268.33	2016.0	806.4	1268.33	841.33	336.53				
	1268.42	2520.0	1008.0	1268.42	1051.67	420.67				
1714.4	1268.50	3024.0	1209.6	1268.50	1262.00	504.80	1268.50	0.00	0.00	0.00
	1268.58	3459.6	1383.9	1268.58	1472.33	588.93	1268.58	0.09	68.37	1.62
	1268.67	3839.2	1535.7	1268.67	1682.67	673.07	1268.67	0.25	192.77	2.29
	1268.75	4183.0	1673.2	1268.75	1893.00	757.20	1268.75	0.47	353.02	2.78
	1268.83	4498.2	1799.3	1268.83	2103.33	841.33	1268.83	0.72	541.78	3.20
	1268.92	4789.3	1915.7	1268.92	2313.67	925.47	1268.92	1.00	754.72	3.56
4022.1	1269.00	5059.1	2023.6	1269.00	2524.00	1009.60	1269.00	1.31	988.88	3.87
	1269.08	5309.9	2124.0	1269.08	2734.33	1093.73	1269.08	1.64	1242.07	4.16
	1269.17	5543.5	2217.4	1269.17	2944.67	1177.87	1269.17	2.00	1512.52	4.42
	1269.25	5761.2	2304.5	1269.25	3155.00	1262.00	1269.25	2.38	1798.83	4.66
	1269.33	5964.2	2385.7	1269.33	3365.33	1346.13	1269.33	2.78	2099.78	4.89
	1269.42	6153.7	2461.5	1269.42	3575.67	1430.27	1269.42	3.19	2414.35	5.10
	1269.50	6330.4	2532.1	1269.50	3786.00	1514.40	1269.50	3.63	2741.63	5.29
	1269.58	6495.2	2598.1	1269.58	3996.33	1598.53	1269.58	4.08	3080.82	5.47
	1269.67	6648.8	2659.5	1269.67	4206.67	1682.67	1269.67	4.54	3431.21	5.65
	1269.75	6791.9	2716.7	1269.75	4417.00	1766.80	1269.75	5.02	3792.14	5.81
	1269.83	6925.0	2770.0	1269.83	4627.33	1850.93	1269.83	5.51	4163.02	5.96
	1269.92	7048.7	2819.5	1269.92	4837.67	1935.07	1269.92	6.01	4543.28	6.11
9817.0	1270.00	7163.6	2865.4	1270.00	5048.00	2019.20	1270.00	6.52	4932.44	6.24
	1270.08	7270.0	2908.0	1270.08	5258.33	2103.33	1270.08	7.05	5330.00	6.37
	1270.17	7368.5	2947.4	1270.17	5468.67	2187.47	1270.17	7.59	5735.53	6.50
	1270.25	7459.4	2983.8	1270.25	5679.00	2271.60	1270.25	8.13	6148.60	6.61
	1270.33	7543.2	3017.3	1270.33	5889.33	2355.73	1270.33	8.69	6568.81	6.72
	1270.42	7620.2	3048.1	1270.42	6099.67	2439.87	1270.42	9.25	6995.79	6.83
	1270.50	7690.8	3076.3	1270.50	6310.00	2524.00	1270.50	9.83	7429.18	6.93
	1270.58	7755.4	3102.1	1270.58	6520.33	2608.13	1270.58	10.41	7868.63	7.02
	1270.67	7814.2	3125.7	1270.67	6730.67	2692.27	1270.67	11.00	8313.82	7.11
	1270.75	7867.6	3147.0	1270.75	6941.00	2776.40	1270.75	11.59	8764.42	7.19
	1270.83	7915.9	3166.3	1270.83	7151.33	2860.53	1270.83	12.20	9220.13	7.27
	1270.92	7959.3	3183.7	1270.92	7361.67	2944.67	1270.92	12.81	9680.65	7.35
16373.8	1271.00	7998.3	3199.3	1271.00	7572.00	3028.80	1271.00	13.42	10145.70	7.42
	1271.08	8033.0	3213.2	1271.08	7782.33	3112.93	1271.08	14.04	10615.00	7.48
	1271.17	8063.7	3225.5	1271.17	7992.67	3197.07	1271.17	14.67	11088.28	7.54
	1271.25	8090.7	3236.3	1271.25	8203.00	3281.20	1271.25	15.30	11565.27	7.60
	1271.33	8114.3	3245.7	1271.33	8413.33	3365.33	1271.33	15.93	12045.71	7.65
	1271.42	8134.6	3253.9	1271.42	8623.67	3449.47	1271.42	16.57	12529.36	7.70
	1271.50	8152.0	3260.8	1271.50	8834.00	3533.60	1271.50	17.22	13015.96	7.75
	1271.58	8166.7	3266.7	1271.58	9044.33	3617.73	1271.58	17.86	13505.27	7.79
	1271.67	8178.9	3271.6	1271.67	9254.67	3701.87	1271.67	18.51	13997.05	7.82
	1271.75	8188.9	3275.6	1271.75	9465.00	3786.00	1271.75	19.17	14491.07	7.86
	1271.83	8196.9	3278.8	1271.83	9675.33	3870.13	1271.83	19.82	14987.10	7.89
	1271.92	8203.1	3281.2	1271.92	9885.67	3954.27	1271.92	20.48	15484.90	7.91
23305.8	1272.00	8207.8	3283.1	1272.00	10096.00	4038.40	1272.00	21.14	15984.25	7.94
	1272.08	8211.1	3284.4	1272.08	10306.33	4122.53	1272.08	21.81	16484.92	7.96
	1272.17	8213.3	3285.3	1272.17	10516.67	4206.67	1272.17	22.47	16986.69	7.97
	1272.25	8214.7	3285.9	1272.25	10727.00	4290.80	1272.25	23.13	17489.34	7.98
	1272.33	8215.4	3286.1	1272.33	10937.33	4374.93	1272.33	23.80	17992.64	7.99
	1272.42	8215.6	3286.2	1272.42	11147.67	4459.07	1272.42	24.47	18496.39	8.00
	1272.50	8215.6	3286.3	1272.50	11358.00	4543.20	1272.50	25.13	19000.35	8.00
	1272.58	8215.7	3286.3	1272.58	11568.33	4627.33	1272.58	25.80	19504.32	8.00
	1272.67	8215.9	3286.4	1272.67	11778.67	4711.47	1272.67	26.47	20008.06	7.99
	1272.75	8216.6	3286.7	1272.75	11989.00	4795.60	1272.75	27.13	20511.37	7.98
	1272.83	8218.0	3287.2	1272.83	12199.33	4879.73	1272.83	27.80	21014.02	7.97
	1272.92	8220.2	3288.1	1272.92	12409.67	4963.87	1272.92	28.46	21515.79	7.96
30353.9	1273.00	8223.5	3289.4	1273.00	12620.00	5048.00	1273.00	29.12	22016.46	7.94
	1273.08	8228.2	3291.3	1273.08	12830.33	5132.13	1273.08	29.78	22515.81	7.91
	1273.17	8234.4	3293.8	1273.17	13040.67	5216.27	1273.17	30.44	23013.61	7.89
	1273.25	8242.4	3296.9	1273.25	13251.00	5300.40	1273.25	31.10	23509.63	7.86
	1273.33	8252.3	3300.9	1273.33	13461.33	5384.53	1273.33	31.75	24003.65	7.82
	1273.42	8264.6	3305.8	1273.42	13671.67	5468.67	1273.42	32.40	24495.44	7.79
	1273.50	8279.3	3311.7	1273.50	13882.00	5552.80	1273.50	33.05	24984.75	7.75
	1273.58	8296.7	3318.7	1273.58	14092.33	5636.93	1273.58	33.69	25471.35	7.70
	1273.67	8317.0	3326.8	1273.67	14302.67	5721.07	1273.67	34.33	25954.99	7.65
	1273.75	8340.6	3336.2	1273.75	14513.00	5805.20	1273.75	34.97	26435.44	7.60
	1273.83	8367.6	3347.0	1273.83	14723.33	5889.33	1273.83	35.60	26912.43	7.54
	1273.92	8398.3	3359.3	1273.92	14933.67	5973.47	1273.92	36.22	27385.70	7.48
37285.8	1274.00	8433.0	3373.2	1274.00	15144.00	6057.60	1274.00	36.85	27855.00	7.42
	1274.08	8471.9	3388.8	1274.08	15354.33	6141.73	1274.08	37.46	28320.05	7.35
	1274.17	8515.4	3406.2	1274.17	15564.67	6225.87	1274.17	38.07	28780.58	7.27
	1274.25	8563.7	3425.5	1274.25	15775.00	6310.00	1274.25	38.67	29236.29	7.19
	1274.33	8617.1	3446.8	1274.33	15985.33	6394.13	1274.33	39.27	29686.89	7.11
	1274.42	8675.9	3470.4	1274.42	16195.67	6478.27	1274.42	39.86	30132.07	7.02
	1274.50	8740.5	3496.2	1274.50	16406.00	6562.40	1274.50	40.44	30571.52	6.93
	1274.58	8811.1	3524.4	1274.58	16616.33	6646.53	1274.58	41.01	31004.91	6.83
	1274.67	8888.1	3555.2	1274.67	16826.67	6730.67	1274.67	41.58	31431.90	6.72
	1274.75	8971.9	3588.8	1274.75	17037.00	6814.80	1274.75	42.13	31852.11	6.61
	1274.83	9062.8	3625.1	1274.83	17247.33	6898.93	1274.83	42.68	32265.18	6.50
	1274.92	9161.3	3664.5	1274.92	17457.67	6983.07	1274.92	43.22	32670.70	6.37

43842.6	1275.00	9267.7	3707.1	1275.00	17668.00	7067.20	1275.00	43.74	33068.27	6.24
	1275.08	9382.6	3753.0	1275.08	17878.33	7151.33	1275.08	44.26	33457.42	6.11
	1275.17	9506.3	3802.5	1275.17	18088.67	7235.47	1275.17	44.76	33837.69	5.96
	1275.25	9639.4	3855.8	1275.25	18299.00	7319.60	1275.25	45.25	34208.56	5.81
	1275.33	9782.5	3913.0	1275.33	18509.33	7403.73	1275.33	45.73	34569.49	5.65
	1275.42	9936.1	3974.4	1275.42	18719.67	7487.87	1275.42	46.19	34919.88	5.47
	1275.50	10100.9	4040.4	1275.50	18930.00	7572.00	1275.50	46.64	35259.08	5.29
	1275.58	10277.6	4111.1	1275.58	19140.33	7656.13	1275.58	47.07	35586.36	5.10
	1275.67	10467.1	4186.8	1275.67	19350.67	7740.27	1275.67	47.49	35900.93	4.89
	1275.75	10670.1	4268.0	1275.75	19561.00	7824.40	1275.75	47.89	36201.88	4.66
	1275.83	10887.8	4355.1	1275.83	19771.33	7908.53	1275.83	48.26	36488.18	4.42
	1275.92	11121.4	4448.5	1275.92	19981.67	7992.67	1275.92	48.62	36758.64	4.16
	1276.00	11372.2	4548.9	1276.00	20192.00	8076.80	1276.00	48.96	37011.82	3.87
49637.5	1276.08	11642.0	4656.8	1276.08	20402.33	8160.93	1276.08	49.27	37245.99	3.56
	1276.17	11933.1	4773.2	1276.17	20612.67	8245.07	1276.17	49.55	37458.93	3.20
	1276.25	12248.3	4899.3	1276.25	20823.00	8329.20	1276.25	49.80	37647.68	2.78
	1276.33	12592.1	5036.8	1276.33	21033.33	8413.33	1276.33	50.01	37807.93	2.29
	1276.42	12971.7	5188.7	1276.42	21243.67	8497.47	1276.42	50.18	37932.33	1.62
	1276.50	13407.3	5362.9	1276.50	21454.00	8581.60	1276.50	50.27	38000.70	0.00
51945.2	1276.58	13911.3	5564.5	1276.58	21664.33	8665.73				
	1276.67	14415.3	5766.1	1276.67	21874.67	8749.87				
	1276.75	14919.3	5967.7	1276.75	22085.00	8834.00				
	1276.83	15423.3	6169.3	1276.83	22295.33	8918.13				
	1276.92	15927.3	6370.9	1276.92	22505.67	9002.27				
53659.6	1277.00	16431.3	6572.5	1277.00	22716.00	9086.40				

Corrugated Metal Pipe Design Guide

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Durability Design Guide for Drainage Products

Proper design of culverts and storm sewers requires structural, hydraulic and durability considerations. While most designers are comfortable with structural and hydraulic design, the mechanics of evaluating abrasion, corrosion and water chemistry to perform a durability design are not commonly found in most civil engineering handbooks.

The durability and service life of a drainage pipe installation is directly related to the environmental conditions encountered at the site and the type of materials and coatings from which the culvert is fabricated. Two principle causes of early failure in drainage pipe materials are corrosion and abrasion.

Service life can be affected by the corrosive action of the backfill in contact with the outside of a drainage pipe or more commonly by the corrosive and abrasive action of the flow in the invert of the drainage pipe. The design life analysis should include a check for both the water side and soil side environments to determine which is more critical— or which governs service life.

The potential for metal loss in the invert of a drainage pipe due to abrasive flows is often overlooked by designers and its effects are often mistaken for corrosion. An estimate for potential abrasion is required at each pipe location in order to determine the appropriate material and gage.

This manual is intended to guide specifiers through the mechanics of selecting appropriate drainage products to meet service life requirements. The information contained in the following pages is a composite of several national guidelines.



Using the Design Guide

The choice of material, gage and product type can be extremely important to service life. The following steps describe the procedure for selecting the appropriate drainage product, material and gage to meet a specific service life requirement.

Design Sequence

1. Select pipe or structure based on hydraulic and clearance requirements. Use Tables 4 and 5 as reference for size limits and hydraulic properties of all drainage products.
2. Use Height of Cover tables for the chosen pipe or structure to determine the material gage required for the specific loading condition.
3. Use Table 1 to select the appropriate material for the site-specific environmental conditions. Whenever possible, existing installations of drainage structures along the same water course offer the most reliable estimate of long-term performance for specific environment conditions. In many cases, there will be more than one material that is appropriate for the project environmental conditions. Generally speaking, the metal material types increase in price as you move from top down on Table 1. Please contact your local CONTECH Sales Representative for pricing.
4. Use Table 2 to determine which abrasion level most accurately describes the typical storm event (2 year storm). The expected stream velocity and associated abrasion conditions should be based on a typical flow and not a 10 or 50-year design flood.
5. Use Table 3 to determine whether the structural gage for the selected material is sufficient for the design service life. If the structural gage is greater than or equal to the gage required for a particular abrasion condition and service life, use the structural gage. Conversely, if the structural gage is less than the gage required for a particular abrasion condition and service life, use the gage required by Table 3.

Note:

Both Contech round pipe and pipe-arch are available with either helical or annular corrugations. Contech HEL-COR® pipe (helical corrugations) is furnished with continuous lock seams and annular re-rolled ends. Contech riveted pipe is furnished with annular corrugations only. The height of cover tables in this guide are helical corrugations only. Consult your Contech representative for Height of Cover tables on riveted pipe.

Table 1 — Recommended Environments

Material Type	Soil* and Water pH												Resistivity (ohm-cm)	
	3	4	5	6	7	8	9	10	11	12			Minimum	Maximum
Galvanized Steel*													2000	8000
Aluminized Steel Type 2													1500	N/A
Polymer Coated													250	N/A
Aluminum Alloy													500	N/A

*Appropriate pH range for Galvanized Steel is 6.0 to 10

Table 2 — FHWA Abrasion Guidelines

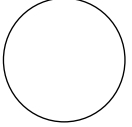
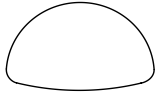
Abrasion Level	Abrasion Condition	Bed Load	Flow Velocity (fps)
1	Non- Abrasive	None	Minimal
2	Low Abrasion	Minor	< 5
3	Moderate Abrasion	Moderate	5 - 15
4	Severe Abrasion	Heavy	> 15

"Interim Direct Guidelines on Drainage Pipe Alternative Selection."
FHWA, 2005.

Table 3 — Drainage Product Usage Guide¹

Application Roadway Classification Design Service Life Abrasion Level	Culverts, Storm Drain, Cross Drain, Median Drain, Side Drain											
	Abrasion Level 1 & 2				Abrasion Level 3				Abrasion Level 4			
	Rural 25	Minor 50	Major 75	Urban 100	Rural 25	Minor 50	Major 75	Urban 100	Rural 25	Minor 50	Major 75	Urban 100
CMP (1/2" & 1" deep corrugations, ULTRA FLO ³ & Smooth Cor ^{2,3})												
Galvanized (2 oz.)	16	12	10	8 ⁴	14	10	8	N/A	14 ⁵	10 ⁵	8 ⁵	N/A
Galvanized and Asphalt Coated	16	14	10	8	14	12	8	N/A	14 ⁵	12 ⁵	8 ⁵	N/A
Galv., Asphalt Coated and Paved Invert	16	16	14	10	16	14	12	8	14	12	10	N/A
Aluminized Type 2	16	16	16	14	14	14	14	12	14 ⁶	14 ⁶	14 ⁶	12 ⁶
Polymer Coated	16	16	16 ⁸	16 ⁹	16	16	16 ⁸	16 ⁹	14 ⁷	14 ⁷	14 ^{7,8}	14 ^{7,9}
Aluminum Alloy	16	16	16	16	14	14	14	14	14 ⁵	14 ⁵	14 ⁵	14 ⁵

- Based on Table 1 - Recommended Environments.
- SmoothCor[™] Steel Pipe combines a corrugated steel exterior shell with a hydraulically smooth interior liner.
- Service life estimates for ULTRA FLO[®] and SmoothCor Pipe assume a storm sewer application. Storm sewers rarely achieve abrasion levels 3 or 4. For applications other than storm sewers or abrasion conditions above Abrasion Level 2, please contact your Contech Sales Representative for gage and coating recommendations.
- Design service life for 8 gage galvanized is 97 years.
- Invert protection to consist of velocity reduction structures.
- Asphalt coated and paved invert or velocity reduction structures are needed.
- Requires a field applied concrete paved invert with minimum thickness 1" above corrugation crests.
- 75 year service life for polymer coated is based on a pH range of 4-9 and resistivity greater than 750 ohm-cm.
- 100 year service life for polymer coated is based on a pH range of 5-9 and resistivity greater than 1500 ohm-cm.

Table 4 - Product Dimensions					
	Drainage Product	Common Uses	Size Limits*		Manning's "n" Value
			Minimum	Maximum	
	Corrugated Steel (1/2" deep corrugation)	Culverts, small bridges, storm water detention/retention systems, conduits, tunnels, storm sewers.	12"	84"	0.011 - 0.021
	Corrugated Steel with Paved Invert (1/2" deep corrugation)		12"	84"	0.014 - 0.020
	Corrugated Steel (1" deep corrugation)		54"	144"	0.022 - 0.027
	Corrugated Steel with Paved Invert (1" deep corrugation)		54"	144"	0.019 - 0.023
	Corrugated Aluminum (1/2" deep corrugation)		12"	72"	0.011 - 0.021
	Corrugated Aluminum (1" deep corrugation)		30"	120"	0.023 - 0.027
	ULTRA FLO® Steel	Storm sewers, culverts, storm water detention/retention systems.	18"	102"	0.012
	ULTRA FLO Aluminum		18"	84"	0.012
	SmoothCor™ Steel (1/2" deep corrugation)		18"	66"	0.012
	SmoothCor Steel (1" deep corrugation)		48"	126"	0.012
	Corrugated Steel (1/2" deep corrugation)	Culverts, small bridges, storm water detention/retention systems, conduits, tunnels, storm sewers.	17" x 13"	83" x 57"	0.011 - 0.021
	Corrugated Steel with Paved Invert (1/2" deep corrugation)		17" x 13"	83" x 57"	0.014 - 0.019
	Corrugated Steel (1" deep corrugation)		53" x 41"	142" x 91"	0.023 - 0.027
	Corrugated Steel with Paved Invert (1" deep corrugation)		53" x 41"	142" x 91"	0.019 - 0.022
	Corrugated Aluminum (1/2" deep corrugation)		17" x 13"	71" x 47"	0.011 - 0.021
	Corrugated Aluminum (1" deep corrugation)		60" x 46"	112" x 75"	0.023 - 0.027
	ULTRA FLO Steel	Storm sewers, culverts, storm water detention/retention systems.	20" x 16"	66" x 51"	0.012
	ULTRA FLO Aluminum		20" x 16"	66" x 51"	0.012
	SmoothCor Steel (1/2" deep corrugation)		21" x 15"	77" x 52"	0.012
	SmoothCor Steel (1" deep corrugation)		53" x 41"	137" x 87"	0.012

* For sizes outside of these limits, please contact your Contech representative.

Table 5 — Corrugated Steel Pipe—Values of Coefficient of Roughness (n)										
	All Diameters	1-1/2" x 1/4"		Helical* Corrugation						
				Helical—2-2/3" x 1/2"						
2-2/3" x 1/2"	Annular	8 in.	10 in.	12 in.	15 in.	18 in.	24 in.	36 in.	48 in.	60 in. +
Unpaved	0.024	0.012	0.014	0.011	0.012	0.013	0.015	0.018	0.020	0.021
PAVED-INVERT	0.021						0.014	0.017	0.020	0.019
SmoothCor	N/A					0.012	0.012	0.012	0.012	0.012
3" x 1"	Annular			Helical*—3" x 1"						
				36 in.	42 in.	48 in.	54 in.	60 in.	66 in.	72 in. +
Unpaved	0.027			0.022	0.022	0.023	0.023	0.024	0.025	0.026
PAVED-INVERT	0.023			0.019	0.019	0.020	0.020	0.021	0.022	0.022
SmoothCor	N/A					0.012	0.012	0.012	0.012	0.012
5" x 1"	Annular			Helical*—5" x 1"						
						48 in.	54 in.	60 in.	66 in.	72 in. +
Unpaved	N/A					0.022	0.022	0.023	0.024	0.024
PAVED-INVERT	N/A					0.019	0.019	0.020	0.021	0.021
ULTRA FLO	N/A									
3/4" x 3/4" x 7-1/2" All diameters n = 0.012										

* Tests on helically corrugated pipe demonstrate a lower coefficient of roughness than for annularly corrugated steel pipe. Pipe-arches approximately have the same roughness characteristics as their equivalent round pipes.

Table 6 - AASHTO Reference Specifications					
	Material Type	Material	Pipe	Design*	Installation*
Pipe & Pipe-Arch	CMP (1/2" or 1" deep corrugations)				
	Galvanized (2 oz.)	M218	M36	Section 12	Section 26
	Asphalt Coated	M190	M36	Section 12	Section 26
	Asphalt Coated and Paved Invert	M190	M36	Section 12	Section 26
	Aluminized Type 2	M274	M36	Section 12	Section 26
	Polymer Coated	M246	M36 & M245	Section 12	Section 26
	Aluminum Alloy	M197	M196	Section 12	Section 26
	ULTRA FLO				
	(3/4" x 3/4" x 7-1/2" corrugation)				
	Galvanized (2 oz.)	M218	M36	Section 12	Section 26
	Aluminized Type 2	M274	M36	Section 12	Section 26
	Polymer Coated	M246	M36 & M245	Section 12	Section 26
	Aluminum Alloy	M197	M196	Section 12	Section 26
	SmoothCor				
	Polymer Coated	M246	M36 & M245	Section 12	Section 26

* AASHTO LRFD Bridge Design Specification and AASHTO Standard Specification for Highway Bridges



Corrugated Steel Pipe

Heights of Cover

2-2/3" x 1/2" Height of Cover Limits for Corrugated Steel Pipe

H 20 and H 25 Live Loads

Diameter or Span, Inches	Minimum Cover, Inches	Maximum Cover, Feet ⁽²⁾					
		Specified Thickness, Inches					
		0.052	0.064	0.079	0.109	0.138	0.168
6 ¹⁰	12	388	486				
8 ¹⁰		291	365				
10 ¹⁰		233	392				
12		197	248	310			
15		158	198	248			
18		131	165	206			
21		113	141	177	248		
24		98	124	155	217		
30			99	124	173		
36			83	103	145	186	
42			71	88	124	159	195
48			62	77	108	139	171
54				67	94	122	150
60					80	104	128
66					68	88	109
72						75	93
78							79
84	12						66

E 80 Live Loads

Diameter or Span, Inches	Minimum Cover, Inches	Maximum Cover, Feet ⁽²⁾					
		Specified Thickness, Inches					
		0.052	0.064	0.079	0.109	0.138	0.168
12	12	197	248	310			
15		158	198	248			
18		131	165	206			
21		113	141	177	248		
24		98	124	155	217		
30			99	124	173		
36			83	103	145	186	
42			71	88	124	159	195
48	12		62	77	108	139	171
54	18			67	94	122	150
60					80	104	128
66					68	88	109
72	18					75	93
78	24						79
84	24						66

Heights of Cover Notes:

- These tables are for lock-seam or welded-seam construction. They are not for riveted construction. Consult your Contech Sales Representative for Height of Cover tables on riveted pipe.
- These values, where applicable, were calculated using a load factor of K=0.86 as adopted in the NCSPA CSP Design Manual, 2008.
- The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.
- E 80 minimum cover is measured from top of pipe to bottom of tie.
- H 20 and H 25 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
- The H 20 and H 25 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
- The E 80 pipe-arch tables minimum and maximum covers are based on the corner bearing pressures shown. These values may increase or decrease with changes in allowable corner bearing pressures.

H 20 and H 25 Live Loads, Pipe-Arch

Size		Minimum Structural Thickness, Inches	Minimum Cover, Inches	Maximum ⁽⁷⁾ Cover, Feet
Round Equivalent, Inches	Span x Rise, Inches			
15	17 x 13	0.064	12	16
18	21 x 15	0.064		15
21	24 x 18	0.064		
24	28 x 20	0.064		
30	35 x 24	0.064		
36	42 x 29	0.064		
42	49 x 33	0.064*		
48	57 x 38	0.064*		
54	64 x 43	0.079*		
60	71 x 47	0.109*		
66	77 x 52	0.109*		
72	83 x 57	0.138*	12	15

E 80 Live Loads, Pipe-Arch

Size		Minimum Structural Thickness, Inches	Minimum Cover, Inches	Maximum ⁽⁸⁾ Cover, Feet
Round Equivalent, Inches	Span x Rise, Inches			
15	17 x 13	0.079	24	22
18	21 x 15	0.079		
21	24 x 18	0.109		
24	28 x 20	0.109		
30	35 x 24	0.138		
36	42 x 29	0.138		
42	49 x 33	0.138*		
48	57 x 38	0.138*		
54	64 x 43	0.138*		
60	71 x 47	0.138*	24	22

* These values are based on the AISI Flexibility Factor limit (0.0433 x 1.5) for pipe-arch.

- 0.052" is 18 gage.
- 0.064" is 16 gage.
- 0.079" is 14 gage.
- 0.109" is 12 gage.
- 0.138" is 10 gage.
- 0.168" is 8 gage.
- For construction loads, see Page 15.
- 1-1/2" x 1/4" corrugation. H20, H25 and E80 loading.
- SmoothCor has same Height of Cover properties as corrugated steel pipe. The exterior shell of SmoothCor is manufactured in either 2-2/3" x 1/2" or 3" x 1" corrugations; maximum exterior shell gage is 12.
- Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.

5" x 1" or 3" x 1" Height of Cover Limits for Corrugated Steel Pipe

H 20 and H 25 Live Loads

Diameter or Span, Inches	Minimum Cover Inches	Maximum Cover, Feet ⁽²⁾				
		Specified Thickness, Inches				
		0.064	0.079	0.109	0.138	0.168
54	12	56	70	98	127	155
60		50	63	88	114	139
66		46	57	80	103	127
72		42	52	74	95	116
78		39	48	68	87	107
84		36	45	63	81	99
90		33	42	59	76	93
96	12	31	39	55	71	87
102	18	29	37	52	67	82
108			35	49	63	77
114			32	45	58	72
120			30	42	54	66
126				39	50	61
132				36	46	58
138				33	43	53
144	18				39	49

Maximum cover heights shown are for 5" x 1".

To obtain maximum cover for 3" x 1", increase these values by 12%

E 80 Live Loads

Diameter or Span, Inches	Minimum Cover Inches	Maximum Cover, Feet ⁽²⁾				
		Specified Thickness, Inches				
		0.064	0.079	0.109	0.138	0.168
54	18	56	70	98	127	155
60		50	63	88	114	139
66		46	57	80	103	127
72	18	42	52	74	95	116
78	24	39	48	68	87	107
84		36	45	63	81	99
90		33 ⁽¹⁾	42	59	76	93
96	24	31 ⁽¹⁾	39	55	71	87
102	30	29 ⁽¹⁾	37	52	67	82
108			35	49	63	77
114			32 ⁽¹⁾	45	58	72
120	30		30 ⁽¹⁾	42	54	66
126	36			39	50	61
132				36	46	58
138				33 ⁽¹⁾	43	53
144	36				39	49

Maximum cover heights shown are for 5" x 1".

To obtain maximum cover for 3" x 1", increase these values by 12%.

⁽¹⁾ These diameters in these gages require additional minimum cover.

5" x 1" Pipe-Arch Height of Cover Limits for Corrugated Steel Pipe

H 20 and H 25 Live Loads

Equivalent Pipe Diameter	Size Span x Rise Inches ⁽³⁾	Minimum Specified Thickness, Inches*	Minimum Cover Inches	Maximum ⁽⁷⁾ Cover, Feet 2 Tons/Ft. ² Corner Bearing Pressure
72	81 x 59	0.109	18	21
78	87 x 63	0.109	18	20
84	95 x 67	0.109	18	20
90	103 x 71	0.109	18	20
96	112 x 75	0.109	21	20
102	117 x 79	0.109	21	19
108	128 x 83	0.109	24	19
114	137 x 87	0.109	24	19
120	142 x 91	0.138	24	19

Larger sizes are available in some areas of the United States. Check with your local Contech representative. Some minimum heights-of-cover for pipe-arches have been increased to take into account allowable "plus" tolerances on the manufactured rise.

E 80 Live Loads

Equivalent Pipe Diameter	Size Span x Rise Inches ⁽³⁾	Minimum Specified Thickness, Inches*	Minimum Cover Inches	Maximum ⁽⁸⁾ Cover, Feet 2 Tons/Ft. ² Cover Bearing Pressure
72	81 x 59	0.109	30	21
78	87 x 63	0.109	30	18
84	95 x 67	0.109	30	18
90	103 x 71	0.109	36	18
96	112 x 75	0.109	36	18
102	117 x 79	0.109	36	17
108	128 x 83	0.109	42	17
114	137 x 87	0.109	42	17
120	142 x 91	0.138	42	17

* Some 3" x 1" and 5" x 1" minimum gages shown for pipe-arch are due to manufacturing limitations.

Heights of Cover Notes:

- These tables are for lock-seam or welded-seam construction. They are not for riveted construction. Consult your Contech Sales Representative for Height of Cover tables on riveted pipe.
- These values, where applicable, were calculated using a load factor of K=0.86 as adopted in the NCSPA CSP Design Manual, 2008.
- The span and rise shown in these tables are nominal. Typically the actual rise that forms is greater than the specified nominal. This actual rise is within the tolerances as allowed by the AASHTO & ASTM specifications. The minimum covers shown are more conservative than required by the AASHTO and ASTM specifications to account for this anticipated increase in rise. Less cover height may be tolerated depending upon actual rise of supplied pipe arch.
- The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.
- E 80 minimum cover is measured from top of pipe to bottom of tie.
- H 20 and H 25 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
- The H 20 and H 25 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
- The E 80 pipe-arch tables minimum and maximum covers are based on the corner bearing pressures shown. These values may increase or decrease with changes in allowable corner bearing pressures.
- 0.052" is 18 gage. 0.064" is 16 gage. 0.079" is 14 gage. 0.109" is 12 gage. 0.138" is 10 gage. 0.168" is 8 gage.
- For construction loads, see Page 15.
- SmoothCor has same Height of Cover properties as corrugated steel pipe. The exterior shell of SmoothCor is manufactured in either 2'-2/3" x 1/2" or 3"x1" corrugations; maximum exterior shell gage is 12.
- Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.

3" x 1" Pipe-Arch Height of Cover Limits for Corrugated Steel Pipe-Arch

H 20 and H 25 Live Loads

Size		Minimum Specified Thickness, Inches*	Minimum Cover Inches	Maximum ⁽⁷⁾ Cover, Feet
Equivalent Pipe Diameter	Span x Rise Inches			
48	53 x 41	0.079	12	25
54	60 x 46	0.079	15	25
60	66 x 51	0.079	15	25
66	73 x 55	0.079	18	24
72	81 x 59	0.079	18	21
78	87 x 63	0.079	18	20
84	95 x 67	0.079	18	20
90	103 x 71	0.079	18	20
96	112 x 75	0.079	21	20
102	117 x 79	0.109	21	19
108	128 x 83	0.109	24	19
114	137 x 87	0.109	24	19
120	142 x 91	0.138	24	19

Larger sizes are available in some areas of the United States. Check with your local Contech Sales Representative.

Some minimum heights-of-cover for pipe-arches have been increased to take into account allowable "plus" tolerances on the manufactured rise.

E 80 Live Loads

Size		Minimum Specified Thickness, Inches*	Minimum Cover Inches	Maximum ⁽⁸⁾ Cover, Feet
Equivalent Pipe Diameter	Span x Rise Inches			
48	53 x 41	0.079	24	25
54	60 x 46	0.079	24	25
60	66 x 51	0.079	24	25
66	73 x 55	0.079	30	24
72	81 x 59	0.079	30	21
78	87 x 63	0.079	30	18
84	95 x 67	0.079	30	18
90	103 x 71	0.079	36	18
96	112 x 75	0.079	36	18
102	117 x 79	0.109	36	17
108	128 x 83	0.109	42	17
114	137 x 87	0.109	42	17
120	142 x 91	0.138	42	17

* Some 3" x 1" and 5" x 1" minimum gages shown for pipe-arch are due to manufacturing limitations.

Heights of Cover Notes:

- These tables are for lock-seam or welded-seam construction. They are not for riveted construction. Consult your Contech Sales Representative for Height of Cover tables on riveted pipe.
- These values, where applicable, were calculated using $K=0.86$ as adopted in the NCSPA CSP Design Manual, 2008.
- The span and rise shown in these tables are nominal. Typically the actual rise that forms is greater than the specified nominal. This actual rise is within the tolerances as allowed by the AASHTO & ASTM specifications. The minimum covers shown are more conservative than required by the AASHTO and ASTM specifications to account for this anticipated increase in rise. Less cover height may be tolerated depending upon actual rise of supplied pipe arch.
- The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.
- E 80 minimum cover is measured from top of pipe to bottom of tie.
- H 20 and H 25 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
- The H 20 and H 25 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
- The E 80 pipe-arch tables minimum and maximum covers are based on the corner bearing pressures shown. These values may increase or decrease with changes in allowable corner bearing pressures.
- 0.052" is 18 gage.
0.064" is 16 gage.
0.079" is 14 gage.
0.109" is 12 gage.
0.138" is 10 gage.
0.168" is 8 gage.
- For construction loads, see Page 15.
- SmoothCor has same Height of Cover properties as corrugated steel pipe. The exterior shell of SmoothCor is manufactured in either 2-²/₃" x 1-¹/₂" or 3" x 1" corrugations; maximum exterior shell gage is 15.
- Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.



Approximate Weight (Pounds/Foot) Contech Corrugated Steel Pipe

(Estimated Average Weights—Not for
Specification Use)

1-1/2" x 1/4" Corrugation			
Inside Diameter, in.	Specified Thickness, in.	Galvanized & ALUMINIZED	Full Coated
6	0.052	4	5
	0.064	5	6
8	0.052	5	6
	0.064	6	7
10	0.052	6	7
	0.064	7	8

Steel Thicknesses by Gage						
Gage	18	16	14	12	10	8
Thickness	.052	.064	.079	.109	.138	.168

2-2/3" x 1/2" Corrugation					
Inside Diameter, in.	Specified Thickness	Galvanized & ALUMINIZED	Full Coated	Coated & PAVED-INVERT	SmoothCor
12	0.052	8	10	13	
	0.064	10	12	15	
	0.079	12	14	17	
15	0.052	10	13	16	
	0.064	12	15	18	
	0.079	15	18	21	
18	0.052	12	16	19	
	0.064	15	19	22	25
	0.079	18	22	25	28
21	0.052	14	18	23	
	0.064	17	21	26	29
	0.079	21	25	30	33
	0.109	29	33	33	41
24	0.052	15	20	26	
	0.064	19	24	30	30
	0.079	24	29	35	38
	0.109	33	38	44	47
30	0.064	24	30	36	42
	0.079	30	36	42	48
	0.109	41	47	53	59
	0.138	51	58	64	71
36	0.064	29	36	44	51
	0.079	36	43	51	58
	0.109	49	56	64	71
	0.138	62	69	77	
42	0.064	34	42	51	60
	0.079	42	50	59	68
	0.109	57	65	74	82
	0.138	72	80	89	
	0.168	88	96	105	
48	0.064	38	48	57	67
	0.079	48	58	67	77
	0.109	65	75	84	94
	0.138	82	92	101	
	0.168	100	110	119	
54	0.079	54	65	76	87
	0.109	73	84	95	106
	0.138	92	103	114	
	0.168	112	123	134	
	0.109	81	92	106	117
60	0.138	103	114	128	
	0.168	124	135	149	
	0.109	89	101	117	129
66	0.138	113	125	141	
	0.168	137	149	165	
	0.138	123	137	154	(2)
72	0.168	149	163	180	
	0.168	161	177	194	(2)
84	0.168	173	190	208	(2)

3" x 1" or 5" x 1" Corrugation					
Inside Diameter, in.	Specified Thickness	Galvanized & ALUMINIZED	Full Coated	Coated & PAVED-INVERT	SmoothCor
54	0.064	50	66	84	84
	0.079	61	77	95	95
	0.109	83	100	118	118
	0.138	106	123	140	
	0.168	129	146	163	
60	0.064	55	73	93	93
	0.079	67	86	105	105
	0.109	92	110	130	130
	0.138	118	136	156	
	0.168	143	161	181	
66	0.064	60	80	102	102
	0.079	74	94	116	116
	0.109	101	121	143	145
	0.138	129	149	171	
	0.168	157	177	199	
72	0.064	66	88	111	112
	0.079	81	102	126	127
	0.109	110	132	156	157
	0.138	140	162	186	
	0.168	171	193	217	
78	0.064	71	95	121	120
	0.079	87	111	137	136
	0.109	119	143	169	168
	0.138	152	176	202	
	0.168	185	209	235	
84	0.064	77	102	130	130
	0.079	94	119	147	147
	0.109	128	154	182	181
	0.138	164	189	217	
	0.168	199	224	253	
90	0.064	82	109	140	139
	0.079	100	127	158	157
	0.109	137	164	195	194
	0.138	175	202	233	
	0.168	213	240	271	
96	0.064	87	116	149	148
	0.079	107	136	169	168
	0.109	147	176	209	208
	0.138	188	217	250	
	0.168	228	257	290	
102	0.064	93	124	158	158
	0.079	114	145	179	179
	0.109	155	186	220	222
	0.138	198	229	263	
	0.168	241	272	306	
108	0.079	120	153	188	189
	0.109	165	198	233	235
	0.138	211	244	279	
	0.168	256	289	324	
	0.079	127	162	199	200
114	0.109	174	209	246	248
	0.138	222	257	294	
	0.168	271	306	343	
	0.079	134	171	210	211
	0.109	183	220	259	260
120	0.138	234	271	310	
	0.168	284	321	360	
126	0.109	195	233	274	276
	0.138	247	285	326	
	0.168	299	338	378	
132	0.109	204	244	287	289
	0.138	259	299	342	
	0.168	314	354	397	
	0.109	213	255	300	300
138	0.138	270	312	357	
	0.168	328	370	415	
144	0.138	282	326	373	
	0.168	344	388	435	(2)

- Weights for polymer coated pipe are 1% to 4% higher, varying by gage.
- Please contact your Contech Sales Representative.
- Weights listed in the 3" x 1" or 5" x 1" table are for 3" x 1" pipe. Weights for 5" x 1" are approximately 12% less than those used in this table, for metallic coated pipe.

Corrugated Aluminum Pipe

Heights of Cover

2-2/3" X 1/2" Height of Cover Limits for Corrugated Aluminum Pipe

HL 93 Live Load

Diameter or Span (In.)	Minimum Cover (In.)	Maximum Cover, (Ft.) ⁽²⁾ Equiv. Standard Gage					
		18	16	14	12	10	8 ⁽⁵⁾
6 ⁽⁴⁾	12	197	247				
8 ⁽⁴⁾		147	185				
10 ⁽⁴⁾		119	148				
12			125	157			
15			100	125			
18			83	104			
21			71	89			
24			62	78	109		
27				69	97		
30				62	87		
36				51	73	94	
42					62	80	
48	12				54	70	85
54	15				48	62	76
60	15					52	64
66	18						52
72	18						43

2 2/3" x 1/2" Height of Cover Limits for Corrugated Aluminum Pipe-Arch

HL 93 Live Load

Round Pipe Dia. (Inches)	Size, (In.) Span x Rise	Minimum Gage	Minimum ⁽³⁾ Cover (Inches)	Maximum Cover, (Ft.) Aluminum Pipe-Arch ⁽²⁾ 2 Tons/Ft. ² for Corner Bearing Pressures
15	17x13	16	12	13
18	21x15	16	12	12
21	24x18	16	12	12
24	28x20	14	12	12
30	35x24	14	12	12
36	42x29	12	12	12
42	49x33	12	15	12
48	57x38	10	15	12
54	64x43	10	18	12
60	71x47	8 ⁽⁵⁾	18	12

Notes:

1. Height-of-cover is measured to top of rigid pavement or to bottom of flexible pavement.
2. Maximum cover meets AASHTO LRFD design criteria.
3. Minimum cover meets AASHTO and ASTM B 790 design criteria.
4. 1 1/2" x 1/4" corrugation.
5. 8-gage pipe has limited availability.
6. For construction loads, see page 15.

Heights of Cover

3" x 1" Height of Cover Limits for Corrugated Aluminum Pipe

HL 93 Live Load

Diameter or Span (In.)	Minimum ⁽³⁾ Cover (In.)	Maximum Cover, (Ft.) ⁽²⁾ Equiv. Standard Gage				
		16	14	12	10	8 ⁽⁶⁾
30	12	57	72	101	135	159
36		47	60	84	112	132
42		40	51	72	96	113
48	12	35	44	62	84	99
54	15	31	39	55	74	88
60	15	28	35	50	67	79
66	18	25	32	45	61	72
72	18	23	29	41	56	66
78	21		27	38	51	61
84	21			35	48	56
90	24			33	44	52
96	24			31	41	49
102	24				39	46
108	24				37	43
114	24					39
120	24					36

3" x 1" Height of Cover Limits for Corrugated Aluminum Pipe-Arch

HL 93 Live Load

Round Pipe Dia. (Inches)	Size, (In.) Span x Rise	Minimum Gage	Minimum ⁽³⁾ Cover (Inches)	Maximum Cover, (Ft.) Aluminum Pipe-Arch ⁽²⁾ 2 Tons/Ft. ² for Corner Bearing Pressures
54	60x46	14	15	20
60	66x51	14	18	20
66	73x55	14	21	20
72	81x59	12	21	16
78 ⁽⁴⁾	87x63	12	24	16
84 ⁽⁴⁾	95x67	12	24	16
90 ⁽⁴⁾	103x71	10	24	16
96 ⁽⁴⁾	112x75	8 ⁽⁵⁾	24	16

Notes:

1. Height-of-cover is measured to top of rigid pavement or to bottom of flexible pavement.
2. Maximum cover meets AASHTO LRFD design criteria.
3. Minimum cover meets ASTM B 790 design criteria.
4. Limited availability on these sizes.
5. 8-gage pipe has limited availability.
6. For construction loads, see page 15.

Approximate Weight/Foot Contech Corrugated Aluminum Pipe

(Estimated Average Weights—Not for Specification Use)

2 2/3" x 1 1/2" Corrugation Aluminum Pipe						
Diameter or Span (Inches)	Weight (Lb./Lineal Ft.)					
	Equiv. Standard Gage					
	(.048) 18	(.060) 16	(.075) 14	(.105) 12	(.135) 10	(.164) 8 ⁽³⁾
6 ⁽²⁾	1.3	1.6				
8 ⁽²⁾	1.7	2.1				
10 ⁽²⁾	2.1	2.6				
12		3.2	4.0			
15		4.0	4.9			
18		4.8	5.9			
21		5.6	6.9			
24		6.3	7.9	10.8		
27			8.8	12.2		
30			9.8	13.5		
36			11.8	16.3	20.7	
42				19.0	24.2	
48				21.7	27.6	33.5
54				24.4	31.1	37.7
60					34.6	41.9
66						46.0
72						50.1

3" x 1" Corrugation Aluminum Pipe					
Diameter or Span (Inches)	Weight (Lb./Lineal Ft.)				
	Equiv. Standard Gage				
	(.060) 16	(.075) 14	(.105) 12	(.135) 10	(.164) 8 ⁽³⁾
30	9.3	11.5	15.8	20.2	
36	11.1	13.7	18.9	24.1	
42	12.9	16.0	22.0	28.0	
48	14.7	18.2	25.1	32.0	38.8
54	16.5	20.5	28.2	35.9	43.6
60	18.3	22.7	31.3	40.0	48.3
66	20.2	24.9	34.3	43.7	53.0
72	22.0	27.1	37.4	47.6	57.8
78		29.3	40.4	51.5	62.5
84			43.5	55.4	67.2
90			46.6	59.3	71.9
96			49.6	63.2	76.7
102				66.6	80.8
108				71.0	86.1
114					90.9
120					95.6

Notes:

1. Helical lockseam pipe only. Annular riveted pipe weights will be higher.
2. 1 1/2" x 1/4" Corrugation.
3. 8-gage pipe has limited availability.



ULTRA FLO®

Heights of Cover

**Galvanized, ALUMINIZED STEEL Type 2 or
Polymer Coated** Steel ULTRA FLO H 20 and H 25 Live Load**

Diameter (Inches)	Minimum/Maximum Cover (Feet) Specified Thickness and Gage			
	(0.064) 16	(0.079) 14	(0.109) 12	(0.138) 10
18	1.0/108	1.0/151		
21	1.0/93	1.0/130	1.0/216	
24	1.0/81	1.0/113	1.0/189	
30	1.0/65	1.0/91	1.0/151	
36	1.0/54	1.0/75	1.0/126	
42	1.0/46	1.0/65	1.0/108	
48	1.0/40	1.0/56	1.0/94	1.0/137
54	1.25/36	1.25/50	1.0/84	1.0/122
60	1.25*/32*	1.25/45	1.0/75	1.0/109
66		1.5/41	1.25/68	1.25/99
72		1.5*/37*	1.25/63	1.25/91
78		1.75*/34*	1.5/58	1.5/84
84			1.75/54	1.75/78
90			2.0*/50*	2.0/73
96			2.0*/47*	2.0/68
102			2.5*/43*	2.5/61
108				2.5*/54*
114				2.5*/49*
120				2.5*/43*

**Galvanized, ALUMINIZED STEEL Type 2 or
Polymer Coated** Steel ULTRA FLO E 80 Live Load**

Diameter (Inches)	Minimum/Maximum Cover (Feet) Specified Thickness and Gage			
	(0.064) 16	(0.079) 14	(0.109) 12	(0.138) 10
18	1.0 / 93	1.0 / 130		
21	1.0 / 79	1.0 / 111	1.0 / 186	
24	1.0 / 69	1.0 / 97	1.0 / 162	
30	1.0 / 55	1.0 / 78	1.0 / 130	
36	1.5 / 46	1.25 / 65	1.0 / 108	
42	1.5 / 39	1.5 / 55	1.25 / 93	
48	2.0 / 34	1.75 / 48	1.5 / 81	1.5 / 118
54	3.0* / 28*	2.0 / 43	1.5 / 72	1.5 / 104
60		2.0 / 39	1.75 / 65	1.75 / 94
66		2.5* / 35*	2.0 / 58	2.0 / 85
72			2.0 / 49	2.0 / 78
78			2.5 / 42	2.5 / 72
84			2.75* / 35*	2.5 / 67
90				2.5 / 62
96				2.5* / 58*
102				3.0* / 52*

Notes:

- The tables for Steel H 20 and H 25 loading are based on the NCSPA CSP Design Manual, 2008 and were calculated using a load factor of K=0.86. The tables for Steel E 80 loading are based on the AREMA Manual. The tables for Aluminum HL 93 loading are based on AASHTO LRFD Design Criteria.
- The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.
- E 80 minimum cover is measured from top of pipe to bottom of tie.
- H 20, H 25 and HL 93 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
- The H 20, H 25 and HL 93 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
- The E 80 pipe-arch tables minimum and maximum covers are based on 3 tons per square foot corner bearing pressures shown.
- Larger size pipe-arches may be available on special order.
- M.L. (Heavier gage is required to prevent crimping at the haunches.)
- For construction loads, see Page 15.
- Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.

**Galvanized, ALUMINIZED STEEL Type 2 or
Polymer Coated** Steel ULTRA FLO Pipe-Arch H 20 and H 25 Live Load**

Equiv. Pipe Dia. (Inches)	Span (Inches)	Rise (Inches)	Minimum/Maximum Cover (Feet) Specified Thickness and Gage		
			(0.064) 16	(0.079) 14	(0.109) 12
18	20	16	1.0/16		
21	23	19	1.0/15		
24	27	21	1.0/13		
30	33	26	1.0/13	1.0/13	
36	40	31	1.0/13	1.0/13	
42	46	36	M.L. ⁸	M.L. ⁸	1.0/13
48	53	41	M.L. ⁸	M.L. ⁸	1.25/13
54	60	46	M.L. ⁸	M.L. ⁸	1.25/13
60	66	51	M.L. ⁸	M.L. ⁸	1.25/13

**Galvanized, ALUMINIZED STEEL Type 2 or
Polymer Coated** Steel ULTRA FLO Pipe-Arch E 80 Live Load**

Span x Rise (Inches)	Round Equivalent	Minimum Cover (Inches)	Minimum Gage	Max Cover (Feet)
20x16	18	24	16	22
23x19	21	24	16	21
27x21	24	24	16	18
33x26	30	24	16	18
40x31	36	24	16	17
46x36	42	24	12	18
53x41	48	24	12	18
60x46	54	24	12	18
66x51	60	24	12	18



ULTRA FLO can be manufactured from polymer coated steel for added durability.

- All heights of cover are based on trench conditions. If embankment conditions exist, there may be restriction on gages for the large diameters. Your Contech Sales Representative can provide further guidance for a project in embankment conditions.
 - All steel ULTRA FLO is installed in accordance with ASTM A798 "Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications."
- * These sizes and gage combinations are installed in accordance with ASTM A796 paragraphs 18.2.3 and ASTM A798. For aluminum ULTRA FLO refer to ASTM B790 and B788.
- ** Contact your local Contech representative for more specific information on Polymer Coated ULTRA FLO for gages 12 and 10.

Heights of Cover

Aluminum ULTRA FLO HL 93 Live Load

Diameter (Inches)	Minimum/Maximum Cover (Feet) Specified Thickness and Gage			
	(0.060) 16	(0.075) 14	(0.105) 12	(0.135) 10
18	1.0/43	1.0/61		
21	1.0/38	1.0/52	1.0/84	
24	1.0/33	1.0/45	1.0/73	
30	1.0/26	1.25/36	1.25/58	
36	1.5*/21*	1.50/30	1.5/49	1.5/69
42		1.75*/25*	1.75/41	1.75/59
48			2.0/36	2.0/51
54			2.0/32	2.0/46
60			2.0*/29*	2.0/41
66				2.0/37
72				2.5*/34*

See previous page for height of cover notes.

Aluminum ULTRA FLO Pipe-Arch HL 93 Live Load

Equiv. Pipe Dia. (Inches)	Span (Inches)	Rise (Inches)	Minimum/Maximum Cover (Feet) Specified Thickness and Gage			
			(0.060) 16	(0.075) 14	(0.105) 12	(0.135) 10
18	20	16	1.0/16			
21	23	19	1.0/15			
24	27	21	1.25/13	1.25/13		
30	33	26	1.5/13	1.5/13	1.5/13	
36	40	31		1.75/13	1.75/13	
42	46	36			2.0/13	2.0/13
48	53	41			2.0/13	2.0/13
54	60	46			2.0*/13*	2.0/13
60	66	51				2.0/13

Approximate Weight/Foot Contech ULTRA FLO Pipe

Handling Weight for ALUMINIZED STEEL Type 2 or Galvanized Steel ULTRA FLO

Diameter (Inches)	Weight (Pounds/Lineal Foot) Specified Thickness and Gage			
	(0.064) 16	(0.079) 14	(0.109) 12	(0.138) 10
18	15	18		
21	17	21	29	
24	19	24	36	
30	24	30	42	
36	29	36	50	
42	33	42	58	
48	38	48	66	80
54	45	54	75	90
60	48	60	83	99
66		66	91	109
72		72	99	119
78		78	108	129
84			116	139
90			124	149
96			132	158
102			141	168
108				175
114				196
120				206

Handling Weight for ALUMINUM ULTRA FLO

Diameter (Inches)	Weight (Pounds/Lineal Foot) Specified Thickness and Gage			
	(0.060) 16	(0.075) 14	(0.105) 12	(0.135) 10
18	5	6		
21	6	8	11	
24	7	9	13	
30	9	11	15	
36	11	13	18	23
42	12	15	21	26
48		17	24	30
54		19	27	34
60			30	37
66			33	41
72			36	45
78				49
84				52

Weights for polymer coated pipe are 1% to 4% higher, varying by gage.



ULTRA FLO is available in long lengths. And, its light weight allows it to be unloaded and handled with small equipment.



Reduced excavation because of ULTRA FLO's smaller outside diameter.

Installation Corrugated Metal Pipe

Overview

Satisfactory site preparation, trench excavation, bedding and backfill operations are essential to develop the strength of any flexible conduit. In order to obtain proper strength while preventing settlement, it is necessary that the soil envelope around the pipe be of good granular material, properly placed and carefully compacted.

Bedding

Bedding preparation is critical to both pipe performance and service life. The bed should be constructed to uniform line and grade to avoid distortions that may create undesirable stresses in the pipe and/or rapid deterioration of the roadway. The bed should be free of rock formations, protruding stones, frozen lumps, roots and other foreign matter that may cause unequal settlement.

Placing the pipe

Corrugated metal pipe weighs much less than other commonly used drainage structures. This is due to the efficient strength of the metal, further improved with carefully designed and formed corrugations. Even the heaviest sections of Contech pipe can be handled with relatively light equipment compared with equipment required for much heavier reinforced concrete pipe.

Backfill

Satisfactory backfill material, proper placement and compaction are key factors in obtaining maximum strength and stability. Backfill should be a well-graded granular material and should be free of large stones, frozen lumps and other debris.

Backfill materials should be placed in layers about six inches deep, deposited alternately on opposite sides of the pipe. Each layer should be compacted carefully. Select backfill is placed and compacted until minimum cover height is reached, at which point, standard road embankment backfill procedures are used.

Installation References

For more information, see AASHTO Bridge Construction Specification Section 26, the Installation Manual of the National Corrugated Steel Pipe Association, ASTM A798 for steel and ASTM B788 for aluminum ULTRA FLO.

Additional Considerations for ULTRA FLO Installations

Bedding and Backfill

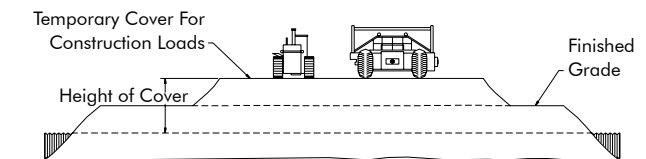
Typical ULTRA FLO installation requirements are the same as for any other corrugated metal pipe installed in a trench. Bedding and backfill materials for ULTRA FLO follow the requirements of the CMP installation specifications mentioned above, and must be free from stones, frozen lumps or other debris. When ASTM A796 (steel) or B790 (aluminum) designs are to be followed for condition III requirements, indicated by asterisk (*) in the tables on page 13 and 14, use clean, easily compacted granular backfill materials.

Embankment Conditions

ULTRA FLO is a superior CMP storm sewer product that is normally installed in a trench condition. In those unusual embankment installation conditions, pipe sizes and gages may be restricted. Your Contech Sales Representative can provide you with further guidance.

Construction Loads

For temporary construction vehicle loads, an extra amount of compacted cover may be required over the top of the pipe. The Height of Cover shall meet minimum requirements shown in the table below. The use of heavy construction equipment necessitates greater protection for the pipe than finished grade cover minimums for normal highway traffic.



Min. Height of Cover Requirements for Construction Loads On Corrugated Steel Pipe*

Diameter/ Span, (Inches)	Minimum Cover (feet) for Indicated Axle Loads (kips)			
	18-50	50-75	75-110	110-150
12-42	2.0	2.5	3.0	3.0
48-72	3.0	3.0	3.5	4.0
78-120	3.0	3.5	4.0	4.0
126-144	3.5	4.0	4.5	4.5

Min. Height of Cover Requirements for Construction Loads On Corrugated Aluminum Pipe*

Diameter/ Span (Inches)	Axle Load (Kips)			
	18-50	50-75	75-110	110-150
12-42	3.0'	3.5'	4.0'	4.0'
48-72	4.0'	4.0'	5.0'	5.5'
78-120	4.0'	5.0'	5.5'	5.5'

Min. Height of Cover Requirements for Construction Loads On ULTRA FLO Pipe*

Diameter/ Span (Inches)	Axle Load (Kips)			
	18-50	50-75	75-110	110-150
Steel 3/4" x 3/4" x 7-1/2"				
15-42	2.0'	2.5'	3.0'	3.0'
48-72	3.0'	3.0'	3.5'	4.0'
78-108	3.0'	3.5'	4.0'	4.5'
Aluminum 3/4" x 3/4" x 7-1/2"				
15-42	3.0'	3.5'	4.0'	4.0'

* Minimum cover may vary depending on local conditions. The contractor must provide the additional cover required to avoid damage to the pipe. Minimum cover is measured from the top of the pipe to the top of the maintained construction roadway surface.

SmoothCor™ Pipe

Excellent Hydraulics, Long Lengths and Easy Installation

Corrugated Steel Shell

SmoothCor pipe has a smooth interior steel liner that provides a Manning’s “n” of 0.012. Its rugged, corrugated steel shell supplies the structural strength to outperform rigid pipe. SmoothCor pipe is both the economical and performance alternate to concrete.

Superior hydraulics

SmoothCor, with its smooth interior surface, is hydraulically superior to conventional corrugated steel pipe and with fewer joints and better interior surface, outperforms reinforced concrete pipe.

SmoothCor, with its long lengths, light weight and beam strength, is superior to concrete pipe in many difficult situations such as poor soils, poor subsurface drainage conditions, steep slopes and high fills. SmoothCor should be specified as an alternate under normal site conditions, and specified exclusively under very difficult situations that demand the strength of CSP with positive joints and a hydraulically efficient smooth liner.

Two Pipe Shapes

In addition to full-round pipe, SmoothCor comes in a pipe-arch shape for limited headroom conditions. The low, wide pipe-arch design distributes the flow area horizontally, enabling it to be installed with lower head room than a round pipe.

Reference specifications

Material	Polymer Coated	ASTM A 929 AASHTO M246 ASTM A 742
Pipe	Polymer	AASHTO M245 ASTM A 762 & A 760
Design	Steel Pipe	AASHTO Section 12 ASTM A 796
Installation	Steel Pipe	AASHTO Section 26 ASTM A 798

Structural Design

SmoothCor is lined with either 18 or 20 gage steel. Contech has taken a conservative approach to the Height of Cover. The maximum heights-of-cover are based on the shell thickness with no additional structural allowance for the liner as provided for in the AASHTO and ASTM design specifications. Using this approach, the Height of Cover tables for 2 2/3" x 1/2" and 3"x1" steel corrugations can be used for SmoothCor.

Diameters

SmoothCor is available in diameters ranging from 18 inches to 66 inches in 2 2/3" x 1/2" corrugation. The 3" x 1" corrugation is available in diameters of 48 inches to 126 inches.

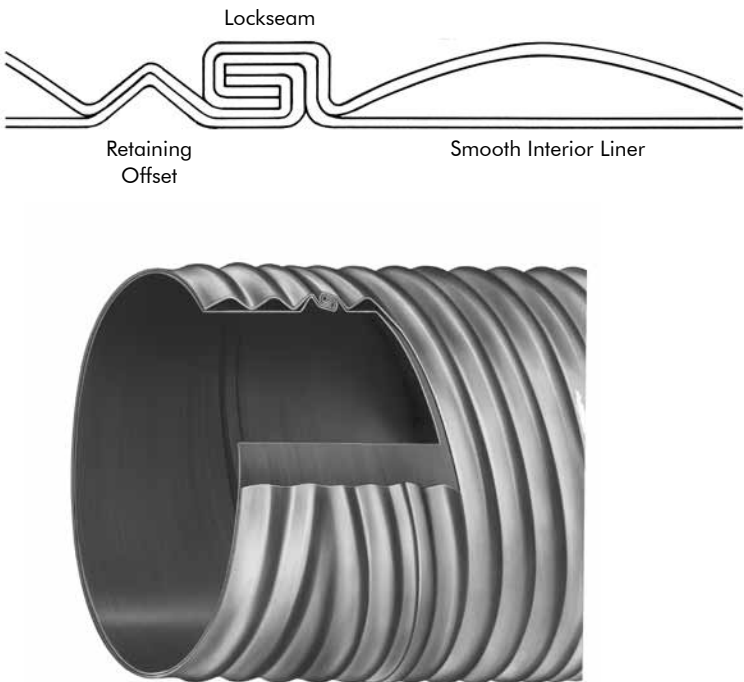
Pipe-arch sizes range from 21" x 15" through 77" x 52" for 2 2/3" x 1/2" corrugations, and 53" x 41" through 137" x 87" for 3"x1" corrugations.

Materials

SmoothCor is available with Dow's TRENCHCOAT® that allows the engineer to design for long service life. TRENCHCOAT is a tough, heavy-gage polymer film laminated to both sides of the steel coil, providing a barrier to corrosion and mild abrasion. TRENCHCOAT is particularly effective for protection in corrosive soils.

Fittings

SmoothCor can be fabricated into any type of structure including tees, elbows, laterals, catch basins, manifolds and reducers. Pre-fabricated fittings are more economical and have superior hydraulic characteristics when compared to concrete structures.



QUICK STAB® Joint

Save Time and Money With Faster Pipe Bell and Spigot Coupling

The Contech QUICK STAB Bell and Spigot joint speeds installation of corrugated metal pipe (CMP), reducing your costs. With the QUICK STAB coupling system, installation of CMP storm sewers and culverts has never been easier or faster.

The QUICK STAB joint creates a bell and spigot joining system with the bell only 1-1/2" larger than the pipe's O.D. Assembled at the factory, the QUICK STAB bell is shipped to the job site ready for installation. The only field operation is placing a special fluted gasket onto the spigot end of the pipe, applying lubricant and pushing it into the bell end of the preceding pipe. Without bands, bolts and wrenches to work and worry with, you can join pipe segments 50% to 90% faster—saving time, money and aggravation.

Soil Tight Joint

Contech's QUICK STAB joint provides the same soil tightness as conventional CMP bands. Each QUICK STAB joint uses a double sealing fluted gasket to seal the spigot against the bell. A flat gasket is installed at the plant between the pipe and the corrugated end of the bell. With the deep bell, you gain maximum soil tightness with minimal installation effort.

Wide Variety of Coatings and Materials

- Plain galvanized
- Aluminized Steel Type 2
- Aluminum
- Polymeric coated

Four Times Faster Installation Than Concrete

The QUICK STAB's bell and spigot joining system allows pipe segments to be joined quicker than reinforced concrete pipe. Next, add in Contech's corrugated metal pipe's length advantage—each segment is four times longer than standard concrete pipe lengths. That means fewer joints and faster installation—up to four times faster! Plus, with the bell only 1-1/2" larger than the pipe, trench excavation is considerably less compared with concrete—again, saving time and money.

Field Installation Instructions

The spigot and bell ends must be cleaned of any dirt or debris prior to assembly. The fluted gasket shall be placed in the first corrugation with the lower flute nearest the end of the pipe. The bell & gasket shall be thoroughly lubed just

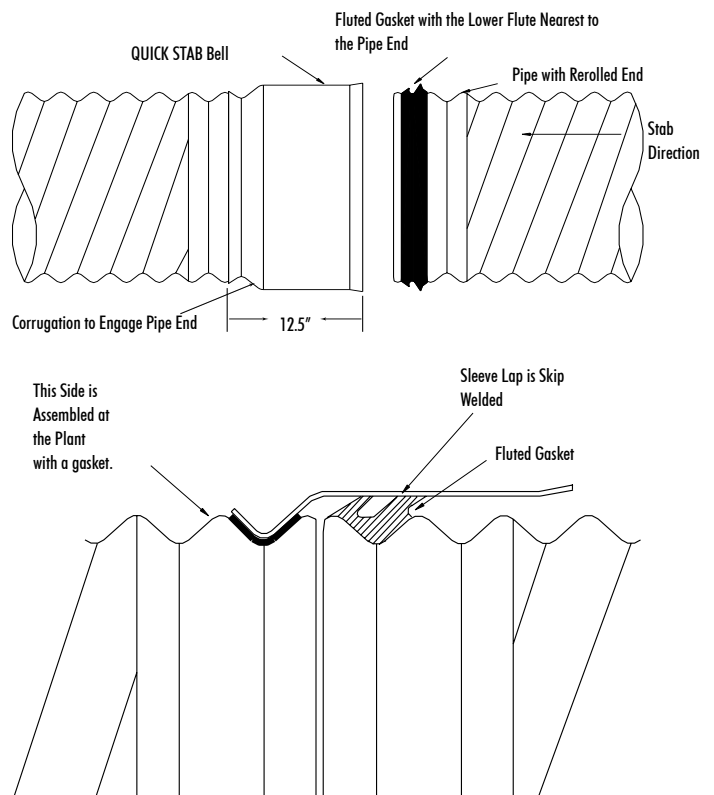
before stabbing in the bell. Do not place hands, fingers, or any other body parts between bell and spigot during assembly. If it is necessary to pull the joint apart, the bell, spigot and gasket shall be inspected and cleaned of any dirt or debris prior to re-stabbing.

Corrugated Metal Pipe Bell and Spigot Joint Specification

The joints shall be of such design and the ends of the corrugated metal pipe sections so formed that the pipe can be laid together to make a continuous line of pipe. The joint shall be made from the same material as the pipe and shall prevent infiltration of the fill material.



Bell and Spigot Coupling System for CMP



The Bell and Spigot joint is available on ULTRA FLO and 2-2/3" x 1/2" corrugation in 15" through 60" diameter.

End Sections

Easily installed, easily maintained culvert end treatments for corrugated metal pipe, reinforced concrete pipe and HDPE Pipe

Contech End Sections provide a practical, economical and hydraulically superior method of finishing a variety of culvert materials.

The lightweight, flexible metal construction of Contech End Sections creates an attractive, durable and erosion-preventing treatment for all sizes of culvert inlets and outlets. They can be used with corrugated metal pipe having either annular or helical corrugations, and both reinforced concrete and plastic pipes. End sections can be salvaged when lengthening or relocating the culvert.

Standard End Sections are fabricated from pregalvanized steel. For added corrosion resistance, Aluminized Type II or Aluminum End Sections are available in smaller sizes. Special End Sections for multiple pipe installations may be available on a specific inquiry basis.

Better hydraulics

Flow characteristics are greatly improved by the exacting design of Contech End Sections. Scour and sedimentation conditions are improved, and headwater depth can be better controlled. Culverts aligned with the stream flow and finished with Contech End Sections generally require no additional hydraulic controls.

Improved appearance

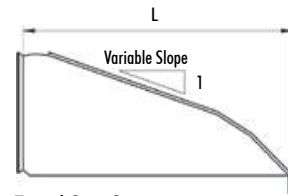
Contech End Sections blend well with the surroundings. The tapered sides of an End Section merge with slope design to improve roadside appearance. Unsightly weeds and debris collection at the culvert end are reduced.

Economical installation

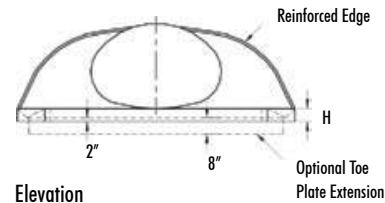
Lightweight equipment and simple crew instructions result in smooth and easy installation. Contech End Sections are easily joined to culvert barrels, forming a continuous, one-piece structure. For easiest installation, End Sections should be installed at the same time as the culvert. Installation is completed by tamping soil around the End Section.

Low maintenance

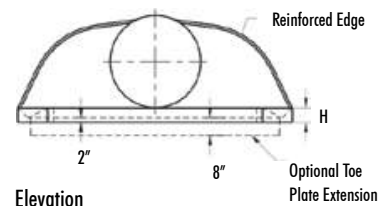
Contech End Sections reduce maintenance expense because their tapered design promotes easier mowing and snow removal. There is no obstruction to hamper weed cutting.



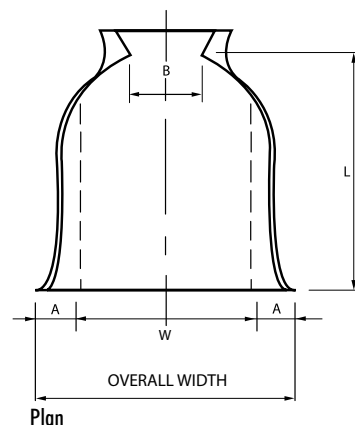
Typical Cross Section



Elevation



Elevation



Plan

Notes for all End Sections:

1. All three-piece bodies to have 12-gage sides and 10-gage center panels. Multiple panel bodies to have lap seams which are to be tightly joined by galvanized rivets or bolts.
2. For 60" through 84" sizes, reinforced edges are supplemented with stiffener angles. The angles are attached by galvanized nuts and bolts. For the 66" and 72" equivalent round pipe-arch sizes, reinforced edges are supplemented by angles. The angles are attached by galvanized nuts and bolts.
3. Angle reinforcements are placed under the center panel seams on the 66" and 72" equivalent round pipe-arch sizes.
4. Toe plate is available as an accessory, when specified on the order, and will be same gage as the End Section.
5. Stiffener angles, angle reinforcement, and toe plates are the same base metal as end section body.
6. End sections with 6:1 and 4:1 slopes are available in 12" through 24" diameters.
7. Actual dimensions may vary slightly.
8. During manufacturing, a slight invert slope may result along the length of the end section to be accommodated in the field.

End Sections for Round Pipe (2-2/3" x 1/2", 3" x 1" and 5" x 1")

Pipe Diameter (Inches)	Gage	Approximate Dimensions, Inches ⁽⁷⁾					
		A (+/- 1") (Inches)	B (Max) (Inches)	H (Min) (Inches)	L (+/- 2") (Inches)	W (+/- 2") (Inches)	Overall Width (+/- 4") (Inches)
12	16	6	6	6	21	24	36
15	16	7	8	6	26	30	44
18	16	8	10	6	31	36	52
21	16	9	12	6	36	42	60
24	16	10	13	6	41	48	68
30	14	12	16	8	51	60	84
36	14	14	19	9	60	72	100
42	12	16	22	11	69	84	116
48	12	18	27	12	78	90	126
54	12	18	30	12	84	102	138
60	12/10	18	33	12	87	114	150
66	12/10	18	36	12	87	120	156
72	12/10	18	39	12	87	126	162
78	12/10	18	42	12	87	132	168
84	12/10	18	45	12	87	138	174

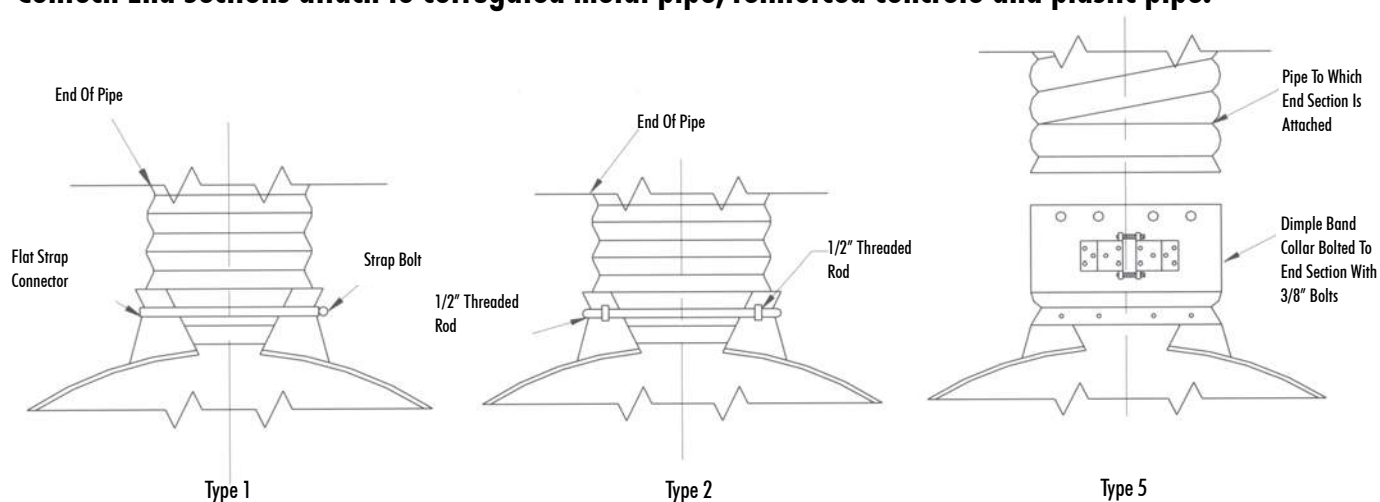
End Sections for Pipe-Arch (2-2/3" x 1/2")

Span/Rise	Equiv. Round (Inches)	Gage	Approximate Dimensions, Inches ⁽⁷⁾					
			A (+/- 1") (Inches)	B (Max) (Inches)	H (+/- 1") (Inches)	L (+/- 2") (Inches)	W (+/- 2") (Inches)	Overall Width (+/- 4") (Inches)
17"x13"	15	16	7	9	6	19	30	44
21"x15"	18	16	7	10	6	23	36	50
24"x18"	21	16	8	12	6	28	42	58
28"x20"	24	16	9	14	6	32	48	66
35"x24"	30	14	10	16	6	39	60	80
42"x29"	36	14	12	18	8	46	75	99
49"x33"	42	12	13	21	9	53	85	111
57"x38"	48	12	18	26	12	63	90	126
64"x43"	54	12	18	30	12	70	102	138
71"x47"	60	12/10	18	33	12	77	114	150
77"x52"	66	12/10	18	36	12	77	126	162
83"x57"	72	12/10	18	39	12	77	138	174

End Sections for Pipe-Arch (3" x 1" and 5" x 1")

Span/Rise	Equiv. Round (Inches)	Gage	Approximate Dimensions, Inches ⁽⁷⁾					
			A (+/- 1") (Inches)	B (Max) (Inches)	H (+/- 1") (Inches)	W (+/- 2") (Inches)	L (+/- 2") (Inches)	Overall Width (+/- 4") (Inches)
53"x41"	48	12	18	25	12	90	63	126
60"x46"	54	12	18	34	12	102	70	138
66"x51"	60	12/10	18	33	12	116	77	152
73"x55"	66	12/10	18	36	12	126	77	162
81"x59"	72	12/10	18	39	12	138	77	174
87"x63"	78	12/10	20	38	12	148	77	188
95"x67"	84	12/10	20	34	12	162	87	202
103"x71"	90	12/10	20	38	12	174	87	214
112"x75"	96	12/10	20	40	12	174	87	214

Contech End Sections attach to corrugated metal pipe, reinforced concrete and plastic pipe.



Note: The Type 3 connection is not illustrated. This connection is a one-foot length of pipe attached to the end section.



End Section on Round CSP



End Sections are available for CSP
Pipe-Arch



Contech End Sections are often used
on concrete pipe. They can be used
on both the bell and spigot end.



Low-slope End Sections—Contech manufactures
4:1 and 6:1 low-slope End Sections for
corrugated metal pipe. This photo shows the
optional field-attached safety bars.

Contech Engineered Solutions LLC is a leading provider of site solution products and services for the civil engineering industry. Contech's product portfolio includes bridges, drainage, retaining walls, sanitary sewer, stormwater, erosion control, soil stabilization and wastewater products.

For more information, call one of Contech's Regional Offices located in the following cities:

Ohio (Corporate Office) 513-645-7000

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BIO CLEAN SCREENING FILTER WITH TROUGH SYSTEM

FOR USE IN CURB INLETS

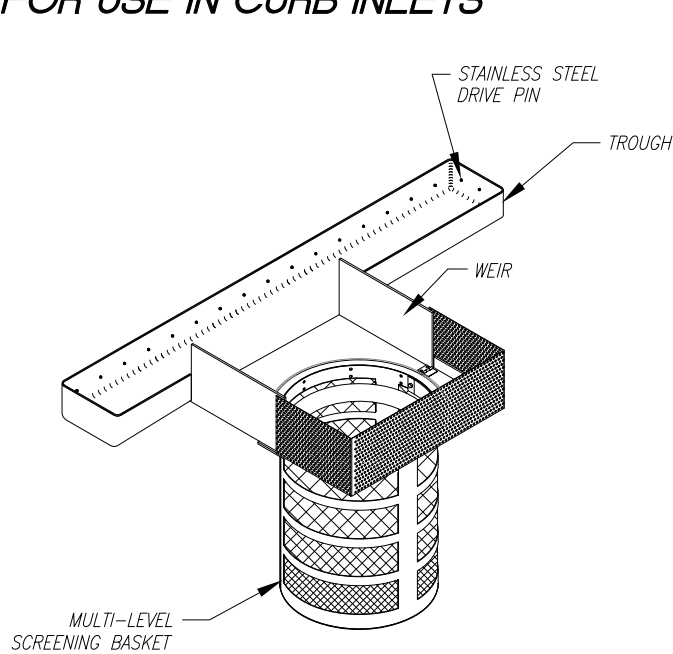


FIGURE 1:
DETAIL OF PARTS

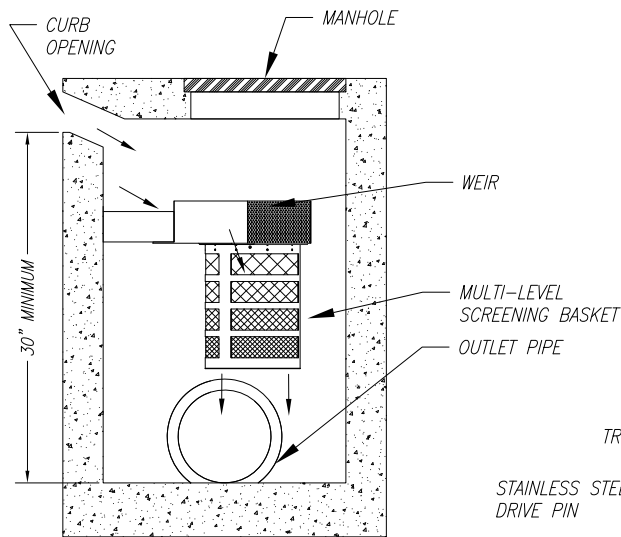


FIGURE 4:
DETAIL OF PROFILE

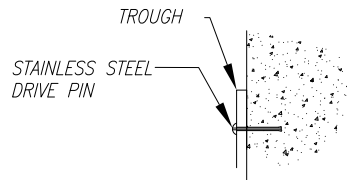


FIGURE 3:
DETAIL OF MOUNTING

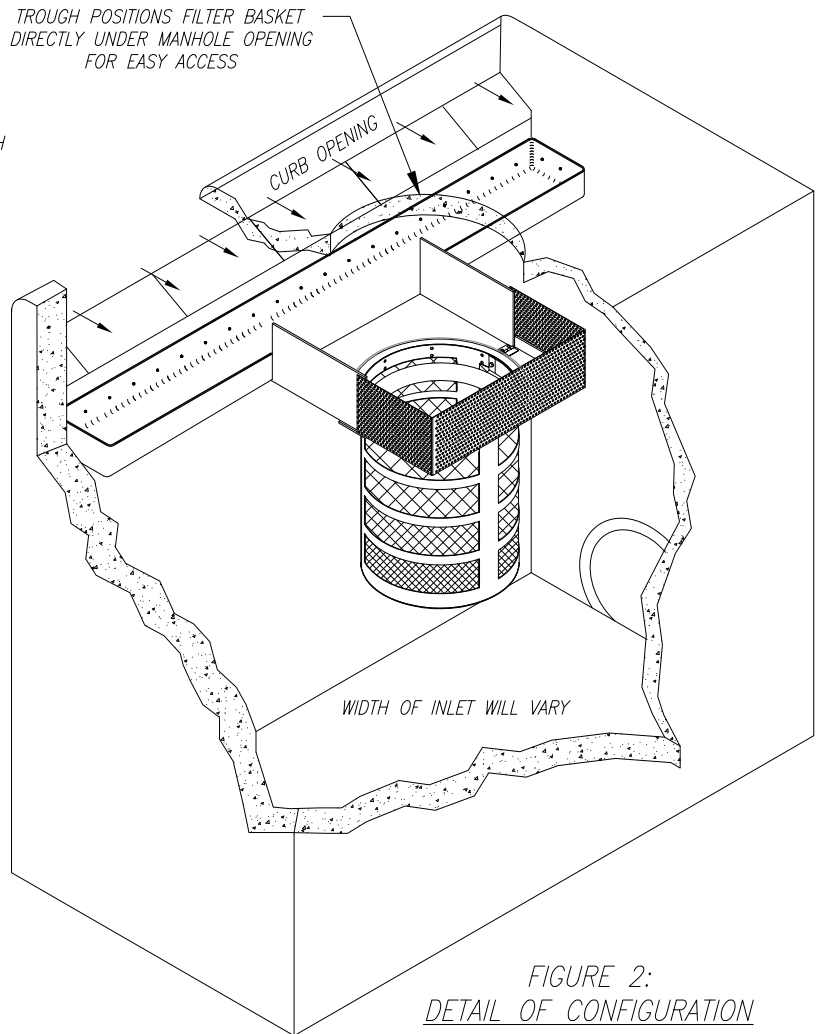


FIGURE 2:
DETAIL OF CONFIGURATION

NOTES:

1. TROUGH SYSTEM PROVIDES FOR ENTIRE COVERAGE OF INLET OPENING SO TO DIVERT ALL FLOW TO FILTER.
2. TROUGH SYSTEM MANUFACTURED FROM MARINE GRADE FIBERGLASS, GEL COATED FOR UV PROTECTION.
3. SYSTEM ATTACHED TO THE CATCH BASIN WITH NON-CORROSIVE HARDWARE.
4. FILTER MANUFACTURED OF 100% STAINLESS STEEL.
5. FILTER MADE OF NON-CLOGGIN SCREEN WITH 4.7 MM OPENINGS AND MEETS FULL CAPTURE REQUIREMENTS.
6. FILTER CAN BE FITTED WITH HYDROCARBON ABSORBENT BOOM
7. FILTER IS LOCATED DIRECTLY UNDER THE MANHOLE FOR EASY REMOVAL AND MAINTENANCE.
8. LENGTH OF TROUGH CAN VARY FROM 2' TO 30'
9. OTHER STANDARD AND CUSTOM MODEL SIZES AVAILABLE - CONTACT BIO CLEAN FOR MORE INFORMATION.
10. CONSIDERS A SAFETY FACTOR OF 2.0
11. BYPASS IS FACILITATED VIA OVERFLOW OF THE TROUGH SYSTEM AND IS EQUAL TO THE CAPACITY OF THE CURB OPENING
12. STORAGE CAPACITY BASED ON THE BASKET HALF FULL.
13. ADDITIONAL TREATMENT AND STORAGE CAPACITY CAN BE ACHIEVED BY UTILIZING MULTIPLE FILTER BASKETS.

MODEL NUMBER	TREATMENT FLOW (cfs)*	SOLIDS STORAGE CAPACITY (cu ft)
BC-CURB-30	2.85	2.21
BC-CURB-24	2.85	1.77
BC-CURB-18	2.85	1.33
BC-CURB-12	2.81	0.88

*SEE PAGE 2 FOR EXPLANATION OF FLOW RATES

DRAWING: BIO CLEAN CURB INLET FILTER DETAILS	
TREATMENT FLOW RATE: 2.85 cfs	
WARRANTY: 5 YEAR MANUFACTURERS	
BIO CLEAN ENVIRONMENTAL SERVICES, INC. 398 VIA EL CENTRO, OCEANSIDE CA 92058 PHONE: 760-433-7640 FAX: 760-433-3176	
DATE: 10/12/2017	SCALE: NTS
DRAFTER: M.C.P.	UNITS = INCHES

MULTI-LEVEL SCREENING	
MODEL #: BC-CURB-MLS	
PROJECT:	
REVISIONS:	DATE:
REVISIONS:	DATE:
REVISIONS:	DATE:
REVISIONS:	DATE:

Bio Clean
A Forterra Company

Unit Hydrograph Analysis

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2004, Version 7.0

Study date 06/10/20

+++++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6145

KEYSTONE - RIALTO TOWNHOUSES
2 YEAR STORM EVENT - PROPOSED CONDITION
UNIT HYDROGRAPH STUDY
2213PUH2

Storm Event Year = 2

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 2		
4.45	1	0.64

Rainfall data for year 2
4.45 6 1.68

Rainfall data for year 2
4.45 24 3.10

+++++

***** Area-averaged max loss rate, Fm *****

SCS curve No.(AMCII)	SCS curve NO.(AMC 1)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
32.0	16.6	4.45	1.000	1.000	0.200	0.200

Area-averaged adjusted loss rate Fm (In/Hr) = 0.200

***** Area-Averaged low loss rate fraction, Yb *****

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC1)	S	Pervious Yield Fr
---------------	---------------	------------------	------------------	---	----------------------

0.89	0.200	32.0	16.6	15.50	0.000
3.56	0.800	98.0	98.0	0.20	0.925

Area-averaged catchment yield fraction, Y = 0.740
Area-averaged low loss fraction, Yb = 0.260
User entry of time of concentration = 0.124 (hours)
++++
Watershed area = 4.45(Ac.)
Catchment Lag time = 0.099 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 84.0054
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.200(In/Hr)
Average low loss rate fraction (Yb) = 0.260 (decimal)
VALLEY DEVELOPED S-Graph Selected
Computed peak 5-minute rainfall = 0.235(In)
Computed peak 30-minute rainfall = 0.482(In)
Specified peak 1-hour rainfall = 0.636(In)
Computed peak 3-hour rainfall = 1.154(In)
Specified peak 6-hour rainfall = 1.680(In)
Specified peak 24-hour rainfall = 3.100(In)

Rainfall depth area reduction factors:
Using a total area of 4.45(Ac.) (Ref: fig. E-4)

5-minute factor = 1.000	Adjusted rainfall = 0.235(In)
30-minute factor = 1.000	Adjusted rainfall = 0.482(In)
1-hour factor = 1.000	Adjusted rainfall = 0.636(In)
3-hour factor = 1.000	Adjusted rainfall = 1.154(In)
6-hour factor = 1.000	Adjusted rainfall = 1.680(In)
24-hour factor = 1.000	Adjusted rainfall = 3.100(In)

Unit Hydrograph
++++
Interval 'S' Graph Unit Hydrograph
Number Mean values ((CFS))

(K = 53.82 (CFS))

1	12.391	6.669
2	67.521	29.669
3	95.128	14.858
4	99.092	2.133
5	100.000	0.488

Total soil rain loss = 0.76(In)
Total effective rainfall = 2.34(In)
Peak flow rate in flood hydrograph = 7.68(CFS)

++++
24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	2.5	5.0	7.5	10.0
0+ 5	0.0002	0.02	Q				

0+10	0.0010	0.13	Q
0+15	0.0023	0.18	Q
0+20	0.0036	0.19	Q
0+25	0.0049	0.19	Q
0+30	0.0062	0.19	Q
0+35	0.0075	0.19	Q
0+40	0.0089	0.19	Q
0+45	0.0102	0.19	Q
0+50	0.0115	0.19	Q
0+55	0.0129	0.19	Q
1+ 0	0.0142	0.20	Q
1+ 5	0.0156	0.20	Q
1+10	0.0169	0.20	Q
1+15	0.0183	0.20	Q
1+20	0.0196	0.20	Q
1+25	0.0210	0.20	Q
1+30	0.0224	0.20	QV
1+35	0.0238	0.20	QV
1+40	0.0251	0.20	QV
1+45	0.0265	0.20	QV
1+50	0.0279	0.20	QV
1+55	0.0293	0.20	QV
2+ 0	0.0307	0.20	QV
2+ 5	0.0321	0.20	QV
2+10	0.0335	0.20	QV
2+15	0.0349	0.20	QV
2+20	0.0363	0.21	QV
2+25	0.0377	0.21	QV
2+30	0.0392	0.21	QV
2+35	0.0406	0.21	QV
2+40	0.0420	0.21	QV
2+45	0.0435	0.21	Q V
2+50	0.0449	0.21	Q V
2+55	0.0464	0.21	Q V
3+ 0	0.0478	0.21	Q V
3+ 5	0.0493	0.21	Q V
3+10	0.0507	0.21	Q V
3+15	0.0522	0.21	Q V
3+20	0.0537	0.21	Q V
3+25	0.0552	0.21	Q V
3+30	0.0566	0.22	Q V
3+35	0.0581	0.22	Q V
3+40	0.0596	0.22	Q V
3+45	0.0611	0.22	Q V
3+50	0.0626	0.22	Q V
3+55	0.0642	0.22	Q V
4+ 0	0.0657	0.22	Q V
4+ 5	0.0672	0.22	Q V
4+10	0.0687	0.22	Q V
4+15	0.0703	0.22	Q V
4+20	0.0718	0.22	Q V
4+25	0.0734	0.22	Q V
4+30	0.0749	0.23	Q V
4+35	0.0765	0.23	Q V
4+40	0.0781	0.23	Q V
4+45	0.0796	0.23	Q V
4+50	0.0812	0.23	Q V
4+55	0.0828	0.23	Q V
5+ 0	0.0844	0.23	Q V
5+ 5	0.0860	0.23	Q V
5+10	0.0876	0.23	Q V
5+15	0.0892	0.23	Q V
5+20	0.0908	0.24	Q V

5+25	0.0925	0.24	Q	V				
5+30	0.0941	0.24	Q	V				
5+35	0.0957	0.24	Q	V				
5+40	0.0974	0.24	Q	V				
5+45	0.0991	0.24	Q	V				
5+50	0.1007	0.24	Q	V				
5+55	0.1024	0.24	Q	V				
6+ 0	0.1041	0.24	Q	V				
6+ 5	0.1058	0.25	Q	V				
6+10	0.1075	0.25	Q	V				
6+15	0.1092	0.25	Q	V				
6+20	0.1109	0.25	Q	V				
6+25	0.1126	0.25	Q	V				
6+30	0.1143	0.25	Q	V				
6+35	0.1161	0.25	Q	V				
6+40	0.1178	0.25	Q	V				
6+45	0.1195	0.25	Q	V				
6+50	0.1213	0.26	Q	V				
6+55	0.1231	0.26	Q	V				
7+ 0	0.1249	0.26	Q	V				
7+ 5	0.1266	0.26	Q	V				
7+10	0.1284	0.26	Q	V				
7+15	0.1303	0.26	Q	V				
7+20	0.1321	0.26	Q	V				
7+25	0.1339	0.27	Q	V				
7+30	0.1357	0.27	Q	V				
7+35	0.1376	0.27	Q	V				
7+40	0.1394	0.27	Q	V				
7+45	0.1413	0.27	Q	V				
7+50	0.1432	0.27	Q	V				
7+55	0.1451	0.27	Q	V				
8+ 0	0.1470	0.28	Q	V				
8+ 5	0.1489	0.28	Q	V				
8+10	0.1508	0.28	Q	V				
8+15	0.1527	0.28	Q	V				
8+20	0.1547	0.28	Q	V				
8+25	0.1566	0.28	Q	V				
8+30	0.1586	0.29	Q	V				
8+35	0.1606	0.29	Q	V				
8+40	0.1626	0.29	Q	V				
8+45	0.1646	0.29	Q	V				
8+50	0.1666	0.29	Q	V				
8+55	0.1686	0.29	Q	V				
9+ 0	0.1706	0.30	Q	V				
9+ 5	0.1727	0.30	Q	V				
9+10	0.1748	0.30	Q	V				
9+15	0.1769	0.30	Q	V				
9+20	0.1789	0.30	Q	V				
9+25	0.1811	0.31	Q	V				
9+30	0.1832	0.31	Q	V				
9+35	0.1853	0.31	Q	V				
9+40	0.1875	0.31	Q	V				
9+45	0.1897	0.32	Q	V				
9+50	0.1918	0.32	Q	V				
9+55	0.1940	0.32	Q	V				
10+ 0	0.1963	0.32	Q	V				
10+ 5	0.1985	0.32	Q	V				
10+10	0.2008	0.33	Q	V				
10+15	0.2030	0.33	Q	V				
10+20	0.2053	0.33	Q	V				
10+25	0.2076	0.34	Q	V				
10+30	0.2100	0.34	Q	V				
10+35	0.2123	0.34	Q	V				

10+40	0.2147	0.34	Q	V			
10+45	0.2171	0.35	Q	V			
10+50	0.2195	0.35	Q	V			
10+55	0.2219	0.35	Q	V			
11+ 0	0.2243	0.36	Q	V			
11+ 5	0.2268	0.36	Q	V			
11+10	0.2293	0.36	Q	V			
11+15	0.2318	0.37	Q	V			
11+20	0.2344	0.37	Q	V			
11+25	0.2369	0.37	Q	V			
11+30	0.2395	0.38	Q	V			
11+35	0.2421	0.38	Q	V			
11+40	0.2448	0.38	Q	V			
11+45	0.2475	0.39	Q	V			
11+50	0.2502	0.39	Q	V			
11+55	0.2529	0.40	Q	V			
12+ 0	0.2557	0.40	Q	V			
12+ 5	0.2585	0.42	Q	V			
12+10	0.2618	0.47	Q	V			
12+15	0.2653	0.50	Q	V			
12+20	0.2688	0.51	Q	V			
12+25	0.2724	0.52	Q	V			
12+30	0.2760	0.52	Q	V			
12+35	0.2796	0.53	Q	V			
12+40	0.2833	0.54	Q	V			
12+45	0.2870	0.54	Q	V			
12+50	0.2908	0.55	Q	V			
12+55	0.2946	0.55	Q	V			
13+ 0	0.2985	0.56	Q	V			
13+ 5	0.3024	0.57	Q	V			
13+10	0.3063	0.57	Q	V			
13+15	0.3103	0.58	Q	V			
13+20	0.3144	0.59	Q	V			
13+25	0.3185	0.60	Q	V			
13+30	0.3227	0.61	Q	V			
13+35	0.3269	0.61	Q	V			
13+40	0.3312	0.62	Q	V			
13+45	0.3356	0.63	Q	V			
13+50	0.3400	0.64	Q	V			
13+55	0.3445	0.65	Q	V			
14+ 0	0.3491	0.67	Q	V			
14+ 5	0.3538	0.68	Q	V			
14+10	0.3585	0.69	Q	V			
14+15	0.3634	0.70	Q	V			
14+20	0.3684	0.72	Q	V			
14+25	0.3734	0.73	Q	V			
14+30	0.3786	0.75	Q	V			
14+35	0.3839	0.77	Q	V			
14+40	0.3893	0.79	Q	V			
14+45	0.3949	0.81	Q	V			
14+50	0.4006	0.83	Q	V			
14+55	0.4065	0.86	Q	V			
15+ 0	0.4126	0.89	Q	V			
15+ 5	0.4189	0.91	Q	V			
15+10	0.4254	0.95	Q	V			
15+15	0.4322	0.99	Q	V			
15+20	0.4393	1.03	Q	V			
15+25	0.4465	1.04	Q	V			
15+30	0.4530	0.94	Q	V			
15+35	0.4594	0.92	Q	V			
15+40	0.4663	1.01	Q	V			
15+45	0.4740	1.12	Q	V			
15+50	0.4829	1.29	Q	V			

15+55	0.4935	1.54		Q		V		
16+ 0	0.5078	2.08			Q	V		
16+ 5	0.5344	3.87				V		
16+10	0.5873	7.68			Q		V	Q
16+15	0.6184	4.52					V	
16+20	0.6307	1.78		Q			V	
16+25	0.6389	1.19		Q			V	
16+30	0.6463	1.08		Q			V	
16+35	0.6534	1.04		Q			V	
16+40	0.6601	0.96		Q			V	
16+45	0.6662	0.90		Q			V	
16+50	0.6720	0.84		Q			V	
16+55	0.6775	0.80		Q			V	
17+ 0	0.6827	0.76		Q			V	
17+ 5	0.6877	0.72		Q			V	
17+10	0.6925	0.70		Q			V	
17+15	0.6971	0.67		Q			V	
17+20	0.7016	0.65		Q			V	
17+25	0.7059	0.63		Q			V	
17+30	0.7101	0.61		Q			V	
17+35	0.7142	0.59		Q			V	
17+40	0.7181	0.58		Q			V	
17+45	0.7220	0.56		Q			V	
17+50	0.7258	0.55		Q			V	
17+55	0.7295	0.54		Q			V	
18+ 0	0.7331	0.53		Q			V	
18+ 5	0.7366	0.50		Q			V	
18+10	0.7396	0.44		Q			V	
18+15	0.7424	0.41		Q			V	
18+20	0.7451	0.39		Q			V	
18+25	0.7478	0.39		Q			V	
18+30	0.7504	0.38		Q			V	
18+35	0.7529	0.37		Q			V	
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18+45	0.7579	0.36		Q			V	
18+50	0.7603	0.35		Q			V	
18+55	0.7627	0.34		Q			V	
19+ 0	0.7650	0.34		Q			V	
19+ 5	0.7673	0.33		Q			V	
19+10	0.7696	0.33		Q			V	
19+15	0.7718	0.32		Q			V	
19+20	0.7740	0.32		Q			V	
19+25	0.7761	0.31		Q			V	
19+30	0.7783	0.31		Q			V	
19+35	0.7804	0.31		Q			V	
19+40	0.7824	0.30		Q			V	
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19+55	0.7885	0.29		Q			V	
20+ 0	0.7905	0.29		Q			V	
20+ 5	0.7924	0.28		Q			V	
20+10	0.7943	0.28		Q			V	
20+15	0.7962	0.28		Q			V	
20+20	0.7981	0.27		Q			V	
20+25	0.8000	0.27		Q			V	
20+30	0.8018	0.27		Q			V	
20+35	0.8036	0.26		Q			V	
20+40	0.8054	0.26		Q			V	
20+45	0.8072	0.26		Q			V	
20+50	0.8090	0.26		Q			V	
20+55	0.8107	0.25		Q			V	
21+ 0	0.8125	0.25		Q			V	
21+ 5	0.8142	0.25		Q			V	

21+10	0.8159	0.25	Q				V
21+15	0.8176	0.24	Q				V
21+20	0.8192	0.24	Q				V
21+25	0.8209	0.24	Q				V
21+30	0.8225	0.24	Q				V
21+35	0.8241	0.24	Q				V
21+40	0.8257	0.23	Q				V
21+45	0.8273	0.23	Q				V
21+50	0.8289	0.23	Q				V
21+55	0.8305	0.23	Q				V
22+ 0	0.8321	0.23	Q				V
22+ 5	0.8336	0.22	Q				V
22+10	0.8351	0.22	Q				V
22+15	0.8367	0.22	Q				V
22+20	0.8382	0.22	Q				V
22+25	0.8397	0.22	Q				V
22+30	0.8412	0.22	Q				V
22+35	0.8426	0.21	Q				V
22+40	0.8441	0.21	Q				V
22+45	0.8455	0.21	Q				V
22+50	0.8470	0.21	Q				V
22+55	0.8484	0.21	Q				V
23+ 0	0.8499	0.21	Q				V
23+ 5	0.8513	0.21	Q				V
23+10	0.8527	0.20	Q				V
23+15	0.8541	0.20	Q				V
23+20	0.8555	0.20	Q				V
23+25	0.8568	0.20	Q				V
23+30	0.8582	0.20	Q				V
23+35	0.8596	0.20	Q				V
23+40	0.8609	0.20	Q				V
23+45	0.8623	0.20	Q				V
23+50	0.8636	0.19	Q				V
23+55	0.8649	0.19	Q				V
24+ 0	0.8663	0.19	Q				V
24+ 5	0.8674	0.17	Q				V
24+10	0.8678	0.06	Q				V
24+15	0.8679	0.01	Q				V
24+20	0.8679	0.00	Q				V

Attachment C

Educational Material & BMP Fact Sheet

Help Protect Our Waterways!

Use these guidelines for Outdoor Cleaning Activities and Wash Water Disposal

Did you know that disposing of pollutants into the street, gutter, storm drain or body of water is **PROHIBITED** by law and can result in stiff penalties?

Best Management Practices

Waste wash water from Mechanics, Plumbers, Window/Power Washers, Carpet Cleaners, Car Washing and Mobile Detailing activities may contain significant quantities of motor oil, grease, chemicals, dirt, detergents, brake pad dust, litter and other materials.

Best Management Practices, or BMPs as they are known, are guides to prevent pollutants from entering the storm drains. *Each of us* can do our part to keep stormwater clean by using the suggested BMPs below:

Simple solutions for both light and heavy duty jobs:

Do...consider dry cleaning methods first such as a mop, broom, rag or wire brush. Always keep a spill response kit on site.

Do...prepare the work area before power cleaning by using sand bags, rubber mats, vacuum booms, containment pads or temporary berms to keep wash water away from the gutters and storm drains.

Do...use vacuums or other machines to remove and collect loose debris or litter before applying water.

Do...obtain the property owner's permission to dispose of *small amounts* of power washing waste water on to landscaped, gravel or unpaved surfaces.

Do...check your local sanitary sewer agency's policies on wash water disposal regulations before disposing of wash water into the sewer. (See list on reverse side)

Do...be aware that if discharging to landscape areas, soapy wash water may damage landscaping. Residual wash water may remain on paved surfaces to evaporate. Sweep up solid residuals and dispose of properly. Vacuum booms are another option for capturing and collecting wash water.

Do...check to see if local ordinances prevent certain activities.

Do not let...wash or waste water from sidewalk, plaza or building cleaning go into a street or storm drain.



Report illegal storm drain disposal
Call Toll Free
1-800-506-2555

Using Cleaning Agents

Try using biodegradable/phosphate-free products. They are easier on the environment, but don't confuse them with being toxic free. Soapy water entering the storm drain system can impact the delicate aquatic environment.



When cleaning surfaces with a *high-pressure washer* or *steam cleaner*, additional precautions should be taken to prevent the discharge of pollutants into the storm drain system. These two methods of surface cleaning can loosen additional material that can contaminate local waterways.

Think Water Conservation

Minimize water use by using high pressure, low volume nozzles. Be sure to check all hoses for leaks. Water is a precious resource, don't let it flow freely and be sure to shut it off in between uses.

Screening Wash Water

Conduct thorough dry cleanup before washing exterior surfaces, such as buildings and decks *with loose paint*, sidewalks or plaza areas. Keep debris from entering the storm drain after cleaning by first passing the wash water through a "20 mesh" or finer screen to catch the solid materials, then dispose of the mesh in a refuse container. Do not let the remaining wash water enter a street, gutter or storm drain.

Drain Inlet Protection & Collection of Wash Water

- Prior to any washing, block all storm drains with an impervious barrier such as sandbags or berms, or seal the storm drain with plugs or other appropriate materials.
- Create a containment area with berms and traps or take advantage of a low spot to keep wash water contained.
- Wash vehicles and equipment on grassy or gravel areas so that the wash water can seep into the ground.
- Pump or vacuum up all wash water in the contained area.

Concrete/Coring/Saw Cutting and Drilling Projects

Protect any down-gradient inlets by using dry activity techniques whenever possible. If water is used, minimize the amount of water used during the coring/drilling or saw cutting process. Place a barrier of sandbags and/or absorbent berms to protect the storm drain inlet or watercourse. Use a shovel or wet vacuum to remove the residue from the pavement. Do not wash residue or particulate matter into a storm drain inlet or watercourse.

Helpful telephone numbers and links:

Riverside County Stormwater Protection Partners

Flood Control District	(951) 955-1200
County of Riverside	(951) 955-1000
City of Banning	(951) 922-3105
City of Beaumont	(951) 769-8520
City of Calimesa	(909) 795-9801
City of Canyon Lake	(951) 244-2955
Cathedral City	(760) 770-0327
City of Coachella	(760) 398-4978
City of Corona	(951) 736-2447
City of Desert Hot Springs	(760) 329-6411
City of Eastvale	(951) 361-0900
City of Hemet	(951) 765-2300
City of Indian Wells	(760) 346-2489
City of Indio	(760) 391-4000
City of Lake Elsinore	(951) 674-3124
City of La Quinta	(760) 777-7000
City of Menifee	(951) 672-6777
City of Moreno Valley	(951) 413-3000
City of Murrieta	(951) 304-2489
City of Norco	(951) 270-5607
City of Palm Desert	(760) 346-0611
City of Palm Springs	(760) 323-8299
City of Perris	(951) 943-6100
City of Rancho Mirage	(760) 324-4511
City of Riverside	(951) 361-0900
City of San Jacinto	(951) 654-7337
City of Temecula	(951) 694-6444
City of Wildomar	(951) 677-7751

REPORT ILLEGAL STORM DRAIN DISPOSAL

1-800-506-2555 or e-mail us at
fcnpdes@rcflood.org

- Riverside County Flood Control and Water Conservation District
www.rcflood.org

Online resources include:

- California Storm Water Quality Association
www.casqa.org
- State Water Resources Control Board
www.waterboards.ca.gov
- Power Washers of North America
www.thepwna.org

Stormwater Pollution

What you should know for...

Outdoor Cleaning Activities and Professional Mobile Service Providers



Storm drain pollution prevention information for:

- Car Washing / Mobile Detailers
- Window and Carpet Cleaners
- Power Washers
- Waterproofers / Street Sweepers
- Equipment cleaners or degreasers and all mobile service providers

Do you know where street flows actually go?

Storm drains are NOT connected to sanitary sewer systems and treatment plants!

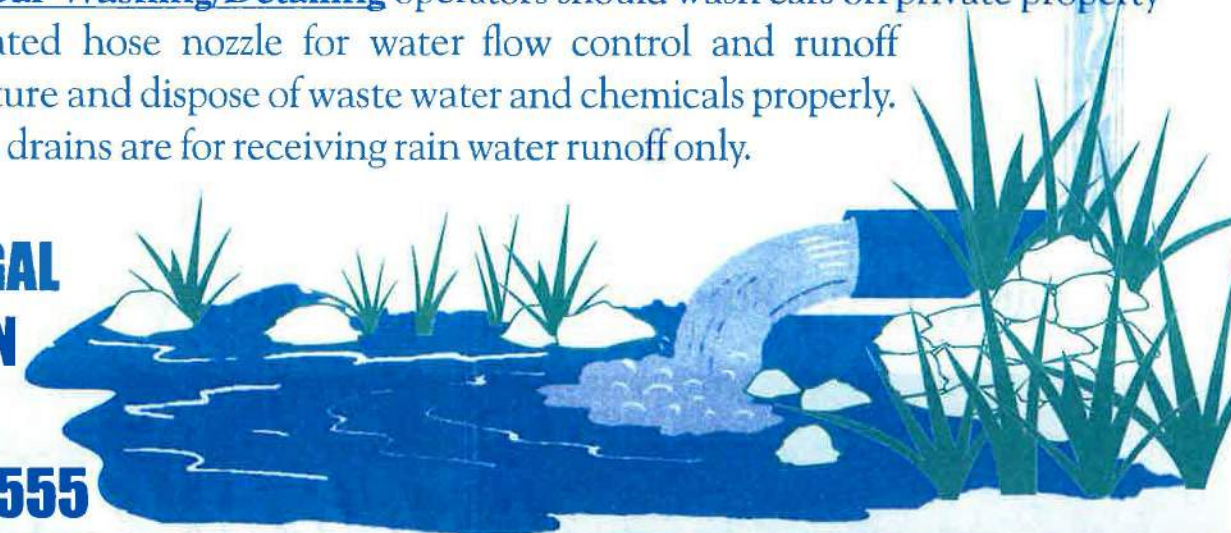


The primary purpose of storm drains is to carry rain water away from developed areas to prevent flooding. Pollutants discharged to storm drains are transported directly into rivers, lakes and streams. Soaps, degreasers, automotive fluids, litter and a host of materials are washed off buildings, sidewalks, plazas and parking areas. Vehicles and equipment must be properly managed to prevent the pollution of local waterways.

Unintentional spills by mobile service operators can flow into storm drains and pollute our waterways. **Avoid mishaps.** Always have a **Spill Response Kit** on hand to clean up unintentional spills. Only emergency **Mechanical** repairs should be done in City streets, using drip pans for spills. **Plumbing** should be done on private property. Always store chemicals in a leak-proof container and keep covered when not in use. **Window/Power Washing** waste water shouldn't be released into the streets, but should be disposed of in a sanitary sewer, landscaped area or in the soil. Soiled **Carpet Cleaning** wash water should be filtered before being discharged into the sanitary sewer. Dispose of all filter debris properly. **Car Washing/Detailing** operators should wash cars on private property and use a regulated hose nozzle for water flow control and runoff prevention. Capture and dispose of waste water and chemicals properly. Remember, storm drains are for receiving rain water runoff only.

REPORT ILLEGAL STORM DRAIN DISPOSAL

1-800-506-2555





A Citizen's Guide to Understanding Stormwater



EPA 833-B-03-002
January 2003
EPA
United States
Environmental Protection
Agency
For more information, contact:
www.epa.gov/nps
or visit
www.epa.gov/nps/stormwater

After the Storm



What is stormwater runoff?

Stormwater runoff occurs when precipitation from rain or snowmelt flows over the ground. Impervious surfaces like driveways, sidewalks, and streets prevent stormwater from naturally soaking into the ground.

The effects of pollution

Polluted stormwater runoff can have many adverse effects on plants, fish, animals, and people.

- ◆ Sediment can cloud the water and make it difficult or impossible for aquatic plants to grow. Sediment also can destroy aquatic habitats.
- ◆ Excess nutrients can cause algae blooms. When algae die, they sink to the bottom and decompose in a process that removes oxygen from the water. Fish and other aquatic organisms can't exist in water with low dissolved oxygen levels.
- ◆ Bacteria and other pathogens can wash into swimming areas and create health hazards, often making beach closures necessary.
- ◆ Debris—plastic bags, six-pack rings, bottles, and cigarette butts—washed into waterbodies can choke, suffocate, or disable aquatic life like ducks, fish, turtles, and birds.
- ◆ Household hazardous wastes like insecticides, pesticides, paint, solvents, used motor oil, and other auto fluids can poison aquatic life. Land animals and people can become sick or die from eating diseased fish and shellfish or ingesting polluted water.

Why is stormwater runoff a problem?

Stormwater can pick up debris, chemicals, dirt, and other pollutants and flow into a storm sewer system or directly to a lake, stream, river, wetland, or coastal water. Anything that enters a storm sewer system is discharged untreated into the waterbodies we use for swimming, fishing, and providing drinking water.

- ◆ Polluted stormwater often affects drinking water sources. This, in turn, can affect human health and increase drinking water treatment costs.

Stormwater Pollution Solutions

Residential

Recycle or properly dispose of household products that contain chemicals, such as insecticides, pesticides, paint, solvents, and used motor oil and other auto fluids. Don't pour them onto the ground or into storm drains.

Lawn care

Excess fertilizers and pesticides applied to lawns and gardens wash off and pollute streams. In addition, yard clippings and leaves can wash into storm drains and contribute nutrients and organic matter to streams.

- ◆ Don't overwater your lawn. Consider using a soaker hose instead of a sprinkler.
- ◆ Use pesticides and fertilizers sparingly. When use is necessary, use these chemicals in the recommended amounts. Use organic mulch or safer pest control methods whenever possible.
- ◆ Compost or mulch yard waste. Don't leave it in the street or sweep it into storm drains or streams.
- ◆ Cover piles of dirt or mulch being used in landscaping projects.



Septic systems

Leaking and poorly maintained septic systems release nutrients and pathogens (bacteria and viruses) that can be picked up by stormwater and discharged into nearby waterbodies. Pathogens can cause public health problems and environmental concerns.

- ◆ Inspect your system every 3 years and pump your tank as necessary (every 3 to 5 years).
- ◆ Don't dispose of household hazardous waste in sinks or toilets.



Auto care

Washing your car and degreasing auto parts at home can send detergents and other contaminants through the storm sewer system. Dumping automotive fluids into storm drains has the same result as dumping the materials directly into a waterbody.

- ◆ Use a commercial car wash that treats or recycles its wastewater, or wash your car on your yard so the water infiltrates into the ground.
- ◆ Repair leaks and dispose of used auto fluids and batteries at designated drop-off or recycling locations.



Pet waste

Pet waste can be a major source of bacteria and excess nutrients in local waters.

- ◆ When walking your pet, remember to pick up the waste and dispose of it properly. Flushing pet waste is the best disposal method. Leaving pet waste on the ground increases public health risks by allowing harmful bacteria and nutrients to wash into the storm drain and eventually into local waterbodies.



Residential landscaping

Permeable Pavement—Traditional concrete and asphalt don't allow water to soak into the ground. Instead these surfaces rely on storm drains to divert unwanted water. Permeable pavement systems allow rain and snowmelt to soak through, decreasing stormwater runoff.

Rain Barrels—You can collect rainwater from rooftops in mosquito-proof containers. The water can be used later on lawn or garden areas.

Rain Gardens and Grassy Swales—Specially designed areas planted with native plants can provide natural places for

rainwater to collect and soak into the ground. Rain from rooftop areas or paved areas can be diverted into these areas rather than into storm drains.



Vegetated Filter Strips—Filter strips are areas of native grass or plants created along roadways or streams. They trap the pollutants stormwater picks up as it flows across driveways and streets.



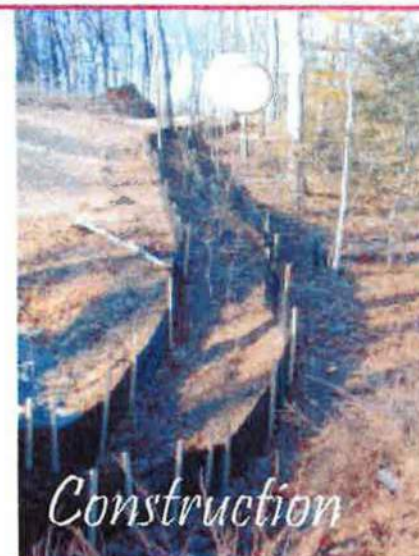
Commercial

Dirt, oil, and debris that collect in parking lots and paved areas can be washed into the storm sewer system and eventually enter local waterbodies.

- ◆ Sweep up litter and debris from sidewalks, driveways and parking lots, especially around storm drains.
- ◆ Cover grease storage and dumpsters and keep them clean to avoid leaks.
- ◆ Report any chemical spill to the local hazardous waste cleanup team. They'll know the best way to keep spills from harming the environment.

Erosion controls that aren't maintained can cause excessive amounts of sediment and debris to be washed into the stormwater system. Construction vehicles can leak fuel, oil, and other harmful fluids that can be picked up by stormwater and deposited into local waterbodies.

- ◆ Divert stormwater away from disturbed or exposed areas of the construction site.
- ◆ Install silt fences, vehicle mud removal areas, vegetative cover, and other sediment and erosion controls and properly maintain them, especially after rainstorms.
- ◆ Prevent soil erosion by minimizing disturbed areas during construction projects, and seed and mulch bare areas as soon as possible.



Construction



Agriculture

Lack of vegetation on streambanks can lead to erosion. Overgrazed pastures can also contribute excessive amounts of sediment to local waterbodies. Excess fertilizers and pesticides can poison aquatic animals and lead to destructive algae blooms. Livestock in streams can contaminate waterways with bacteria, making them unsafe for human contact.

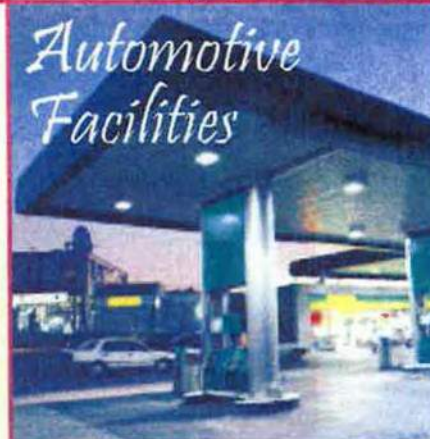
- ◆ Keep livestock away from streambanks and provide them a water source away from waterbodies.
- ◆ Store and apply manure away from waterbodies and in accordance with a nutrient management plan.
- ◆ Vegetate riparian areas along waterways.
- ◆ Rotate animal grazing to prevent soil erosion in fields.
- ◆ Apply fertilizers and pesticides according to label instructions to save money and minimize pollution.



Forestry

Improperly managed logging operations can result in erosion and sedimentation.

- ◆ Conduct preharvest planning to prevent erosion and lower costs.
- ◆ Use logging methods and equipment that minimize soil disturbance.
- ◆ Plan and design skid trails, yard areas, and truck access roads to minimize stream crossings and avoid disturbing the forest floor.
- ◆ Construct stream crossings so that they minimize erosion and physical changes to streams.
- ◆ Expedite revegetation of cleared areas.



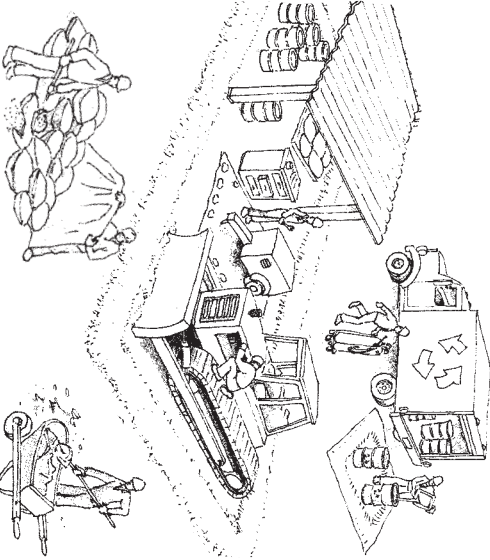
Automotive Facilities

Uncovered fueling stations allow spills to be washed into storm drains. Cars waiting to be repaired can leak fuel, oil, and other harmful fluids that can be picked up by stormwater.

- ◆ Clean up spills immediately and properly dispose of cleanup materials.
- ◆ Provide cover over fueling stations and design or retrofit facilities for spill containment.
- ◆ Properly maintain fleet vehicles to prevent oil, gas, and other discharges from being washed into local waterbodies.
- ◆ Install and maintain oil/water separators.

- ## Best Management Practices (BMPs) for:

 - Developers
 - General Contractors
 - Home Builders
 - Construction Inspectors
 - Anyone in the construction business



GENERAL CONSTRUCTION & SITE SUPERVISION

StormWater Pollution

What you should know for...

The StormWater/CleanWater Protection Program gratefully acknowledges the Santa Clara Valley Nonpoint Pollution Control Program, Alameda Countywide CleanWater Program and the City of Los Angeles Stormwater Management Division for information provided in this brochure.



To order additional brochures or to obtain information on other pollution prevention activities, please call (909) 955-1200 or visit the StormWater/CleanWater Protection Program website at:
www.co.riverside.ca.us/depts/flood/waterquality/index.asp

To report an illegal dumping or a clogged storm drain, call:

1-800-506-2555

For recycling and hazardous waste disposal, call:

Riverside County Hazardous Materials Emergency Response Team
(909) 358-5055 8:00 a.m. – 5:00 p.m.
(909) 358-5245 after 5:00 p.m.

In an emergency call: **911**

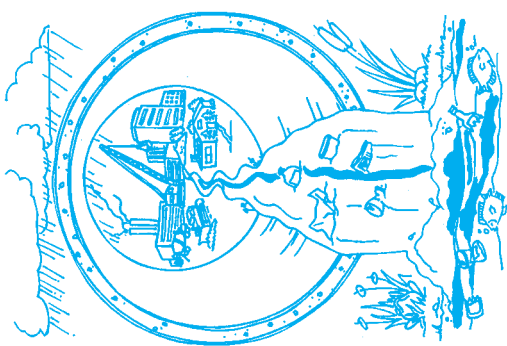
To report a hazardous materials spill, call:

StormWater Pollution . . . What You Should Know

Riverside County has two drainage systems - sewers and storm drains. The storm drain system was developed to reduce flooding by carrying excess rainwater away from streets and developed areas. Since the storm drain system does not provide the *unintended* function of transporting pollutants directly to our local waterways.

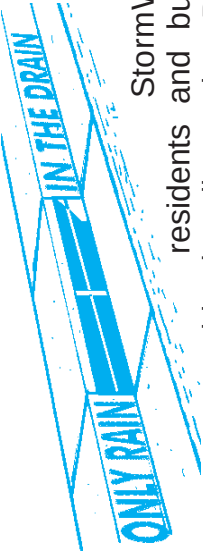
Unlike sanitary sewers, storm drains are not connected to a wastewater treatment plant – they flow directly to our local streams, rivers and lakes.

Stormwater runoff is a part of the natural hydrologic process. However, land development and construction activities can significantly alter natural drainage processes and introduce pollutants into stormwater runoff. Polluted stormwater runoff from construction sites has been identified as a major source of water pollution in California. It jeopardizes the quality of our local waterways and can pose a serious threat to the health of our aquatic ecosystems.



The Cities and County of Riverside StormWater/CleanWater Protection Program

Because preventing pollution is much easier and less costly than cleaning up “after the fact,” the Cities and County of Riverside StormWater/CleanWater Protection Program informs residents and businesses on pollution prevention activities. This pamphlet describes various Best Management Practices (BMPs) that construction site operators can use to prevent stormwater pollution.



In accordance with applicable federal and state law, the Cities and County of Riverside have adopted ordinances for stormwater management and discharge control that [prohibit](#) the discharge of pollutants into the storm drain system or local surface water. This includes discharges from construction sites containing sediment, concrete, mortar, paint, solvents, lubricants, vehicle fluids, fuel, pesticides, and construction debris.

PLEASE NOTE: The Federal, State and local regulations strictly prohibit the discharge of sediment and pollutants into the streets, the storm drain system or waterways. As an owner, operator or supervisor of a construction site, you may be held financially responsible for any environmental damage caused by your subcontractors or employees.

STORMWATER POLLUTION FROM CONSTRUCTION ACTIVITIES

The two most common sources of stormwater pollution problems associated with construction activities are **erosion** and **sedimentation**. Failure to maintain adequate erosion and sediment controls at construction sites often results in sediment discharges into the storm drain system, creating multiple problems once it enters local waterways.

Construction vehicles and heavy equipment can also track significant amounts of mud and sediment onto adjacent streets. Additionally, wind may transport construction materials and wastes into streets storm drains, or directly into our local waterways.



Resources

State Water Resources Control Board

Division of Water Quality
 1001 I Street
 Sacramento CA 95814
 (916) 341-5455
www.swrcb.ca.gov/stormwtr/

Colorado River Basin Regional Water Quality Control Board - Region 7
 73-720 Fred Waring Drive, Suite 100
 Palm Desert, CA 92260
 (760) 346-7491
www.swrcb.ca.gov/~rwqcb7/

Santa Ana Regional Water Quality Control Board - Region 8
 3737 Main Street, Suite 500
 Riverside, CA 92501-3348
 (909) 782-4130
www.swrcb.ca.gov/~rwqcb8/

San Diego Regional Water Quality Control Board - Region 9
 9771 Clairemont Mesa Blvd., Suite A
 San Diego, CA 92124
 (858) 467-2952
www.swrcb.ca.gov/~rwqcb9/

What Should You Do?

Advance Planning to Prevent Pollution

- ❑ Remove existing vegetation only as needed.
- ❑ Schedule excavation, grading, and paving operations for dry weather periods, if possible.
- ❑ Designate a specific area of the construction site, well away from storm drain inlets or watercourses, for material storage and equipment maintenance.
- ❑ Develop and implement an effective combination of erosion and sediment controls for the construction site.
- ❑ Practice source reduction by ordering only the amount of materials that are needed to finish the project.
- ❑ Educate your employees and subcontractors about stormwater management requirements and their pollution prevention responsibilities.
- ❑ Control the amount of surface runoff at the construction site by impeding internally generated flows and using berms or drainage ditches to direct incoming offsite flows to go around the site. *Note: Consult local drainage policies for more information.*

BEST MANAGEMENT PRACTICES

The following Best Management Practices (BMPs) can significantly reduce pollutant discharges from your construction site. Compliance with stormwater regulations can be as simple as minimizing stormwater contact with potential pollutants by providing covers and secondary containment for construction materials, designating areas away from storm drain systems for storing equipment and materials and implementing good housekeeping practices at the construction site.

- ❑ Protect all storm drain inlets and streams located near the construction site to prevent sediment-laden water from entering the storm drain system.
- ❑ Limit access to and from the site. Stabilize construction entrances/exits to minimize the track out of dirt and mud onto adjacent streets. Conduct frequent street sweeping.
- ❑ Protect stockpiles and construction materials from winds and rain by storing them under a roof, secured impermeable tarp or plastic sheeting.
- ❑ Avoid storing or stockpiling materials near storm drain inlets, gullies or streams.
- ❑ Phase grading operations to limit disturbed areas and duration of exposure.
- ❑ Perform major maintenance and repairs of vehicles and equipment offsite.
- ❑ Wash out concrete mixers only in designated washout areas at the construction site.
- ❑ Set-up and operate small concrete mixers on tarps or heavy plastic drop cloths.
- ❑ Keep construction sites clean by removing trash, debris, wastes, etc. on a regular basis.
- ❑ Clean-up spills immediately using dry clean-up methods (e.g., absorbent materials such as cat litter, sand or rags for liquid spills; sweeping for dry spills such as cement, mortar or fertilizer) and by removing the contaminated soil from spills on dirt areas. .
- ❑ Prevent erosion by implementing any or a combination of soil stabilization practices such as mulching, surface roughening, permanent or temporary seeding.
- ❑ Maintain all vehicles and equipment in good working condition. Inspect frequently for leaks, and repair promptly.
- ❑ Practice proper waste disposal. Many construction materials and wastes, including solvents, water-based paint, vehicle fluids, broken asphalt and concrete, wood, and cleared vegetation can be recycled. Materials that cannot be recycled must be taken to an appropriate landfill or disposed of as hazardous waste.
- ❑ Cover open dumpsters with secured tarps or plastic sheeting. Never clean out a dumpster by washing it down on the construction site.
- ❑ Arrange for an adequate debris disposal schedule to insure that dumpsters do not overflow.

GENERAL CONSTRUCTION ACTIVITIES STORMWATER PERMIT

(Construction Activities General Permit)

The State Water Resources Control Board (SWRCB) adopted a new Construction Activities General Permit (WQ Order No. 99-08DWQ) on August 19, 1999, superseding the now expired SWRCB statewide General Permit (WQ Order No. 92-08DWQ). This permit is administered and enforced by the SWRCB and the local Regional Water Quality Control Boards (RWQCB). The updated Construction Activities General Permit establishes a number of new stormwater management requirements for construction site operator.

***NOTE:** Some construction activies stormwater permits are issued on a regional basis. Consult your local RWQCB to find out if your project requires coverage under any of these permits.*

Frequently Asked Questions:

Does my construction site require coverage under the Construction Activities General Permit?

Yes, if construction activity results in the disturbance of five or more acres of total land area or is part of a common plan of development that results in the disturbance of five or more acres.

How do I obtain coverage under the Construction Activities General Permit?

Obtain the permit package and submit the completed Notice of Intent (NOI) form to the

SWRCB prior to grading or disturbing soil at the construction site. For ongoing construction activity involving a change of ownership, the new owner must submit a new NOI within 30 days of the date of change of ownership. The completed NOI along with the required fee should be mailed to the SWRCB.

What must I do to comply with the requirements of the Construction Activities General Permit?

- Implement BMPs for non-stormwater discharges year-round.
- Prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) prior to commencing construction activities.
- Keep a copy of the SWPPP at the construction site for the entire duration of the project.
- Calculate the anticipated stormwater run-off.
- Implement an effective combination of erosion and sediment control on all soil disturbed areas.
- Conduct site inspections prior to anticipated storm events, every 24-hours during extended storm events, and after actual storm event.
- Perform repair and maintenance of BMPs as soon as possible after storm events depending upon worker safety.

- Update the SWPPP as needed, to manage pollutants or reflect changes in site conditions.
- Include description of post construction BMPs at the construction site, including parties responsible for long-term maintenance.

***NOTE:** Please refer to the Construction Activities General Permit for detailed information. You may contact the SWRCB, your local RWQCB, or visit the SWRCB website at www.swrcb.ca.gov/stormwtr/ to obtain a State Construction Activities Stormwater General Permit packet.*

How long is this Construction Activities General Permit in effect?

The Permit coverage stays in effect until you submit a Notice of Termination (NOT) to the SWRCB. For the purpose of submitting a NOT, all soil disturbing activities have to be completed and one of the three following criteria has to be met:

1. Change of ownership;
2. A uniform vegetative cover with 70 percent coverage has been established; or,
3. Equivalent stabilization measures such as the use of reinforced channel liners, soil cement, fiber matrices, geotextiles, etc., have been employed.

For Information:

For more information on the General Industrial Storm Water Permit contact:

State Water Resources Control Board (SWRCB)
(916) 657-1146 or www.swrcb.ca.gov/ or, at your
Regional Water Quality Control Board (RWQCB).

Santa Ana Region (8)
California Tower
3737 Main Street, Ste. 500
Riverside, CA 92501-3339
(909) 782-4130

San Diego Region (9)
9771 Clairemont Mesa Blvd., Ste. A
San Diego, CA 92124
(619) 467-2952

Colorado River Basin Region (7)
73-720 Fred Waring Dr., Ste. 100
Palm Desert, CA 92260
(760) 346-7491

SPILL RESPONSE AGENCY:
HAZ-MAT: (909) 358-5055
HAZARDOUS WASTE DISPOSAL: (909) 358-5055
RECYCLING INFORMATION: 1-800-366-SAVE
**TO REPORT ILLEGAL DUMPING OR A CLOGGED
STORM DRAIN:** 1-800-506-2555

To order additional brochures or to obtain information
on other pollution prevention activities, call:
(909) 955-1111.



Riverside County gratefully acknowledges the State Water Quality Control Board and the American Public Works Association, Storm Water Quality Task Force for the information provided in this brochure.

DID YOU KNOW . . .

YOUR FACILITY MAY NEED A STORM WATER PERMIT?



Many industrial facilities
and manufacturing operations
must obtain coverage under the
Industrial Activities Storm Water
General Permit

***FIND OUT
IF YOUR FACILITY
MUST OBTAIN A PERMIT***

StormWater Pollution . . . What you should know

Riverside County has two drainage systems - sanitary sewers and storm drains. The storm drain system is designed to help prevent flooding by carrying excess rainwater away from streets. Since the storm drain system does not provide for water treatment, it also serves the *unintended* function of transporting pollutants directly to our waterways.

Unlike sanitary sewers, storm drains are not connected to a treatment plant - they flow directly to our local streams, rivers and lakes.

In recent years, awareness of the need to protect water quality has increased. As a result, federal, state, and local programs have been established to reduce polluted stormwater discharges to our waterways. The emphasis of these programs is to prevent stormwater pollution since it's much easier, and less costly, than cleaning up "after the fact."



National Pollutant Discharge Elimination System (NPDES)

In 1987, the Federal Clean Water Act was amended to establish a framework for regulating industrial stormwater discharges under the NPDES permit program. In California, NPDES permits are issued by the State Water Resources Control Board (SWRCB) and the nine (9) Regional Water Quality Control Boards (RWQCB). In general, certain industrial facilities and manufacturing operations must obtain coverage under the Industrial Activities Storm Water General Permit if the type of facilities or operations falls into one of the several categories described in this brochure.

How Do I Know If I Need A Permit?

Following are general descriptions of the industry categories types that are regulated by the Industrial Activities Storm Water General Permit. Contact your local Region Water Quality Control Board to determine if your facility/operation requires coverage under the Permit.

→ Facilities such as cement manufacturing; feedlots; fertilizer manufacturing; petroleum refining; phosphate manufacturing; steam electric power generation; coal mining; mineral mining and processing; ore mining and dressing; and asphalt emulsion;

→ Facilities classified as lumber and wood products (except wood kitchen cabinets); pulp, paper, and paperboard mills; chemical producers (except some pharmaceutical and biological products); petroleum and coal products; leather production and products; stone, clay and glass products; primary metal industries; fabricated structural metal; ship and boat building and repairing;

→ Active or inactive mining operations and oil and gas exploration, production, processing, or treatment operations;

→ Hazardous waste treatment, storage, or disposal facilities;

→ Landfills, land application sites and open dumps that receive or have received any industrial waste; unless there is a new overlying land use such as a golf course, park, etc., and there is no discharge associated with the landfill;

→ Facilities involved in the recycling of materials, including metal scrap yards, battery reclaimers, salvage yards, and automobile junkyards;

→ Steam electric power generating facilities, facilities that generate steam for electric power by combustion;

→ Transportation facilities that have vehicle maintenance shops, fueling facilities, equipment cleaning operations, or airport deicing operations. This includes school bus maintenance facilities operated by a school district;

→ Sewage treatment facilities;

→ Facilities that have areas where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water.

How do I obtain coverage under the Industrial Activities Storm Water General Permit?

Obtain a permit application package from your local Regional Water Quality Control Board listed on the back of this brochure or the State Water Resources Control Board (SWRCB). Submit a completed Notice of Intent (NOI) form, site map and the appropriate fee (\$250 or \$500) to the SWRCB. Facilities must submit an NOI thirty (30) days prior to beginning operation. Once you submit the NOI, the State Board will send you a letter acknowledging receipt of your NOI and will assign your facility a waste discharge identification number (WDID No.). You will also receive an annual fee billing. These billings should roughly coincide with the date the State Board processed your original NOI submittal.

What are the requirements of the Industrial Activities Storm Water General Permit?

The basic requirements of the Permit are:

1. The facility must eliminate any non-stormwater discharges or obtain a separate permit for such discharges.
2. The facility must develop and implement a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must identify sources of pollutants that may be exposed to stormwater. Once the sources of pollutants have been identified, the facility operator must develop and implement Best Management Practices (BMPs) to minimize or prevent polluted runoff.

Guidance in preparing a SWPPP is available from a document prepared by the California Storm Water Quality Task Force called the California Storm Water Best Management Practice Handbook.

3. The facility must develop and implement a Monitoring Program that includes conducting visual observations and collecting samples of the facility's storm water discharges associated with industrial activity. The General Permit requires that the analysis be conducted by a laboratory that is certified by the State of California.
4. The facility must submit to the Regional Board, every July 1, an annual report that includes the results of its monitoring program.

A Non-Storm Water Discharge is... any discharge to a storm drain system that is not composed entirely of storm water. The following non-storm water discharges are authorized by the General Permit: fire hydrant flushing; potable water sources, including potable water related to the operation, maintenance, or testing of potable water systems; drinking fountain water; atmospheric condensates including refrigeration, air conditioning, and compressor condensate; irrigation drainage; landscape watering; springs; non-contaminated ground water; foundation or footing drainage; and sea water infiltration where the sea waters are discharged back into the sea water source.

A BMP is . . . a technique, process, activity, or structure used to reduce the pollutant content of a storm water discharge. BMPs may include simple, non-structural methods such as good housekeeping, staff training and preventive maintenance. Additionally, BMPs may include structural modifications such as the installation of berms, canopies or treatment control (e.g. setting basins, oil/water separators, etc.)



WARNING: There are significant penalties for non-compliance: a minimum fine of \$5,000 for failing to obtain permit coverage, and, up to \$10,000 per day, per violation plus \$10 per gallon of discharge in excess of 1,000 gallons.



Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

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



SC-41 Building & Grounds Maintenance

- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

Suggested Protocols

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.
- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.

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- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Training

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the nature of the staff.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Other Considerations

Alternative pest/weed controls may not be available, suitable, or effective in many cases.

Requirements

Costs

- Cost will vary depending on the type and size of facility.
- Overall costs should be low in comparison to other BMPs.

Maintenance

Sweep paved areas regularly to collect loose particles. Wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

Building fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, polyphosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

California's Nonpoint Source Program Plan <http://www.swrcb.ca.gov/nps/index.html>

Clark County Storm Water Pollution Control Manual
<http://www.co.clark.wa.us/pubworks/bmpman.pdf>

King County Storm Water Pollution Control Manual <http://dnr.metrokc.gov/wlr/dss/spcm.htm>

Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASMAA). <http://www.basmaa.org/>

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). <http://www.basmaa.org/>

Santa Clara Valley Urban Runoff Pollution Prevention Program <http://www.scvurppp.org>

The Storm Water Managers Resource Center <http://www.stormwatercenter.net/>

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.



SD-10 Site Design & Landscape Planning

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

Site Design & Landscape Planning SD-10

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.

SD-10 Site Design & Landscape Planning

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.



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



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 $\frac{1}{4}$ to $\frac{1}{2}$ 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



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.



- 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.



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



– 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.



Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.

Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☒
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

- ☒ Primary Objective
- ☒ Secondary Objective

Targeted Constituents

Sediment	☒
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	☒
Organics	

Potential Alternatives

None



- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from \$58/hour (3 yd³ hopper) to \$88/hour (9 yd³ hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

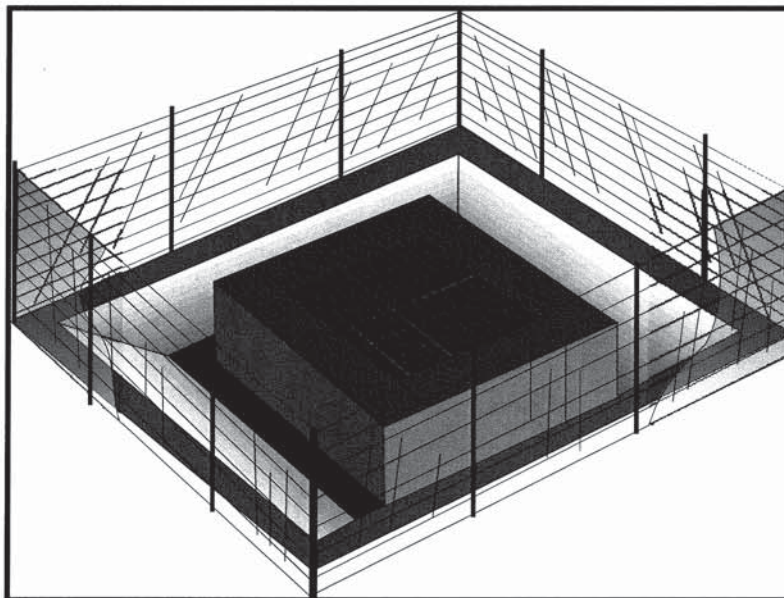
Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.



Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area in, around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle. Some filter configurations also remove sediment by filtering, but usually the ponding action results in the greatest sediment reduction. Temporary geotextile storm drain inserts attach underneath storm drain grates to capture and filter storm water.

Suitable Applications

Every storm drain inlet receiving runoff from unstabilized or otherwise active work areas should be protected. Inlet protection should be used in conjunction with other erosion and sediment controls to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.

Limitations

- Drainage area should not exceed 1 acre.
- In general straw bales should not be used as inlet protection.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.

Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

- ☒ Primary Category
- ☒ Secondary Category

Targeted Constituents

Sediment	☒
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

- SE-1 Silt Fence
- SE-5 Fiber Rolls
- SE-6 Gravel Bag Berm
- SE-8 Sandbag Barrier
- SE-14 Biofilter Bags



- Sediment removal may be inadequate to prevent sediment discharges in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use other onsite sediment trapping techniques in conjunction with inlet protection.
- Frequent maintenance is required.
- Limit drainage area to 1 acre maximum. For drainage areas larger than 1 acre, runoff should be routed to a sediment-trapping device designed for larger flows. See BMPs SE-2, Sediment Basin, and SE-3, Sediment Traps.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capability is needed.

Implementation

General

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through SE-2, Sediment Basin or SE-3, Sediment Trap and/or used in conjunction with other drainage control, erosion control, and sediment control BMPs to protect the site. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Alternative methods are available in addition to the methods described/shown herein such as prefabricated inlet insert devices, or gutter protection devices.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed and which method to use.

- The key to successful and safe use of storm drain inlet protection devices is to know where runoff that is directed toward the inlet to be protected will pond or be diverted as a result of installing the protection device.
 - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
 - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desired areas, and prevent or control diversions.

- Six types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.
 - Silt Fence: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.
 - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (SE-3).
 - Gravel bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5 cfs, and where overtopping is required to prevent flooding.
 - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
 - Temporary Geotextile Storm drain Inserts: Different products provide different features. Refer to manufacturer details for targeted pollutants and additional features.
 - Biofilter Bag Barrier: Used to create a small retention area upstream of inlets and can be located on pavement or soil. Biofilter bags slowly filter runoff allowing sediment to settle out. Appropriate for flows under 0.5 cfs.
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Provide area around the inlet for water to pond without flooding structures and property.
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed) 1 to 2 ft with 2:1 side slopes around the inlet.

Installation

- **DI Protection Type 1 - Silt Fence** - Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced and water flow through the grate will be blocked resulting in flooding. See typical Type 1 installation details at the end of this fact sheet.
 1. Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.
 2. Place 2 in. by 2 in. wooden stakes around the perimeter of the inlet a maximum of 3 ft apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes should be at least 48 in.
 3. Lay fabric along bottom of trench, up side of trench, and then up stakes. See SE-1, Silt Fence, for details. The maximum silt fence height around the inlet is 24 in.
 4. Staple the filter fabric (for materials and specifications, see SE-1, Silt Fence) to wooden stakes. Use heavy-duty wire staples at least 1 in. in length.

5. Backfill the trench with gravel or compacted earth all the way around.
- **DI Protection Type 2 - Excavated Drop Inlet Sediment Trap** - Install filter fabric fence in accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd³/acre of drainage area. See typical Type 2 installation details at the end of this fact sheet.
 - **DI Protection Type 3 - Gravel bag** - Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with SE-6, Gravel Bag Berm. Gravel bags should be used due to their high permeability. See typical Type 3 installation details at the end of this fact sheet.
 1. Construct on gently sloping street.
 2. Leave room upstream of barrier for water to pond and sediment to settle.
 3. Place several layers of gravel bags – overlapping the bags and packing them tightly together.
 4. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.
 - **DI Protection Type 4 – Block and Gravel Filter** - Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction. See typical Type 4 installation details at the end of this fact sheet.
 1. Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place woven geotextile over the wire mesh.
 2. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.
 3. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
 4. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.
 - **DI Protection Type 5 – Temporary Geotextile Insert (proprietary)** – Many types of temporary inserts are available. Most inserts fit underneath the grate of a drop inlet or inside of a curb inlet and are fastened to the outside of the grate or curb. These inserts are removable and many can be cleaned and reused. Installation of these inserts differs between manufacturers. Please refer to manufacturer instruction for installation of proprietary devices.

- **DI Protection Type 6 - Biofilter bags** – Biofilter bags may be used as a substitute for gravel bags in low-flow situations. Biofilter bags should conform to specifications detailed in SE-14, Biofilter bags.
 1. Construct in a gently sloping area.
 2. Biofilter bags should be placed around inlets to intercept runoff flows.
 3. All bag joints should overlap by 6 in.
 4. Leave room upstream for water to pond and for sediment to settle out.
 5. Stake bags to the ground as described in the following detail. Stakes may be omitted if bags are placed on a paved surface.

Costs

- Average annual cost for installation and maintenance of DI Type 1-4 and 6 (one year useful life) is \$200 per inlet.
- Temporary geotextile inserts are proprietary and cost varies by region. These inserts can often be reused and may have greater than 1 year of use if maintained and kept undamaged. Average cost per insert ranges from \$50-75 plus installation, but costs can exceed \$100. This cost does not include maintenance.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Silt Fences. If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes. At a minimum, remove the sediment behind the fabric fence when accumulation reaches one-third the height of the fence or barrier height.
- Gravel Filters. If the gravel becomes clogged with sediment, it should be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Inspect and maintain temporary geotextile insert devices according to manufacturer's specifications.
- Remove storm drain inlet protection once the drainage area is stabilized.

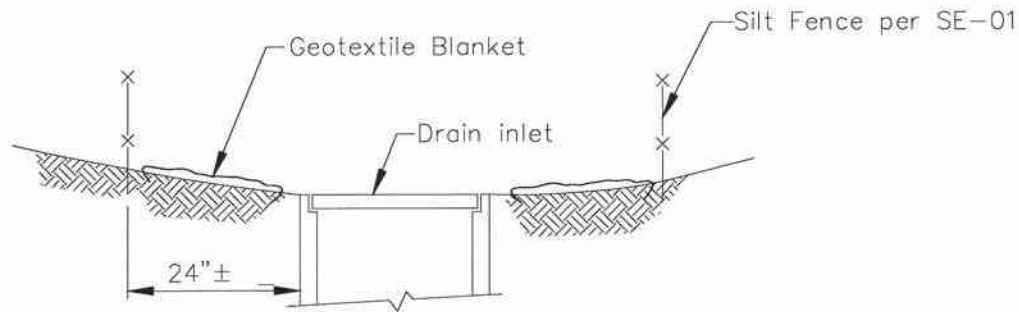
- Clean and regrade area around the inlet and clean the inside of the storm drain inlet, as it should be free of sediment and debris at the time of final inspection.

References

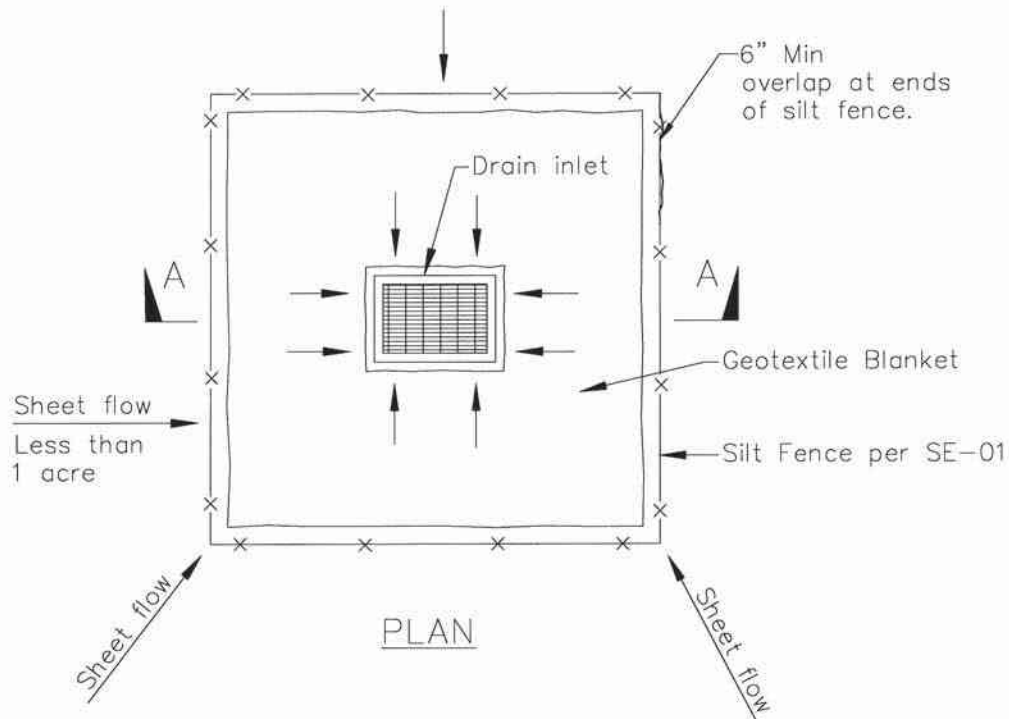
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



SECTION A-A

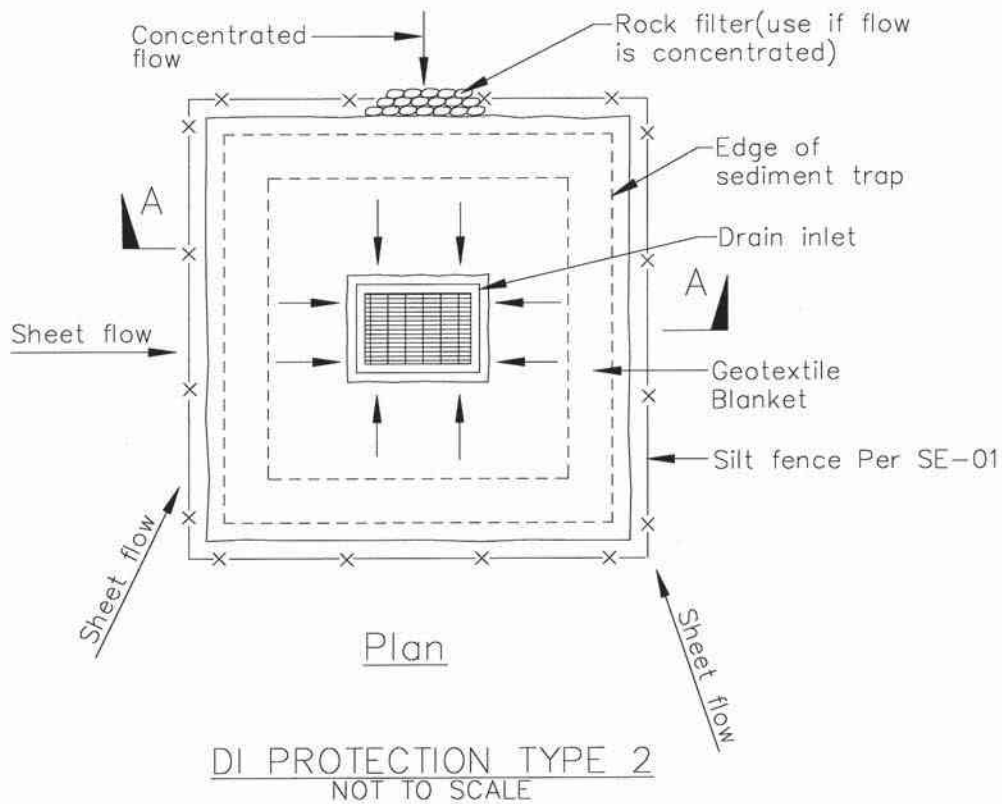
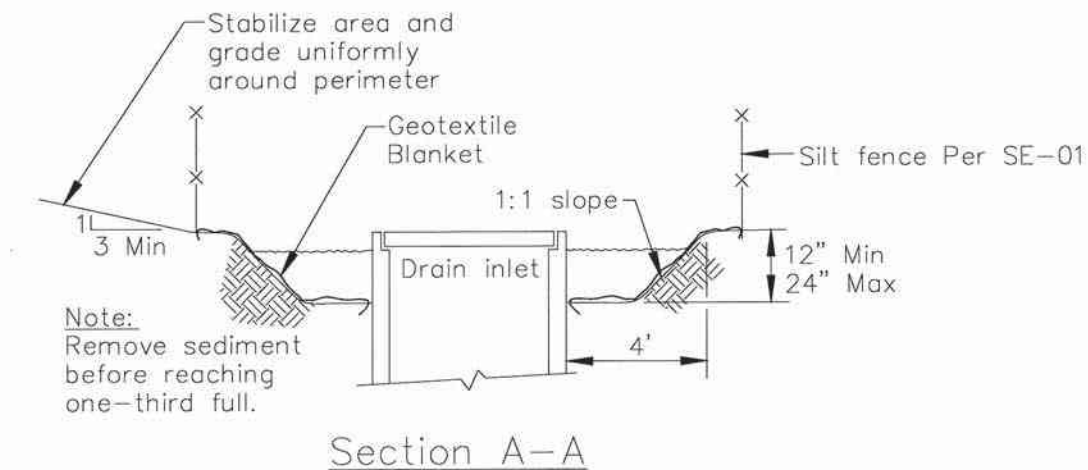


PLAN

DI PROTECTION TYPE 1
NOT TO SCALE

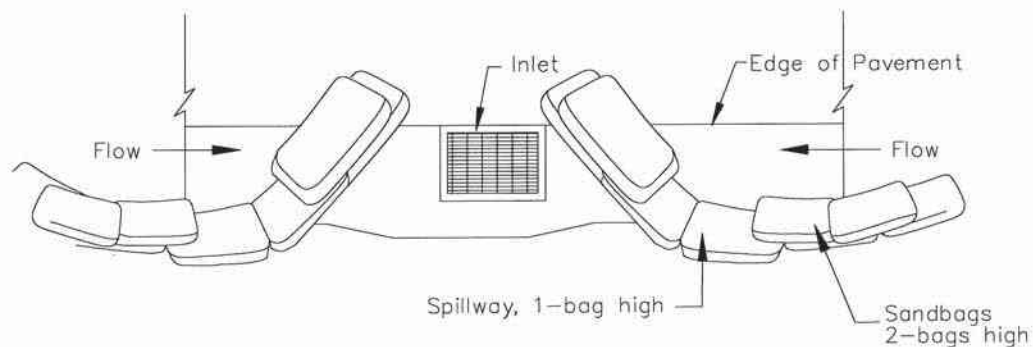
NOTES:

1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable with concentrated flows.

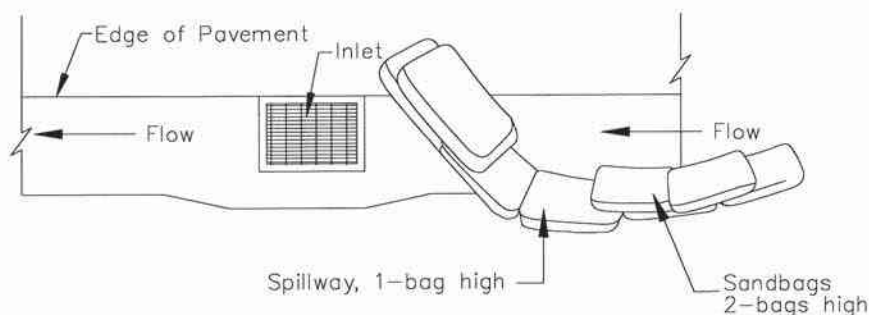


Notes

1. For use in cleared and grubbed and in graded areas.
2. Shape basin so that longest inflow area faces longest length of trap.
3. For concentrated flows, shape basin in 2:1 ratio with length oriented towards direction of flow.



TYPICAL PROTECTION FOR INLET ON SUMP

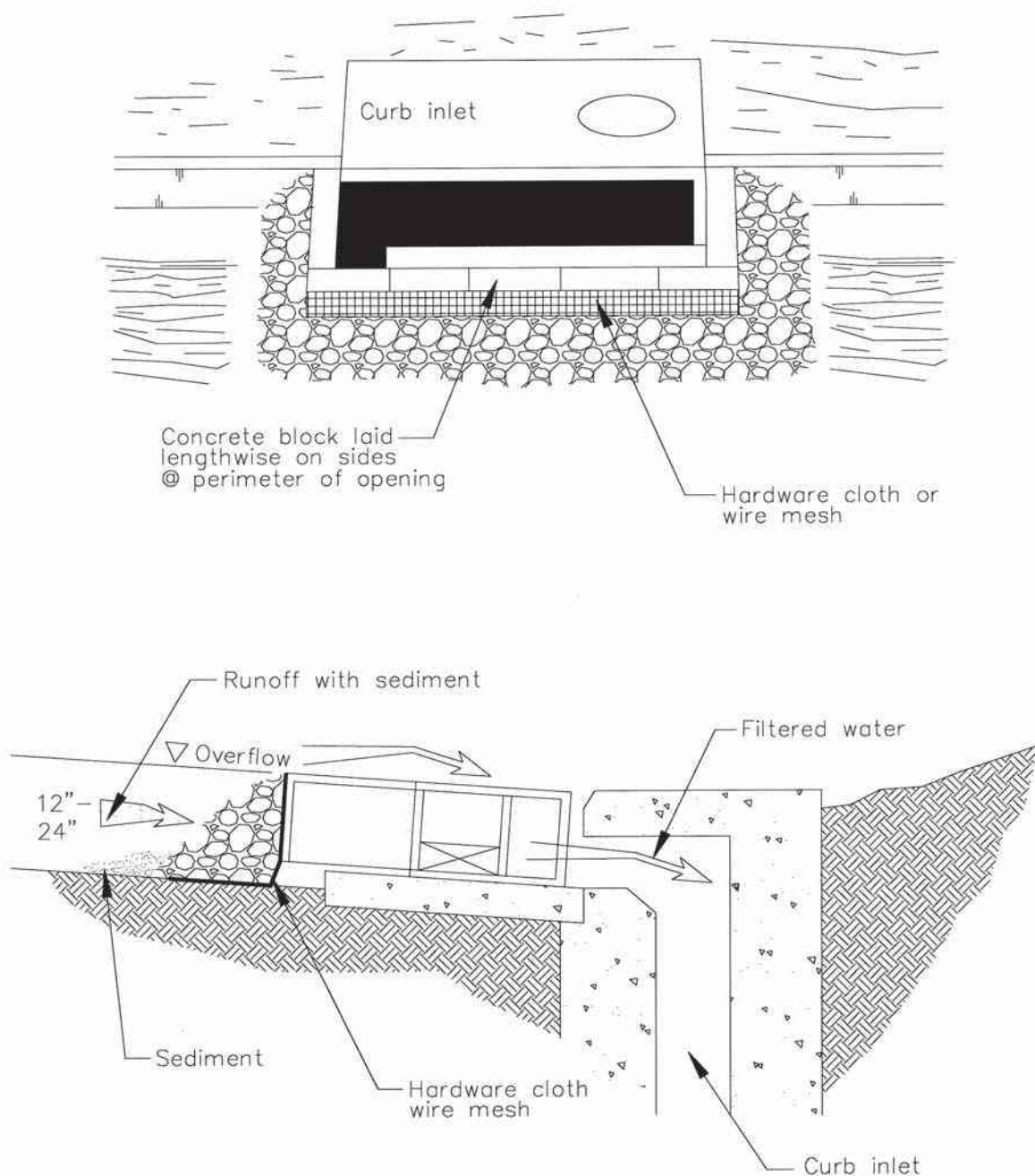


TYPICAL PROTECTION FOR INLET ON GRADE

NOTES:

1. Intended for short-term use.
2. Use to inhibit non-storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

DI PROTECTION TYPE 3
NOT TO SCALE



DI PROTECTION — TYPE 4
NOT TO SCALE

Description

Drain inserts are manufactured filters or fabric placed in a drop inlet to remove sediment and debris. There are a multitude of inserts of various shapes and configurations, typically falling into one of three different groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are one box; that is, the setting area and filtration through media occur in the same box. Some products consist of one or more trays or mesh grates. The trays may hold different types of media. Filtration media vary by manufacturer. Types include polypropylene, porous polymer, treated cellulose, and activated carbon.

California Experience

The number of installations is unknown but likely exceeds a thousand. Some users have reported that these systems require considerable maintenance to prevent plugging and bypass.

Advantages

- Does not require additional space as inserts as the drain inlets are already a component of the standard drainage systems.
- Easy access for inspection and maintenance.
- As there is no standing water, there is little concern for mosquito breeding.
- A relatively inexpensive retrofit option.

Limitations

Performance is likely significantly less than treatment systems that are located at the end of the drainage system such as ponds and vaults. Usually not suitable for large areas or areas with trash or leaves than can plug the insert.

Design and Sizing Guidelines

Refer to manufacturer's guidelines. Drain inserts come in many configurations but can be placed into three general groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are

Design Considerations

- Use with other BMPs
- Fit and Seal Capacity within Inlet

Targeted Constituents

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

Removal Effectiveness

See New Development and Redevelopment Handbook-Section 5.



one box; that is, the setting area and filtration through media occurs in the same box. One manufacturer has a double-box. Stormwater enters the first box where setting occurs. The stormwater flows into the second box where the filter media is located. Some products consist of one or more trays or mesh grates. The trays can hold different types of media. Filtration media vary with the manufacturer: types include polypropylene, porous polymer, treated cellulose, and activated carbon.

Construction/Inspection Considerations

Be certain that installation is done in a manner that makes certain that the stormwater enters the unit and does not leak around the perimeter. Leakage between the frame of the insert and the frame of the drain inlet can easily occur with vertical (drop) inlets.

Performance

Few products have performance data collected under field conditions.

Siting Criteria

It is recommended that inserts be used only for retrofit situations or as pretreatment where other treatment BMPs presented in this section area used.

Additional Design Guidelines

Follow guidelines provided by individual manufacturers.

Maintenance

Likely require frequent maintenance, on the order of several times per year.

Cost

- The initial cost of individual inserts ranges from less than \$100 to about \$2,000. The cost of using multiple units in curb inlet drains varies with the size of the inlet.
- The low cost of inserts may tend to favor the use of these systems over other, more effective treatment BMPs. However, the low cost of each unit may be offset by the number of units that are required, more frequent maintenance, and the shorter structural life (and therefore replacement).

References and Sources of Additional Information

Hrachovec, R., and G. Minton, 2001, Field testing of a sock-type catch basin insert, Planet CPR, Seattle, Washington

Interagency Catch Basin Insert Committee, Evaluation of Commercially-Available Catch Basin Inserts for the Treatment of Stormwater Runoff from Developed Sites, 1995

Larry Walker Associates, June 1998, NDMP Inlet/In-Line Control Measure Study Report

Manufacturers literature

Santa Monica (City), Santa Monica Bay Municipal Stormwater/Urban Runoff Project - Evaluation of Potential Catch basin Retrofits, Woodward Clyde, September 24, 1998

Woodward Clyde, June 11, 1996, Parking Lot Monitoring Report, Santa Clara Valley Nonpoint Source Pollution Control Program.



Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

California Experience

Infiltration basins have a long history of use in California, especially in the Central Valley. Basins located in Fresno were among those initially evaluated in the National Urban Runoff Program and were found to be effective at reducing the volume of runoff, while posing little long-term threat to groundwater quality (EPA, 1983; Schroeder, 1995). Proper siting of these devices is crucial as underscored by the experience of Caltrans in siting two basins in Southern California. The basin with marginal separation from groundwater and soil permeability failed immediately and could never be rehabilitated.

Advantages

- Provides 100% reduction in the load discharged to surface waters.
- The principal benefit of infiltration basins is the approximation of pre-development hydrology during which a

Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

Targeted Constituents

☒	Sediment	■
☒	Nutrients	■
☒	Trash	■
☒	Metals	■
☒	Bacteria	■
☒	Oil and Grease	■
☒	Organics	■

Legend (Removal Effectiveness)

- Low
- High
- ▲ Medium



significant portion of the average annual rainfall runoff is infiltrated and evaporated rather than flushed directly to creeks.

- If the water quality volume is adequately sized, infiltration basins can be useful for providing control of channel forming (erosion) and high frequency (generally less than the 2-year) flood events.

Limitations

- May not be appropriate for industrial sites or locations where spills may occur.
- Infiltration basins require a minimum soil infiltration rate of 0.5 inches/hour, not appropriate at sites with Hydrologic Soil Types C and D.
- If infiltration rates exceed 2.4 inches/hour, then the runoff should be fully treated prior to infiltration to protect groundwater quality.
- Not suitable on fill sites or steep slopes.
- Risk of groundwater contamination in very coarse soils.
- Upstream drainage area must be completely stabilized before construction.
- Difficult to restore functioning of infiltration basins once clogged.

Design and Sizing Guidelines

- Water quality volume determined by local requirements or sized so that 85% of the annual runoff volume is captured.
- Basin sized so that the entire water quality volume is infiltrated within 48 hours.
- Vegetation establishment on the basin floor may help reduce the clogging rate.

Construction/Inspection Considerations

- Before construction begins, stabilize the entire area draining to the facility. If impossible, place a diversion berm around the perimeter of the infiltration site to prevent sediment entrance during construction or remove the top 2 inches of soil after the site is stabilized. Stabilize the entire contributing drainage area, including the side slopes, before allowing any runoff to enter once construction is complete.
- Place excavated material such that it can not be washed back into the basin if a storm occurs during construction of the facility.
- Build the basin without driving heavy equipment over the infiltration surface. Any equipment driven on the surface should have extra-wide ("low pressure") tires. Prior to any construction, rope off the infiltration area to stop entrance by unwanted equipment.
- After final grading, till the infiltration surface deeply.
- Use appropriate erosion control seed mix for the specific project and location.

Performance

As water migrates through porous soil and rock, pollutant attenuation mechanisms include precipitation, sorption, physical filtration, and bacterial degradation. If functioning properly, this approach is presumed to have high removal efficiencies for particulate pollutants and moderate removal of soluble pollutants. Actual pollutant removal in the subsurface would be expected to vary depending upon site-specific soil types. This technology eliminates discharge to surface waters except for the very largest storms; consequently, complete removal of all stormwater constituents can be assumed.

There remain some concerns about the potential for groundwater contamination despite the findings of the NURP and Nightingale (1975; 1987a,b,c; 1989). For instance, a report by Pitt et al. (1994) highlighted the potential for groundwater contamination from intentional and unintentional stormwater infiltration. That report recommends that infiltration facilities not be sited in areas where high concentrations are present or where there is a potential for spills of toxic material. Conversely, Schroeder (1995) reported that there was no evidence of groundwater impacts from an infiltration basin serving a large industrial catchment in Fresno, CA.

Siting Criteria

The key element in siting infiltration basins is identifying sites with appropriate soil and hydrogeologic properties, which is critical for long term performance. In one study conducted in Prince George's County, Maryland (Galli, 1992), all of the infiltration basins investigated clogged within 2 years. It is believed that these failures were for the most part due to allowing infiltration at sites with rates of less than 0.5 in/hr, basing siting on soil type rather than field infiltration tests, and poor construction practices that resulted in soil compaction of the basin invert.

A study of 23 infiltration basins in the Pacific Northwest showed better long-term performance in an area with highly permeable soils (Hilding, 1996). In this study, few of the infiltration basins had failed after 10 years. Consequently, the following guidelines for identifying appropriate soil and subsurface conditions should be rigorously adhered to.

- Determine soil type (consider RCS soil type 'A, B or C' only) from mapping and consult USDA soil survey tables to review other parameters such as the amount of silt and clay, presence of a restrictive layer or seasonal high water table, and estimated permeability. The soil should not have more than 30% clay or more than 40% of clay and silt combined. Eliminate sites that are clearly unsuitable for infiltration.
- Groundwater separation should be at least 3 m from the basin invert to the measured ground water elevation. There is concern at the state and regional levels of the impact on groundwater quality from infiltrated runoff, especially when the separation between groundwater and the surface is small.
- Location away from buildings, slopes and highway pavement (greater than 6 m) and wells and bridge structures (greater than 30 m). Sites constructed of fill, having a base flow or with a slope greater than 15% should not be considered.
- Ensure that adequate head is available to operate flow splitter structures (to allow the basin to be offline) without ponding in the splitter structure or creating backwater upstream of the splitter.

- Base flow should not be present in the tributary watershed.

Secondary Screening Based on Site Geotechnical Investigation

- At least three in-hole conductivity tests shall be performed using USBR 7300-89 or Bouwer-Rice procedures (the latter if groundwater is encountered within the boring), two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m. The tests shall measure permeability in the side slopes and the bed within a depth of 3 m of the invert.
- The minimum acceptable hydraulic conductivity as measured in any of the three required test holes is 13 mm/hr. If any test hole shows less than the minimum value, the site should be disqualified from further consideration.
- Exclude from consideration sites constructed in fill or partially in fill unless no silts or clays are present in the soil boring. Fill tends to be compacted, with clays in a dispersed rather than flocculated state, greatly reducing permeability.
- The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Additional Design Guidelines

- (1) Basin Sizing - The required water quality volume is determined by local regulations or sufficient to capture 85% of the annual runoff.
- (2) Provide pretreatment if sediment loading is a maintenance concern for the basin.
- (3) Include energy dissipation in the inlet design for the basins. Avoid designs that include a permanent pool to reduce opportunity for standing water and associated vector problems.
- (4) Basin invert area should be determined by the equation:

$$A = \frac{WQV}{kt}$$

where A = Basin invert area (m²)

WQV = water quality volume (m³)

k = 0.5 times the lowest field-measured hydraulic conductivity (m/hr)

t = drawdown time (48 hr)

- (5) The use of vertical piping, either for distribution or infiltration enhancement shall not be allowed to avoid device classification as a Class V injection well per 40 CFR146.5(e)(4).

Maintenance

Regular maintenance is critical to the successful operation of infiltration basins. Recommended operation and maintenance guidelines include:

- Inspections and maintenance to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.
- Observe drain time for the design storm after completion or modification of the facility to confirm that the desired drain time has been obtained.
- Schedule semiannual inspections for beginning and end of the wet season to identify potential problems such as erosion of the basin side slopes and invert, standing water, trash and debris, and sediment accumulation.
- Remove accumulated trash and debris in the basin at the start and end of the wet season.
- Inspect for standing water at the end of the wet season.
- Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of the basin.
- If erosion is occurring within the basin, revegetate immediately and stabilize with an erosion control mulch or mat until vegetation cover is established.
- To avoid reversing soil development, scarification or other disturbance should only be performed when there are actual signs of clogging, rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a very light tractor.

Cost

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about \$2 per ft (adjusted for inflation) of storage for a 0.25-acre basin (SWRPC, 1991). As with other BMPs, these published cost estimates may deviate greatly from what might be incurred at a specific site. For instance, Caltrans spent about \$18/ft³ for the two infiltration basins constructed in southern California, each of which had a water quality volume of about 0.34 ac.-ft. Much of the higher cost can be attributed to changes in the storm drain system necessary to route the runoff to the basin locations.

Infiltration basins typically consume about 2 to 3% of the site draining to them, which is relatively small. Additional space may be required for buffer, landscaping, access road, and fencing. Maintenance costs are estimated at 5 to 10% of construction costs.

One cost concern associated with infiltration practices is the maintenance burden and longevity. If improperly maintained, infiltration basins have a high failure rate. Thus, it may be necessary to replace the basin with a different technology after a relatively short period of time.

References and Sources of Additional Information

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- Nightingale, H.I., 1975, "Lead, Zinc, and Copper in Soils of Urban Storm-Runoff Retention Basins," *American Water Works Assoc. Journal*. Vol. 67, p. 443-446.
- Nightingale, H.I., 1987a, "Water Quality beneath Urban Runoff Water Management Basins," *Water Resources Bulletin*, Vol. 23, p. 197-205.
- Nightingale, H.I., 1987b, "Accumulation of As, Ni, Cu, and Pb in Retention and Recharge Basin Soils from Urban Runoff," *Water Resources Bulletin*, Vol. 23, p. 663-672.
- Nightingale, H.I., 1987c, "Organic Pollutants in Soils of Retention/Recharge Basins Receiving Urban Runoff Water," *Soil Science* Vol. 148, pp. 39-45.
- Nightingale, H.I., Harrison, D., and Salo, J.E., 1985, "An Evaluation Technique for Groundwater Quality Beneath Urban Runoff Retention and Percolation Basins," *Ground Water Monitoring Review*, Vol. 5, No. 1, pp. 43-50.
- Oberts, G. 1994. Performance of Stormwater Ponds and Wetlands in Winter. *Watershed Protection Techniques* 1(2): 64–68.
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- Schueler, T. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC.
- Schroeder, R.A., 1995, *Potential For Chemical Transport Beneath a Storm-Runoff Recharge (Retention) Basin for an Industrial Catchment in Fresno, CA*, USGS Water-Resource Investigations Report 93-4140.

Southeastern Wisconsin Regional Planning Commission (SWRPC). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

U.S. EPA, 1983, *Results of the Nationwide Urban Runoff Program: Volume 1 – Final Report*, WH-554, Water Planning Division, Washington, DC.

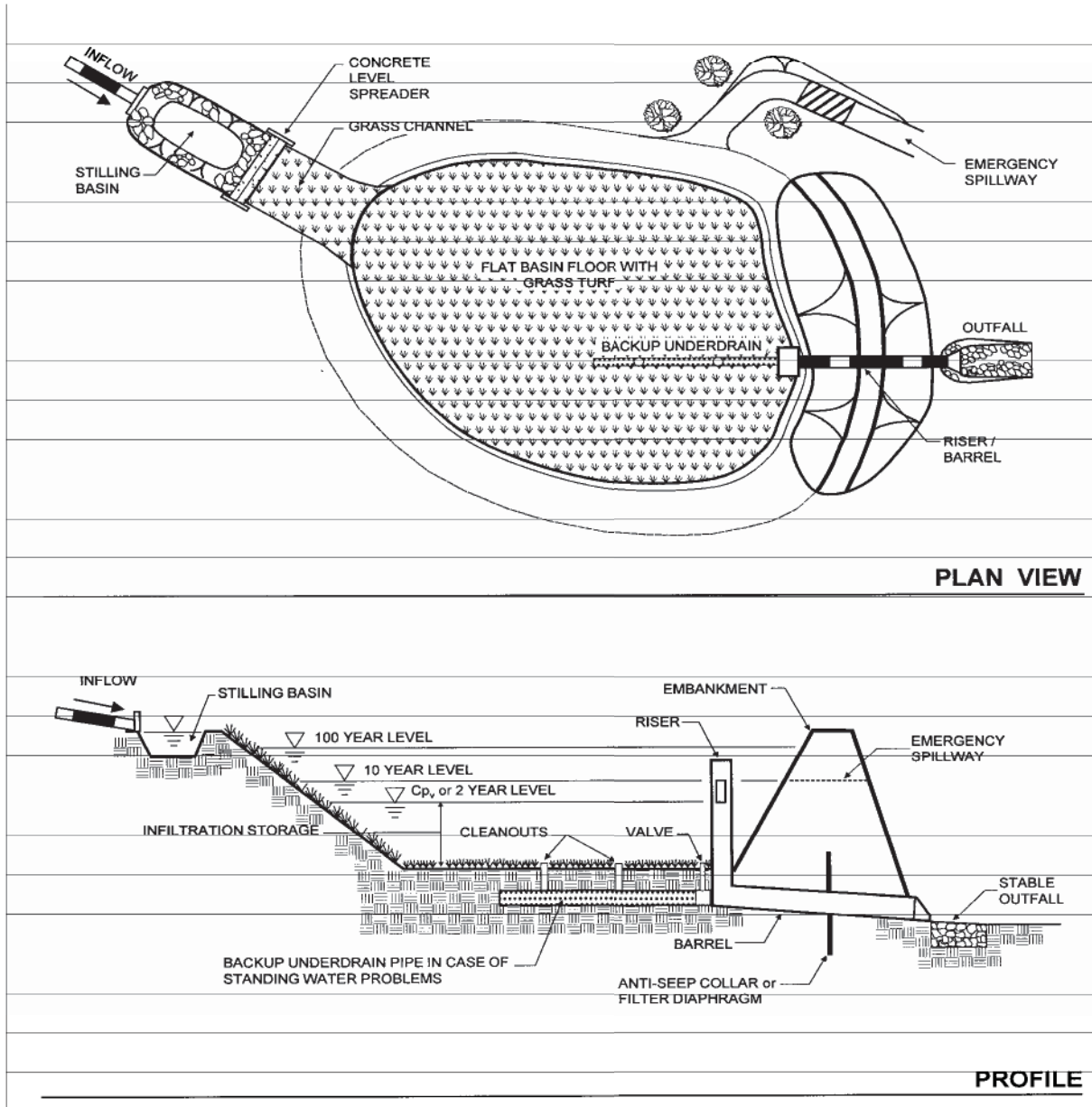
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Information Resources

Center for Watershed Protection (CWP). 1997. *Stormwater BMP Design Supplement for Cold Climates*. Prepared for U.S. Environmental Protection Agency Office of Wetlands, Oceans and Watersheds. Washington, DC.

Ferguson, B.K., 1994. *Stormwater Infiltration*. CRC Press, Ann Arbor, MI.

USEPA. 1993. *Guidance to Specify Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.





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.

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.

Targeted Constituents

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

Legend (Removal Effectiveness)

- Low
- High
- ▲ Medium



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. ■ 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.	As needed
■ Remove and replace dead and diseased vegetation.	
■ Add mulch.	
■ 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.

References

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

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July, 1998, revised February, 2002.

U.S. Environmental Protection Agency, Post-Construction Stormwater Management in New Development & Redevelopment BMP Factsheets. Available at:
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.

XIV.1. Hydrologic Source Control Fact Sheets (HSC)

HSC-1: Localized On-Lot Infiltration

'Localized on-lot infiltration' refers to the practice of collecting on-site runoff from small distributed areas within a catchment and diverting it to a dedicated on-site infiltration area. This technique can include disconnecting downspouts and draining sidewalks and patios into french drains, trenches, small rain gardens, or other surface depressions. For downspout disconnections and other impervious area disconnection involving dispersion over pervious surfaces, but without intentional ponding, see HSC-2: Impervious Area Dispersion.

Feasibility Screening Considerations

- 'Localized on-lot infiltration' shall meet infiltration infeasibility screening criteria to be considered for use.

Opportunity Criteria

- Runoff can be directed to and temporarily pond in pervious area depressions, rock trenches, or similar.
- Soils are adequate for infiltration or can be amended to provide an adequate infiltration rate.
- Shallow utilities are not present below infiltration areas.

OC-Specific Design Criteria and Considerations

- ☐ A single on-lot infiltration area should not be sized to retain runoff from impervious areas greater than 4,000 sq. ft.; if the drainage area exceeds this criteria, sizing should be based on calculations for bioretention areas or infiltration trenches.
- ☐ Soils should be sufficiently permeable to eliminate ponded water within 24 hours following a 85th percentile, 24-hour storm event.
- ☐ Maximum ponding depth should be should be less than 3 inches and trench depth should be less than 1.5 feet.
- ☐ Infiltration should not be used when the depth to the mounded seasonally high table is within 5 feet of the bottom of infiltrating surface.
- ☐ Infiltration via depression storage, french drains, or rain gardens should be located greater than 8 feet from building foundations.
- ☐ Site slope should be less than 10%.
- ☐ Infiltration unit should not be located within 50 feet of slopes greater than 15 percent.
- ☐ Side slopes of rain garden or depression storage should not exceed 3H:1V.
- ☐ Effective energy dissipation and uniform flow spreading methods should be employed to prevent erosion resulting from water entering infiltration areas.

Also known as:

- Downspout infiltration
- Retention grading
- French drains
- On-lot rain gardens



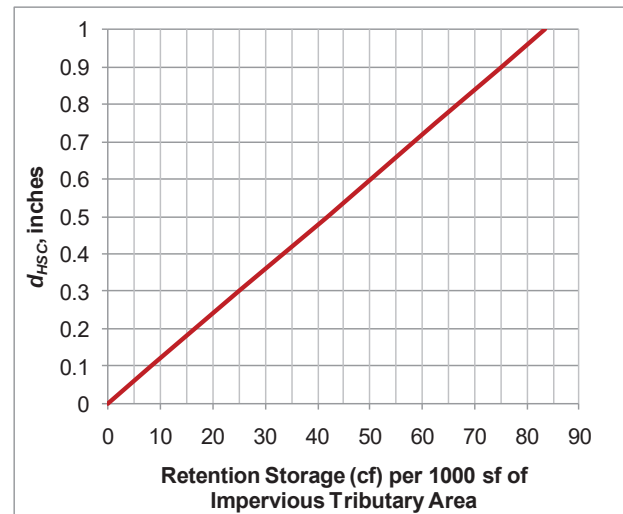
On-lot rain garden

Source: lowimpactdevelopment.org

- ☐ Overflow should be located such that it does not cause erosion and is conveyed away from structures toward the downstream conveyance and treatment system. .

Calculating HSC Retention Volume

- The retention volume provided by localized on-lot infiltration can be computed as the storage volume provided by surface ponding and the pore space within an amended soil layer or gravel trench.
- Estimate the average retention volume per 1000 square feet impervious tributary area provided by on-lot infiltration.
- Look up the storm retention depth, d_{HSC} from the chart to the right.
- The max d_{HSC} is equal to the design capture storm depth for the project site.



Configuration for Use in a Treatment Train

- Localized on-lot infiltration would typically serve as the first in a treatment train and should only be used where tributary areas do not generate significant sediment that would require pretreatment to mitigate clogging.
- The use of impervious area disconnection reduces the sizing requirement for downstream LID and/or conventional treatment control BMPs.

Additional References for Design Guidance

- LID Center – Rain Garden Design Template.
http://www.lowimpactdevelopment.org/raingarden_design/
- University of Wisconsin Extension. Rain Gardens: A How-To Manual for Homeowners.
<http://learningstore.uwex.edu/assets/pdfs/GWQ037.pdf>

HSC-2: Impervious Area Dispersion

Impervious area dispersion refers to the practice of routing runoff from impervious areas, such as rooftops, walkways, and patios onto the surface of adjacent pervious areas. Runoff is dispersed uniformly via splash block or dispersion trench and soaks into the ground as it move slowly across the surface of pervious areas. Minor ponding may occur, but it is not the intent of this practice to actively promote localized on-lot storage (See HSC-1: Localized On-Lot Infiltration).

Feasibility Screening Considerations

- Impervious area dispersion can be used where infiltration would otherwise be infeasible, however dispersion depth over landscaped areas should be limited by site-specific conditions to prevent standing water or geotechnical issues.

Opportunity Criteria

- Rooftops and other low traffic impervious surface present in drainage area.
- Soils are adequate for infiltration. If not, soils can be amended to improve capacity to absorb dispersed water (see MISC-2: Amended Soils).
- Significant pervious area present in drainage area with shallow slope
- Overflow from pervious area can be safely managed.

OC-Specific Design Criteria and Considerations

- ☐ Soils should be preserved from their natural condition or restored via soil amendments to meet minimum criteria described in Section .
- ☐ A minimum of 1 part pervious area capable of receiving flow should be provided for every 2 parts of impervious area disconnected.
- ☐ The pervious area receiving flow should have a slope ≤ 2 percent and path lengths of ≥ 20 feet per 1000 sf of impervious area.
- ☐ Dispersion areas should be maintained to remove trash and debris, loose vegetation, and protect any areas of bare soil from erosion.
- ☐ Velocity of dispersed flow should not be greater than 0.5 ft per second to avoid scour.

Calculating HSC Retention Volume

- The retention volume provided by downspout dispersion is a function of the ratio of impervious to pervious area and the condition of soils in the pervious area.
- Determine flow patterns in pervious area and estimate footprint of pervious area receiving dispersed flow. Calculate the ratio of pervious to impervious area.
- Check soil conditions using the soil condition design criteria below; amend if necessary.
- Look up the storm retention depth, d_{HSC} from the chart below.

Also known as:

- Downspout disconnection
- Impervious area disconnection
- Sheet flow dispersion



Simple Downspout Dispersion

Source:
toronto.ca/environment/water.htm

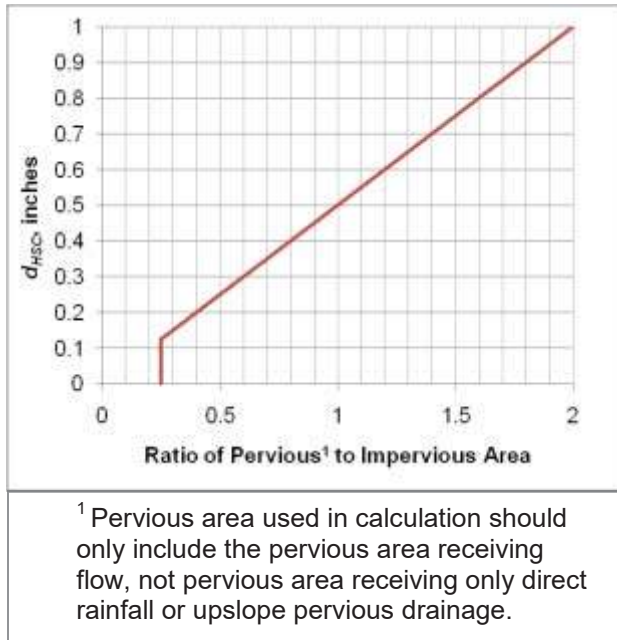
- The max d_{HSC} is equal to the design storm depth for the project site.

Soil Condition Design Criteria

- ☐ Maximum slope of 2 percent
- ☐ Well-established lawn or landscaping
- ☐ Minimum soil amendments per criteria in MISC-2: Amended Soils.

Configuration for Use in a Treatment Train

- Impervious area disconnection is an HSC that may be used as the first element in any treatment train
- The use of impervious area disconnection reduces the sizing requirement for downstream LID and/or treatment control BMPs

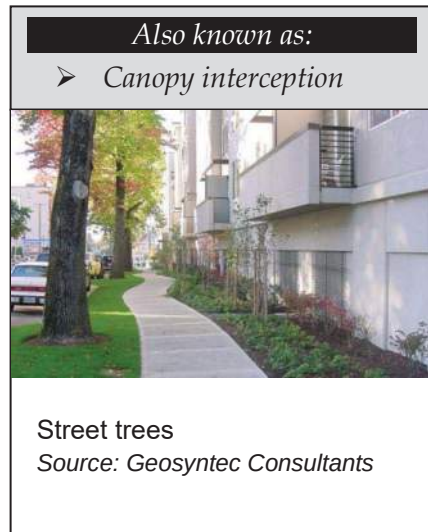


Additional References for Design Guidance

- SMC LID Manual (pp 131)
http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- City of Portland Bureau of Environmental Services. 2010. How to manage stormwater – Disconnect Downspouts. <http://www.portlandonline.com/bes/index.cfm?c=43081&a=177702>
- Seattle Public Utility:
http://www.cityofseattle.org/util/stellent/groups/public/@spu/@usm/documents/webcontent/spu01_006395.pdf
- Thurston County, Washington State (pp 10):
http://www.co.thurston.wa.us/stormwater/manual/docs-faqs/DG-5-Roof-Runoff-Control_Rev11Jan24.pdf

HSC-3: Street Trees

By intercepting rainfall, trees can provide several aesthetic and stormwater benefits including peak flow control, increased infiltration and ET, and runoff temperature reduction. The volume of precipitation intercepted by the canopy reduces the treatment volume required for downstream treatment BMPs. Shading reduces the heat island effect as well as the temperature of adjacent impervious surfaces, over which stormwater flows, and thus reduces the heat transferred to downstream receiving waters. Tree roots also strengthen the soil structure and provide infiltrative pathways, simultaneously reducing erosion potential and enhancing infiltration.



Feasibility Screening Considerations

- Not applicable

Opportunity Criteria

- Street trees can be incorporated in green streets designs along sidewalks, streets, parking lots, or driveways.
- Street trees can be used in combination with bioretention systems along medians or in traffic calming bays.
- There must be sufficient space available to accommodate both the tree canopy and root system.

OC-Specific Design Criteria and Considerations

- ☐ Mature tree canopy, height, and root system should not interfere with subsurface utilities, suspended powerlines, buildings and foundations, or other existing or planned structures. Required setbacks should be adhered to.
- ☐ Depending on space constraints, a 20 to 30 foot diameter canopy (at maturity) is recommended for stormwater mitigation.
- ☐ Native, drought-tolerant species should be selected in order to minimize irrigation requirements and improve the long-term viability of trees.
- ☐ Trees should not impede pedestrian or vehicle sight lines.
- ☐ Planting locations should receive adequate sunlight and wind protection; other environmental factors should be considered prior to planting.
- ☐ Frequency and degree of vegetation management and maintenance should be considered with respect to owner capabilities (e.g., staffing, funding, etc.).
- ☐ Soils should be preserved in their natural condition (if appropriate for planting) or restored via soil amendments to meet minimum criteria described in MISC-2: Amended Soils. If necessary, a landscape architect or plant biologist should be consulted.
- ☐ A street tree selection guide, such as that specific to the City of Los Angeles, may need to be consulted to select species appropriate for the site design constraints (e.g., parkway size, tree height, canopy spread, etc.)
- ☐ Infiltration should not cause geotechnical hazards related to adjacent structures (buildings,

roadways, sidewalks, utilities, etc.)

Calculating HSC Retention Volume

- The retention volume provided by street trees via canopy interception is dependent on the tree species, time of the year, and maturity.
- To compute the retention depth, the expected impervious area covered by the full tree canopy after 4 years of growth must be computed (IA_{HSC}). The maximum retention depth credit for canopy interception (d_{HSC}) is 0.05 inches over the area covered by the canopy at 4 years of growth.

Configuration for Use in a Treatment Train

- As a HSC, street trees would serve as the first step in a treatment train by reducing the treatment volume and flow rate of a downstream treatment BMP.

Additional References for Design Guidance

- California Stormwater BMP Handbook.
http://www.cabmphandbooks.com/Documents/Development/Section_3.pdf
- City of Los Angeles, Street Tree Division - Street Tree Selection Guide.
<http://bss.lacity.org/UrbanForestryDivision/StreetTreeSelectionGuide.htm>
- Portland Stormwater Management Manual.
<http://www.portlandonline.com/bes/index.cfm?c=35122&a=55791>
- San Diego County – Low Impact Development Fact Sheets.
<http://www.sdcountry.ca.gov/dplu/docs/LID-Appendices.pdf>

Attachment D

Infiltration Report & Factor of Safety Worksheet H

April 24, 2020

Attention: Keystone DCS

**Subject: Percolation Testing for
 Storm Water Retention
 Proposed Residential Development
 1075 West Foothill Boulevard
 Rialto, California**

This letter presents the results of our geotechnical investigation for the storm water infiltration rate for design of infiltration system at the subject site. The scope of this work consisted of percolation testing on the subject site in order to determine the infiltration potential of the surface soils. The percolation rates determined should be useful in assessing storm water retention needs. It is our understanding that on-site storm water retention will be required. We anticipate that the storm water system will be installed at an approximate depth of 5 to 6 feet below the finished surface to be installed on native soils. This report presents the results of our study, discussion of our findings, and provides percolation rates for the subject system.

PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to determine the general percolation rates and physical characteristics of the onsite soils in order to provide design parameters for the proposed onsite infiltration system. Services provided for this study consisted of the following:

- Review of available information;
- Site exploration consisting of the excavation and logging of two test holes;
- Percolation testing in the borings (P-1 and P-2);
- Compilation of this report, which presents the results of our study and provides percolation rates for the design of an onsite infiltration system.

SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The subject property is located at 1075 West Foothill Boulevard in the city of Rialto, California. The site is fairly level throughout and near the elevation of the adjacent properties and roadways. Further information regarding proposed development and test holes locations is shown on Figure 1, Plot Plan.

FIELD INVESTIGATION

Our field investigation consisted of excavating two exploratory test holes used as percolation borings. Hollow stem auger drill rig was utilized to excavate the exploratory test holes to the maximum depth explored depth (6 feet bgs). An engineer logged and observed the test holes excavations. Soil classification was based on visual observation. The approximate locations of the exploratory and percolation test holes are shown on Figure 1 (Plot Plan). Logs of the exploratory borings are presented in Appendix A.

SUBSURFACE SOILS CONDITIONS

SOIL PROFILE

The subsurface conditions encountered in our borings consisted predominately of silty sand to the maximum depth explored (6 feet bgs). A more detailed description of these materials is provided in the exploratory boring logs included in the enclosed Appendix A. Soils encountered were classified according to the Unified Soil Classification System (USCS).

GROUNDWATER

Groundwater was not encountered within our exploratory borings to the maximum depth of exploration (6 feet below ground surface). Review of the available maps prepared by the Department of Water Resources indicates that the historic high groundwater level is in excess of 50 feet below ground surface.

PERCOLATION TESTING AND PROCEDURE

Percolation testing was performed in general accordance with Technical Guidance Document for Water Quality Management Plans (WQMP), San Bernardino County Storm Water Program.

The falling-head test procedure was utilized for testing. A 2-inch diameter, 0.02 slotted PVC pipe was placed in the borehole and the annulus was filled with gravel to approximately 1 foot above the slotted interval. Water was allowed to presoak in each test hole prior to obtaining test readings. Following the presoak period, the drop in water level in each hole was monitored every 10 to 30 minutes to determine the appropriate method for testing. Test holes were refilled following each reading or when the water depth was below 6 inches. The drop in water level was recorded to the nearest 1/10th inch to produce conservative water level readings.

SUMMARY OF INFILTRATION TEST RESULTS

We used borehole-type method, the percolation rate obtained converted to a reasonable estimate of the infiltration rate using the Porchet Method (aka Inverse Borehole Method). The conversion equation used in our calculations is:

$$It = \Delta H (60r) / (\Delta t(r + 2H_{avg}))$$

“Ho” is the initial height of water at the selected time interval.

“Hf” is the final height of water at the selected time interval.

“ΔH” is the change in height over the time interval.

“Havg” is the average head height over the time interval.

“It” is the tested infiltration rate

It should be noted that the infiltration rates determined are ultimate rates based upon field test results. An appropriate safety factor should be applied to account for subsoil inconsistencies and potential silting of the percolating soils. The safety factor should be determined with consideration to other factors in the storm water retention system design (particularly storm water volume estimates) and the safety factors associated with those design components.

Infiltration tests results are summarized below:

Test Hole No.	Rate (IN/HOUR)
1	6.07
2	5.67

It should be noted that the infiltration rates determined are ultimate rates based upon field test results. An appropriate safety factor should be applied to account for subsoil inconsistencies and potential silting of the percolating soils. The safety factor should be determined with consideration to other factors in the storm water retention system design (particularly storm water volume estimates) and the safety factors associated with those design components.

ON-SITE STORM WATER DISPOSAL

To dispose of storm water on-site, there has to be a suitable area underlain by a layer of sufficient thickness and permeability to accept the storm water. The layer should also be located below the floor slab level of nearby structures so that subdrain systems for the structures do not intercept the storm water and be above the historic high ground water level.

The Storm water Manager's Resource Center (SMRC) web site (<http://www.stormwatercenter.net/>) sponsored by the Environmental Protection Agency (EPA) includes guidelines for disposal of storm water.

The SMRC includes guidelines for disposal of storm water with respect to setback of structures. It is included in the SMRC that infiltration facilities should be setback 5 feet down-gradient from structures. In order to avoid potential adversely impacting any existing structures, we recommend that any infiltration system be kept a horizontal distance of at least 5 feet from the edge of any buildings, property line, or adjacent pavements. On-site disposal of storm water by infiltration is therefore considered to be feasible for this project.

LIMITATIONS

The findings and recommendations of this report were prepared in accordance with generally accepted professional engineering and engineering geologic principals and practice within our opinion at this time in Southern California. Our conclusions and recommendations are based on the results of the field investigations, combined with an interpolation of subsurface conditions between and beyond exploration locations.

As the project evolves; our continued consultation and construction monitoring should be considered. Geotechnical International should review plans and specifications to ensure the recommendations presented herein have been appropriately interpreted, and that the design assumptions used in this study are valid. Where significant design changes occur, Geotechnical International may be required to augment or modify these recommendations. Subsurface conditions may differ in some locations from those encountered in the explorations and may require additional analyses and/or modified recommendations. This report was written for Client, and design team members, and only for the proposed development described herein. We are not responsible for technical interpretations made by others, or exploratory information that has not been described or documented in this report. Specific questions or interpretations concerning our findings and conclusions may require written clarification.

We appreciate the opportunity to provide service to you on this project. If you have questions regarding this letter or the data included, please contact the undersigned.

Sincerely,
GEOBODEN, INC.

A handwritten signature in blue ink, appearing to read 'Radvar', with a long horizontal flourish extending to the right.

Cyrus Radvar,
Principal Engineer, G.E. 2742

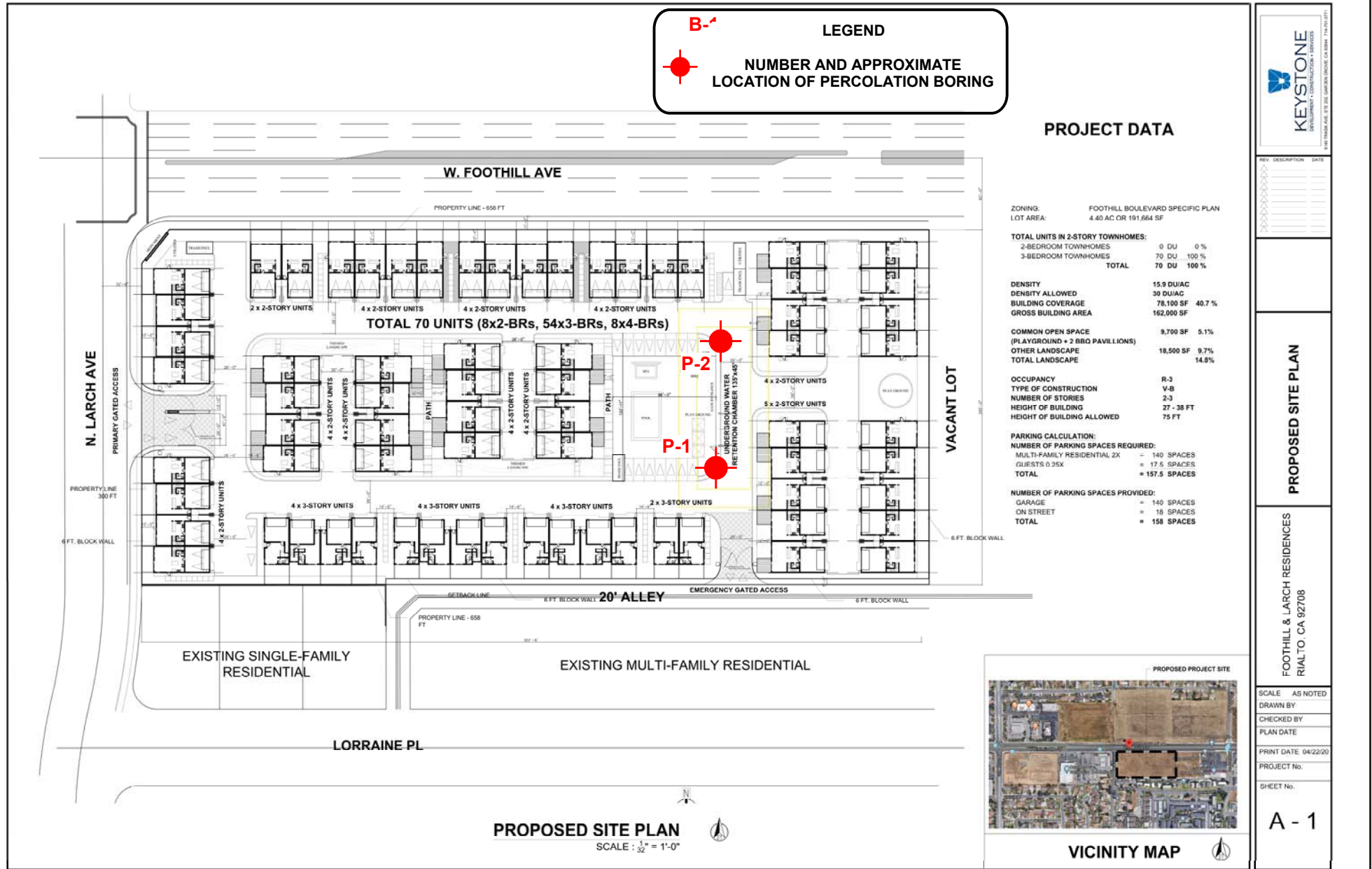


Attachments:

Figure 1 – Plot Plan
Appendix A – Test Borings Logs

REFERENCES

Technical Guidance Document for Water Quality Management Plans (WQMP), San Bernardino County Storm Water Program, 2011.



**GEOBODEN
INC.**

PERCOLATION BORING LOCATION MAP
Proposed Residential Development
1075 West Foothill Boulevard
Rialto, California

Figure By S.R.	Project No. Rialto-1-01
Map No. XX	Figure No.
Date 04-24-20	1

CLIENT Keystone

PROJECT NUMBER Rialto-2-01

DATE STARTED 4/17/20 COMPLETED 4/17/20

DRILLING CONTRACTOR Geoboden, Inc

DRILLING METHOD Hollow Stem Auger

LOGGED BY S.R. CHECKED BY _____

NOTES _____

PROJECT NAME Proposed Infiltration System - Residential Development

PROJECT LOCATION 1075 West Foothill Boulevard, Rialto, CA

GROUND ELEVATION _____ HOLE SIZE 8"

GROUND WATER LEVELS:
AT TIME OF DRILLING ---
AT END OF DRILLING ---
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0.0		SILTY SAND (SM): dark olive brown, moist										
2.5												
5.0												
Bottom of borehole at 6 feet below ground surface. No groundwater was encountered. Boring was backfilled with cuttings. Bottom of borehole at 6.0 feet.												

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 4/24/20 08:18 - C:\PASSPORT\GIBI\PROPOSED RESIDENTIAL DEVELOPMENT-RIALTO-DAVID\PERCOLATION\LOGS.GPJ

Boring Percolation Testing Field Log P-1

Project No.: Rialto-1-01
 Project Name: Proposed Residential Development
 Project Location: 1075 West Foothill Boulevard, Rialto
 Earth Description: alluvium
 Tested by: CR
 Liquid Description: Clear Clean Water

Date: 04/17/20 - 04/17/20

Boring/Test Number: P-1
 Diameter of Boring, inches: 8
 Diameter of Casing, inches: 2
 Depth of Boring, feet: 6
 Depth to Invert of BMP, feet: NE
 Depth to Groundwater, feet: NE
 Depth to Initial Water Depth, (d_i) feet: 3.80

Start Time for Pre-Soak: 4/17/20 8:00
 Start Time for Standard: 4/17/20 8:20
 Standard Time Interval Between Readings, 10 mins.

Reading Number	Time Start/End (hh:mm)	Elapsed Time Δtime (min)	Water Depth (feet) ¹	Water Drop, Δd (feet)	Water Drop, Δd (inch)	Percolation Rate (in/hr)	Initial Height of Water (ft)	Initial Height of Water (in)	Final Height of Water (ft)	Final Height of Water (in)	Change in Height of Water, ΔH (inch)	Average Head Height of Water over Interval	Infiltration Rate (in/hr)	Notes
1	8:20	10	3.80	1.88	22.6	135.4	2.2	26.4	0.3	3.8	22.6	15.1	15.81	Refilled to initial water depth every 30 minutes
	8:30		5.68											
2	8:30	10	3.80	1.46	17.5	105.1	2.2	26.4	0.7	8.9	17.5	17.6	10.70	
	8:40		5.26											
3	8:40	10	3.80	1.32	15.8	95.0	2.2	26.4	0.9	10.6	15.8	18.5	9.28	
	8:50		5.12											
4	8:50	10	3.80	1.16	13.9	83.5	2.2	26.4	1.0	12.5	13.9	19.4	7.79	
	9:00		4.96											
5	9:00	10	3.80	1.12	13.4	80.6	2.2	26.4	1.1	13.0	13.4	19.7	7.44	
	9:10		4.92											
6	9:10	10	3.80	1.04	12.5	74.9	2.2	26.4	1.2	13.9	12.5	20.2	6.76	
	9:20		4.84											
7	9:20	10	3.80	0.92	11.0	66.2	2.2	26.4	1.3	15.4	11.0	20.9	5.79	
	9:30		4.72											
8	9:30	10	3.80	0.88	10.6	63.4	2.2	26.4	1.3	15.8	10.6	21.1	5.48	
	9:40		4.68											
9	9:40	10	3.80	0.82	9.8	59.0	2.2	26.4	1.4	16.6	9.8	21.5	5.03	
	9:50		4.62											
10	9:50	10	3.80	0.78	9.4	56.2	2.2	26.4	1.4	17.0	9.4	21.7	4.74	
	10:00		4.58											
11	10:00	10	3.80	0.78	9.4	56.2	2.2	26.4	1.4	17.0	9.4	21.7	4.74	
	10:10		4.58											
12	10:10	10	3.80	0.78	9.4	56.2	2.2	26.4	1.4	17.0	9.4	21.7	4.74	Final Reading used to calculate the infiltration rate.
	10:20		4.58											

¹Water depth below ground surface

Infiltration Rate: 6.07 in/hr

Boring Percolation Testing Field Log P-2

Project No.: Rialto-1-01
 Project Name: Proposed Residential Development
 Project Location: 1075 West Foothill Boulevard, Rialto
 Earth Description: alluvium
 Tested by: CR
 Liquid Description: Clear Clean Water

Date: 04/17/20 - 04/17/20

Boring/Test Number: P-2
 Diameter of Boring, inches: 8
 Diameter of Casing, inches: 2
 Depth of Boring, feet: 6
 Depth to Invert of BMP, feet: NE
 Depth to Groundwater, feet: NE
 Depth to Initial Water Depth, (d_i) feet: 3.80

Start Time for Pre-Soak: 4/17/20 8:10
 Start Time for Standard: 4/17/20 9:27
 Standard Time Interval Between Readings, 10 mins.

Reading Number	Time Start/End (hh:mm)	Elapsed Time Δtime (min)	Water Depth (feet) ¹	Water Drop, Δd (feet)	Water Drop, Δd (inch)	Percolation Rate (in/hr)	Initial Height of Water (ft)	Initial Height of Water (in)	Final Height of Water (ft)	Final Height of Water (in)	Change in Height of Water, ΔH (inch)	Average Head Height of Water over Interval	Infiltration Rate (in/hr)	Notes
1	9:27	10	3.80	1.94	23.3	139.7	2.2	26.4	0.3	3.1	23.3	14.8	16.67	Refilled to initial water depth every 30 minutes
	9:37		5.74											
2	9:37	10	3.80	1.85	22.2	133.2	2.2	26.4	0.4	4.2	22.2	15.3	15.40	
	9:47		5.65											
3	9:47	10	3.80	1.65	19.8	118.8	2.2	26.4	0.6	6.6	19.8	16.5	12.84	
	9:57		5.45											
4	9:57	10	3.80	1.46	17.5	105.1	2.2	26.4	0.7	8.9	17.5	17.6	10.70	
	10:07		5.26											
5	10:07	10	3.80	1.30	15.6	93.6	2.2	26.4	0.9	10.8	15.6	18.6	9.09	
	10:17		5.10											
6	10:17	10	3.80	1.02	12.2	73.4	2.2	26.4	1.2	14.2	12.2	20.3	6.59	
	10:27		4.82											
7	10:27	10	3.80	0.94	11.3	67.7	2.2	26.4	1.3	15.1	11.3	20.8	5.95	
	10:37		4.74											
8	10:37	10	3.80	0.89	10.7	64.1	2.2	26.4	1.3	15.7	10.7	21.1	5.56	
	10:47		4.69											
9	10:47	10	3.80	0.82	9.8	59.0	2.2	26.4	1.4	16.6	9.8	21.5	5.03	
	10:57		4.62											
10	10:57	10	3.80	0.76	9.1	54.7	2.2	26.4	1.4	17.3	9.1	21.8	4.59	
	11:07		4.56											
11	11:07	10	3.80	0.76	9.1	54.7	2.2	26.4	1.4	17.3	9.1	21.8	4.59	
	11:17		4.56											
12	11:17	10	3.80	0.76	9.1	54.7	2.2	26.4	1.4	17.3	9.1	21.8	4.59	Final Reading used to calculate the infiltration rate.
	11:27		4.56											

¹Water depth below ground surface

Infiltration Rate: 5.67 in/hr

VII.4.1. Site Suitability Considerations

Suitability assessment related considerations include ([Table VII.3](#)):

- Soil assessment methods – the site assessment extent (e.g., number of borings, test pits, etc.) and the measurement method used to estimate the short-term infiltration rate.
- Predominant soil texture/percent fines – soil texture and the percent of fines can greatly influence the potential for clogging.
- Site soil variability – site with spatially heterogeneous soils (vertically or horizontally) as determined from site investigations are more difficult to estimate average properties for resulting in a higher level of uncertainty associated with initial estimates.
- Depth to seasonal high groundwater/impervious layer – groundwater mounding may become an issue during excessively wet conditions where shallow aquifers or shallow clay lenses are present.

Table VII.3: Suitability Assessment Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern
Assessment methods (see explanation below)	Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates	Direct measurement of ≥ 20 percent of infiltration area with localized infiltration measurement methods (e.g., infiltrometer)	Direct measurement of ≥ 50 percent of infiltration area with localized infiltration measurement methods or Use of extensive test pit infiltration measurement methods
Texture Class	Silty and clayey soils with significant fines	Loamy soils	Granular to slightly loamy soils
Site soil variability	Highly variable soils indicated from site assessment or limited soil borings collected during site assessment	Soil borings/test pits indicate moderately homogeneous soils	Multiple soil borings/test pits indicate relatively homogeneous soils
Depth to groundwater/ impervious layer	<5 ft below facility bottom	5-10 ft below facility bottom	>10 below facility bottom

Per infiltration report in Attachment D

Per infiltration report in Attachment D

Per infiltration report in Attachment D

Per infiltration report in Attachment D

Localized infiltration testing refers to methods such as the double ring infiltrometer test (ASTM D3385-88) which measure infiltration rates over an area less than 10 sq-ft, may include lateral

flow, and do not attempt to account for heterogeneity of soil. The amount of area each test represents should be estimated depending on the observed heterogeneity of the soil.

Extensive infiltration testing refers to methods that include excavating a significant portion of the proposed infiltration area, filling the excavation with water, and monitoring drawdown. The excavation should be to the depth of the proposed infiltration surface and ideally be at least 50 to 100 square feet.

In all cases, testing should be conducted in the area of the proposed BMP where, based on review of available geotechnical data, soils appear least likely to support infiltration.

VII.4.2. Design Related Considerations

Design related considerations include ([Table VII.4](#)):

- Size of area tributary to facility – all things being equal, risk factors related to infiltration facilities increase with an increase in the tributary area served. Therefore facilities serving larger tributary areas should use more restrictive adjustment factors.
- Level of pretreatment/expected influent sediment loads – credit should be given for good pretreatment by allowing less restrictive factors to account for the reduced probability of clogging from high sediment loading. Also, facilities designed to capture runoff from relatively clean surfaces such as rooftops are likely to see low sediment loads and therefore should be allowed to apply less restrictive safety factors.
- Redundancy – facilities that consist of multiple subsystems operating in parallel such that parts of the system remains functional when other parts fail and/or bypass should be rewarded for the built-in redundancy with less restrictive correction and safety factors. For example, if bypass flows would be at least partially treated in another BMP, the risk of discharging untreated runoff in the event of clogging the primary facility is reduced. A bioretention facility that overflows to a landscaped area is another example.
- Compaction during construction – proper construction oversight is needed during construction to ensure that the bottoms of infiltration facility are not overly compacted. Facilities that do not commit to proper construction practices and oversight should have to use more restrictive correction and safety factors.

Table VII.4: Design Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern
Tributary area size	Greater than 10 acres.	Greater than 2 acres but less than 10 acres.	2 acres or less.
Level of pretreatment/ expected influent sediment loads	Pretreatment from gross solids removal devices only, such as hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, or any other areas expected to produce high sediment, trash, or debris loads.	Good pretreatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be relatively low (e.g., low traffic, mild slopes, disconnected impervious areas, etc.).	Excellent pretreatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops.
Redundancy of treatment	No redundancy in BMP treatment train.	Medium redundancy, other BMPs available in treatment train to maintain at least 50% of function of facility in event of failure.	High redundancy, multiple components capable of operating independently and in parallel, maintaining at least 90% of facility functionality in event of failure.
Compaction during construction	Construction of facility on a compacted site or elevated probability of unintended/ indirect compaction.	Medium probability of unintended/ indirect compaction.	Heavy equipment actively prohibited from infiltration areas during construction and low probability of unintended/ indirect compaction.

Catch basin filters (Bio-Clean or approved equal) will be provided in all on-site catch basins as a pre-treatment control BMP prior to allowing runoff to be conveyed to the primary treatment BMP. The catch basin filters will help remove large debris, trash, sediment and oil/grease from the runoff before outleting into the the on-site infiltration systems. See Attachment B for catch basin filter specification.

The soil in the proposed infiltration system footprints will be uncompacted in-place native material.

Specific project site pollutants that will be treated by these Bio-Clean Filter Systems are as follows: Heavy Metals (79% of Zinc), Sediments (93% of Turbidity), Trash & Debris, and Oil and Grease before the pollutants go to the on-site infiltration system. See Attachment B for catch basin filter specification.

VII.4.3. Determining Factor of Safety

A factor of safety shall be used. To assist in selecting the appropriate design infiltration rate, the measured short term infiltration rate should be adjusted using a weighted average of several safety factors using the worksheet shown in [Worksheet H](#) below. The design infiltration rate would be determined as follows:

1. For each consideration shown in [Table VII.3](#) and [Table VII.4](#) above, determine whether the consideration is a high, medium, or low concern.
2. For all high concerns, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.
3. Multiply each of the factors by the corresponding weight to get a product.
4. Sum the products within each factor category to obtain a safety factor for each.
5. Multiply the two safety factors together to get the final combined safety factor. If the combined safety factor is less than 2, then 2 shall be used as the safety factor.
6. Divide the measured short term infiltration rate by the combined safety factor to obtain the adjusted design infiltration rate for use in sizing the infiltration facility.

The design infiltration rate shall be used to size BMPs and to evaluate their expected long term performance. This rate shall not be less than 2, but may be higher at the discretion of the design engineer.

Worksheet H: Factor of Safety and Design Infiltration Rate and Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) $p = w \times v$
A	Suitability Assessment	Soil assessment methods	0.25	1	0.25
		Predominant soil texture	0.25	1	0.25
		Site soil variability	0.25	1	0.25
		Depth to groundwater / impervious layer	0.25	1	0.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			
B	Design	Tributary area size	0.25	2	0.50
		Level of pretreatment/ expected sediment loads	0.25	2	0.50
		Redundancy	0.25	2	0.50
		Compaction during construction	0.25	1	0.25
		Design Safety Factor, $S_B = \Sigma p$			
Combined Safety Factor, ~~$S_{TOT} = S_A \times S_B$~~ $S_{TOT} = S_A + S_B$				2.75 USE 3	
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)				6 in/hr	
Design Infiltration Rate, in/hr, $K_{DESIGN} = \frac{S_{TOT} \times K_M}{S_{TOT} + K_M}$ $K_M \div S_{TOT}$				2 in/hr	
Supporting Data					
Briefly describe infiltration test and provide reference to test forms: See Attachment D for Infiltration Report. Safety Factor of 3 will be used for BMP Calculations. Use 2 in/hr for design.					

Per infiltration report in Attachment D

Note: The minimum combined adjustment factor shall not be less than 2.0 and the maximum combined adjustment factor shall not exceed 9.0.

VII.5. References

- ASTM D 3385-94, 2003. "Standard Test Method for Infiltration Rate of Soils Field Using Double-Ring Infiltrometer." American Society for Testing Materials, Conshohocken, PA. 10 Jun, 2003.
- Caltrans, 2003. "Infiltration Basin Site Selection". Study Volume I. California Department of Transportation. Report No. CTSW-RT-03-025.
- City of Portland, 2010. *Appendix F.2: Infiltration Testing*. Portland Stormwater Management Manual, Revised February 1, 2010.
- United States Department of the Interior, Bureau of Reclamation (USBR), 1990a, "Procedure for Performing Field Permeability Testing by the Well Permeameter Method (USBR 7300-89)," in *Earth Manual, Part 2, A Water Resources Technical Publication*, 3rd ed., Bureau of Reclamation, Denver, Colo.