Preliminary

Water Quality Management Plan

For:

W. Highland Ave. & Medical Center Dr., Residential Development

Prepared for:

Warmington Residential

3090 Pullman Street

Costa Mesa, CA 92626

Phone:

Prepared by:

Allard Engineering

16866 Seville Avenue

Fontana, CA 92335

Phone (909) 356-1815

rallard@allardeng.com

Preparation Date: September 30, 2021

Entitlement Approval Date:

Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for Warmington Residential, by Allard Engineering. The WQMP is intended to comply with the requirements of the County of San Bernardino and the NPDES Area wide 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):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN : 0143-191-59

Owner's Signature			
Owner Name:			
Title	President		
Company	Warmington Residential		
Address	3090 Pullman Street, Costa Mesa, CA 92626		
Email			
Telephone #	(714) 557-5511		
Signature		Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN : 0143-191-59

"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: RAYMOND ALLARD		PE Stamp Below
Title	PRESIDENT	
Company	Allard Engineering	
Address	16866 Seville Avenue	
Email	rallard@allardeng.com	
Telephone #	(909) 356-1815	
Signature		
Date		

Table of Contents

Section 1 Discretionary Permits 1-1
Section 2 Project Description 2-1
2.1 Project Information 2-1
2.2 Property Ownership / Management 2-2
2.3 Potential Stormwater Pollutants 2-3
2.4 Water Quality Credits 2-4
Section 3 Site and Watershed Description 3-1
Section 4 Best Management Practices 4-1
4.1 Source Control BMP 4-1
4.1.1 Pollution Prevention 4-1
4.1.2 Preventative LID Site Design Practices 4-7
4.2 Project Performance Criteria 4-8
4.3 Project Conformance Analysis 4-14
4.3.1 Site Design Hydrologic Source Control BMP 4-19
4.3.2 Infiltration BMP 4-26
4.3.3 Harvest and Use BMP 4-30
4.3.4 Biotreatment BMP 4.31
4.3.5 Conformance Summary 4-35
4.3.6 Hydromodification Control BMP 4-38
4.4 Alternative Compliance Plan (if applicable) 4-39
Section 5 Inspection & Maintenance Responsibility Post Construction BMPs 5-1
Section 6 Site Plan and Drainage Plan 6-1
6.1. Site Plan and Drainage Plan 6-1
6.2 Electronic Data Submittal 6-1

Forms

Form 1-1 Project Information 1-1
Form 2.1-1 Description of Proposed Project 2-1
Form 2.2-1 Property Ownership/Management 2-2
Form 2.3-1 Pollutants of Concern 2-3
Form 2.4-1 Water Quality Credits 2-4
Form 3-1 Site Location and Hydrologic Features 3-1
Form 3-2 Hydrologic Characteristics 3-2
Form 3-3 Watershed Description 3-5
Form 4.1-1 Non-Structural Source Control BMP 4-2
Form 4.1-2 Structural Source Control BMP 4-5
Form 4.1-3 Site Design Practices Checklist 4-7
Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume 4-8
Form 4.2-2 Summary of HCOC Assessment 4-11

Form 4.2-3 HCOC Assessment for Runoff Volume 4-12
Form 4.2-4 HCOC Assessment for Time of Concentration 4-13
Form 4.2-5 HCOC Assessment for Peak Runoff.. 4-14
Form 4.3-1 Infiltration BMP Feasibility 4-16
Form 4.3-2 Site Design Hydrologic Source Control BMP 4-20
Form 4.3-3 Infiltration LID BMP... 4-27
Form 4.3-4 Harvest and Use BMP 4-30
Form 4.3-5 Selection and Evaluation of Biotreatment BMP 4-31
Form 4.3-6 Volume Based Biotreatment – Bioretention and Planter Boxes w/Underdrains 4-32
Form 4.3-7 Volume Based Biotreatment- Constructed Wetlands and Extended Detention 4-33
Form 4.3-8 Flow Based Biotreatment 4-34
Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate 4-35
Form 4.3-10 Hydromodification Control BMP 4-38
Form 5-1 BMP Inspection and Maintenance 5-1

Section 1 Discretionary Permit(s)

<table>
<tr><th colspan="6">Form 1-1 Project Information</th></tr>
<tr><td colspan="2">Project Name</td><td colspan="4">Highland Avenue and Medical Center Drive Residential Development</td></tr>
<tr><td colspan="2">Project Owner Contact Name:</td><td colspan="4">Warmington Residential</td></tr>
<tr><td>Mailing Address:</td><td>3090 Pullman Street, Costa Mesa, CA 92626</td><td>E-mail Address:</td><td></td><td>Telephone:</td><td>714-557-5511</td></tr>
<tr><td colspan="2">Permit/Application Number(s):</td><td colspan="2"></td><td>Tract/Parcel Map Number(s):</td><td>APN: 0143-191-59</td></tr>
<tr><td colspan="2">Additional Information/
Comments:</td><td colspan="4">N/A</td></tr>
<tr><td colspan="2">Description of Project:</td><td colspan="4">The project which located at the northwest of W. Highland Avenue and Medical Center Drive comprises the site area of approximately 9.9 acre of the proposed 95 units of single-family residential development located in the City of San Bernardino, County of San Bernardino, State of California.

In current condition the site is undeveloped barren area. In the existing condition, the entire property drains via sheet flow to the southwest direction to the side street (Madison St), drain to 20th Street and conveys to Medical Center Drive via existing curb/gutter, drains to the existing storm drain system (Muscott Storm Drain System, 60” RCP) in Medical Center Dr. and finally drains to the Lytle Creek Wash (Unlined Channel). The storm water ultimately conveyed to the Santa Ana River (Conc Lined, EHM) Channel via Warm Creek (Conc. Box Channel, EHM).

This project is proposing a new development of the site proposing to build 95 single family residential units, private driveways, private streets, walkways, planters, open spaces and landscape areas.

The proposed drainage includes below surface Contech retention/infiltration chamber systems (7 units) for retention and infiltration, grate inlets with Filter Inserts for pre-treatment, swales, and storm water piping.

The entire site (DA-1) is preliminary designed as single drainage management area: DMA-1 (9.9 acres).

In DMA-1 onsite drainage systems consist of swales, gutters, grated inlets, catch basin with pre-treatment devices and pipes will convey the flows to the proposed below surface Contech retention/infiltration chamber systems (7-units) to retain/infiltrate water volume to mitigate WQ capture volume, and to mitigate the HCOC condition volume for 2-yr and 100-yr storm events. For larger storms and the system failure, the water will overflow the proposed retention/infiltration chamber systems, flows on the surface, drains southwesterly to the side street (Madison St), drain to 20th Street, conveys to Medical Center Drive via existing curb/gutter, drains to the existing storm drain system (Muscott Storm Drain System,</td></tr>
</table>

	60" RCP) in Medical Center Dr. and finally drains to the Lytle Creek Wash (Unlined Channel). The storm water ultimately conveyed to the Santa Ana River (Conc Lined, EHM) Channel via Warm Creek (Conc. Box Channel, EHM). HCOC mitigation will be satisfied by retention of the difference in water volume in developed and existing condition for 2-yr 24-hr and 100-yr 24-hr storm event. Water will be drained out from the site at or below the existing flowrate.
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	

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 *May require source control LID BMPs and other LIP requirements. Please consult with local jurisdiction on specific requirements.*			

2 Project Area (ft2):	431,244 sf	3 Number of Dwelling Units:	95	4 SIC Code:	1522
5 Is Project going to be phased? Yes ☐ No ☒ *If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.*					

6 Does Project include roads? Yes ☐ No ☒ *If yes, ensure that applicable requirements for transportation projects are addressed (see Appendix A of TGD for WQMP)*

The proposed roads will be a part of a private new development and the proposed development area will be non-adjoining to the existing public roads. Therefore transportation project guidance does not apply to this project.

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 of WQMP stormwater facilities:
Warmington Residential will be responsible to build the site and the maintenance of the post-developed BMPs. Address: Warmington Residential 3090 Pullman Street Costa Mesa, CA 92626 Phone Number: 714-557-5511

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 ☐	Bacteria and viruses are a potential pollutant for Residential tract developments. Due to the nature of the development the site will be treated using site and source and treatment control BMPs. Bacteria and virus can also be detected in pavement runoff, therefore, the site has incorporated treatment control throughout. All paved and hardened surfaces will flow through the proposed grate inlet pre-treatment units prior to discharge into the proposed Infiltration Basin as part of Low Impact Design (LID). Impacted Water Body: Lytle Creek, Santa Ana River Reach 4, 3.
Nutrients/Noxious Aquatic Plants	E ☒	N ☐	This residential tract site includes landscaping area which will be the potential generation of this type of pollutants. Impacted Water Body: None
Sediment / Total suspended solids / pH	E ☒	N ☐	This residential tract site includes landscaping area which will be the potential generation of this type of pollutants.
Metals	E ☒	N ☐	Generates from residential tract site Impacted Water Body: Santa Ana River Reach 3.
Oil and Grease	E ☒	N ☐	Generates from Commercial/Industrial project
Trash/Debris	E ☒	N ☐	Debris/trash is a potential pollutant for residential tract site . The site will intercept debris into the proposed infiltration basin. Also trash/debris from paved surfaces will be intercepted in the proposed catch basin with filtration devices as part of the source and treatment control BMPs. Impacted Water Body: None
Pesticides / Herbicides	E ☒	N ☐	Generates from Landscape area. Impacted Water Body: None
Organic Compounds	E ☒	N ☐	This site includes landscaping area and the usage of solvents which will be the potential generation of this type of pollutants. Impacted Water Body: None
Other: Nutrients	E ☒	N ☐	Include nitrogen and phosphorus from usages of fertilizers in the proposed landscape area. Impacted Water Body: None
Oxygen Demanding Compounds	E ☒	N ☐	This site includes landscaping area which will be the potential generation of this type of pollutants. Impacted Water Body: None
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: *Select all that apply*			
☐ 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)	N/A		

Section 3 Site and Watershed Description

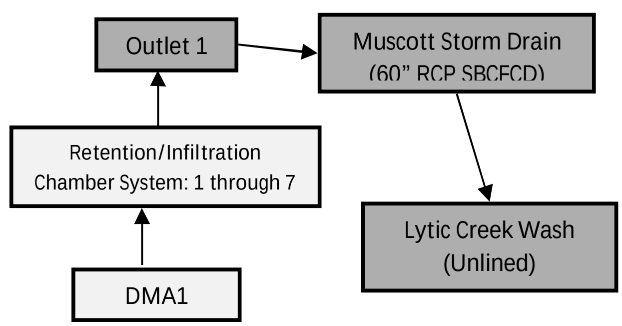
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and 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: 34.13489° N	Longitude: - 117.32537° W	Thomas Bros Map page PAGE ___ GRID _ _

1 San Bernardino County climatic region: ☒ Valley ☐ Mountain

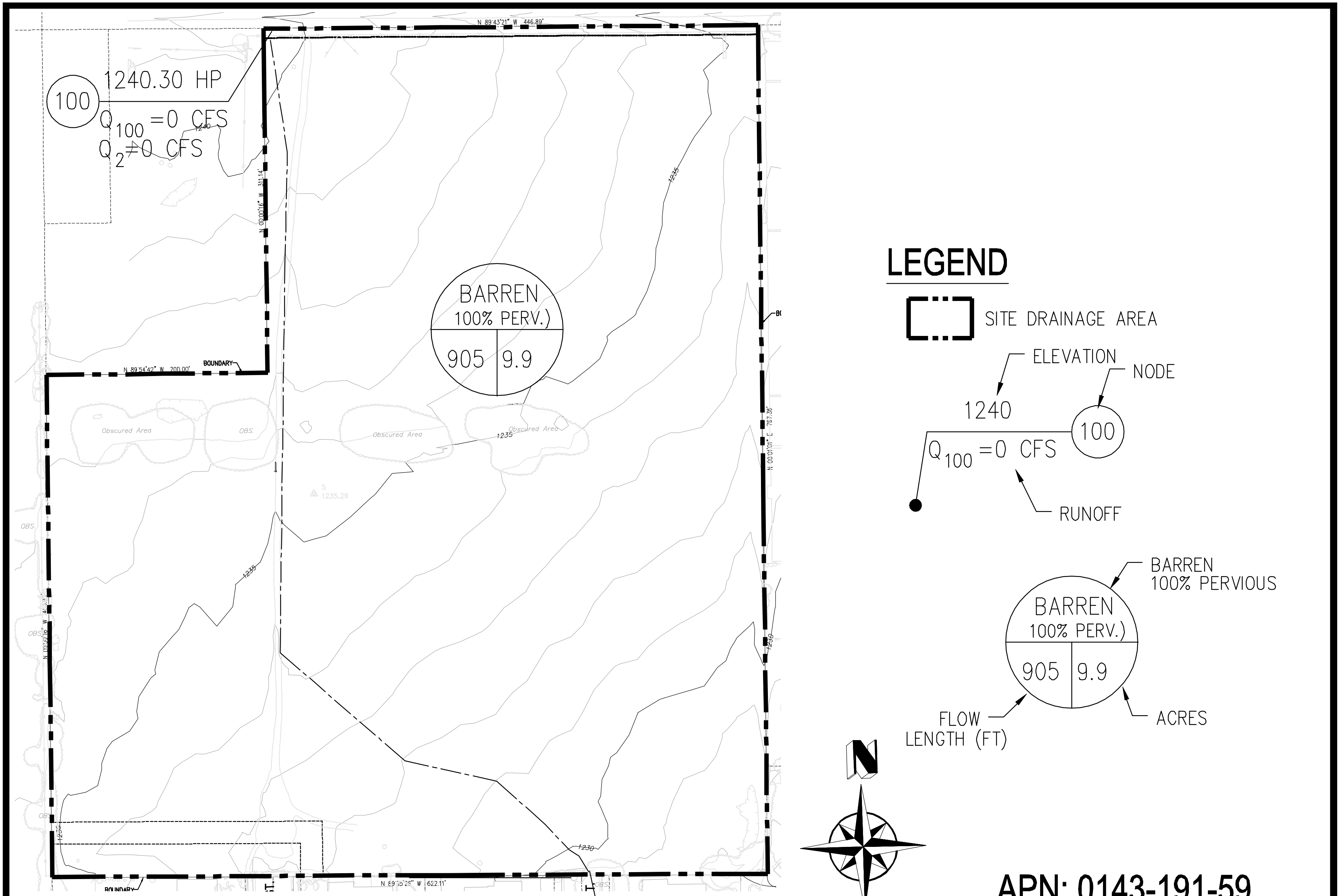
2 Does the site have more than one drainage area (DA): Yes☐ No☒ *If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached*



Conveyance	
DMA1 to Outlet 1	The entire site (DA-1) is preliminary designed as single drainage management area: DMA-1 (9.9 acres). In DMA-1 onsite drainage systems consist of swales, gutters, grated inlets, catch basin with pre-treatment devices and pipes will convey the flows to the proposed below surface Contech retention/infiltration chamber systems (7-units) to retain/infiltrate water volume to mitigate WQ capture volume, and to mitigate the HCOC condition volume for 2-yr and 100-yr storm events. For larger storms and the system failure, the water will overflow the proposed Contech retention/infiltration chamber systems (7-unit), flows on the surface, drains southwesterly to the side street (Madison St), drain to 20th Street, conveys to Medical Center Drive via existing curb/gutter, drains to the existing storm drain system (Muscott Storm Drain System, 60" RCP) in Medical Center Dr.

	and finally drains to the Lytle Creek Wash (Unlined Channel). The storm water ultimately conveyed to the Santa Ana River (Conc Lined, EHM) Channel via Warm Creek (Conc. Box Channel, EHM). HCOC mitigation will be satisfied by retention of the difference in water volume in developed and existing condition for 2-yr 24-hr and 100-yr 24-hr storm event. Water will be drained out from the site at or below the existing flowrate.

Form 3-2 Existing Hydrologic Characteristics for Drainage Areas				
For Drainage Areas 1 sub-watershed DMA, provide the following characteristics	DMA1			
1 DMA drainage area (ft^2)	431,244 sf			
2 Existing site impervious area (ft^2)	0 sf			
3 Antecedent moisture condition *For valley areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	III			
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	A			
5 Longest flowpath length (ft)	905			
6 Longest flowpath slope (ft/ft)	1.3%			
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Open Brush (Poor)			
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Poor			



Prepared By:
ALLARD ENGINEERING
Civil Engineering - Land Surveying - Land Planning
16866 Seville Avenue
Fontana, California 92335
(909) 356-1815 Fax (909) 356-1795

SCALE: 1"= 120'

APN: 0143-191-59
COUNTY OF SAN BERNARDINO
DRAINAGE EXHIBIT-EXISTING

Filename: I:\Warmington Homes\Medical Center Drive San Bernardino\DWG's\ENTITLEMENT\EXHIBIT\DRAINAGE EXHIBIT.dwg

WQMP Project Report

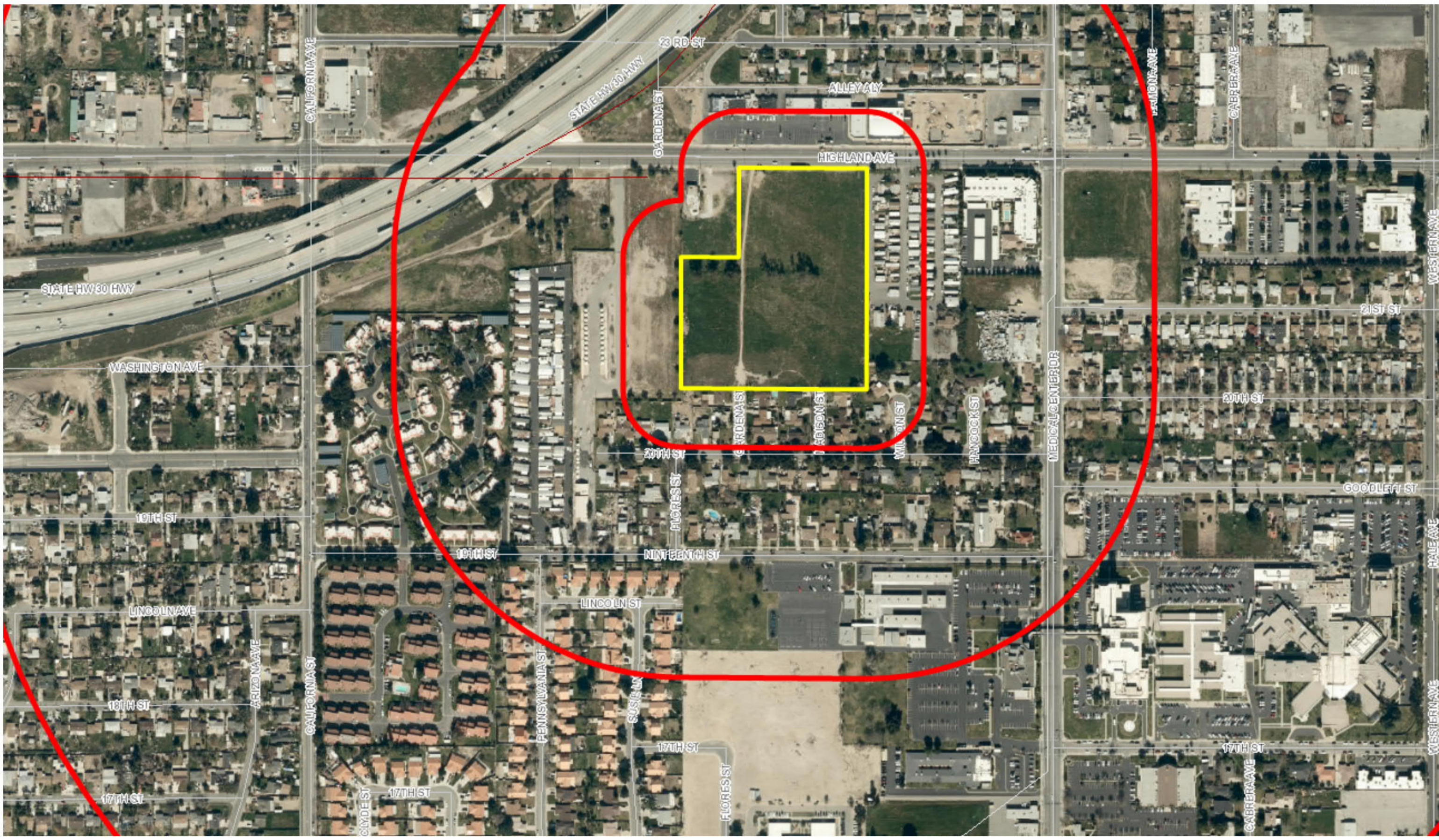
County of San Bernardino Stormwater Program

Santa Ana River Watershed Geodatabase

Monday, September 27, 2021

Note: The information provided in this report and on the Stormwater Geodatabase for the County of San Bernardino Stormwater Program is intended to provide basic guidance in the preparation of the applicant's Water Quality Management Plan (WQMP) and should not be relied upon without independent verification.

Project Site Parcel Number(s):	014319159
Project Site Acreage:	9.918
HCOC Exempt Area:	No
Closest Receiving Waters: **(Applicant to verify based on local drainage facilities and topography.)**	**System Number** - 218 **Facility Name** - Muscott Storm Drain **Owner** - SBCFCD
Closest channel segment's susceptibility to Hydromodification:	EHM
Highest downstream hydromodification susceptibility:	High
Is this drainage segment subject to TMDLs?	No
Are there downstream drainage segments subject to TMDLs?	No
Is this drainage segment a 303d listed stream?	No
Are there 303d listed streams downstream?	Yes
Are there unlined downstream waterbodies?	No
Project Site Onsite Soil Group(s):	A
Environmentally Sensitive Areas within 200':	None
Groundwater Depth (FT):	-298
Parcels with potential septic tanks within 1000':	No
Known Groundwater Contamination Plumes within 1000':	Yes
Studies and Reports Related to Project Site:	CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Hydraulic Design Data Preliminary Report on Proposed North SBFCP School Site Map Comprehensive Storm Drain Plan SBVMWD High Groundwater / Pressure Zone Area



0.1 Miles

Site Address: permitrack.sbcounty.gov/wap

Form 3-3 Watershed Description for Drainage Area DA1/DA2	
Receiving waters *Refer to Watershed Mapping Tool -* *http://sbcounty.permitrack.com/WAP* *See 'Drainage Facilities" link at this website*	Muscott Storm Drain (SBCFCD Facility# 218) Lytle Creek Wash Lytle-Cajon Channel (SBCFCD Flood Control Channel). Warm Creek Santa Ana River Reach 5 Santa Ana River Reach 4 Santa Ana River Reach 3
Applicable TMDLs *Refer to Local Implementation Plan*	Lytle Creek Wash-None Lytle-Cajun Channel: Pathogens "Fical indicator bacteria" Warm Creek: Chlorpyrifos "Pesticides" Santa Ana River Reach 5: NONE Santa Ana River Reach 4: Pathogens "Fical indicator bacteria" Santa Ana River Reach 3: Pathogens "Bacterial Indicator TMLDs for Middle Santa Ana River Watershed Waterbodies (Bill Rice) Nitrate : Santa Ana River Reach 3 Nitrate TMDL (Hope Smythe) Prado Flood Control basin Pathogens "Bacterial Indicator TMLDs for Middle Santa Ana River Watershed Waterbodies (Bill Rice) Santa Ana River Reach 2 NONE Santa Ana River Reach 1 NONE Tidal Prism, Santa Ana River NONE
303(d) listed impairments *Refer to Local Implementation Plan and Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP and State Water Resources Control Board website – http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml*	Expected pollutants of concern include organic compounds and trash/debris. Potential pollutants of concern include bacteria vitus, nutrients, pesticides, sediments, and oxygen demanding substances. There is no evidence to suggest that any other pollutants will be produced from the project site other than these. 303(d) listed impairment: Lytle Creek: Patheogens Santa Ana River Reach 3: Copper, Lead, Pathogens Prado Flood Control Basin: Pathogens and Nutrients Santa Ana River Reach 2: Pathogens Santa Ana River Reach 1 and Tidal prism Santa Ana River : NONE
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP*	NONE

Unlined Downstream Water Bodies *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/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	☒	☐	Practical education materials will be provided to property owners and Maintenance staffs covering various water quality issues that will need to be addressed on their specific site. These materials will include general practices that contribute to the protection of storm water quality and BMP's that eliminate or reduce pollution during property improvements. The developer will request these materials in writing at least 30 days prior to intended distribution and will then be responsible for publication and distribution.
N2	Activity Restrictions	☒	☐	At minimum Pesticide applications will be performed by an applicator certified by the California Department of Pesticide Regulation. Vehicle washing will be prohibited.
N3	Landscape Management BMPs	☒	☐	According to the California Stormwater Quality Associations Stormwater Best Management Practice Handbook, landscape planning is implemented to reduce groundwater and storm water contamination. This will be accomplished through an debris basins, infiltration basins, and landscape areas.
N4	BMP Maintenance	☒	☐	See section 5, Table 5.1 for details on BMP maintenance
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	No hazardous waster onsite
N6	Local Water Quality Ordinances	☒	☐	Comply with any applicable local water quality ordinances complying through this WQMP
N7	Spill Contingency Plan	☒	☐	Applicable "absorbent" materials shall be kept onsite in case of oils spills in parking lot.
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tank on the site.

Form 4.1-1 Non-Structural Source Control BMPs

N9	Hazardous Materials Disclosure Compliance	☐	☒	No Hazardous waste stored onsite.

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	☒	☐	Compliance with Article 80 of the Uniform Fire Code enforced by the fire protection agency. No fire hazardous waste is stored on site.
N11	Litter/Debris Control Program	☒	☐	Owners of individual lots will implement trash management and litter control procedures. At a minimum the site will be inspected weekly and trash picked up as necessary.
N12	Employee Training	☒	☐	Gardenaers and other maintenance staff will have training regarding the location and maintenance of the BMP.
N13	Housekeeping of Loading Docks	☐	☒	No Loading docks proposed.
N14	Catch Basin Inspection Program	☒	☐	Catch basins will be inspected a minimum of once every three months during the dry season and a minimum of once every two months during the rainy season.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	Private driveways/private streets and onsite pavement will be vacume sweep by the owner. At a minimum all paved areas shall be swept, in late summer or early fall. Prior to the start of the rainy season or equivalent, as govern by the governing jurisdiction.

N16	Other Non-structural Measures for Public Agency Projects	☐	☒	Not a public agency project.
N17	Comply with all other applicable NPDES permits	☒	☐	Construction is not over an acre so no general construction permit is required however this WQMP is in compliance with NPDES permit requirements.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One: Included	Check One: Not Applicable	Describe BMP Implementation OR, If not applicable, state reason
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	Signs will be placed above storm drain inlets to warn the public of prohibitions against waste disposal. The sign will be "NO DUMPING – THIS DRAINS TO OCEAN".
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	No material storages areas in the project
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	-Trash storage area will be roofed & paved to contain leaks & spills to minimize direct precipitation & exposure according to the design requirements of CASQA source control BMP SD-32 (Trash Enclosures).
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (State wide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	Rain sensors will be incorporated into the onsite sprinkler system so that no unnecessary watering of landscaped areas occurs after storm events.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	New landscaped areas will be constructed at a minimum of 1 inch below existing paved areas
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☒	☐	Slopes and Channel will be protected with rip-rap and vegetated swale (see plans for location) per San Bernardino County Standard.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	No dock, Not applicable
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No Bays, Not applicable
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No Vehicle Wash at the site, Not applicable
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No outdoor Processing, Not applicable

Form 4.1-2 Structural Source Control BMPs				
Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No equipment wash, Not applicable
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	No Fueling, Not applicable
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	No Hillside Landscaping, Not applicable
S14	Wash water control for food preparation areas	☐	☒	No food Preparation, Not applicable
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No Community Car Wash, Not applicable

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 *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*
Minimize impervious areas: Yes ☒ No ☐ Explanation: We will build more landscaping, planter areas in addition to the infiltration basin for infiltration.
Maximize natural infiltration capacity: Yes ☒ No ☐ Explanation: Runoff from a portion of impervious surfaces (Driveways, building roof etc) will first drain to the proposed landscaped areas/planters for bio-filtration and incidental infiltration before entering the proposed swale/grate inlets so that infiltration is maximized. Runoff will also be intercepted by the proposed infiltration basin for retention and infiltration.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: The site currently drains Southwest on surface and drains to Inland Center Dr and/or existing inlet structure by the Lytle-Cajon Channel. Post developed flow will also drain southwest to the Lytle/Cajon Channel via the proposed drainage system and proposed concrete channel. This is consistent with existing and flow patterns.
Disconnect impervious areas: Yes ☒ No ☐ Explanation: Impervious areas will drain into landscaped areas and numerous planter areas..
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: There are no environmentally sensitive areas with in the proposed sub-division and existing vegetation will be kept as much as possible in the open dirt area.
Re-vegetate disturbed areas: Yes ☒ No ☐ Explanation: Part of the disturbed areas will be revegeated, see landscape plan.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: There will be no compaction in infiltration basin basin area during compaction.
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☒ No ☐ Explanation: Utilized graded vegetated swale. Also Runoff will also be intercepted by the proposed infiltration basin and existing landscaped areas/planters within project site

Stake off areas that will be used for landscaping to minimize compaction during construction: Yes ☒ No ☐ Explanation: No compaction will be performed within the proposed area of infiltrationbasin and the landscape/planter areas.

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 P_6 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 mi^2), 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 (DMA1)		
1 Project area (DMA-1) (ft^2): 431,244	2 Imperviousness after applying preventative site design practices (Imp%): 70%	3 Runoff Coefficient (Rc): 0.49 *R_c = 0.858(Imp%)^3-0.78(Imp%)^2+0.774(Imp%)+0.04*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr-1hr}$ (in): 0.614 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.9093 (Using C1=1.4807) *P_6 = 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): 31,682 (Using C2=1.963) *DCV = 1/12 * [Item 1* Item 3 *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*		

Target Captured Volume
Watershed DA 1

1) Calculate the "Watershed Imperviousness Ratio", I which is equal to the percent of impervious area in the BMP Drainage Area divided by 100

Imperviousness(i)= **0.7**

Total Acreage(A) = **9.90** **431,244** SF

2) Calculate the composite Runoff Coefficient C_{bmp} for the drainage area

$Rc = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$

Rc 0.49

3) Determine which Regression Coefficient to use by region the project is located in

Valley	1.481
Mountain	1.909
Desert	1.237

Regression coefficient for this project is: 1.481

4) Determine the area averaged "6 hour Mean Storm Rainfall" , P_6

2 yr 1 Hr Rainfall Depth per NOAA Atlas 14= **0.614** inches

P_6 = 2 yr 1 hr Rainfall x Regression coefficient

P_6 = 0.9093 inches

5) Determine Regression Constant (a) for 48 hour drawdown

a for 24 hour = 1.582
a for 48 hour = 1.963

a = 1.963

6) Calculate the Maximized Detention Volume, P_0

$P_0 = C \times a \times P6$

Po(inches) = 0.8816

7) Calculate the Target Capture Volume, V_0, in acre feet

$V_0 = (P_0 * A)/12$

V_0 = 0.73 acre-feet
V_0 = 31,682 CF

NOAA Atlas 14, Volume 6, Version 2
Location name: San Bernardino, California, USA*
Latitude: 34.1349°, Longitude: -117.3254°
Elevation: 1232.88 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.125** (0.104-0.152)	**0.163** (0.136-0.199)	**0.216** (0.179-0.263)	**0.260** (0.213-0.319)	**0.321** (0.255-0.409)	**0.371** (0.288-0.482)	**0.422** (0.320-0.563)	**0.478** (0.352-0.656)	**0.556** (0.393-0.797)	**0.620** (0.423-0.920)
10-min	**0.179** (0.149-0.217)	**0.234** (0.195-0.285)	**0.309** (0.256-0.377)	**0.372** (0.306-0.457)	**0.461** (0.366-0.586)	**0.531** (0.413-0.691)	**0.606** (0.459-0.807)	**0.685** (0.504-0.940)	**0.798** (0.563-1.14)	**0.889** (0.606-1.32)
15-min	**0.216** (0.180-0.263)	**0.283** (0.235-0.344)	**0.374** (0.310-0.456)	**0.450** (0.370-0.553)	**0.557** (0.442-0.709)	**0.642** (0.499-0.835)	**0.732** (0.555-0.976)	**0.828** (0.610-1.14)	**0.965** (0.681-1.38)	**1.08** (0.732-1.60)
30-min	**0.321** (0.267-0.390)	**0.420** (0.349-0.511)	**0.554** (0.459-0.676)	**0.667** (0.548-0.820)	**0.826** (0.656-1.05)	**0.953** (0.740-1.24)	**1.09** (0.823-1.45)	**1.23** (0.905-1.69)	**1.43** (1.01-2.05)	**1.60** (1.09-2.37)
60-min	**0.469** (0.390-0.569)	**0.614** (0.510-0.747)	**0.810** (0.671-0.988)	**0.975** (0.801-1.20)	**1.21** (0.958-1.54)	**1.39** (1.08-1.81)	**1.59** (1.20-2.12)	**1.80** (1.32-2.46)	**2.09** (1.48-2.99)	**2.33** (1.59-3.46)
2-hr	**0.681** (0.566-0.827)	**0.875** (0.727-1.06)	**1.14** (0.940-1.38)	**1.35** (1.11-1.66)	**1.65** (1.31-2.10)	**1.88** (1.46-2.45)	**2.13** (1.61-2.84)	**2.38** (1.76-3.27)	**2.74** (1.93-3.92)	**3.03** (2.06-4.49)
3-hr	**0.841** (0.699-1.02)	**1.07** (0.892-1.31)	**1.38** (1.15-1.69)	**1.64** (1.35-2.01)	**1.99** (1.58-2.53)	**2.26** (1.76-2.94)	**2.55** (1.93-3.39)	**2.84** (2.09-3.90)	**3.25** (2.29-4.65)	**3.57** (2.43-5.30)
6-hr	**1.19** (0.991-1.45)	**1.51** (1.26-1.84)	**1.94** (1.61-2.36)	**2.29** (1.88-2.81)	**2.76** (2.19-3.51)	**3.13** (2.43-4.06)	**3.50** (2.65-4.66)	**3.89** (2.86-5.33)	**4.41** (3.12-6.32)	**4.83** (3.29-7.16)
12-hr	**1.58** (1.32-1.92)	**2.02** (1.68-2.46)	**2.60** (2.15-3.17)	**3.06** (2.52-3.77)	**3.69** (2.93-4.70)	**4.17** (3.24-5.42)	**4.66** (3.53-6.21)	**5.16** (3.80-7.08)	**5.84** (4.12-8.35)	**6.36** (4.33-9.43)
24-hr	**2.11** (1.87-2.44)	**2.74** (2.42-3.16)	**3.54** (3.12-4.10)	**4.19** (3.67-4.89)	**5.07** (4.29-6.10)	**5.73** (4.76-7.05)	**6.40** (5.19-8.07)	**7.09** (5.59-9.18)	**8.01** (6.06-10.8)	**8.72** (6.38-12.2)
2-day	**2.58** (2.28-2.97)	**3.39** (3.00-3.92)	**4.46** (3.93-5.16)	**5.33** (4.66-6.21)	**6.50** (5.50-7.83)	**7.40** (6.14-9.10)	**8.31** (6.73-10.5)	**9.25** (7.29-12.0)	**10.5** (7.96-14.2)	**11.5** (8.42-16.1)
3-day	**2.75** (2.44-3.17)	**3.68** (3.25-4.24)	**4.90** (4.33-5.67)	**5.91** (5.17-6.89)	**7.29** (6.17-8.78)	**8.36** (6.94-10.3)	**9.46** (7.66-11.9)	**10.6** (8.35-13.7)	**12.2** (9.20-16.4)	**13.4** (9.79-18.7)
4-day	**2.93** (2.59-3.37)	**3.95** (3.50-4.56)	**5.31** (4.69-6.15)	**6.44** (5.64-7.51)	**8.00** (6.77-9.64)	**9.22** (7.65-11.3)	**10.5** (8.48-13.2)	**11.8** (9.29-15.3)	**13.6** (10.3-18.3)	**15.0** (11.0-21.0)

7-day	**3.31** (2.93-3.81)	**4.51** (3.99-5.21)	**6.12** (5.40-7.08)	**7.46** (6.53-8.70)	**9.32** (7.90-11.2)	**10.8** (8.95-13.3)	**12.3** (9.97-15.5)	**13.9** (11.0-18.0)	**16.1** (12.2-21.7)	**17.9** (13.1-25.0)
10-day	**3.61** (3.19-4.16)	**4.95** (4.38-5.71)	**6.76** (5.96-7.81)	**8.26** (7.23-9.63)	**10.4** (8.78-12.5)	**12.0** (9.98-14.8)	**13.8** (11.1-17.3)	**15.6** (12.3-20.2)	**18.1** (13.7-24.4)	**20.2** (14.7-28.1)
20-day	**4.44** (3.93-5.12)	**6.16** (5.45-7.11)	**8.48** (7.48-9.81)	**10.4** (9.13-12.2)	**13.2** (11.2-15.9)	**15.4** (12.7-18.9)	**17.6** (14.3-22.2)	**20.1** (15.8-26.0)	**23.5** (17.7-31.6)	**26.2** (19.2-36.5)
30-day	**5.24** (4.64-6.04)	**7.29** (6.44-8.40)	**10.1** (8.87-11.6)	**12.4** (10.8-14.4)	**15.7** (13.3-18.9)	**18.3** (15.2-22.5)	**21.0** (17.0-26.5)	**24.0** (18.9-31.0)	**28.1** (21.2-37.9)	**31.4** (23.0-43.8)
45-day	**6.28** (5.56-7.24)	**8.70** (7.70-10.0)	**12.0** (10.6-13.9)	**14.7** (12.9-17.2)	**18.6** (15.8-22.5)	**21.7** (18.0-26.7)	**25.0** (20.3-31.5)	**28.5** (22.5-36.9)	**33.4** (25.3-45.1)	**37.4** (27.4-52.2)
60-day	**7.34** (6.50-8.45)	**10.1** (8.92-11.6)	**13.8** (12.2-16.0)	**16.9** (14.8-19.8)	**21.4** (18.1-25.7)	**24.9** (20.7-30.6)	**28.6** (23.2-36.0)	**32.6** (25.7-42.2)	**38.2** (28.9-51.5)	**42.7** (31.2-59.6)

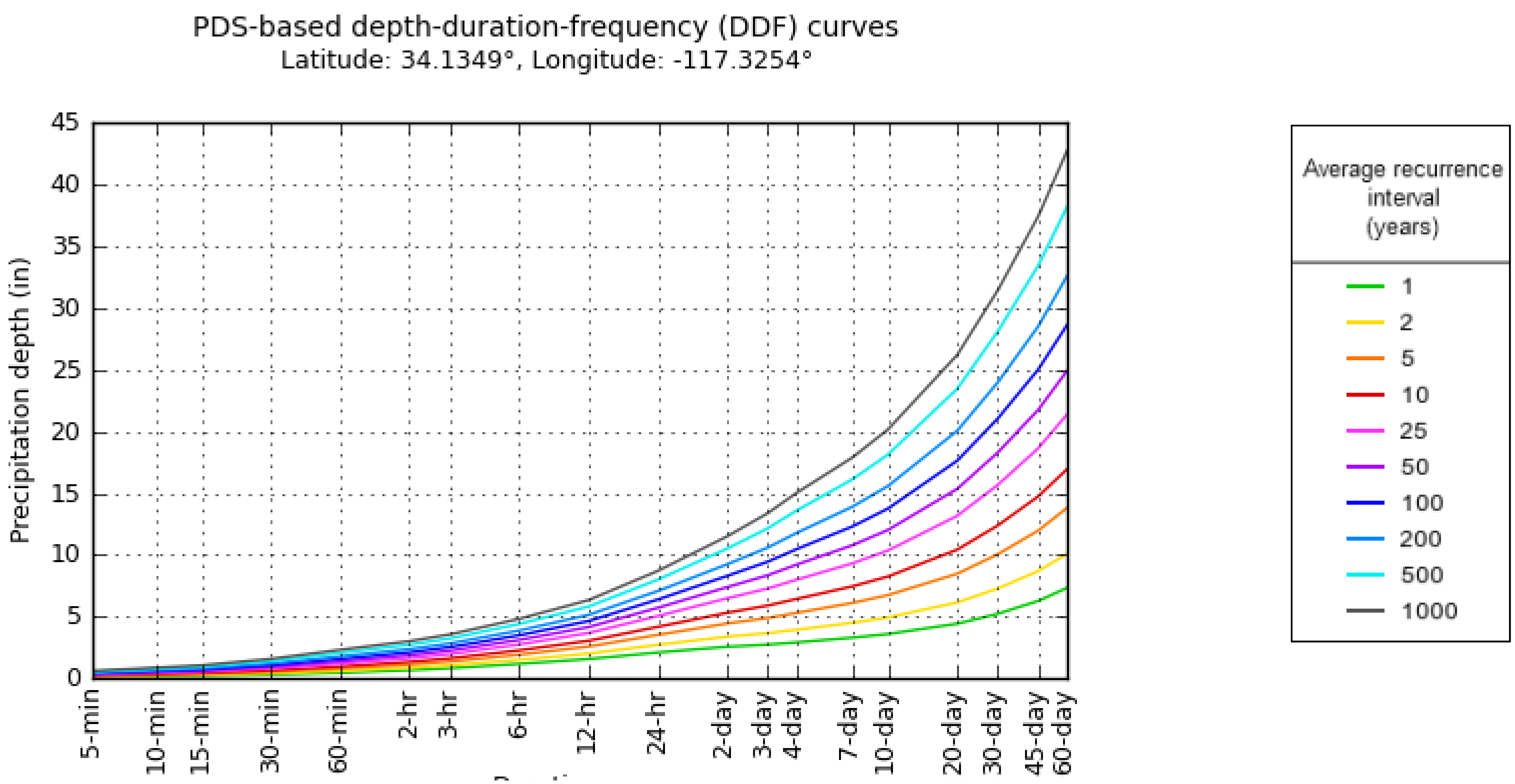
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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 average 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.

Back to Top

PF graphical



ACTUAL IMPERVIOUS COVER

Land Use (1)	Range-Percent	Recommended Value For Average Conditions-Percent (2)
Natural or Agriculture	0 - 0	0
Public Park	10 - 25	15
School	30 - 50	40
Single Family Residential: (3)		
2.5 acre lots	5 - 15	10
1 acre lots	10 - 25	20
2 dwellings/acre	20 - 40	30
3-4 dwellings/acre	30 - 50	40
5-7 dwellings/acre	35 - 55	50
8-10 dwellings/acre	50 - 70	60
More than 10 dwellings/acre	65 - 90	80
Multiple Family Residential:		
Condominiums	45 - 70	65
Apartments	65 - 90	80
Mobile Home Park	60 - 85	75
Commercial, Downtown Business or Industrial	80 - 100	90

Notes:

1. Land use should be based on ultimate development of the watershed. Long range master plans for the County and incorporated cities should be reviewed to insure reasonable land use assumptions.

2. Recommended values are based on average conditions which may not apply to a particular study area. The percentage impervious may vary greatly even on comparable sized lots due to differences in dwelling size, improvements, etc. Landscape practices should also be considered as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. A field investigation of a study area shall always be made, and a review of aerial photos, where available, may assist in estimating the percentage of impervious cover in developed areas.

3. For typical equestrian subdivisions increase impervious area 5 percent over the values recommended in the table above.

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

ACTUAL IMPERVIOUS COVER FOR DEVELOPED AREAS

Form 4.2-2 Summary of HCOC Assessment

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

Go to: http://sbcounty.permitrack.com/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 8,307	2 *25.4*	3 *2.3*
Post-developed	4 57,621	5 *15.3*	6 *10.8*
Difference	7 *49,314*	8 *-10.1*	9 *8.5*
Difference (as % of pre-developed)	10 *594% Increase* *Item 7 / Item 1*	11 *-40% Decrease* *Item 8 / Item 2*	12 *369% Increase* *Item 9 / Item 3*

For runoff volume calculation refer to Unit Hydrograph method analysis for 2-year 24 hour storm event for Pre-develop and Developed condition. For Time of Concentration and Peak Runoff calculation refer to the rational method hydrology analysis in pre-developed and developed condition of the site.

Per *http://sbcounty.permitrack.com/WAP* the project site is not located within the HCOC exempt area. Refer to the attached WQMP Project Report. The project site is proposing seven (7) underground Contech Chamber Systems to retain and infiltrate upto 50,218 cf which exceeds the difference in water volume (49,314 cf) in developed and undeveloped condition for HCOC mitigation and to satisfy required WQ water volume mitigation (DCV: 31,682 cf). Therefore the proposed Contech Systems will help mitigate the increased runoff volume due to development.

The proposed Contech retention/infiltration chamber systems will increase the time of concentration and decrease the peak runoff flowrate substantially by retaining the inflows before discharging on to the surface and ultimately drains to existing street at/below the existing flow rate.

WQMP Project Report

County of San Bernardino Stormwater Program

Santa Ana River Watershed Geodatabase

Monday, September 27, 2021

Note: The information provided in this report and on the Stormwater Geodatabase for the County of San Bernardino Stormwater Program is intended to provide basic guidance in the preparation of the applicant's Water Quality Management Plan (WQMP) and should not be relied upon without independent verification.

Project Site Parcel Number(s):	014319159
Project Site Acreage:	9.918
HCOC Exempt Area:	No
Closest Receiving Waters: (Applicant to verify based on local drainage facilities and topography.)	**System Number** - 218 **Facility Name** - Muscott Storm Drain **Owner** - SBCFCD
Closest channel segment's susceptibility to Hydromodification:	EHM
Highest downstream hydromodification susceptibility:	High
Is this drainage segment subject to TMDLs?	No
Are there downstream drainage segments subject to TMDLs?	No
Is this drainage segment a 303d listed stream?	No
Are there 303d listed streams downstream?	Yes
Are there unlined downstream waterbodies?	No
Project Site Onsite Soil Group(s):	A
Environmentally Sensitive Areas within 200':	None
Groundwater Depth (FT):	-298
Parcels with potential septic tanks within 1000':	No
Known Groundwater Contamination Plumes within 1000':	Yes
Studies and Reports Related to Project Site:	CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Hydraulic Design Data Preliminary Report on Proposed North SBFCP School Site Map Comprehensive Storm Drain Plan SBVMWD High Groundwater / Pressure Zone Area

HCOC ASSESSMENT FOR

-RUNOFF VOLUME
-TC & PEAK RUNOFF

HCOC MITIGATION CALCULATION

THE SITE IS NOT HCOC EXEMPT FOR WATER QUALITY ASPECT.

RUNOFF VOLUME IN DEVELOPED CONDITION: 1.3228 AC-FT ~ 57,621 CF
(2-YR, 24-HR STORM EVENT)

RUNOFF VOLUME IN EXISTING CONDITION: 0.1907 AC-FT ~ 8,307 CF
(2-YR, 24-HR STORM EVENT)

REQUIRED RETENTION VOLUME FOR HCOC MITIGATION (2-YR 24-HR STORM EVENT): 49,314 CF

RETENTION/INFILTRATION VOLUME PROVIDED WITH 7-BELOW SURFACE CONTECH RET/INF. CHAMBER SYSTEM: (7*7,159) = 50,218 CF
(RET/INFILTRATION CAPACITY OF EACH CONTECH CHAMBER SYSTEM: 7,174 CF)

THEREFOR HCOC MITTIGATED BY FULL RETENTION/INFILTRATION PROVIDING BY THE CONTECH CHAMBER SYSTEM 1 THROUGH 7.

SEE THE FOLLOWING PAGES FOR HYDROLIGY CALCULATION FOR 2-STORM EVENT.

RATIONAL METHOD HYDROLOGY-2YR STORM EVENT
DEVELOPED CONDITION

```
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2016 Advanced Engineering Software (aes)
             Ver. 23.0  Release Date: 07/01/2016  License ID 1400

                           Analysis prepared by:




 ************************** DESCRIPTION OF STUDY **************************
* MEDICAL CENTER DR SITE                                                   *
* 2-YR STORM EVENT                                                         *
* DEVELOPED CONDITION                                                      *
 **************************************************************************

  FILE NAME: PALM.DAT
  TIME/DATE OF STUDY: 13:50 10/05/2021
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.7000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.6140

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

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

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

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1115.00
  ELEVATION DATA: UPSTREAM(FEET) =   1240.30  DOWNSTREAM(FEET) =   1228.16

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   15.289
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.599
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      A        9.90      0.98     0.400    32   15.29
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
```

```
  SUBAREA RUNOFF(CFS) =     10.77
  TOTAL AREA(ACRES) =      9.90   PEAK FLOW RATE(CFS) =     10.77
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        9.9  TC(MIN.) =     15.29
  EFFECTIVE AREA(ACRES) =      9.90  AREA-AVERAGED Fm(INCH/HR)=  0.39
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap = 0.400
  PEAK FLOW RATE(CFS)   =      10.77
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

RATIONAL METHOD HYDROLOGY-2YR STORM EVENT
EXISTING CONDITION

```
****************************************************************************
              RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
           (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
          (c) Copyright 1983-2016 Advanced Engineering Software (aes)
              Ver. 23.0  Release Date: 07/01/2016  License ID 1400

                            Analysis prepared by:




 ************************** DESCRIPTION OF STUDY **************************
* MEDICAL CENTER DR SITE                                                   *
* 2-YR STORM EVENT                                                         *
* EXISTING CONDITION                                                       *
 **************************************************************************

  FILE NAME: PALM.DAT
  TIME/DATE OF STUDY: 13:58 10/05/2021
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.7000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.6140

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

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

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

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   905.00
  ELEVATION DATA: UPSTREAM(FEET) =   1240.30  DOWNSTREAM(FEET) =   1228.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   25.399
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.121
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  NATURAL FAIR COVER
  "OPEN BRUSH"               A        9.90      0.86     1.000    46   25.40
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.86
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
```

```
  SUBAREA RUNOFF(CFS) =      2.32
  TOTAL AREA(ACRES) =      9.90   PEAK FLOW RATE(CFS) =      2.32
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        9.9  TC(MIN.) =     25.40
  EFFECTIVE AREA(ACRES) =      9.90  AREA-AVERAGED Fm(INCH/HR)=  0.86
  AREA-AVERAGED Fp(INCH/HR) =  0.86  AREA-AVERAGED Ap = 1.000
  PEAK FLOW RATE(CFS)   =       2.32
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

UNIT HYDROGRAPH METHOD-2YR, 24HR STORM EVENT
DEVELOPED CONDITION

```
       U n i t   H y d r o g r a p h   A n a l y s i s

       Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2018, Version 9.0

              Study date  10/05/21

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
------------------------------------------------------------------------

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


Program License Serial Number 6484

---------------------------------------------------------------------
UH METHOD
2-YR 24-HR STORM EVENT
DEVELOPED CONDITION

--------------------------------------------------------------------

       Storm Event Year = 2

       Antecedent Moisture Condition = 2

 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        Duration        Isohyetal
       (Ac.)            (hours)         (In)
Rainfall data for year 2
            9.90           1           0.61
--------------------------------------------------------------------
Rainfall data for year 2
            9.90           6           1.51
--------------------------------------------------------------------
Rainfall data for year 2
            9.90          24           2.74
--------------------------------------------------------------------
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

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


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 2)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 32.0      32.0          9.90      1.000     0.978    0.400    0.391

Area-averaged adjusted loss rate Fm (In/Hr) =  0.391

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

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC2)           Yield Fr
     3.96   0.400         32.0      32.0      13.70     0.000
     5.94   0.600         98.0      98.0       0.20     0.916

Area-averaged catchment yield fraction, Y =  0.550
Area-averaged low loss fraction, Yb =  0.450
Direct entry of lag time by user
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
Watershed area =       9.90(Ac.)
Catchment Lag time =   0.204 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 40.8497
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.391(In/Hr)
Average low loss rate fraction (Yb) = 0.450 (decimal)
VALLEY DEVELOPED S-Graph Selected
Computed peak 5-minute rainfall =  0.291(In)
Computed peak 30-minute rainfall =  0.499(In)
Specified peak 1-hour rainfall =  0.614(In)
Computed peak 3-hour rainfall =  1.066(In)
Specified peak 6-hour rainfall =  1.510(In)
Specified peak 24-hour rainfall =  2.740(In)


Rainfall depth area reduction factors:
Using a total area of       9.90(Ac.) (Ref: fig. E-4)

5-minute factor = 1.000     Adjusted rainfall =  0.291(In)
30-minute factor = 1.000    Adjusted rainfall =  0.498(In)
1-hour factor = 1.000       Adjusted rainfall =  0.614(In)
3-hour factor = 1.000       Adjusted rainfall =  1.066(In)
6-hour factor = 1.000       Adjusted rainfall =  1.510(In)
24-hour factor = 1.000      Adjusted rainfall =  2.740(In)
---------------------------------------------------------------------

                      U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values            ((CFS))
---------------------------------------------------------------------
               (K =       119.73 (CFS))

  1                3.149                  3.771
  2               20.376                 20.625
  3               51.474                 37.233
  4               79.346                 33.370
  5               91.904                 15.035
  6               97.070                  6.186
  7               98.579                  1.807
  8               99.315                  0.880
  9              100.000                  0.821
---------------------------------------------------------------------
Peak Unit   Adjusted mass rainfall  Unit rainfall
Number              (In)                (In)
  1              0.2912              0.2912
  2              0.3585              0.0673
  3              0.4049              0.0464
  4              0.4414              0.0365
  5              0.4720              0.0306
  6              0.4985              0.0265
  7              0.5221              0.0236
  8              0.5434              0.0213
  9              0.5630              0.0195
 10              0.5810              0.0181
 11              0.5979              0.0169
 12              0.6137              0.0158
 13              0.6389              0.0252
 14              0.6632              0.0242
 15              0.6866              0.0234
 16              0.7092              0.0226
 17              0.7311              0.0219
 18              0.7524              0.0213
 19              0.7732              0.0207
 20              0.7934              0.0202
 21              0.8130              0.0197
 22              0.8323              0.0192
 23              0.8511              0.0188
 24              0.8695              0.0184
 25              0.8875              0.0180
```

26	0.9052	0.0177
27	0.9225	0.0173
28	0.9395	0.0170
29	0.9562	0.0167
30	0.9727	0.0164
31	0.9888	0.0162
32	1.0047	0.0159
33	1.0204	0.0157
34	1.0358	0.0154
35	1.0510	0.0152
36	1.0660	0.0150
37	1.0808	0.0148
38	1.0954	0.0146
39	1.1098	0.0144
40	1.1240	0.0142
41	1.1380	0.0140
42	1.1518	0.0139
43	1.1655	0.0137
44	1.1791	0.0135
45	1.1925	0.0134
46	1.2057	0.0132
47	1.2188	0.0131
48	1.2317	0.0130
49	1.2446	0.0128
50	1.2573	0.0127
51	1.2698	0.0126
52	1.2823	0.0124
53	1.2946	0.0123
54	1.3068	0.0122
55	1.3189	0.0121
56	1.3309	0.0120
57	1.3428	0.0119
58	1.3546	0.0118
59	1.3662	0.0117
60	1.3778	0.0116
61	1.3893	0.0115
62	1.4007	0.0114
63	1.4120	0.0113
64	1.4232	0.0112
65	1.4343	0.0111
66	1.4454	0.0110
67	1.4563	0.0110
68	1.4672	0.0109
69	1.4780	0.0108
70	1.4887	0.0107
71	1.4994	0.0106
72	1.5100	0.0106
73	1.5189	0.0090
74	1.5278	0.0089
75	1.5367	0.0088
76	1.5455	0.0088
77	1.5542	0.0087
78	1.5628	0.0086
79	1.5714	0.0086
80	1.5799	0.0085
81	1.5884	0.0085
82	1.5968	0.0084
83	1.6051	0.0083
84	1.6134	0.0083
85	1.6216	0.0082
86	1.6298	0.0082
87	1.6379	0.0081
88	1.6460	0.0081
89	1.6540	0.0080
90	1.6620	0.0080
91	1.6699	0.0079
92	1.6777	0.0079
93	1.6855	0.0078
94	1.6933	0.0078
95	1.7010	0.0077
96	1.7087	0.0077

97	1.7163	0.0076
98	1.7239	0.0076
99	1.7314	0.0075
100	1.7389	0.0075
101	1.7464	0.0075
102	1.7538	0.0074
103	1.7612	0.0074
104	1.7685	0.0073
105	1.7758	0.0073
106	1.7830	0.0072
107	1.7903	0.0072
108	1.7974	0.0072
109	1.8046	0.0071
110	1.8117	0.0071
111	1.8187	0.0071
112	1.8257	0.0070
113	1.8327	0.0070
114	1.8397	0.0070
115	1.8466	0.0069
116	1.8535	0.0069
117	1.8603	0.0069
118	1.8672	0.0068
119	1.8739	0.0068
120	1.8807	0.0068
121	1.8874	0.0067
122	1.8941	0.0067
123	1.9008	0.0067
124	1.9074	0.0066
125	1.9140	0.0066
126	1.9206	0.0066
127	1.9271	0.0065
128	1.9336	0.0065
129	1.9401	0.0065
130	1.9465	0.0065
131	1.9530	0.0064
132	1.9593	0.0064
133	1.9657	0.0064
134	1.9721	0.0063
135	1.9784	0.0063
136	1.9847	0.0063
137	1.9909	0.0063
138	1.9971	0.0062
139	2.0034	0.0062
140	2.0095	0.0062
141	2.0157	0.0062
142	2.0218	0.0061
143	2.0279	0.0061
144	2.0340	0.0061
145	2.0401	0.0061
146	2.0461	0.0060
147	2.0521	0.0060
148	2.0581	0.0060
149	2.0641	0.0060
150	2.0700	0.0059
151	2.0759	0.0059
152	2.0818	0.0059
153	2.0877	0.0059
154	2.0936	0.0059
155	2.0994	0.0058
156	2.1052	0.0058
157	2.1110	0.0058
158	2.1168	0.0058
159	2.1225	0.0057
160	2.1282	0.0057
161	2.1340	0.0057
162	2.1396	0.0057
163	2.1453	0.0057
164	2.1510	0.0056
165	2.1566	0.0056
166	2.1622	0.0056
167	2.1678	0.0056

168	2.1734	0.0056
169	2.1789	0.0056
170	2.1844	0.0055
171	2.1899	0.0055
172	2.1954	0.0055
173	2.2009	0.0055
174	2.2064	0.0055
175	2.2118	0.0054
176	2.2172	0.0054
177	2.2227	0.0054
178	2.2280	0.0054
179	2.2334	0.0054
180	2.2388	0.0054
181	2.2441	0.0053
182	2.2494	0.0053
183	2.2547	0.0053
184	2.2600	0.0053
185	2.2653	0.0053
186	2.2705	0.0053
187	2.2758	0.0052
188	2.2810	0.0052
189	2.2862	0.0052
190	2.2914	0.0052
191	2.2966	0.0052
192	2.3017	0.0052
193	2.3069	0.0051
194	2.3120	0.0051
195	2.3171	0.0051
196	2.3222	0.0051
197	2.3273	0.0051
198	2.3324	0.0051
199	2.3374	0.0051
200	2.3425	0.0050
201	2.3475	0.0050
202	2.3525	0.0050
203	2.3575	0.0050
204	2.3625	0.0050
205	2.3675	0.0050
206	2.3724	0.0050
207	2.3774	0.0049
208	2.3823	0.0049
209	2.3872	0.0049
210	2.3921	0.0049
211	2.3970	0.0049
212	2.4019	0.0049
213	2.4068	0.0049
214	2.4116	0.0049
215	2.4164	0.0048
216	2.4213	0.0048
217	2.4261	0.0048
218	2.4309	0.0048
219	2.4357	0.0048
220	2.4404	0.0048
221	2.4452	0.0048
222	2.4500	0.0047
223	2.4547	0.0047
224	2.4594	0.0047
225	2.4641	0.0047
226	2.4688	0.0047
227	2.4735	0.0047
228	2.4782	0.0047
229	2.4829	0.0047
230	2.4875	0.0047
231	2.4922	0.0046
232	2.4968	0.0046
233	2.5014	0.0046
234	2.5060	0.0046
235	2.5106	0.0046
236	2.5152	0.0046
237	2.5198	0.0046
238	2.5243	0.0046

239	2.5289	0.0046
240	2.5334	0.0045
241	2.5380	0.0045
242	2.5425	0.0045
243	2.5470	0.0045
244	2.5515	0.0045
245	2.5560	0.0045
246	2.5605	0.0045
247	2.5649	0.0045
248	2.5694	0.0045
249	2.5738	0.0044
250	2.5783	0.0044
251	2.5827	0.0044
252	2.5871	0.0044
253	2.5915	0.0044
254	2.5959	0.0044
255	2.6003	0.0044
256	2.6047	0.0044
257	2.6091	0.0044
258	2.6134	0.0044
259	2.6178	0.0043
260	2.6221	0.0043
261	2.6265	0.0043
262	2.6308	0.0043
263	2.6351	0.0043
264	2.6394	0.0043
265	2.6437	0.0043
266	2.6480	0.0043
267	2.6522	0.0043
268	2.6565	0.0043
269	2.6608	0.0043
270	2.6650	0.0042
271	2.6692	0.0042
272	2.6735	0.0042
273	2.6777	0.0042
274	2.6819	0.0042
275	2.6861	0.0042
276	2.6903	0.0042
277	2.6945	0.0042
278	2.6987	0.0042
279	2.7028	0.0042
280	2.7070	0.0042
281	2.7111	0.0042
282	2.7153	0.0041
283	2.7194	0.0041
284	2.7235	0.0041
285	2.7277	0.0041
286	2.7318	0.0041
287	2.7359	0.0041
288	2.7400	0.0041

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0041	0.0018	0.0022
2	0.0041	0.0018	0.0023
3	0.0041	0.0019	0.0023
4	0.0041	0.0019	0.0023
5	0.0041	0.0019	0.0023
6	0.0042	0.0019	0.0023
7	0.0042	0.0019	0.0023
8	0.0042	0.0019	0.0023
9	0.0042	0.0019	0.0023
10	0.0042	0.0019	0.0023
11	0.0042	0.0019	0.0023
12	0.0042	0.0019	0.0023
13	0.0042	0.0019	0.0023
14	0.0043	0.0019	0.0023
15	0.0043	0.0019	0.0023
16	0.0043	0.0019	0.0024

17	0.0043	0.0019	0.0024
18	0.0043	0.0019	0.0024
19	0.0043	0.0020	0.0024
20	0.0043	0.0020	0.0024
21	0.0044	0.0020	0.0024
22	0.0044	0.0020	0.0024
23	0.0044	0.0020	0.0024
24	0.0044	0.0020	0.0024
25	0.0044	0.0020	0.0024
26	0.0044	0.0020	0.0024
27	0.0044	0.0020	0.0024
28	0.0045	0.0020	0.0024
29	0.0045	0.0020	0.0025
30	0.0045	0.0020	0.0025
31	0.0045	0.0020	0.0025
32	0.0045	0.0020	0.0025
33	0.0045	0.0020	0.0025
34	0.0046	0.0021	0.0025
35	0.0046	0.0021	0.0025
36	0.0046	0.0021	0.0025
37	0.0046	0.0021	0.0025
38	0.0046	0.0021	0.0025
39	0.0046	0.0021	0.0026
40	0.0047	0.0021	0.0026
41	0.0047	0.0021	0.0026
42	0.0047	0.0021	0.0026
43	0.0047	0.0021	0.0026
44	0.0047	0.0021	0.0026
45	0.0047	0.0021	0.0026
46	0.0048	0.0021	0.0026
47	0.0048	0.0022	0.0026
48	0.0048	0.0022	0.0026
49	0.0048	0.0022	0.0027
50	0.0048	0.0022	0.0027
51	0.0049	0.0022	0.0027
52	0.0049	0.0022	0.0027
53	0.0049	0.0022	0.0027
54	0.0049	0.0022	0.0027
55	0.0049	0.0022	0.0027
56	0.0050	0.0022	0.0027
57	0.0050	0.0022	0.0027
58	0.0050	0.0023	0.0027
59	0.0050	0.0023	0.0028
60	0.0050	0.0023	0.0028
61	0.0051	0.0023	0.0028
62	0.0051	0.0023	0.0028
63	0.0051	0.0023	0.0028
64	0.0051	0.0023	0.0028
65	0.0052	0.0023	0.0028
66	0.0052	0.0023	0.0028
67	0.0052	0.0023	0.0029
68	0.0052	0.0024	0.0029
69	0.0053	0.0024	0.0029
70	0.0053	0.0024	0.0029
71	0.0053	0.0024	0.0029
72	0.0053	0.0024	0.0029
73	0.0054	0.0024	0.0029
74	0.0054	0.0024	0.0030
75	0.0054	0.0024	0.0030
76	0.0054	0.0024	0.0030
77	0.0055	0.0025	0.0030
78	0.0055	0.0025	0.0030
79	0.0055	0.0025	0.0030
80	0.0055	0.0025	0.0030
81	0.0056	0.0025	0.0031
82	0.0056	0.0025	0.0031
83	0.0056	0.0025	0.0031
84	0.0056	0.0025	0.0031
85	0.0057	0.0026	0.0031
86	0.0057	0.0026	0.0031
87	0.0057	0.0026	0.0032

88	0.0058	0.0026	0.0032
89	0.0058	0.0026	0.0032
90	0.0058	0.0026	0.0032
91	0.0059	0.0026	0.0032
92	0.0059	0.0027	0.0032
93	0.0059	0.0027	0.0033
94	0.0060	0.0027	0.0033
95	0.0060	0.0027	0.0033
96	0.0060	0.0027	0.0033
97	0.0061	0.0027	0.0033
98	0.0061	0.0028	0.0034
99	0.0062	0.0028	0.0034
100	0.0062	0.0028	0.0034
101	0.0062	0.0028	0.0034
102	0.0063	0.0028	0.0034
103	0.0063	0.0028	0.0035
104	0.0063	0.0029	0.0035
105	0.0064	0.0029	0.0035
106	0.0064	0.0029	0.0035
107	0.0065	0.0029	0.0036
108	0.0065	0.0029	0.0036
109	0.0066	0.0030	0.0036
110	0.0066	0.0030	0.0036
111	0.0067	0.0030	0.0037
112	0.0067	0.0030	0.0037
113	0.0068	0.0030	0.0037
114	0.0068	0.0031	0.0037
115	0.0069	0.0031	0.0038
116	0.0069	0.0031	0.0038
117	0.0070	0.0031	0.0038
118	0.0070	0.0031	0.0038
119	0.0071	0.0032	0.0039
120	0.0071	0.0032	0.0039
121	0.0072	0.0032	0.0039
122	0.0072	0.0032	0.0040
123	0.0073	0.0033	0.0040
124	0.0073	0.0033	0.0040
125	0.0074	0.0033	0.0041
126	0.0075	0.0034	0.0041
127	0.0075	0.0034	0.0041
128	0.0076	0.0034	0.0042
129	0.0077	0.0035	0.0042
130	0.0077	0.0035	0.0042
131	0.0078	0.0035	0.0043
132	0.0079	0.0035	0.0043
133	0.0080	0.0036	0.0044
134	0.0080	0.0036	0.0044
135	0.0081	0.0037	0.0045
136	0.0082	0.0037	0.0045
137	0.0083	0.0037	0.0046
138	0.0083	0.0038	0.0046
139	0.0085	0.0038	0.0046
140	0.0085	0.0038	0.0047
141	0.0086	0.0039	0.0047
142	0.0087	0.0039	0.0048
143	0.0088	0.0040	0.0049
144	0.0089	0.0040	0.0049
145	0.0106	0.0048	0.0058
146	0.0106	0.0048	0.0058
147	0.0108	0.0049	0.0059
148	0.0109	0.0049	0.0060
149	0.0110	0.0050	0.0061
150	0.0111	0.0050	0.0061
151	0.0113	0.0051	0.0062
152	0.0114	0.0051	0.0063
153	0.0116	0.0052	0.0064
154	0.0117	0.0053	0.0064
155	0.0119	0.0054	0.0065
156	0.0120	0.0054	0.0066
157	0.0122	0.0055	0.0067
158	0.0123	0.0056	0.0068

159	0.0126	0.0057	0.0069
160	0.0127	0.0057	0.0070
161	0.0130	0.0058	0.0071
162	0.0131	0.0059	0.0072
163	0.0134	0.0060	0.0074
164	0.0135	0.0061	0.0074
165	0.0139	0.0062	0.0076
166	0.0140	0.0063	0.0077
167	0.0144	0.0065	0.0079
168	0.0146	0.0066	0.0080
169	0.0150	0.0068	0.0082
170	0.0152	0.0068	0.0084
171	0.0157	0.0071	0.0086
172	0.0159	0.0072	0.0087
173	0.0164	0.0074	0.0090
174	0.0167	0.0075	0.0092
175	0.0173	0.0078	0.0095
176	0.0177	0.0080	0.0097
177	0.0184	0.0083	0.0101
178	0.0188	0.0085	0.0103
179	0.0197	0.0089	0.0108
180	0.0202	0.0091	0.0111
181	0.0213	0.0096	0.0117
182	0.0219	0.0099	0.0121
183	0.0234	0.0105	0.0129
184	0.0242	0.0109	0.0133
185	0.0158	0.0071	0.0087
186	0.0169	0.0076	0.0093
187	0.0195	0.0088	0.0107
188	0.0213	0.0096	0.0117
189	0.0265	0.0120	0.0146
190	0.0306	0.0138	0.0168
191	0.0464	0.0209	0.0255
192	0.0673	0.0303	0.0370
193	0.2912	0.0326	0.2586
194	0.0365	0.0164	0.0201
195	0.0236	0.0106	0.0130
196	0.0181	0.0081	0.0099
197	0.0252	0.0113	0.0138
198	0.0226	0.0102	0.0124
199	0.0207	0.0093	0.0114
200	0.0192	0.0087	0.0106
201	0.0180	0.0081	0.0099
202	0.0170	0.0077	0.0094
203	0.0162	0.0073	0.0089
204	0.0154	0.0069	0.0085
205	0.0148	0.0067	0.0081
206	0.0142	0.0064	0.0078
207	0.0137	0.0062	0.0075
208	0.0132	0.0060	0.0073
209	0.0128	0.0058	0.0070
210	0.0124	0.0056	0.0068
211	0.0121	0.0055	0.0066
212	0.0118	0.0053	0.0065
213	0.0115	0.0052	0.0063
214	0.0112	0.0051	0.0062
215	0.0110	0.0049	0.0060
216	0.0107	0.0048	0.0059
217	0.0090	0.0040	0.0049
218	0.0088	0.0040	0.0048
219	0.0086	0.0039	0.0047
220	0.0084	0.0038	0.0046
221	0.0082	0.0037	0.0045
222	0.0081	0.0036	0.0044
223	0.0079	0.0036	0.0043
224	0.0078	0.0035	0.0043
225	0.0076	0.0034	0.0042
226	0.0075	0.0034	0.0041
227	0.0074	0.0033	0.0040
228	0.0072	0.0033	0.0040
229	0.0071	0.0032	0.0039

230	0.0070	0.0032	0.0039
231	0.0069	0.0031	0.0038
232	0.0068	0.0031	0.0037
233	0.0067	0.0030	0.0037
234	0.0066	0.0030	0.0036
235	0.0065	0.0029	0.0036
236	0.0065	0.0029	0.0035
237	0.0064	0.0029	0.0035
238	0.0063	0.0028	0.0035
239	0.0062	0.0028	0.0034
240	0.0061	0.0028	0.0034
241	0.0061	0.0027	0.0033
242	0.0060	0.0027	0.0033
243	0.0059	0.0027	0.0033
244	0.0059	0.0026	0.0032
245	0.0058	0.0026	0.0032
246	0.0057	0.0026	0.0031
247	0.0057	0.0026	0.0031
248	0.0056	0.0025	0.0031
249	0.0056	0.0025	0.0031
250	0.0055	0.0025	0.0030
251	0.0054	0.0025	0.0030
252	0.0054	0.0024	0.0030
253	0.0053	0.0024	0.0029
254	0.0053	0.0024	0.0029
255	0.0052	0.0024	0.0029
256	0.0052	0.0023	0.0029
257	0.0051	0.0023	0.0028
258	0.0051	0.0023	0.0028
259	0.0051	0.0023	0.0028
260	0.0050	0.0023	0.0028
261	0.0050	0.0022	0.0027
262	0.0049	0.0022	0.0027
263	0.0049	0.0022	0.0027
264	0.0049	0.0022	0.0027
265	0.0048	0.0022	0.0026
266	0.0048	0.0022	0.0026
267	0.0047	0.0021	0.0026
268	0.0047	0.0021	0.0026
269	0.0047	0.0021	0.0026
270	0.0046	0.0021	0.0025
271	0.0046	0.0021	0.0025
272	0.0046	0.0021	0.0025
273	0.0045	0.0020	0.0025
274	0.0045	0.0020	0.0025
275	0.0045	0.0020	0.0025
276	0.0044	0.0020	0.0024
277	0.0044	0.0020	0.0024
278	0.0044	0.0020	0.0024
279	0.0043	0.0020	0.0024
280	0.0043	0.0019	0.0024
281	0.0043	0.0019	0.0024
282	0.0043	0.0019	0.0023
283	0.0042	0.0019	0.0023
284	0.0042	0.0019	0.0023
285	0.0042	0.0019	0.0023
286	0.0042	0.0019	0.0023
287	0.0041	0.0019	0.0023
288	0.0041	0.0019	0.0023

```
--------------------------------------------------------------------
--------------------------------------------------------------------
Total soil rain loss =      1.14(In)
Total effective rainfall =      1.60(In)
Peak flow rate in flood hydrograph =     11.86(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         5.0       10.0      15.0      20.0
-----------------------------------------------------------------------
  0+ 5       0.0001      0.01  Q         |         |         |         |
  0+10       0.0004      0.05  Q         |         |         |         |
  0+15       0.0014      0.14  Q         |         |         |         |
  0+20       0.0029      0.21  Q         |         |         |         |
  0+25       0.0046      0.25  Q         |         |         |         |
  0+30       0.0064      0.26  Q         |         |         |         |
  0+35       0.0082      0.27  Q         |         |         |         |
  0+40       0.0101      0.27  Q         |         |         |         |
  0+45       0.0120      0.27  Q         |         |         |         |
  0+50       0.0139      0.27  Q         |         |         |         |
  0+55       0.0158      0.28  Q         |         |         |         |
  1+ 0       0.0177      0.28  Q         |         |         |         |
  1+ 5       0.0196      0.28  Q         |         |         |         |
  1+10       0.0215      0.28  Q         |         |         |         |
  1+15       0.0234      0.28  Q         |         |         |         |
  1+20       0.0253      0.28  Q         |         |         |         |
  1+25       0.0273      0.28  Q         |         |         |         |
  1+30       0.0292      0.28  Q         |         |         |         |
  1+35       0.0312      0.28  Q         |         |         |         |
  1+40       0.0331      0.28  QV        |         |         |         |
  1+45       0.0351      0.28  QV        |         |         |         |
  1+50       0.0370      0.29  QV        |         |         |         |
  1+55       0.0390      0.29  QV        |         |         |         |
  2+ 0       0.0410      0.29  QV        |         |         |         |
  2+ 5       0.0430      0.29  QV        |         |         |         |
  2+10       0.0450      0.29  QV        |         |         |         |
  2+15       0.0469      0.29  QV        |         |         |         |
  2+20       0.0490      0.29  QV        |         |         |         |
  2+25       0.0510      0.29  QV        |         |         |         |
  2+30       0.0530      0.29  QV        |         |         |         |
  2+35       0.0550      0.29  QV        |         |         |         |
  2+40       0.0570      0.29  QV        |         |         |         |
  2+45       0.0591      0.30  QV        |         |         |         |
  2+50       0.0611      0.30  QV        |         |         |         |
  2+55       0.0632      0.30  QV        |         |         |         |
  3+ 0       0.0652      0.30  QV        |         |         |         |
  3+ 5       0.0673      0.30  Q V       |         |         |         |
  3+10       0.0694      0.30  Q V       |         |         |         |
  3+15       0.0715      0.30  Q V       |         |         |         |
  3+20       0.0735      0.30  Q V       |         |         |         |
  3+25       0.0756      0.30  Q V       |         |         |         |
  3+30       0.0778      0.31  Q V       |         |         |         |
  3+35       0.0799      0.31  Q V       |         |         |         |
  3+40       0.0820      0.31  Q V       |         |         |         |
  3+45       0.0841      0.31  Q V       |         |         |         |
  3+50       0.0863      0.31  Q V       |         |         |         |
  3+55       0.0884      0.31  Q V       |         |         |         |
  4+ 0       0.0906      0.31  Q V       |         |         |         |
  4+ 5       0.0927      0.31  Q V       |         |         |         |
  4+10       0.0949      0.32  Q V       |         |         |         |
  4+15       0.0971      0.32  Q V       |         |         |         |
  4+20       0.0993      0.32  Q  V      |         |         |         |
  4+25       0.1015      0.32  Q  V      |         |         |         |
  4+30       0.1037      0.32  Q  V      |         |         |         |
  4+35       0.1059      0.32  Q  V      |         |         |         |
  4+40       0.1081      0.32  Q  V      |         |         |         |
  4+45       0.1103      0.32  Q  V      |         |         |         |
  4+50       0.1126      0.33  Q  V      |         |         |         |
  4+55       0.1148      0.33  Q  V      |         |         |         |
  5+ 0       0.1171      0.33  Q  V      |         |         |         |
  5+ 5       0.1194      0.33  Q  V      |         |         |         |
  5+10       0.1216      0.33  Q  V      |         |         |         |
  5+15       0.1239      0.33  Q  V      |         |         |         |
  5+20       0.1262      0.33  Q  V      |         |         |         |
  5+25       0.1285      0.34  Q  V      |         |         |         |
  5+30       0.1309      0.34  Q  V      |         |         |         |
  5+35       0.1332      0.34  Q   V     |         |         |         |
  5+40       0.1355      0.34  Q   V     |         |         |         |
```

```
 5+45       0.1379      0.34  Q   V     |         |         |         |
 5+50       0.1402      0.34  Q   V     |         |         |         |
 5+55       0.1426      0.34  Q   V     |         |         |         |
 6+ 0       0.1450      0.35  Q   V     |         |         |         |
 6+ 5       0.1474      0.35  Q   V     |         |         |         |
 6+10       0.1498      0.35  Q   V     |         |         |         |
 6+15       0.1522      0.35  Q   V     |         |         |         |
 6+20       0.1546      0.35  Q   V     |         |         |         |
 6+25       0.1571      0.35  Q   V     |         |         |         |
 6+30       0.1595      0.36  Q   V     |         |         |         |
 6+35       0.1620      0.36  Q   V     |         |         |         |
 6+40       0.1645      0.36  Q   V     |         |         |         |
 6+45       0.1670      0.36  Q    V    |         |         |         |
 6+50       0.1695      0.36  Q    V    |         |         |         |
 6+55       0.1720      0.37  Q    V    |         |         |         |
 7+ 0       0.1745      0.37  Q    V    |         |         |         |
 7+ 5       0.1771      0.37  Q    V    |         |         |         |
 7+10       0.1796      0.37  Q    V    |         |         |         |
 7+15       0.1822      0.37  Q    V    |         |         |         |
 7+20       0.1848      0.37  Q    V    |         |         |         |
 7+25       0.1874      0.38  Q    V    |         |         |         |
 7+30       0.1900      0.38  Q    V    |         |         |         |
 7+35       0.1926      0.38  Q    V    |         |         |         |
 7+40       0.1952      0.38  Q    V    |         |         |         |
 7+45       0.1979      0.38  Q    V    |         |         |         |
 7+50       0.2005      0.39  Q     V   |         |         |         |
 7+55       0.2032      0.39  Q     V   |         |         |         |
 8+ 0       0.2059      0.39  Q     V   |         |         |         |
 8+ 5       0.2086      0.39  Q     V   |         |         |         |
 8+10       0.2114      0.40  Q     V   |         |         |         |
 8+15       0.2141      0.40  Q     V   |         |         |         |
 8+20       0.2169      0.40  Q     V   |         |         |         |
 8+25       0.2196      0.40  Q     V   |         |         |         |
 8+30       0.2224      0.41  Q     V   |         |         |         |
 8+35       0.2252      0.41  Q     V   |         |         |         |
 8+40       0.2281      0.41  Q     V   |         |         |         |
 8+45       0.2309      0.41  Q     V   |         |         |         |
 8+50       0.2338      0.42  Q      V  |         |         |         |
 8+55       0.2367      0.42  Q      V  |         |         |         |
 9+ 0       0.2396      0.42  Q      V  |         |         |         |
 9+ 5       0.2425      0.42  Q      V  |         |         |         |
 9+10       0.2454      0.43  Q      V  |         |         |         |
 9+15       0.2484      0.43  Q      V  |         |         |         |
 9+20       0.2514      0.43  Q      V  |         |         |         |
 9+25       0.2544      0.44  Q      V  |         |         |         |
 9+30       0.2574      0.44  Q      V  |         |         |         |
 9+35       0.2604      0.44  Q      V  |         |         |         |
 9+40       0.2635      0.45  Q      V  |         |         |         |
 9+45       0.2666      0.45  Q       V |         |         |         |
 9+50       0.2697      0.45  Q       V |         |         |         |
 9+55       0.2728      0.45  Q       V |         |         |         |
10+ 0       0.2760      0.46  Q       V |         |         |         |
10+ 5       0.2792      0.46  Q       V |         |         |         |
10+10       0.2824      0.47  Q       V |         |         |         |
10+15       0.2856      0.47  Q       V |         |         |         |
10+20       0.2889      0.47  Q       V |         |         |         |
10+25       0.2922      0.48  Q       V |         |         |         |
10+30       0.2955      0.48  Q       V |         |         |         |
10+35       0.2988      0.48  Q        V|         |         |         |
10+40       0.3022      0.49  Q        V|         |         |         |
10+45       0.3056      0.49  Q        V|         |         |         |
10+50       0.3090      0.50  Q        V|         |         |         |
10+55       0.3124      0.50  |Q       V|         |         |         |
11+ 0       0.3159      0.51  |Q       V|         |         |         |
11+ 5       0.3194      0.51  |Q       V|         |         |         |
11+10       0.3230      0.52  |Q       V|         |         |         |
11+15       0.3266      0.52  |Q       V|         |         |         |
11+20       0.3302      0.53  |Q       V|         |         |         |
11+25       0.3338      0.53  |Q        V         |         |         |
11+30       0.3375      0.54  |Q        V         |         |         |
11+35       0.3413      0.54  |Q        V         |         |         |
```

```
11+40       0.3450      0.55  |Q        V         |         |         |
11+45       0.3488      0.55  |Q        V         |         |         |
11+50       0.3527      0.56  |Q        V         |         |         |
11+55       0.3566      0.56  |Q        V         |         |         |
12+ 0       0.3605      0.57  |Q        V         |         |         |
12+ 5       0.3645      0.58  |Q        |V        |         |         |
12+10       0.3686      0.60  |Q        |V        |         |         |
12+15       0.3731      0.64  |Q        |V        |         |         |
12+20       0.3777      0.68  |Q        |V        |         |         |
12+25       0.3825      0.70  |Q        |V        |         |         |
12+30       0.3874      0.71  |Q        |V        |         |         |
12+35       0.3924      0.72  |Q        |V        |         |         |
12+40       0.3974      0.73  |Q        | V       |         |         |
12+45       0.4025      0.74  |Q        | V       |         |         |
12+50       0.4076      0.75  |Q        | V       |         |         |
12+55       0.4128      0.76  |Q        | V       |         |         |
13+ 0       0.4181      0.76  |Q        | V       |         |         |
13+ 5       0.4234      0.77  |Q        | V       |         |         |
13+10       0.4288      0.78  |Q        | V       |         |         |
13+15       0.4343      0.80  |Q        |  V      |         |         |
13+20       0.4398      0.81  |Q        |  V      |         |         |
13+25       0.4455      0.82  |Q        |  V      |         |         |
13+30       0.4512      0.83  |Q        |  V      |         |         |
13+35       0.4570      0.84  |Q        |  V      |         |         |
13+40       0.4629      0.86  |Q        |  V      |         |         |
13+45       0.4689      0.87  |Q        |   V     |         |         |
13+50       0.4750      0.88  |Q        |   V     |         |         |
13+55       0.4812      0.90  |Q        |   V     |         |         |
14+ 0       0.4875      0.92  |Q        |   V     |         |         |
14+ 5       0.4939      0.93  |Q        |   V     |         |         |
14+10       0.5005      0.95  |Q        |    V    |         |         |
14+15       0.5072      0.97  |Q        |    V    |         |         |
14+20       0.5140      0.99  |Q        |    V    |         |         |
14+25       0.5210      1.01  | Q       |    V    |         |         |
14+30       0.5281      1.04  | Q       |    V    |         |         |
14+35       0.5355      1.06  | Q       |     V   |         |         |
14+40       0.5430      1.09  | Q       |     V   |         |         |
14+45       0.5507      1.12  | Q       |     V   |         |         |
14+50       0.5586      1.15  | Q       |     V   |         |         |
14+55       0.5668      1.19  | Q       |      V  |         |         |
15+ 0       0.5752      1.22  | Q       |      V  |         |         |
15+ 5       0.5839      1.27  | Q       |      V  |         |         |
15+10       0.5929      1.31  | Q       |      V  |         |         |
15+15       0.6023      1.36  | Q       |       V |         |         |
15+20       0.6122      1.42  | Q       |       V |         |         |
15+25       0.6223      1.47  | Q       |       V |         |         |
15+30       0.6321      1.43  | Q       |        V|         |         |
15+35       0.6411      1.31  | Q       |        V|         |         |
15+40       0.6496      1.22  | Q       |        V|         |         |
15+45       0.6582      1.26  | Q       |        V|         |         |
15+50       0.6679      1.40  | Q       |         V         |         |
15+55       0.6791      1.63  |  Q      |         V         |         |
16+ 0       0.6933      2.05  |   Q     |         V         |         |
16+ 5       0.7179      3.57  |      Q  |         |V        |         |
16+10       0.7731      8.02  |         |     Q   |  V      |         |
16+15       0.8548     11.86  |         |         |  Q V    |         |
16+20       0.9267     10.45  |         |         Q       V |         |
16+25       0.9653      5.60  |         |Q        |        V|         |
16+30       0.9869      3.14  |     Q   |         |        V|         |
16+35       1.0006      1.99  |  Q      |         |         V         |
16+40       1.0125      1.72  |  Q      |         |         V         |
16+45       1.0236      1.62  |  Q      |         |         V         |
16+50       1.0328      1.33  | Q       |         |         |V        |
16+55       1.0413      1.24  | Q       |         |         |V        |
17+ 0       1.0494      1.17  | Q       |         |         |V        |
17+ 5       1.0570      1.11  | Q       |         |         |V        |
17+10       1.0642      1.05  | Q       |         |         | V       |
17+15       1.0711      1.00  | Q       |         |         | V       |
17+20       1.0777      0.96  |Q        |         |         | V       |
17+25       1.0841      0.92  |Q        |         |         | V       |
17+30       1.0902      0.89  |Q        |         |         | V       |
```

```
17+35       1.0962      0.86  |Q        |         |         |  V      |
17+40       1.1019      0.84  |Q        |         |         |  V      |
17+45       1.1075      0.81  |Q        |         |         |  V      |
17+50       1.1129      0.79  |Q        |         |         |  V      |
17+55       1.1182      0.77  |Q        |         |         |  V      |
18+ 0       1.1234      0.75  |Q        |         |         |  V      |
18+ 5       1.1284      0.73  |Q        |         |         |   V     |
18+10       1.1332      0.70  |Q        |         |         |   V     |
18+15       1.1377      0.65  |Q        |         |         |   V     |
18+20       1.1418      0.61  |Q        |         |         |   V     |
18+25       1.1458      0.58  |Q        |         |         |   V     |
18+30       1.1497      0.56  |Q        |         |         |   V     |
18+35       1.1535      0.55  |Q        |         |         |   V     |
18+40       1.1572      0.54  |Q        |         |         |   V     |
18+45       1.1608      0.53  |Q        |         |         |    V    |
18+50       1.1644      0.52  |Q        |         |         |    V    |
18+55       1.1679      0.51  |Q        |         |         |    V    |
19+ 0       1.1713      0.50  Q         |         |         |    V    |
19+ 5       1.1747      0.49  Q         |         |         |    V    |
19+10       1.1780      0.48  Q         |         |         |    V    |
19+15       1.1813      0.47  Q         |         |         |    V    |
19+20       1.1845      0.47  Q         |         |         |    V    |
19+25       1.1877      0.46  Q         |         |         |    V    |
19+30       1.1908      0.45  Q         |         |         |     V   |
19+35       1.1939      0.45  Q         |         |         |     V   |
19+40       1.1969      0.44  Q         |         |         |     V   |
19+45       1.1999      0.43  Q         |         |         |     V   |
19+50       1.2028      0.43  Q         |         |         |     V   |
19+55       1.2057      0.42  Q         |         |         |     V   |
20+ 0       1.2086      0.42  Q         |         |         |     V   |
20+ 5       1.2114      0.41  Q         |         |         |     V   |
20+10       1.2142      0.41  Q         |         |         |     V   |
20+15       1.2170      0.40  Q         |         |         |     V   |
20+20       1.2197      0.40  Q         |         |         |     V   |
20+25       1.2224      0.39  Q         |         |         |     V   |
20+30       1.2251      0.39  Q         |         |         |      V  |
20+35       1.2277      0.38  Q         |         |         |      V  |
20+40       1.2304      0.38  Q         |         |         |      V  |
20+45       1.2329      0.38  Q         |         |         |      V  |
20+50       1.2355      0.37  Q         |         |         |      V  |
20+55       1.2380      0.37  Q         |         |         |      V  |
21+ 0       1.2405      0.36  Q         |         |         |      V  |
21+ 5       1.2430      0.36  Q         |         |         |      V  |
21+10       1.2455      0.36  Q         |         |         |      V  |
21+15       1.2479      0.35  Q         |         |         |      V  |
21+20       1.2503      0.35  Q         |         |         |      V  |
21+25       1.2527      0.35  Q         |         |         |      V  |
21+30       1.2551      0.34  Q         |         |         |      V  |
21+35       1.2574      0.34  Q         |         |         |       V |
21+40       1.2597      0.34  Q         |         |         |       V |
21+45       1.2620      0.33  Q         |         |         |       V |
21+50       1.2643      0.33  Q         |         |         |       V |
21+55       1.2666      0.33  Q         |         |         |       V |
22+ 0       1.2688      0.33  Q         |         |         |       V |
22+ 5       1.2711      0.32  Q         |         |         |       V |
22+10       1.2733      0.32  Q         |         |         |       V |
22+15       1.2755      0.32  Q         |         |         |       V |
22+20       1.2776      0.32  Q         |         |         |       V |
22+25       1.2798      0.31  Q         |         |         |       V |
22+30       1.2819      0.31  Q         |         |         |       V |
22+35       1.2841      0.31  Q         |         |         |       V |
22+40       1.2862      0.31  Q         |         |         |       V |
22+45       1.2883      0.30  Q         |         |         |       V |
22+50       1.2903      0.30  Q         |         |         |        V|
22+55       1.2924      0.30  Q         |         |         |        V|
23+ 0       1.2944      0.30  Q         |         |         |        V|
23+ 5       1.2965      0.30  Q         |         |         |        V|
23+10       1.2985      0.29  Q         |         |         |        V|
23+15       1.3005      0.29  Q         |         |         |        V|
23+20       1.3025      0.29  Q         |         |         |        V|
23+25       1.3045      0.29  Q         |         |         |        V|
```

```
23+30      1.3064     0.29  Q         |         |         |        V|
23+35      1.3084     0.28  Q         |         |         |        V|
23+40      1.3103     0.28  Q         |         |         |        V|
23+45      1.3123     0.28  Q         |         |         |        V|
23+50      1.3142     0.28  Q         |         |         |        V|
23+55      1.3161     0.28  Q         |         |         |        V|
24+ 0      1.3180     0.27  Q         |         |         |        V|
24+ 5      1.3198     0.26  Q         |         |         |        V|
24+10      1.3213     0.22  Q         |         |         |        V|
24+15      1.3222     0.13  Q         |         |         |        V|
24+20      1.3226     0.06  Q         |         |         |        V|
24+25      1.3227     0.02  Q         |         |         |        V|
24+30      1.3228     0.01  Q         |         |         |        V|
24+35      1.3228     0.00  Q         |         |         |        V|
24+40      1.3228     0.00  Q         |         |         |        V|
----------------------------------------------------------------------
```

1.3228*43,560=57,621 CF

UNIT HYDROGRAPH METHOD-2YR, 24HR STORM EVENT
EXISTING CONDITION

```
       U n i t   H y d r o g r a p h   A n a l y s i s

       Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2018, Version 9.0

              Study date  10/05/21

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
------------------------------------------------------------------------

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


Program License Serial Number 6484

---------------------------------------------------------------------
UH METHOD
2YR 24HR STORM EVENT
EXISTING CONDITION

--------------------------------------------------------------------

       Storm Event Year = 2

       Antecedent Moisture Condition = 2

 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        Duration        Isohyetal
       (Ac.)           (hours)          (In)
Rainfall data for year 2
            9.90           1            0.61
--------------------------------------------------------------------
Rainfall data for year 2
            9.90           6            1.51
--------------------------------------------------------------------
Rainfall data for year 2
            9.90          24            2.74
--------------------------------------------------------------------
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

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


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 2)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 46.0      46.0          9.90      1.000     0.856    1.000    0.856

Area-averaged adjusted loss rate Fm (In/Hr) =  0.856

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

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC2)           Yield Fr
     9.90   1.000         46.0      46.0      11.74     0.005

Area-averaged catchment yield fraction, Y =  0.005
Area-averaged low loss fraction, Yb =  0.995
Direct entry of lag time by user
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =       9.90(Ac.)
```

Catchment Lag time = 0.338 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 24.6548
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.856(In/Hr)
Average low loss rate fraction (Yb) = 0.995 (decimal)
VALLEY UNDEVELOPED S-Graph Selected
Computed peak 5-minute rainfall = 0.291(In)
Computed peak 30-minute rainfall = 0.499(In)
Specified peak 1-hour rainfall = 0.614(In)
Computed peak 3-hour rainfall = 1.066(In)
Specified peak 6-hour rainfall = 1.510(In)
Specified peak 24-hour rainfall = 2.740(In)

Rainfall depth area reduction factors:
Using a total area of 9.90(Ac.) (Ref: fig. E-4)

5-minute factor = 1.000	Adjusted rainfall = 0.291(In)
30-minute factor = 1.000	Adjusted rainfall = 0.498(In)
1-hour factor = 1.000	Adjusted rainfall = 0.614(In)
3-hour factor = 1.000	Adjusted rainfall = 1.066(In)
6-hour factor = 1.000	Adjusted rainfall = 1.510(In)
24-hour factor = 1.000	Adjusted rainfall = 2.740(In)

U n i t H y d r o g r a p h

+++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 119.73 (CFS))	
1	2.263	2.709
2	9.729	8.939
3	22.980	15.866
4	40.131	20.534
5	55.596	18.516
6	65.323	11.647
7	71.571	7.481
8	75.764	5.020
9	79.144	4.046
10	81.918	3.322
11	84.278	2.826
12	86.310	2.432
13	87.987	2.008
14	89.470	1.776
15	90.822	1.618
16	91.915	1.308
17	92.910	1.192
18	93.707	0.953
19	94.482	0.928
20	95.223	0.887
21	95.912	0.824
22	96.462	0.659
23	96.981	0.621
24	97.429	0.537
25	97.851	0.505
26	98.202	0.420
27	98.527	0.389
28	98.780	0.303
29	99.027	0.295
30	99.273	0.295
31	99.520	0.295
32	99.766	0.295
33	100.000	0.280

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.2912	0.2912
2	0.3585	0.0673

3	0.4049	0.0464
4	0.4414	0.0365
5	0.4720	0.0306
6	0.4985	0.0265
7	0.5221	0.0236
8	0.5434	0.0213
9	0.5630	0.0195
10	0.5810	0.0181
11	0.5979	0.0169
12	0.6137	0.0158
13	0.6389	0.0252
14	0.6632	0.0242
15	0.6866	0.0234
16	0.7092	0.0226
17	0.7311	0.0219
18	0.7524	0.0213
19	0.7732	0.0207
20	0.7934	0.0202
21	0.8130	0.0197
22	0.8323	0.0192
23	0.8511	0.0188
24	0.8695	0.0184
25	0.8875	0.0180
26	0.9052	0.0177
27	0.9225	0.0173
28	0.9395	0.0170
29	0.9562	0.0167
30	0.9727	0.0164
31	0.9888	0.0162
32	1.0047	0.0159
33	1.0204	0.0157
34	1.0358	0.0154
35	1.0510	0.0152
36	1.0660	0.0150
37	1.0808	0.0148
38	1.0954	0.0146
39	1.1098	0.0144
40	1.1240	0.0142
41	1.1380	0.0140
42	1.1518	0.0139
43	1.1655	0.0137
44	1.1791	0.0135
45	1.1925	0.0134
46	1.2057	0.0132
47	1.2188	0.0131
48	1.2317	0.0130
49	1.2446	0.0128
50	1.2573	0.0127
51	1.2698	0.0126
52	1.2823	0.0124
53	1.2946	0.0123
54	1.3068	0.0122
55	1.3189	0.0121
56	1.3309	0.0120
57	1.3428	0.0119
58	1.3546	0.0118
59	1.3662	0.0117
60	1.3778	0.0116
61	1.3893	0.0115
62	1.4007	0.0114
63	1.4120	0.0113
64	1.4232	0.0112
65	1.4343	0.0111
66	1.4454	0.0110
67	1.4563	0.0110
68	1.4672	0.0109
69	1.4780	0.0108
70	1.4887	0.0107
71	1.4994	0.0106
72	1.5100	0.0106
73	1.5189	0.0090

74	1.5278	0.0089
75	1.5367	0.0088
76	1.5455	0.0088
77	1.5542	0.0087
78	1.5628	0.0086
79	1.5714	0.0086
80	1.5799	0.0085
81	1.5884	0.0085
82	1.5968	0.0084
83	1.6051	0.0083
84	1.6134	0.0083
85	1.6216	0.0082
86	1.6298	0.0082
87	1.6379	0.0081
88	1.6460	0.0081
89	1.6540	0.0080
90	1.6620	0.0080
91	1.6699	0.0079
92	1.6777	0.0079
93	1.6855	0.0078
94	1.6933	0.0078
95	1.7010	0.0077
96	1.7087	0.0077
97	1.7163	0.0076
98	1.7239	0.0076
99	1.7314	0.0075
100	1.7389	0.0075
101	1.7464	0.0075
102	1.7538	0.0074
103	1.7612	0.0074
104	1.7685	0.0073
105	1.7758	0.0073
106	1.7830	0.0072
107	1.7903	0.0072
108	1.7974	0.0072
109	1.8046	0.0071
110	1.8117	0.0071
111	1.8187	0.0071
112	1.8257	0.0070
113	1.8327	0.0070
114	1.8397	0.0070
115	1.8466	0.0069
116	1.8535	0.0069
117	1.8603	0.0069
118	1.8672	0.0068
119	1.8739	0.0068
120	1.8807	0.0068
121	1.8874	0.0067
122	1.8941	0.0067
123	1.9008	0.0067
124	1.9074	0.0066
125	1.9140	0.0066
126	1.9206	0.0066
127	1.9271	0.0065
128	1.9336	0.0065
129	1.9401	0.0065
130	1.9465	0.0065
131	1.9530	0.0064
132	1.9593	0.0064
133	1.9657	0.0064
134	1.9721	0.0063
135	1.9784	0.0063
136	1.9847	0.0063
137	1.9909	0.0063
138	1.9971	0.0062
139	2.0034	0.0062
140	2.0095	0.0062
141	2.0157	0.0062
142	2.0218	0.0061
143	2.0279	0.0061
144	2.0340	0.0061

145	2.0401	0.0061
146	2.0461	0.0060
147	2.0521	0.0060
148	2.0581	0.0060
149	2.0641	0.0060
150	2.0700	0.0059
151	2.0759	0.0059
152	2.0818	0.0059
153	2.0877	0.0059
154	2.0936	0.0059
155	2.0994	0.0058
156	2.1052	0.0058
157	2.1110	0.0058
158	2.1168	0.0058
159	2.1225	0.0057
160	2.1282	0.0057
161	2.1340	0.0057
162	2.1396	0.0057
163	2.1453	0.0057
164	2.1510	0.0056
165	2.1566	0.0056
166	2.1622	0.0056
167	2.1678	0.0056
168	2.1734	0.0056
169	2.1789	0.0056
170	2.1844	0.0055
171	2.1899	0.0055
172	2.1954	0.0055
173	2.2009	0.0055
174	2.2064	0.0055
175	2.2118	0.0054
176	2.2172	0.0054
177	2.2227	0.0054
178	2.2280	0.0054
179	2.2334	0.0054
180	2.2388	0.0054
181	2.2441	0.0053
182	2.2494	0.0053
183	2.2547	0.0053
184	2.2600	0.0053
185	2.2653	0.0053
186	2.2705	0.0053
187	2.2758	0.0052
188	2.2810	0.0052
189	2.2862	0.0052
190	2.2914	0.0052
191	2.2966	0.0052
192	2.3017	0.0052
193	2.3069	0.0051
194	2.3120	0.0051
195	2.3171	0.0051
196	2.3222	0.0051
197	2.3273	0.0051
198	2.3324	0.0051
199	2.3374	0.0051
200	2.3425	0.0050
201	2.3475	0.0050
202	2.3525	0.0050
203	2.3575	0.0050
204	2.3625	0.0050
205	2.3675	0.0050
206	2.3724	0.0050
207	2.3774	0.0049
208	2.3823	0.0049
209	2.3872	0.0049
210	2.3921	0.0049
211	2.3970	0.0049
212	2.4019	0.0049
213	2.4068	0.0049
214	2.4116	0.0049
215	2.4164	0.0048

216	2.4213	0.0048
217	2.4261	0.0048
218	2.4309	0.0048
219	2.4357	0.0048
220	2.4404	0.0048
221	2.4452	0.0048
222	2.4500	0.0047
223	2.4547	0.0047
224	2.4594	0.0047
225	2.4641	0.0047
226	2.4688	0.0047
227	2.4735	0.0047
228	2.4782	0.0047
229	2.4829	0.0047
230	2.4875	0.0047
231	2.4922	0.0046
232	2.4968	0.0046
233	2.5014	0.0046
234	2.5060	0.0046
235	2.5106	0.0046
236	2.5152	0.0046
237	2.5198	0.0046
238	2.5243	0.0046
239	2.5289	0.0046
240	2.5334	0.0045
241	2.5380	0.0045
242	2.5425	0.0045
243	2.5470	0.0045
244	2.5515	0.0045
245	2.5560	0.0045
246	2.5605	0.0045
247	2.5649	0.0045
248	2.5694	0.0045
249	2.5738	0.0044
250	2.5783	0.0044
251	2.5827	0.0044
252	2.5871	0.0044
253	2.5915	0.0044
254	2.5959	0.0044
255	2.6003	0.0044
256	2.6047	0.0044
257	2.6091	0.0044
258	2.6134	0.0044
259	2.6178	0.0043
260	2.6221	0.0043
261	2.6265	0.0043
262	2.6308	0.0043
263	2.6351	0.0043
264	2.6394	0.0043
265	2.6437	0.0043
266	2.6480	0.0043
267	2.6522	0.0043
268	2.6565	0.0043
269	2.6608	0.0043
270	2.6650	0.0042
271	2.6692	0.0042
272	2.6735	0.0042
273	2.6777	0.0042
274	2.6819	0.0042
275	2.6861	0.0042
276	2.6903	0.0042
277	2.6945	0.0042
278	2.6987	0.0042
279	2.7028	0.0042
280	2.7070	0.0042
281	2.7111	0.0042
282	2.7153	0.0041
283	2.7194	0.0041
284	2.7235	0.0041
285	2.7277	0.0041
286	2.7318	0.0041

287	2.7359	0.0041
288	2.7400	0.0041

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0041	0.0041	0.0000
2	0.0041	0.0041	0.0000
3	0.0041	0.0041	0.0000
4	0.0041	0.0041	0.0000
5	0.0041	0.0041	0.0000
6	0.0042	0.0041	0.0000
7	0.0042	0.0041	0.0000
8	0.0042	0.0042	0.0000
9	0.0042	0.0042	0.0000
10	0.0042	0.0042	0.0000
11	0.0042	0.0042	0.0000
12	0.0042	0.0042	0.0000
13	0.0042	0.0042	0.0000
14	0.0043	0.0042	0.0000
15	0.0043	0.0043	0.0000
16	0.0043	0.0043	0.0000
17	0.0043	0.0043	0.0000
18	0.0043	0.0043	0.0000
19	0.0043	0.0043	0.0000
20	0.0043	0.0043	0.0000
21	0.0044	0.0043	0.0000
22	0.0044	0.0043	0.0000
23	0.0044	0.0044	0.0000
24	0.0044	0.0044	0.0000
25	0.0044	0.0044	0.0000
26	0.0044	0.0044	0.0000
27	0.0044	0.0044	0.0000
28	0.0045	0.0044	0.0000
29	0.0045	0.0045	0.0000
30	0.0045	0.0045	0.0000
31	0.0045	0.0045	0.0000
32	0.0045	0.0045	0.0000
33	0.0045	0.0045	0.0000
34	0.0046	0.0045	0.0000
35	0.0046	0.0046	0.0000
36	0.0046	0.0046	0.0000
37	0.0046	0.0046	0.0000
38	0.0046	0.0046	0.0000
39	0.0046	0.0046	0.0000
40	0.0047	0.0046	0.0000
41	0.0047	0.0047	0.0000
42	0.0047	0.0047	0.0000
43	0.0047	0.0047	0.0000
44	0.0047	0.0047	0.0000
45	0.0047	0.0047	0.0000
46	0.0048	0.0047	0.0000
47	0.0048	0.0048	0.0000
48	0.0048	0.0048	0.0000
49	0.0048	0.0048	0.0000
50	0.0048	0.0048	0.0000
51	0.0049	0.0048	0.0000
52	0.0049	0.0049	0.0000
53	0.0049	0.0049	0.0000
54	0.0049	0.0049	0.0000
55	0.0049	0.0049	0.0000
56	0.0050	0.0049	0.0000
57	0.0050	0.0050	0.0000
58	0.0050	0.0050	0.0000
59	0.0050	0.0050	0.0000
60	0.0050	0.0050	0.0000
61	0.0051	0.0050	0.0000
62	0.0051	0.0051	0.0000
63	0.0051	0.0051	0.0000
64	0.0051	0.0051	0.0000

65	0.0052	0.0051	0.0000
66	0.0052	0.0052	0.0000
67	0.0052	0.0052	0.0000
68	0.0052	0.0052	0.0000
69	0.0053	0.0052	0.0000
70	0.0053	0.0052	0.0000
71	0.0053	0.0053	0.0000
72	0.0053	0.0053	0.0000
73	0.0054	0.0053	0.0000
74	0.0054	0.0053	0.0000
75	0.0054	0.0054	0.0000
76	0.0054	0.0054	0.0000
77	0.0055	0.0054	0.0000
78	0.0055	0.0055	0.0000
79	0.0055	0.0055	0.0000
80	0.0055	0.0055	0.0000
81	0.0056	0.0055	0.0000
82	0.0056	0.0056	0.0000
83	0.0056	0.0056	0.0000
84	0.0056	0.0056	0.0000
85	0.0057	0.0057	0.0000
86	0.0057	0.0057	0.0000
87	0.0057	0.0057	0.0000
88	0.0058	0.0057	0.0000
89	0.0058	0.0058	0.0000
90	0.0058	0.0058	0.0000
91	0.0059	0.0058	0.0000
92	0.0059	0.0059	0.0000
93	0.0059	0.0059	0.0000
94	0.0060	0.0059	0.0000
95	0.0060	0.0060	0.0000
96	0.0060	0.0060	0.0000
97	0.0061	0.0061	0.0000
98	0.0061	0.0061	0.0000
99	0.0062	0.0061	0.0000
100	0.0062	0.0062	0.0000
101	0.0062	0.0062	0.0000
102	0.0063	0.0062	0.0000
103	0.0063	0.0063	0.0000
104	0.0063	0.0063	0.0000
105	0.0064	0.0064	0.0000
106	0.0064	0.0064	0.0000
107	0.0065	0.0064	0.0000
108	0.0065	0.0065	0.0000
109	0.0066	0.0065	0.0000
110	0.0066	0.0066	0.0000
111	0.0067	0.0066	0.0000
112	0.0067	0.0067	0.0000
113	0.0068	0.0067	0.0000
114	0.0068	0.0068	0.0000
115	0.0069	0.0068	0.0000
116	0.0069	0.0069	0.0000
117	0.0070	0.0069	0.0000
118	0.0070	0.0070	0.0000
119	0.0071	0.0070	0.0000
120	0.0071	0.0071	0.0000
121	0.0072	0.0071	0.0000
122	0.0072	0.0072	0.0000
123	0.0073	0.0073	0.0000
124	0.0073	0.0073	0.0000
125	0.0074	0.0074	0.0000
126	0.0075	0.0074	0.0000
127	0.0075	0.0075	0.0000
128	0.0076	0.0075	0.0000
129	0.0077	0.0076	0.0000
130	0.0077	0.0077	0.0000
131	0.0078	0.0078	0.0000
132	0.0079	0.0078	0.0000
133	0.0080	0.0079	0.0000
134	0.0080	0.0080	0.0000
135	0.0081	0.0081	0.0000

136	0.0082	0.0081	0.0000
137	0.0083	0.0082	0.0000
138	0.0083	0.0083	0.0000
139	0.0085	0.0084	0.0000
140	0.0085	0.0085	0.0000
141	0.0086	0.0086	0.0000
142	0.0087	0.0087	0.0000
143	0.0088	0.0088	0.0000
144	0.0089	0.0089	0.0000
145	0.0106	0.0105	0.0000
146	0.0106	0.0106	0.0000
147	0.0108	0.0107	0.0000
148	0.0109	0.0108	0.0001
149	0.0110	0.0110	0.0001
150	0.0111	0.0111	0.0001
151	0.0113	0.0112	0.0001
152	0.0114	0.0113	0.0001
153	0.0116	0.0115	0.0001
154	0.0117	0.0116	0.0001
155	0.0119	0.0118	0.0001
156	0.0120	0.0119	0.0001
157	0.0122	0.0122	0.0001
158	0.0123	0.0123	0.0001
159	0.0126	0.0125	0.0001
160	0.0127	0.0126	0.0001
161	0.0130	0.0129	0.0001
162	0.0131	0.0130	0.0001
163	0.0134	0.0133	0.0001
164	0.0135	0.0135	0.0001
165	0.0139	0.0138	0.0001
166	0.0140	0.0140	0.0001
167	0.0144	0.0143	0.0001
168	0.0146	0.0145	0.0001
169	0.0150	0.0149	0.0001
170	0.0152	0.0151	0.0001
171	0.0157	0.0156	0.0001
172	0.0159	0.0158	0.0001
173	0.0164	0.0164	0.0001
174	0.0167	0.0166	0.0001
175	0.0173	0.0173	0.0001
176	0.0177	0.0176	0.0001
177	0.0184	0.0183	0.0001
178	0.0188	0.0187	0.0001
179	0.0197	0.0196	0.0001
180	0.0202	0.0201	0.0001
181	0.0213	0.0212	0.0001
182	0.0219	0.0218	0.0001
183	0.0234	0.0233	0.0001
184	0.0242	0.0241	0.0001
185	0.0158	0.0157	0.0001
186	0.0169	0.0168	0.0001
187	0.0195	0.0195	0.0001
188	0.0213	0.0212	0.0001
189	0.0265	0.0264	0.0001
190	0.0306	0.0304	0.0001
191	0.0464	0.0462	0.0002
192	0.0673	0.0670	0.0003
193	0.2912	0.0713	0.2199
194	0.0365	0.0363	0.0002
195	0.0236	0.0235	0.0001
196	0.0181	0.0180	0.0001
197	0.0252	0.0251	0.0001
198	0.0226	0.0225	0.0001
199	0.0207	0.0206	0.0001
200	0.0192	0.0191	0.0001
201	0.0180	0.0179	0.0001
202	0.0170	0.0169	0.0001
203	0.0162	0.0161	0.0001
204	0.0154	0.0154	0.0001
205	0.0148	0.0147	0.0001
206	0.0142	0.0141	0.0001

207	0.0137	0.0136	0.0001
208	0.0132	0.0132	0.0001
209	0.0128	0.0128	0.0001
210	0.0124	0.0124	0.0001
211	0.0121	0.0120	0.0001
212	0.0118	0.0117	0.0001
213	0.0115	0.0114	0.0001
214	0.0112	0.0112	0.0001
215	0.0110	0.0109	0.0001
216	0.0107	0.0107	0.0000
217	0.0090	0.0089	0.0000
218	0.0088	0.0087	0.0000
219	0.0086	0.0085	0.0000
220	0.0084	0.0084	0.0000
221	0.0082	0.0082	0.0000
222	0.0081	0.0080	0.0000
223	0.0079	0.0079	0.0000
224	0.0078	0.0077	0.0000
225	0.0076	0.0076	0.0000
226	0.0075	0.0075	0.0000
227	0.0074	0.0073	0.0000
228	0.0072	0.0072	0.0000
229	0.0071	0.0071	0.0000
230	0.0070	0.0070	0.0000
231	0.0069	0.0069	0.0000
232	0.0068	0.0068	0.0000
233	0.0067	0.0067	0.0000
234	0.0066	0.0066	0.0000
235	0.0065	0.0065	0.0000
236	0.0065	0.0064	0.0000
237	0.0064	0.0063	0.0000
238	0.0063	0.0063	0.0000
239	0.0062	0.0062	0.0000
240	0.0061	0.0061	0.0000
241	0.0061	0.0060	0.0000
242	0.0060	0.0060	0.0000
243	0.0059	0.0059	0.0000
244	0.0059	0.0058	0.0000
245	0.0058	0.0058	0.0000
246	0.0057	0.0057	0.0000
247	0.0057	0.0056	0.0000
248	0.0056	0.0056	0.0000
249	0.0056	0.0055	0.0000
250	0.0055	0.0055	0.0000
251	0.0054	0.0054	0.0000
252	0.0054	0.0054	0.0000
253	0.0053	0.0053	0.0000
254	0.0053	0.0053	0.0000
255	0.0052	0.0052	0.0000
256	0.0052	0.0052	0.0000
257	0.0051	0.0051	0.0000
258	0.0051	0.0051	0.0000
259	0.0051	0.0050	0.0000
260	0.0050	0.0050	0.0000
261	0.0050	0.0049	0.0000
262	0.0049	0.0049	0.0000
263	0.0049	0.0049	0.0000
264	0.0049	0.0048	0.0000
265	0.0048	0.0048	0.0000
266	0.0048	0.0048	0.0000
267	0.0047	0.0047	0.0000
268	0.0047	0.0047	0.0000
269	0.0047	0.0046	0.0000
270	0.0046	0.0046	0.0000
271	0.0046	0.0046	0.0000
272	0.0046	0.0045	0.0000
273	0.0045	0.0045	0.0000
274	0.0045	0.0045	0.0000
275	0.0045	0.0044	0.0000
276	0.0044	0.0044	0.0000
277	0.0044	0.0044	0.0000

```
     278              0.0044          0.0044            0.0000
     279              0.0043          0.0043            0.0000
     280              0.0043          0.0043            0.0000
     281              0.0043          0.0043            0.0000
     282              0.0043          0.0042            0.0000
     283              0.0042          0.0042            0.0000
     284              0.0042          0.0042            0.0000
     285              0.0042          0.0042            0.0000
     286              0.0042          0.0041            0.0000
     287              0.0041          0.0041            0.0000
     288              0.0041          0.0041            0.0000
     --------------------------------------------------------------------
     --------------------------------------------------------------------
     Total soil rain loss =      2.51(In)
     Total effective rainfall =      0.23(In)
     Peak flow rate in flood hydrograph =      4.53(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       0.0000      0.00  Q         |         |         |         |
  0+10       0.0000      0.00  Q         |         |         |         |
  0+15       0.0000      0.00  Q         |         |         |         |
  0+20       0.0000      0.00  Q         |         |         |         |
  0+25       0.0000      0.00  Q         |         |         |         |
  0+30       0.0000      0.00  Q         |         |         |         |
  0+35       0.0000      0.00  Q         |         |         |         |
  0+40       0.0001      0.00  Q         |         |         |         |
  0+45       0.0001      0.00  Q         |         |         |         |
  0+50       0.0001      0.00  Q         |         |         |         |
  0+55       0.0001      0.00  Q         |         |         |         |
  1+ 0       0.0001      0.00  Q         |         |         |         |
  1+ 5       0.0001      0.00  Q         |         |         |         |
  1+10       0.0001      0.00  Q         |         |         |         |
  1+15       0.0001      0.00  Q         |         |         |         |
  1+20       0.0002      0.00  Q         |         |         |         |
  1+25       0.0002      0.00  Q         |         |         |         |
  1+30       0.0002      0.00  Q         |         |         |         |
  1+35       0.0002      0.00  Q         |         |         |         |
  1+40       0.0002      0.00  Q         |         |         |         |
  1+45       0.0002      0.00  Q         |         |         |         |
  1+50       0.0003      0.00  Q         |         |         |         |
  1+55       0.0003      0.00  Q         |         |         |         |
  2+ 0       0.0003      0.00  Q         |         |         |         |
  2+ 5       0.0003      0.00  Q         |         |         |         |
  2+10       0.0003      0.00  Q         |         |         |         |
  2+15       0.0003      0.00  Q         |         |         |         |
  2+20       0.0004      0.00  Q         |         |         |         |
  2+25       0.0004      0.00  Q         |         |         |         |
  2+30       0.0004      0.00  Q         |         |         |         |
  2+35       0.0004      0.00  Q         |         |         |         |
  2+40       0.0004      0.00  Q         |         |         |         |
  2+45       0.0004      0.00  Q         |         |         |         |
  2+50       0.0005      0.00  Q         |         |         |         |
  2+55       0.0005      0.00  Q         |         |         |         |
  3+ 0       0.0005      0.00  Q         |         |         |         |
  3+ 5       0.0005      0.00  Q         |         |         |         |
  3+10       0.0005      0.00  Q         |         |         |         |
  3+15       0.0005      0.00  Q         |         |         |         |
  3+20       0.0006      0.00  Q         |         |         |         |
  3+25       0.0006      0.00  Q         |         |         |         |
  3+30       0.0006      0.00  Q         |         |         |         |
  3+35       0.0006      0.00  Q         |         |         |         |
  3+40       0.0006      0.00  Q         |         |         |         |
  3+45       0.0006      0.00  Q         |         |         |         |
```

3+50	0.0007	0.00	Q	|	|	|	|
3+55	0.0007	0.00	Q	|	|	|	|
4+ 0	0.0007	0.00	Q	|	|	|	|
4+ 5	0.0007	0.00	Q	|	|	|	|
4+10	0.0007	0.00	Q	|	|	|	|
4+15	0.0008	0.00	Q	|	|	|	|
4+20	0.0008	0.00	Q	|	|	|	|
4+25	0.0008	0.00	Q	|	|	|	|
4+30	0.0008	0.00	Q	|	|	|	|
4+35	0.0008	0.00	Q	|	|	|	|
4+40	0.0008	0.00	Q	|	|	|	|
4+45	0.0009	0.00	Q	|	|	|	|
4+50	0.0009	0.00	Q	|	|	|	|
4+55	0.0009	0.00	Q	|	|	|	|
5+ 0	0.0009	0.00	Q	|	|	|	|
5+ 5	0.0009	0.00	Q	|	|	|	|
5+10	0.0010	0.00	Q	|	|	|	|
5+15	0.0010	0.00	Q	|	|	|	|
5+20	0.0010	0.00	Q	|	|	|	|
5+25	0.0010	0.00	Q	|	|	|	|
5+30	0.0010	0.00	Q	|	|	|	|
5+35	0.0011	0.00	Q	|	|	|	|
5+40	0.0011	0.00	Q	|	|	|	|
5+45	0.0011	0.00	Q	|	|	|	|
5+50	0.0011	0.00	Q	|	|	|	|
5+55	0.0011	0.00	Q	|	|	|	|
6+ 0	0.0012	0.00	Q	|	|	|	|
6+ 5	0.0012	0.00	Q	|	|	|	|
6+10	0.0012	0.00	Q	|	|	|	|
6+15	0.0012	0.00	Q	|	|	|	|
6+20	0.0012	0.00	Q	|	|	|	|
6+25	0.0013	0.00	Q	|	|	|	|
6+30	0.0013	0.00	Q	|	|	|	|
6+35	0.0013	0.00	Q	|	|	|	|
6+40	0.0013	0.00	Q	|	|	|	|
6+45	0.0013	0.00	Q	|	|	|	|
6+50	0.0014	0.00	Q	|	|	|	|
6+55	0.0014	0.00	Q	|	|	|	|
7+ 0	0.0014	0.00	Q	|	|	|	|
7+ 5	0.0014	0.00	Q	|	|	|	|
7+10	0.0014	0.00	Q	|	|	|	|
7+15	0.0015	0.00	Q	|	|	|	|
7+20	0.0015	0.00	Q	|	|	|	|
7+25	0.0015	0.00	Q	|	|	|	|
7+30	0.0015	0.00	Q	|	|	|	|
7+35	0.0015	0.00	Q	|	|	|	|
7+40	0.0016	0.00	Q	|	|	|	|
7+45	0.0016	0.00	Q	|	|	|	|
7+50	0.0016	0.00	Q	|	|	|	|
7+55	0.0016	0.00	Q	|	|	|	|
8+ 0	0.0017	0.00	Q	|	|	|	|
8+ 5	0.0017	0.00	Q	|	|	|	|
8+10	0.0017	0.00	Q	|	|	|	|
8+15	0.0017	0.00	Q	|	|	|	|
8+20	0.0017	0.00	Q	|	|	|	|
8+25	0.0018	0.00	Q	|	|	|	|
8+30	0.0018	0.00	Q	|	|	|	|
8+35	0.0018	0.00	Q	|	|	|	|
8+40	0.0018	0.00	Q	|	|	|	|
8+45	0.0019	0.00	Q	|	|	|	|
8+50	0.0019	0.00	Q	|	|	|	|
8+55	0.0019	0.00	Q	|	|	|	|
9+ 0	0.0019	0.00	Q	|	|	|	|
9+ 5	0.0020	0.00	Q	|	|	|	|
9+10	0.0020	0.00	Q	|	|	|	|
9+15	0.0020	0.00	Q	|	|	|	|
9+20	0.0020	0.00	Q	|	|	|	|
9+25	0.0021	0.00	Q	|	|	|	|
9+30	0.0021	0.00	Q	|	|	|	|
9+35	0.0021	0.00	Q	|	|	|	|
9+40	0.0021	0.00	Q	|	|	|	|

```
 9+45       0.0022      0.00  Q         |         |         |         |
 9+50       0.0022      0.00  Q         |         |         |         |
 9+55       0.0022      0.00  Q         |         |         |         |
10+ 0       0.0022      0.00  Q         |         |         |         |
10+ 5       0.0023      0.00  Q         |         |         |         |
10+10       0.0023      0.00  Q         |         |         |         |
10+15       0.0023      0.00  Q         |         |         |         |
10+20       0.0023      0.00  Q         |         |         |         |
10+25       0.0024      0.00  Q         |         |         |         |
10+30       0.0024      0.00  Q         |         |         |         |
10+35       0.0024      0.00  Q         |         |         |         |
10+40       0.0024      0.00  Q         |         |         |         |
10+45       0.0025      0.00  Q         |         |         |         |
10+50       0.0025      0.00  Q         |         |         |         |
10+55       0.0025      0.00  Q         |         |         |         |
11+ 0       0.0026      0.00  Q         |         |         |         |
11+ 5       0.0026      0.00  Q         |         |         |         |
11+10       0.0026      0.00  Q         |         |         |         |
11+15       0.0026      0.00  Q         |         |         |         |
11+20       0.0027      0.00  Q         |         |         |         |
11+25       0.0027      0.00  Q         |         |         |         |
11+30       0.0027      0.00  Q         |         |         |         |
11+35       0.0028      0.00  Q         |         |         |         |
11+40       0.0028      0.00  Q         |         |         |         |
11+45       0.0028      0.00  Q         |         |         |         |
11+50       0.0029      0.00  Q         |         |         |         |
11+55       0.0029      0.00  Q         |         |         |         |
12+ 0       0.0029      0.00  Q         |         |         |         |
12+ 5       0.0030      0.00  Q         |         |         |         |
12+10       0.0030      0.00  Q         |         |         |         |
12+15       0.0030      0.00  Q         |         |         |         |
12+20       0.0031      0.01  Q         |         |         |         |
12+25       0.0031      0.01  Q         |         |         |         |
12+30       0.0031      0.01  Q         |         |         |         |
12+35       0.0032      0.01  Q         |         |         |         |
12+40       0.0032      0.01  Q         |         |         |         |
12+45       0.0033      0.01  Q         |         |         |         |
12+50       0.0033      0.01  Q         |         |         |         |
12+55       0.0033      0.01  Q         |         |         |         |
13+ 0       0.0034      0.01  Q         |         |         |         |
13+ 5       0.0034      0.01  Q         |         |         |         |
13+10       0.0035      0.01  Q         |         |         |         |
13+15       0.0035      0.01  Q         |         |         |         |
13+20       0.0036      0.01  Q         |         |         |         |
13+25       0.0036      0.01  Q         |         |         |         |
13+30       0.0036      0.01  Q         |         |         |         |
13+35       0.0037      0.01  Q         |         |         |         |
13+40       0.0037      0.01  Q         |         |         |         |
13+45       0.0038      0.01  Q         |         |         |         |
13+50       0.0038      0.01  Q         |         |         |         |
13+55       0.0039      0.01  Q         |         |         |         |
14+ 0       0.0039      0.01  Q         |         |         |         |
14+ 5       0.0040      0.01  Q         |         |         |         |
14+10       0.0040      0.01  Q         |         |         |         |
14+15       0.0041      0.01  Q         |         |         |         |
14+20       0.0041      0.01  Q         |         |         |         |
14+25       0.0042      0.01  Q         |         |         |         |
14+30       0.0043      0.01  Q         |         |         |         |
14+35       0.0043      0.01  Q         |         |         |         |
14+40       0.0044      0.01  Q         |         |         |         |
14+45       0.0044      0.01  Q         |         |         |         |
14+50       0.0045      0.01  Q         |         |         |         |
14+55       0.0046      0.01  Q         |         |         |         |
15+ 0       0.0046      0.01  Q         |         |         |         |
15+ 5       0.0047      0.01  Q         |         |         |         |
15+10       0.0048      0.01  Q         |         |         |         |
15+15       0.0048      0.01  QV        |         |         |         |
15+20       0.0049      0.01  QV        |         |         |         |
15+25       0.0050      0.01  QV        |         |         |         |
15+30       0.0051      0.01  QV        |         |         |         |
15+35       0.0051      0.01  QV        |         |         |         |
```

```
15+40       0.0052      0.01  QV        |         |         |         |
15+45       0.0053      0.01  QV        |         |         |         |
15+50       0.0054      0.01  QV        |         |         |         |
15+55       0.0054      0.01  QV        |         |         |         |
16+ 0       0.0055      0.01  QV        |         |         |         |
16+ 5       0.0098      0.61  | Q       |         |         |         |
16+10       0.0234      1.98  |   V  Q  |         |         |         |
16+15       0.0476      3.51  |        V|   Q     |         |         |
16+20       0.0788      4.53  |         |     V Q |         |         |
16+25       0.1069      4.09  |         |     Q   | V       |         |
16+30       0.1247      2.58  |         Q         |     V   |         |
16+35       0.1361      1.66  |     Q   |         |       V |         |
16+40       0.1438      1.12  |   Q     |         |         V         |
16+45       0.1500      0.90  |  Q      |         |         |V        |
16+50       0.1551      0.74  | Q       |         |         | V       |
16+55       0.1595      0.63  | Q       |         |         |  V      |
17+ 0       0.1632      0.55  | Q       |         |         |   V     |
17+ 5       0.1664      0.45  |Q        |         |         |   V     |
17+10       0.1691      0.40  |Q        |         |         |    V    |
17+15       0.1716      0.37  |Q        |         |         |     V   |
17+20       0.1737      0.30  |Q        |         |         |     V   |
17+25       0.1756      0.27  |Q        |         |         |     V   |
17+30       0.1771      0.22  Q         |         |         |      V  |
17+35       0.1785      0.21  Q         |         |         |      V  |
17+40       0.1799      0.20  Q         |         |         |      V  |
17+45       0.1812      0.19  Q         |         |         |       V |
17+50       0.1823      0.15  Q         |         |         |       V |
17+55       0.1833      0.14  Q         |         |         |       V |
18+ 0       0.1841      0.13  Q         |         |         |       V |
18+ 5       0.1850      0.12  Q         |         |         |       V |
18+10       0.1856      0.10  Q         |         |         |       V |
18+15       0.1863      0.09  Q         |         |         |        V|
18+20       0.1868      0.07  Q         |         |         |        V|
18+25       0.1873      0.07  Q         |         |         |        V|
18+30       0.1878      0.07  Q         |         |         |        V|
18+35       0.1882      0.07  Q         |         |         |        V|
18+40       0.1887      0.07  Q         |         |         |        V|
18+45       0.1892      0.07  Q         |         |         |        V|
18+50       0.1892      0.01  Q         |         |         |        V|
18+55       0.1893      0.00  Q         |         |         |        V|
19+ 0       0.1893      0.00  Q         |         |         |        V|
19+ 5       0.1893      0.00  Q         |         |         |        V|
19+10       0.1893      0.00  Q         |         |         |        V|
19+15       0.1894      0.00  Q         |         |         |        V|
19+20       0.1894      0.00  Q         |         |         |        V|
19+25       0.1894      0.00  Q         |         |         |        V|
19+30       0.1895      0.00  Q         |         |         |        V|
19+35       0.1895      0.00  Q         |         |         |        V|
19+40       0.1895      0.00  Q         |         |         |        V|
19+45       0.1895      0.00  Q         |         |         |        V|
19+50       0.1896      0.00  Q         |         |         |        V|
19+55       0.1896      0.00  Q         |         |         |        V|
20+ 0       0.1896      0.00  Q         |         |         |        V|
20+ 5       0.1897      0.00  Q         |         |         |        V|
20+10       0.1897      0.00  Q         |         |         |        V|
20+15       0.1897      0.00  Q         |         |         |        V|
20+20       0.1897      0.00  Q         |         |         |        V|
20+25       0.1897      0.00  Q         |         |         |        V|
20+30       0.1898      0.00  Q         |         |         |        V|
20+35       0.1898      0.00  Q         |         |         |        V|
20+40       0.1898      0.00  Q         |         |         |        V|
20+45       0.1898      0.00  Q         |         |         |        V|
20+50       0.1899      0.00  Q         |         |         |        V|
20+55       0.1899      0.00  Q         |         |         |        V|
21+ 0       0.1899      0.00  Q         |         |         |        V|
21+ 5       0.1899      0.00  Q         |         |         |        V|
21+10       0.1900      0.00  Q         |         |         |        V|
21+15       0.1900      0.00  Q         |         |         |        V|
21+20       0.1900      0.00  Q         |         |         |        V|
21+25       0.1900      0.00  Q         |         |         |        V|
21+30       0.1900      0.00  Q         |         |         |        V|
```

```
  21+35        0.1901       0.00  Q          |          |          |        V|
  21+40        0.1901       0.00  Q          |          |          |        V|
  21+45        0.1901       0.00  Q          |          |          |        V|
  21+50        0.1901       0.00  Q          |          |          |        V|
  21+55        0.1901       0.00  Q          |          |          |        V|
  22+ 0        0.1902       0.00  Q          |          |          |        V|
  22+ 5        0.1902       0.00  Q          |          |          |        V|
  22+10        0.1902       0.00  Q          |          |          |        V|
  22+15        0.1902       0.00  Q          |          |          |        V|
  22+20        0.1902       0.00  Q          |          |          |        V|
  22+25        0.1903       0.00  Q          |          |          |        V|
  22+30        0.1903       0.00  Q          |          |          |        V|
  22+35        0.1903       0.00  Q          |          |          |        V|
  22+40        0.1903       0.00  Q          |          |          |        V|
  22+45        0.1903       0.00  Q          |          |          |        V|
  22+50        0.1903       0.00  Q          |          |          |        V|
  22+55        0.1904       0.00  Q          |          |          |        V|
  23+ 0        0.1904       0.00  Q          |          |          |        V|
  23+ 5        0.1904       0.00  Q          |          |          |        V|
  23+10        0.1904       0.00  Q          |          |          |        V|
  23+15        0.1904       0.00  Q          |          |          |        V|
  23+20        0.1904       0.00  Q          |          |          |        V|
  23+25        0.1905       0.00  Q          |          |          |        V|
  23+30        0.1905       0.00  Q          |          |          |        V|
  23+35        0.1905       0.00  Q          |          |          |        V|
  23+40        0.1905       0.00  Q          |          |          |        V|
  23+45        0.1905       0.00  Q          |          |          |        V|
  23+50        0.1905       0.00  Q          |          |          |        V|
  23+55        0.1906       0.00  Q          |          |          |        V|
  24+ 0        0.1906       0.00  Q          |          |          |        V|
  24+ 5        0.1906       0.00  Q          |          |          |        V|
  24+10        0.1906       0.00  Q          |          |          |        V|
  24+15        0.1906       0.00  Q          |          |          |        V|
  24+20        0.1906       0.00  Q          |          |          |        V|
  24+25        0.1906       0.00  Q          |          |          |        V|
  24+30        0.1906       0.00  Q          |          |          |        V|
  24+35        0.1907       0.00  Q          |          |          |        V|
  24+40        0.1907       0.00  Q          |          |          |        V|
  24+45        0.1907       0.00  Q          |          |          |        V|
  24+50        0.1907       0.00  Q          |          |          |        V|
  24+55        0.1907       0.00  Q          |          |          |        V|
  25+ 0        0.1907       0.00  Q          |          |          |        V|
  25+ 5        0.1907       0.00  Q          |          |          |        V|
  25+10        0.1907       0.00  Q          |          |          |        V|
  25+15        0.1907       0.00  Q          |          |          |        V|
  25+20        0.1907       0.00  Q          |          |          |        V|
  25+25        0.1907       0.00  Q          |          |          |        V|
  25+30        0.1907       0.00  Q          |          |          |        V|
  25+35        0.1907       0.00  Q          |          |          |        V|
  25+40        0.1907       0.00  Q          |          |          |        V|
  25+45        0.1907       0.00  Q          |          |          |        V|
  25+50        0.1907       0.00  Q          |          |          |        V|
  25+55        0.1907       0.00  Q          |          |          |        V|
  26+ 0        0.1907       0.00  Q          |          |          |        V|
  26+ 5        0.1907       0.00  Q          |          |          |        V|
  26+10        0.1907       0.00  Q          |          |          |        V|
  26+15        0.1907       0.00  Q          |          |          |        V|
  26+20        0.1907       0.00  Q          |          |          |        V|
  26+25        0.1907       0.00  Q          |          |          |        V|
  26+30        0.1907       0.00  Q          |          |          |        V|
  26+35        0.1907       0.00  Q          |          |          |        V|
  26+40        0.1907       0.00  Q          |          |          |         V
-----------------------------------------------------------------------
```

0.1907*43,560=8,307

Form 4.2-3 HCOC Assessment for Runoff Volume

Weighted Curve Number Determination for: Pre-developed DA-1								
1a Land Cover type								
2a Hydrologic Soil Group (HSG)								
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*								
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP. Site Pervious Area: 35,351 SF. (in DA-1: 40,000 SF)*								
Weighted Curve Number Determination for: Post-developed DA			DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1b Land Cover type								
2b Hydrologic Soil Group (HSG)								
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*								
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP. Site Pervious Area: 19,847 SF. (in DA-1-40,000 SF)*								

5 Pre-Developed area-weighted CN:	7 Pre-developed soil storage capacity, S (in): *S = (1000 / Item 5) – 10*	9 Initial abstraction, I_a (in): *I_a = 0.2 * Item 7*
6 Post-Developed area-weighted CN:	8 Post-developed soil storage capacity, S (in) = 1.23 *S = (1000 / Item 6) – 10*	10 Initial abstraction, I_a (in): *I_a = 0.2 * Item 8*

11 Precipitation for 2 yr, 24 hr storm (in): *Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*
12 Pre-developed Volume (ft^3): *V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*
13 Post-developed Volume (ft^3): *V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*
14 Volume Reduction needed to meet HCOC Requirement, (ft^3): Volume increased by 3,848 CF (59% of pre-development volume). Volume reduction provided by the combination of proposed Chamber System and the proposed retention/infiltration basin for HCOC requirement. *V_{HCOC} = (Item 13 * 0.95) – Item 12*

Form 4.2-4 HCOC Assessment for Time of Concentration

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below)* : *Please refer to the Rational Method Hydrology Study For Pre-developed and Post-developed Drainage Area below:*

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

13 Pre-developed time of concentration (min):

14 Post-developed time of concentration (min):

15 Additional time of concentration needed to meet HCOC requirement (min):

Form 4.2-5 HCOC Assessment for Peak Runoff

Compute peak runoff for pre- and post-developed conditions
Please refer to the Rational Method Hydrology Study For Pre-developed and Post-developed Drainage Area below

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_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*							
2 Drainage Area of each DMA (ft²) *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)*							
3 Ratio of pervious area to total area *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)*							
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*							
5 Maximum loss rate (in/hr) *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)*							
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*							
7 Time of concentration adjustment factor for other DMA to site discharge point *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)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: *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 $7_{DMAA/3}$]*	9 Pre-developed Q_p at T_c for DMA B: *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 $7_{DMAB/3}$]*	10 Pre-developed Q_p at T_c for DMA C: *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 $7_{DMAC/2}$]*
10 Peak runoff from pre-developed condition confluence analysis (cfs): *Maximum of Item 8, 9, and 10 (including additional forms as needed)*		
11 Post-developed Q_p at T_c for DMA A: *Same as Item 8 for post-developed values*	12 Post-developed Q_p at T_c for DMA B: *Same as Item 9 for post-developed values*	13 Post-developed Q_p at T_c for DMA C: *Same as Item 10 for post-developed values*
14 Peak runoff from post-developed condition confluence analysis (cfs): *Maximum of Item 11, 12, and 13 (including additional forms as needed)*		

15	Peak runoff reduction needed to meet HCOC Requirement (cfs):	$Q_{p\text{-}HCOC}$ = *(Item 14 * 0.95) – Item 10*

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)? Design infiltration rate greater than the 0.3 in/hr
Yes ☐ No ☒

If Yes, Provide basis:

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 9 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": Yes
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 = Item2 * 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): *$V_{retention}$ =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) *$V_{retention}$ = (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*			
13 Runoff volume retention from on-lot infiltration (ft^3): *$V_{retention}$ =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 ☒ *If yes, complete Items 15-20. If no, proceed to Item 21*	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) *Use local values, typical ~ 0.1*			
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*			
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*			
19 Retention Volume (ft^3) *$V_{retention}$ = Item 17 * (Item 18 / 24)*			
20 Runoff volume retention from evapotranspiration BMPs (ft^3): 0 ft^3 *$V_{retention}$ =Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 20-2. If no, proceed to Item 24*	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) *$V_{retention}$ = Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*			
25 Runoff volume retention from street tree BMPs (ft^3): 0 ft^3 *$V_{retention}$ = Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrels/cisterns: Yes ☐ No ☒ *If yes, complete Items 27-28; If no, proceed to Item 29*	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) *$V_{retention}$ = Item 27 * 3*			
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): 0 ft^3 *$V_{retention}$ =Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 0 ft^3 *Sum of Items 5, 13, 20, 25 and 29*			

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 (DMA1)

[1] Remaining LID DCV not met by site design HSC BMP (ft^3): 31,682 ft^3 *V_{unmet} = Form 4.2-1 Item 7 - 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*	DMA 1 BMP Type Inf. Basin		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*	8.49		
[3] Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	3.0		
[4] Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	2.83		
[5] Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	48		
[6] Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	-		
[7] Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	6.0		
[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*	9,072 7 Chamber combined		
[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*	0		
[10] Amended soil porosity	0		
[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*	-		
[12] Gravel porosity	0.4		
[13] Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	-		
[14] Above Ground Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*	-		
[15] Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*	50,218		

[16] Total Retention Volume from LID Infiltration BMPs: 50,218 ft^3 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

[17] Fraction of DCV achieved with infiltration BMP: 158% *Retention% = Item 16 / Form 4.2-1 Item 7*

[18] Is full LID DCV retained on-site with combination of hydrologic source control and LID retention and 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.

PROJECT SUMMARY

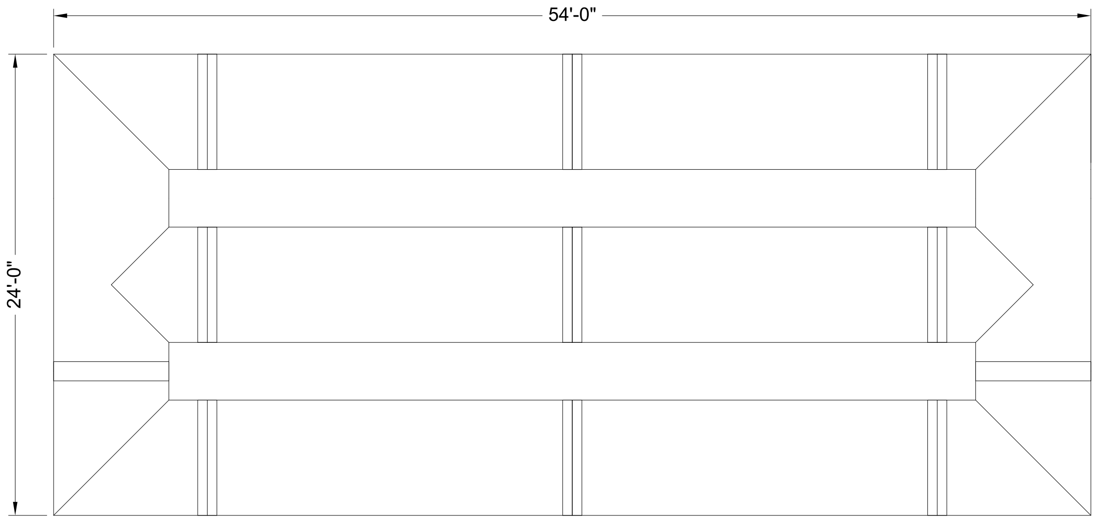
CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 174 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = 7,050 cf.
- PIPE STORAGE VOLUME = 4,920 cf.
- BACKFILL STORAGE VOLUME = 2,255 cf.
- TOTAL STORAGE PROVIDED = 7,174 cf.

COMBINED CAPACITY OF THE PROPOSED 7-CHAMBERS: 7 * 7,174 = 50,218 CF
TOTAL FOOT PRINT: 7 * (54'x24') = 9,072 SF

PIPE DETAILS
- DIAMETER = 72 IN.
- CORRUGATION = 5x1
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 36 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 9 IN.



ASSEMBLY
SCALE: 1" = 10'

NOTES

- ALL RISER AND STUB DIMENSIONS ARE TO CENTERLINE. ALL ELEVATIONS, DIMENSIONS, AND LOCATIONS OF RISERS AND INLETS, SHALL BE VERIFIED BY THE ENGINEER OF RECORD PRIOR TO RELEASING FOR FABRICATION.
- ALL FITTINGS AND REINFORCEMENT COMPLY WITH ASTM A998.
- ALL RISERS AND STUBS ARE $2\frac{2}{3}$" x $\frac{1}{2}$" CORRUGATION AND 16 GAGE UNLESS OTHERWISE NOTED.
- RISERS TO BE FIELD TRIMMED TO GRADE.
- QUANTITY OF PIPE SHOWN DOES NOT PROVIDE EXTRA PIPE FOR CONNECTING THE SYSTEM TO EXISTING PIPE OR DRAINAGE STRUCTURES. OUR SYSTEM AS DETAILED PROVIDES NOMINAL INLET AND/OR OUTLET PIPE STUB FOR CONNECTION TO EXISTING DRAINAGE FACILITIES. IF ADDITIONAL PIPE IS NEEDED IT IS THE RESPONSIBILITY OF THE CONTRACTOR.
- BAND TYPE TO BE DETERMINED UPON FINAL DESIGN.
- THE PROJECT SUMMARY IS REFLECTIVE OF THE DYODS DESIGN, QUANTITIES ARE APPROX. AND SHOULD BE VERIFIED UPON FINAL DESIGN AND APPROVAL. FOR EXAMPLE, TOTAL EXCAVATION DOES NOT CONSIDER ALL VARIABLES SUCH AS SHORING AND ONLY ACCOUNTS FOR MATERIAL WITHIN THE ESTIMATED EXCAVATION FOOTPRINT.
- THESE DRAWINGS ARE FOR CONCEPTUAL PURPOSES AND DO NOT REFLECT ANY LOCAL PREFERENCES OR REGULATIONS. PLEASE CONTACT YOUR LOCAL CONTECH REP FOR MODIFICATIONS.

C:\EXPORTS\TEMPLATES\CMP_V5.DWG 10/18/2019 10:02 AM

DATE	REVISION DESCRIPTION	BY

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH® CMP DETENTION SYSTEMS

CONTECH
DYODS
DRAWING

DYO10714 Warmington
Retention System-Medical Center Dr
Fontana, CA
DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6662	10714	9/30/2021

DESIGNED:	DRAWN:
DYO	DYO
CHECKED:	**APPROVED:**
DYO	DYO

SHEET NO.: D1

Infiltration Drawdown Time Calculation:
(Combied 7-Chambers)

Infiltration Surface Area Provided:	9,072	SF	Combined Footprint of Inf Surface Area
Infiltration Rate per Soil Report	8.49	in/hr	(7-Contech Chamber System)
	0.71	ft/hr	
Facor of Safety	3		
Design Infiltration Rate	0.236	ft/hr	
Volume needed to be Infiltrated	50218	cu.ft	
Infiltration Volume per hour	2139.48	cu.ft/hr	(9072 sft * 0.236 ft/hr)
Infiltration Draw Down Time	23.47	Hours	(50218 cu.ft / 2139.48 cu.ft/hr)
	23.5	< 48 hr draw down time. OK	

logged the excavations and collected soil samples for use in subsequent laboratory testing. The logs of the exploratory borings are included in Appendix A.

Relatively undisturbed soil samples were recovered at various intervals in the geotechnical borings with a California sampler. The California sampler is a 3-inch outside diameter, 2.5-inch inside diameter, split barrel sampler lined with brass rings. The sampler was 18 inches long. The sampler conformed to the requirements of ASTM D 3550. A 140-pound automatic trip hammer was utilized, dropping 30 inches for each blow. The relatively undisturbed samples, together with bulk samples of representative soil types, were returned to the laboratory for testing and evaluation. The California sampler test data are presented on the boring logs in Appendix A.

Percolation Testing

In addition to the geotechnical exploratory borings, two percolation test borings (I-1 and I-2) were excavated in the area of the proposed storm water management basin to depths of about 5 feet. Infiltration/percolation testing was conducted in these borings in general accordance with the requirements of the County of San Bernardino.

The percolation tests consisted of drilling an eight-inch diameter test hole to the desired depth and installing approximately two inches of gravel in the bottom of the hole. A three-inch diameter perforated PVC pipe, wrapped in a filter sock, was placed in the excavations and the annular space was filled with gravel to prevent caving within the boring. Water was then placed in the borings to presoak the holes and percolation testing was performed the following the pre-soak period. Following presoaking it was determined that "sandy soil" criteria was met within both percolation borings. The percolation tests were then performed which consisted of adding water to each test hole and measuring the water drop over a 10-minute period. The water drop was recorded for eight test intervals. Water was added to the test holes after each test interval. The field percolation rates were then converted to an infiltration rate using the Porchet Method.

The results of the conversions indicate infiltration rate range from about 8.49 to 8.74 inches per hour. Copies of the percolation data sheets and the Porchet infiltration rate conversion calculations are presented in Appendix C. No factors of safety were applied to the rates provided. Over the lifetime of the infiltration areas, the infiltration rates may be affected by sediment build up and biological activities, as well as local variations in near surface soil conditions. A suitable factor of safety should be applied to the field rate in designing the infiltration system.

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 x v
A	Suitability Assessment	Soil assessment methods	0.25	1	0.25
		Predominant soil texture	0.25	2	0.50
		Site soil variability	0.25	2	0.50
		Depth to groundwater / impervious layer	0.25	1	0.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1.50
B	Design	Tributary area size	0.25	2	0.50
		Level of pretreatment/ expected sediment loads	0.25	2	0.50
		Redundancy	0.25	3	0.75
		Compaction during construction	0.25	1	0.25
		Design Safety Factor, $S_B = \Sigma p$			2.00
Combined Safety Factor, $S_{TOT} = S_A \times S_B$					3.00
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)					8.49
Design Infiltration Rate, in/hr, $K_{DESIGN} = S_{TOT} / K_M$					2.83

Supporting Data
Briefly describe infiltration test and provide reference to test forms: Lowest measured Inf. Rate : 8.49 in/hr from Geotechnical and Infiltration Evaluation Report, August 21, 2021.

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

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 (DMA 1)
1 Total LID DCV for the Project DMA-1 (ft^3): 31,682 ft^3 *Copy Item 7 in Form 4.2-1*
2 On-site retention with site design hydrologic source control LID BMP (ft^3): 0 ft^3 *Copy Item 30 in Form 4.3-2*
3 On-site retention with LID infiltration BMP (ft^3): 50,218 ft^3 *Copy Item 16 in Form 4.3-3*
4 On-site retention with LID harvest and use BMP (ft^3): 0 ft^3 *Copy Item 9 in Form 4.3-4*
5 On-site biotreatment with volume based biotreatment BMP (ft^3): 0 ft^3 *Copy Item 3 in Form 4.3-5*
6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 ft^3 *Copy Item 6 in Form 4.3-5*
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 ☐ *If yes, sum of Items 2, 3, and 4 is greater than Item 1* • 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 ☐ *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* ▪ 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 ☐ *If yes, Form 4.3-1 Items 7 and 8 were both checked yes*
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: ☐ *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)%* • 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: ☐ *Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed*

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.

<table>
<tr><th colspan="2">Form 4.3-10 Hydromodification Control BMPs (Not Applicable)</th></tr>
<tr><td>1 Volume reduction needed for HCOC performance criteria (ft³): 49,314
(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1</td><td>2 On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft³): 50,218 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</td></tr>
<tr><td>3 Remaining volume for HCOC volume capture (ft³): 0 Item 1 – Item 2</td><td>4 Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft³): 0 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)</td></tr>
<tr><td colspan="2">5 If Item 4 is less than Item 3, incorporate in-stream controls on downstream waterbody segment to prevent impacts due to hydromodification ☐ Attach in-stream control BMP selection and evaluation to this WQMP</td></tr>
<tr><td colspan="2">6 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☒
If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:
• Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site or off-site retention BMP ☒Time of Concentration will be increased due to proposed retention of water in the ret/inf. chamber system BMPs.
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)
• 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 ☐</td></tr>
<tr><td colspan="2">7 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☒
If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:
• Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site or off-site retention BMPs ☒Pick flow will be decreased due to retention of water in the proposed ret/inf chamber system BMPs. Onsite ret basin is designed to retain volume of water up to 100-yr storm and will substantially reduce the peak outflow.
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)
• 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 ☐</td></tr>
</table>

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
Contech Chamber System	Warmington Homes	Step 1) Inspect isolator row for sediment a. inspection ports (if present) a.1. remove/open lid on nyloplast inline drain a.2. remove and clean flexstorm filter if installed a.3. using a flashlight and stadia rod, measure depth of sediment and record on maintenance log a.4. lower a camera into isolator row for visual inspection of sediment levels (optional) a.5. if sediment is at, or above, 3" (80 mm) proceed to step 2. If not, proceed to step 3. b. all isolator rows b.1. remove cover from structure at upstream end of isolator row b.2. using a flashlight, inspect down the isolator row through outlet pipe i) mirrors on poles or cameras may be used to avoid a confined space entry ii) follow osha regulations for confined space entry if entering manhole b.3. if sediment is at, or above, 3" (80 mm) proceed to step 2. if not, proceed to step 3. step 2) clean out isolator row using the jetvac process a. a fixed culvert cleaning nozzle with rear facing spread of 45" (1.1 m) or more is preferred b. apply multiple passes of jetvac until backflush water is clean c. vacuum structure sump as required step 3) replace all covers, grates, filters, and lids; record observations and actions. step 4) inspect and clean basins and manholes upstream of the stormtech system.	1. Inspect every 6 months during the first year of operation. adjust the inspection interval based on previous observations of sediment accumulation and high water elevations. 2. Conduct jetting and vactoring annually or when inspection shows that maintenance is necessary.

Education of Property Owners, Tenants and Occupants on Stormwater BMPs	Warmington Homes	Practical education materials will be provided to property owners covering various water quality issues that will need to be addressed on their specific site. These materials will include general good house keeping practices that contribute to the protection of storm water quality and BMP's that eliminate or reduce pollution during property improvements.	*Ongoing*
Landscape maintenance	Warmington Homes	Landscape planning is implemented to reduce groundwater and storm water contamination. This will be accomplished through an infiltration basin, and landscape areas.	*Monthly*
Litter debris control program	Warmington Homes .	Litter debris control program and site clean will be developed by the Owner	*Ongoing with every visit*
Employee training	Warmington Homes .	Employee training may be developed by City of San Bernardino	*Annually and upon new hires by the owner*
Catch basin inspection program	Warmington Homes	Catch basins and the filter devices will be inspected/clean a minimum of once every three months during the dry season and a minimum of once every two months during the rainy season.	*As stated*
Provide storm drain system stencilling and signage	Warmington Homes	Signs will be placed above storm drain inlets to warn the public of prohibitions against waste disposal	*Inspect once a year and replaceed if degradation occurs*

Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	Warmington Homes	Rain sensors will be incorporated into the onsite sprinkler system so that no unnecessary watering of landscaped areas occurs after storm events.	*Once a year or according to Manufacturer Manuals*
Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	Warmington Homes	New landscaped areas will be constructed at a minimum of 1 inch below existing paved areas	*Once a year*
Street Sweeping	Warmington Homes	Street weeping and Vaccuming	*Bi Monthly*

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

RECORDING REQUESTED BY:
County of San Bernardino
Department of Public Works

AND WHEN RECORDED MAIL TO:
County of San Bernardino
Department of Public Works
825 E. Third Street, Room 117
San Bernardino, CA 92415-0835

SPACE ABOVE THIS LINE FOR RECORDER'S USE

COVENANT AND AGREEMENT REGARDING WATER QUALITY MANAGEMENT PLAN AND STORMWATER BEST MANAGEMENT PRACTICES TRANSFER, ACCESS AND MAINTENANCE

THIS PAGE ADDED TO PROVIDE ADEQUATE SPACE FOR RECORDING INFORMATION

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

OWNER NAME: Warmington Residential

PROPERTY ADDRESS: Highland Ave and Medical Center Dr, San Bernardino, California

APN: 0143-191-59

THIS AGREEMENT is made and entered into in

____________________________________ ,California, this _________ day of

____________________________________ , by and between

____ , hereinafter

referred to as Owner, and the COUNTY OF SAN BERNARDINO, a political subdivision of the State of California, hereinafter referred to as “the County”;

WHEREAS, the Owner owns real property (“Property”) in the County of San Bernardino, State of California, more specifically described in Exhibit “A” and depicted in Exhibit “B”, each of which exhibits is attached hereto and incorporated herein by this reference; and

WHEREAS, at the time of initial approval of development project known as

______________________________________ within the Property described herein, the County required the project to employ Best Management Practices, hereinafter referred to as “BMPs,” to minimize pollutants in urban runoff; and

WHEREAS, the Owner has chosen to install and/or implement BMPs as described in the Water Quality Management Plan, dated ______________________, on file with the County and incorporated herein by this reference, hereinafter referred to as “WQMP”, to minimize pollutants in urban runoff and to minimize other adverse impacts of urban runoff; and

WHEREAS, said WQMP has been certified by the Owner and reviewed and approved by the County; and

WHEREAS, the Owner is aware that periodic and continuous maintenance, including, but not necessarily limited to, filter material replacement and sediment removal, is required to assure peak performance of all BMPs in the WQMP and that, furthermore, such maintenance activity will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs.

NOW THEREFORE, it is mutually stipulated and agreed as follows:

1. Owner shall comply with the WQMP

2. All maintenance or replacement of BMPs proposed as part of the WQMP are the sole responsibility of the Owner in accordance with the terms of this Agreement.

3. Owner hereby provides the County's designee complete access, of any duration, to the BMPs and their immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by the County Director of Public Works, no advance notice, for the purpose of inspection, sampling, testing of the BMPs, and in case of emergency, to undertake all necessary repairs or other preventative measures at owner's expense as provided in paragraph 5 below. The County shall make every effort at all times to minimize or avoid interference with Owner's use of the Property. Denial of access to any premises or facility that contains WQMP features is a breach of this Agreement and may also be a violation of the County's Pollutant Discharge Elimination System regulations, which on the effective date of this Agreement are found in County Code Sections 35.0101 et seq. If there is reasonable cause to believe that an illicit discharge or breach of this Agreement is occurring on the premises then the authorized enforcement agency may seek issuance of a search warrant from any court of competent jurisdiction in addition to other enforcement actions. Owner recognizes that the County may perform routine and regular inspections, as well as emergency inspections, of the BMPs. Owner or Owner's successors or assigns shall pay County for all costs incurred by County in the inspection, sampling, testing of the BMPs within thirty (30) calendar days of County invoice.

4. Owner shall use its best efforts diligently to maintain all BMPs in a manner assuring peak performance at all times. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the removal and extraction of any material(s) from the BMPs and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the County, the Owner shall provide the County with documentation identifying the material(s) removed, the quantity, and disposal destination), testing construction or reconstruction.

5. In the event Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) business days of being given written notice by the County , the County is hereby authorized to cause any maintenance necessary to be done and charge the entire cost and expense against the Property and/or to the Owner or Owner's successors or assigns, including administrative costs, attorneys fees and interest thereon at the maximum rate authorized by the County Code from the date of the notice of expense until paid in full. Owner or Owner's successors or assigns shall pay County within thirty (30) calendar days of County invoice.

6. The County may require the owner to post security in form and for a time period satisfactory to the County to guarantee the performance of the obligations stated herein. Should the Owner fail to perform the obligations under the Agreement, the County may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the surety(ies) to perform the obligations of this Agreement.

7. The County agrees, from time to time, within ten (10) business days after request of Owner, to execute and deliver to Owner, or Owner's designee, an estoppel certificate requested by Owner, stating that this Agreement is in full force and effect, and that Owner is not in default hereunder with regard to any maintenance or payment obligations (or specifying in detail the nature of Owner's default). Owner shall pay all costs and expenses incurred by the County in its investigation of whether to issue an estoppel certificate within thirty (30) calendar days after receipt of a County invoice and prior to the County's issuance of such certificate. Where the County cannot issue an estoppel certificate, Owner shall pay the County within thirty (30) calendar days of receipt of a County invoice.

8. Owner shall not change any BMPs identified in the WQMP without an amendment to this Agreement approved by authorized representatives of both the County and the Owner.

9. County and Owner shall comply with all applicable laws, ordinances, rules, regulations, court orders and government agency orders now or hereinafter in effect in carrying out the terms of this Agreement. If a provision of this Agreement is terminated or held to be invalid, illegal or unenforceable, the validity, legality and enforceability of the remaining provisions shall remain in full effect.

10. In addition to any remedy available to County under this Agreement, if Owner violates any term of this Agreement and does not cure the violation within the time already provided in this Agreement, or, if not provided, within thirty (30) calendar days, or within such time authorized by the County if said cure reasonably requires more than the subject time, the County may bring an action at law or in equity in a court of competent jurisdiction to enforce compliance by the Owner with the terms of this Agreement. In such action, the County may recover any damages to which the County may be entitled for the violation, enjoin the violation by temporary or permanent injunction without the necessity of proving actual damages or the inadequacy of otherwise available legal remedies, or obtain other equitable relief, including, but not limited to, the restoration of the Property and/or the BMPs identified in the WQMP to the condition in which it/they existed prior to any such violation or injury.

11. This Agreement shall be recorded in the Office of the Recorder of San Bernardino County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to said Property of the obligation herein set forth, and also a lien in such amount as will fully reimburse the County, including interest as herein above set forth, subject to foreclosure in event of default in payment.

12. In event of legal action occasioned by any default or action of the Owner, or its successors or assigns, then the Owner and its successors or assigns agree(s) to hold the County harmless and pay all costs incurred by the County in enforcing the terms of this Agreement, including reasonable attorney's fees and costs, and that the same shall become a part of the lien against said Property.

13. It is the intent of the parties hereto that burdens and benefits herein undertaken shall constitute covenants that run with said Property and constitute a lien there against.

14. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or part of the Property about the existence of

this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the County at the same time such notice is provided to the successor.

15. Time is of the essence in the performance of this Agreement.

16. Any notice to a party required or called for in this Agreement shall be served in person, or by deposit in the U.S. Mail, first class postage prepaid, to the address set forth below. Notice(s) shall be deemed effective upon receipt, or seventy-two (72) hours after deposit in the U.S. Mail, whichever is earlier. A party may change a notice address only by providing written notice thereof to the other party.

17. Owner agrees to indemnify, defend (with counsel reasonably approved by the County) and hold harmless the County and its authorized officers, employees, agents and volunteers from any and all claims, actions, losses, damages, and/or liability arising out of this Agreement from any cause whatsoever, including the acts, errors or omissions of any person and for any costs or expenses incurred by the County on account of any claim except where such indemnification is prohibited by law. This indemnification provision shall apply regardless of the existence or degree of fault of indemnitees. The Owner's indemnification obligation applies to the County's "active" as well as "passive" negligence but does not apply to the County's "sole negligence" or "willful misconduct" within the meaning of Civil Code Section 2782, or to any claims, actions, losses, damages, and/or liabilities, to the extent caused by the acts or omissions of any third party contractors undertaking any work (other than field inspections) or other maintenance on the Property on behalf of the County under this Agreement..

[REMAINDER OF THIS PAGE INTENTIONALLY LEFT BLANK]

IF TO COUNTY :

Director of Public Works

825 E. Third Street, Room 117

San Bernardino, CA 92415-0835

IF TO OWNER:

____

____

____

IN WITNESS THEREOF, the parties hereto have affixed their signatures as of the date first written above.

OWNER:

Signature: ________________________

Name: ___________________________

Title: ___________________________

Date: ___________________________

FOR: Maintenance Agreement, dated _________________________, for the project known as __________________________________

______ ________________

(APN) 0143-191-59 __________________,
As described in the WQMP dated _________________________________.

OWNER:

Signature: ________________________

Name: ___________________________

Title: ___________________________

Date: ___________________________

NOTARIES ON FOLLOWING PAGE

A notary acknowledgement is required for recordation.

ACCEPTED BY:

____

KEVIN BLAKESLEE, P.E., Director of Public Works

Date: __________________________________

Attachment: Notary Acknowledgement

ATTACHMENT 1
Notary Acknowledgement)

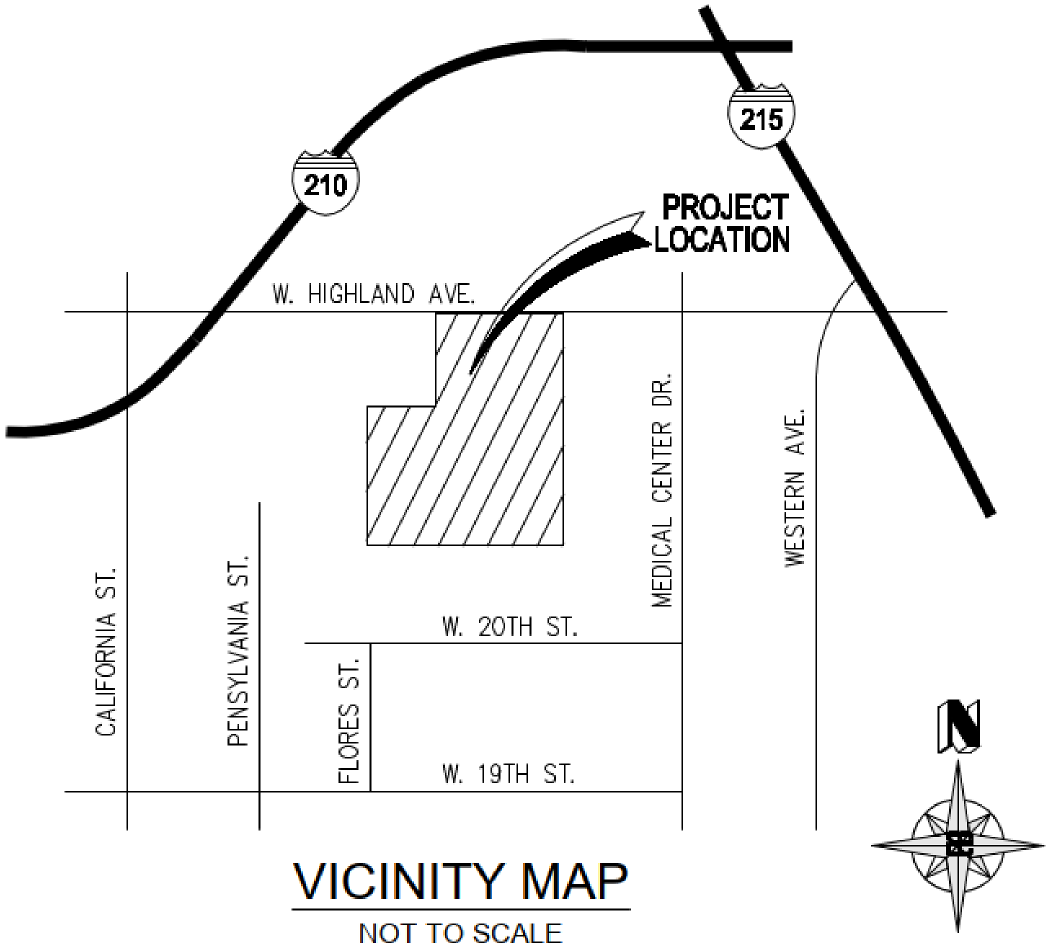
EXHIBIT A
(Legal Description)

EASEMENTS:

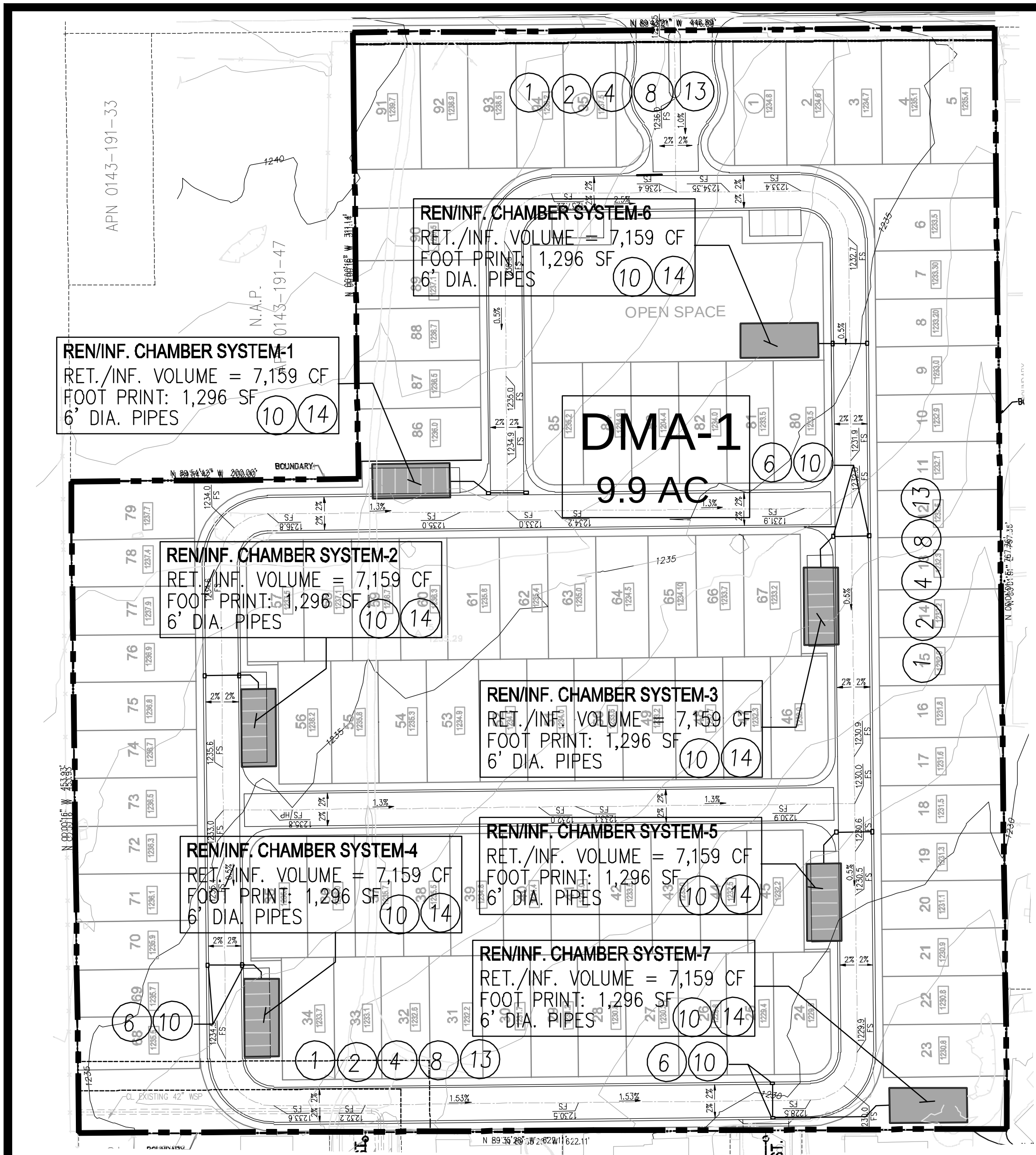
(A) AN EASEMENT FOR TEMPORARY EASEMENT FOR WATER PIPELINES AND APPURTENANT FACILITIES ACROSS AND INCIDENTAL PURPOSES IN THE DOCUMENT RECORDED JANUARY 13, 2005 AS INSTRUMENT NO. 2005-0032185 OF OFFICIAL RECORDS.

(B) AN EASEMENT FOR WATER PIPELINES AND APPURTENANT FACILITIES ACROSS AND INCIDENTIAL PURPOSES IN THE DOCUMENT RECORDED JANUARY 13, 2005 AS INSTRUMENT NO. 2005-0032186 OF OFFICIAL RECORDS.

EXHIBIT B
(Map/illustration)



VICINITY MAP
NOT TO SCALE



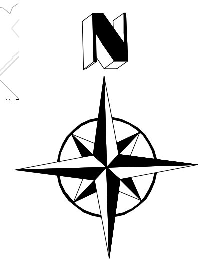
DRAINAGE AREA	PROPOSED BMP	AREA (AC)	DESIGN CAPTURE VOL. (CF)	PROVIDED VOL. (CF)	TOTAL MITIGATED VOLUME (CF)
DMA-1	CONTECH CHAMBER SYSTEM 1 TO 7	9.9	31,682	50,218	50,218

DCV ACHEIVED WITH PROPOSED BMPs: 158%

BMP LIST:

1. EDUCATION OF PROPERTY OWNERS
2. HARDSCAPE AREA (CONCRETE PAVING)
3. LANDSCAPE AREA
4. TRAINING/EDUCATION PROGRAM
5. STREET/DRIVE WAY SWEEPING/VACUUMING
6. COMMON AREA CATCH BASIN INSPECTION
7. LANDSCAPE PLANNING (SD-10)
8. ROOF RUNOFF CONTROLS (SD-11)
9. EFFICIENT IRRIGAION (SD-12)
10. STORM DRAIN SIGNAGE (SD-13) PER CASQA STANDARD
11. OVERFLOW SPILLWAY
12. ENERGY DISSIPATERS
13. TRASH STORAGE AREAS (SD-32)
14. UNDERGROUND INFILTRATION/DETENTION CHAMBER SYSTEM (TC-11) * (6' DIA CONTECH CHAMBER SYSTEM)
15. GRATE INLET FILTER INSERT- ADS FLEXSTORM FILTER INSERT
16. 3-FT V-GUTTER PER CITY STD. PLAN 201.

* WQMP BMP NOT TO BE MODIFIED IN FUTURE
NO CLAY IN TOP 12" OF SOIL



Prepared By:

ALLARD ENGINEERING
Civil Engineering - Land Surveying - Land Planning
16866 Seville Avenue
Fontana, California 92335
(909) 356-1815 Fax (909) 356-1795

SCALE: 1"= 120'

APN: 0143-191-59
COUNTY OF SAN BERNARDINO
WQMP SITE PLAN

Filename: I:\Warmington Homes\Medical Center Drive San Bernardino\DWG's\ENTITLEMENT\EXHIBIT\WQMP.dwg

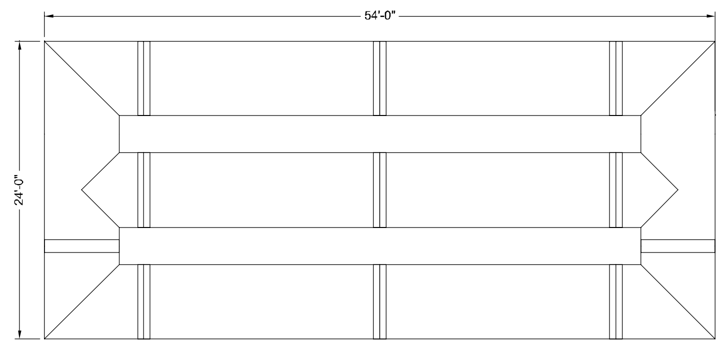
PROJECT SUMMARY

CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 174 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = 7,050 cf.
- PIPE STORAGE VOLUME = 4,920 cf.
- BACKFILL STORAGE VOLUME = 2,255 cf.
- TOTAL STORAGE PROVIDED = 7,174 cf.

PIPE DETAILS
- DIAMETER = 72 IN.
- CORRUGATION = 5x1
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 36 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 9 IN.



NOTES

- ALL RISER AND STUB DIMENSIONS ARE TO CENTERLINE. ALL ELEVATIONS, DIMENSIONS, AND LOCATIONS OF RISERS AND INLETS, SHALL BE VERIFIED BY THE ENGINEER OF RECORD PRIOR TO RELEASING FOR FABRICATION.
- ALL FITTINGS AND REINFORCEMENT COMPLY WITH ASTM A998.
- ALL RISERS AND STUBS ARE $2\frac{2}{3}$" x $\frac{1}{2}$" CORRUGATION AND 16 GAGE UNLESS OTHERWISE NOTED.
- RISERS TO BE FIELD TRIMMED TO GRADE.
- QUANTITY OF PIPE SHOWN DOES NOT PROVIDE EXTRA PIPE FOR CONNECTING THE SYSTEM TO EXISTING PIPE OR DRAINAGE STRUCTURES. OUR SYSTEM AS DETAILED PROVIDES NOMINAL INLET AND/OR OUTLET PIPE STUB FOR CONNECTION TO EXISTING DRAINAGE FACILITIES. IF ADDITIONAL PIPE IS NEEDED IT IS THE RESPONSIBILITY OF THE CONTRACTOR.
- BAND TYPE TO BE DETERMINED UPON FINAL DESIGN.
- THE PROJECT SUMMARY IS REFLECTIVE OF THE DYODS DESIGN, QUANTITIES ARE APPROX. AND SHOULD BE VERIFIED UPON FINAL DESIGN AND APPROVAL. FOR EXAMPLE, TOTAL EXCAVATION DOES NOT CONSIDER ALL VARIABLES SUCH AS SHORING AND ONLY ACCOUNTS FOR MATERIAL WITHIN THE ESTIMATED EXCAVATION FOOTPRINT.
- THESE DRAWINGS ARE FOR CONCEPTUAL PURPOSES AND DO NOT REFLECT ANY LOCAL PREFERENCES OR REGULATIONS. PLEASE CONTACT YOUR LOCAL CONTECH REP FOR MODIFICATIONS.

ASSEMBLY
SCALE: 1" = 10'

C:\EXPORTS\TEMPLATES\CMP_V5.DWG 10/18/2019 10:02 AM

DATE	REVISION DESCRIPTION	BY

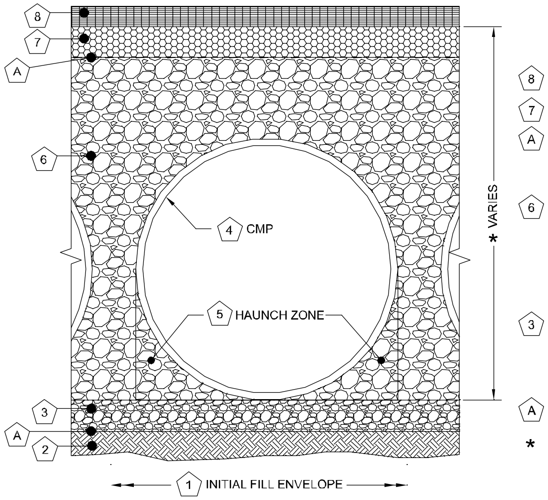
CONTECH®
ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH®
CMP DETENTION SYSTEMS

CONTECH
DYODS
DRAWING

DYO10714 Warmington
Retention System-Medical Center Dr
Fontana, CA
DETENTION SYSTEM

PROJECT No.: 6662	SEQ. No.: 10714	DATE: 9/30/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		



	Infiltration Systems - CMP Infiltration & CMP Perforated Drainage Pipe			
	Material Location	Description	Material Designation	Designation
8	Rigid or Flexible Pavement (if applicable)			
7	Road Base (if applicable			
A	Geotextile Layer	Non-Woven Geotextile	CONTECH C-40 or C-45	Engineer Decision for consideration to prevent soil migration into varying soil types. Wrap the trench only.
6	Backfill	Infiltration pipe systems have a pipe perforation sized of 3/8" diameter. An open graded, free draining stone, with a particle size of ½" – 2 ½" diameter is recommended.	AASHTO M 145- A-1 or AASHTO M 43 - 3, 4	Material shall be worked into the pipe haunches by means of shovel-slicing, rodding, air-tamper, vibratory rod, or other effective methods. 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 his representative is satisfied with the level of compaction"
3	Bedding Stone	Well graded granular bedding material w/maximum particle size of 3"	AASHTO M43 - 3,357,4,467, 5, 56, 57	For soil aggregates larger than 3/8" a dedicated bedding layer is not required for CMP. Pipe may be placed on the trench bottom comprised of native suitable well graded & granular material. For Arch pipes it is recommended to be shaped to a relatively flat bottom or fine-grade the foundation to a slight v-shape. Soil aggregates less than 3/8" and unsuitable material should be over-excavated and re-placed with a 4"-6" layer of well graded & granular stone per the material designation.
A	Geotextile Layer	None	None	Contech does not recommend geotextiles be placed under the invert of Infilitration systems due to the propensity for geotextiles to clog over time.
*	Note: The listed AASHTO designations are for gradation only. The stone must also be angular and clean.			

1 MINIMUM WIDTH DEPENDS ON SITE CONDITIONS AND ENGINEERING JUDGEMENT.

FOUNDATION/BEDDING PREPARATION

2 PRIOR TO PLACING THE BEDDING, THE FOUNDATION MUST BE CONSTRUCTED TO A UNIFORM AND STABLE GRADE. IN THE EVENT THAT UNSUITABLE FOUNDATION MATERIALS ARE ENCOUNTERED DURING EXCAVATION, THEY SHALL BE REMOVED AND BROUGHT BACK TO THE GRADE WITH A FILL MATERIAL AS APPROVED BY THE ENGINEER.

5 HAUNCH ZONE MATERIAL SHALL BE PLACED AND UNIFORMLY COMPACTED WITHOUT SOFT SPOTS.

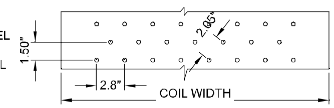
BACKFILL

MATERIAL SHALL BE PLACED IN 8"-10" MAXIMUM LIFTS. INADEQUATE COMPACTION CAN LEAD TO EXCESSIVE DEFLECTIONS WITHIN THE SYSTEM AND SETTLEMENT OF THE SOILS OVER THE SYSTEM. BACKFILL SHALL BE PLACED SUCH THAT THERE IS NO MORE THAN A TWO-LIFT DIFFERENTIAL BETWEEN THE SIDES OF ANY PIPE IN THE SYSTEM AT ALL TIMES DURING THE BACKFILL PROCESS. BACKFILL SHALL BE ADVANCED ALONG THE LENGTH OF THE SYSTEM AT THE SAME RATE TO AVOID DIFFERENTIAL LOADING ON ANY PIPES IN THE SYSTEM.

EQUIPMENT USED TO PLACE AND COMPACT THE BACKFILL SHALL BE OF A SIZE AND TYPE SO AS NOT TO DISTORT, DAMAGE, OR DISPLACE THE PIPE. ATTENTION MUST BE GIVEN TO PROVIDING ADEQUATE MINIMUM COVER FOR SUCH EQUIPMENT. MAINTAIN BALANCED LOADING ON ALL PIPES IN THE SYSTEM DURING ALL SUCH OPERATIONS.

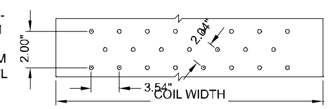
OTHER ALTERNATE BACKFILL MATERIAL MAY BE ALLOWED DEPENDING ON SITE SPECIFIC CONDITIONS. REFER TO TYPICAL BACKFILL DETAIL FOR MATERIAL REQUIRED.

2 2/3" x 1/2" CORRUGATION - STEEL AND ALUMINUM CMP EDGE SPACING EQUAL ON BOTH SIDES



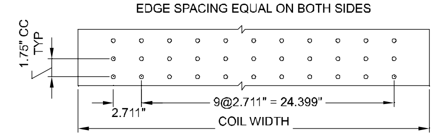
OPEN AREA = 3.76 SQ IN/SQ FT

3" x 1" CORRUGATION - STEEL AND ALUMINUM CMP (COIL PROVIDED FROM CONTECH LANTANA, FL PLANT)



OPEN AREA = 4.16 SQ IN/SQ FT

5" x 1" CORRUGATION - STEEL ONLY EDGE SPACING EQUAL ON BOTH SIDES



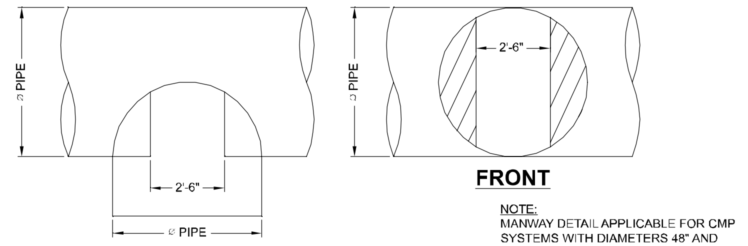
OPEN AREA = 3.33 SQ IN/SQ FT

NOTES:

1. PERFORATIONS MEET AASHTO AND ASTM SPECIFICATIONS.
2. PERFORATION OPEN AREA PER SQUARE FOOT OF PIPE IS BASED ON THE NOMINAL DIAMETER AND LENGTH OF PIPE.
3. ALL DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES.
4. ALL HOLES ⌀3/8".

TYPICAL PERFORATION DETAIL

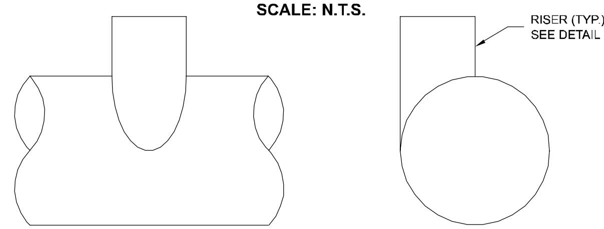
SCALE: N.T.S.



NOTE:
MANWAY DETAIL APPLICABLE FOR CMP SYSTEMS WITH DIAMETERS 48" AND LARGER. MANWAYS MAY BE REQUIRED ON SMALLER SYSTEMS DEPENDING ON ACTUAL SITE SPECIFIC CONDITIONS.

TYPICAL MANWAY DETAIL

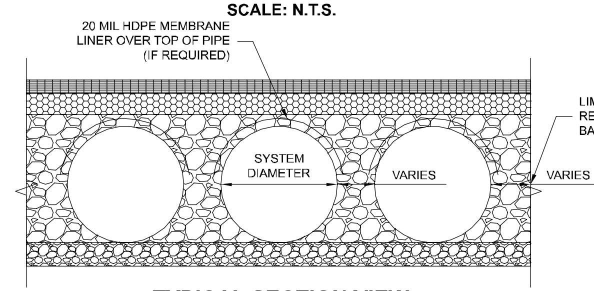
SCALE: N.T.S.



NOTE:
LADDERS ARE OPTIONAL AND ARE NOT REQUIRED FOR ALL SYSTEMS.

TYPICAL RISER DETAIL

SCALE: N.T.S.



TYPICAL SECTION VIEW

LINER OVER ROWS
SCALE: N.T.S.

NOTE: IF SALTING AGENTS FOR SNOW AND ICE REMOVAL ARE USED ON OR NEAR THE PROJECT, AN HDPE MEMBRANE LINER IS RECOMMENDED WITH THE SYSTEM. THE IMPERMEABLE LINER IS INTENDED TO HELP PROTECT THE SYSTEM FROM THE POTENTIAL ADVERSE EFFECTS THAT MAY RESULT FROM A CHANGE IN THE SURROUNDING ENVIRONMENT OVER A PERIOD OF TIME. PLEASE REFER TO THE CORRUGATED METAL PIPE DETENTION DESIGN GUIDE FOR ADDITIONAL INFORMATION.

DATE	REVISION DESCRIPTION	BY

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH® CMP DETENTION SYSTEMS

CONTECH DYODS DRAWING

DYO10714 Warmington
Retention System-Medical Center Dr
Fontana, CA
DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6662	10714	9/30/2021
DESIGNED: DYO		DRAWN: DYO
CHECKED: DYO		APPROVED: DYO
SHEET NO.: D2		

Infiltration Test Report

GEOTECHNICAL AND INFILTRATION EVALUATION

PROPOSED SINGLE-FAMILY RESIDENTIAL DEVELOPMENT
APN 0143-191-59
HIGHLAND AVENUE AND MEDICAL CENTER DRIVE
SAN BERNARDINO, SAN BERNARDINO COUNTY, CALIFORNIA

PREPARED FOR

WARMINGTON RESIDENTIAL
3090 PULLMAN STREET
COSTA MESA, CALIFORNIA 92626

PREPARED BY

GEOTEK, INC.
1548 NORTH MAPLE STREET
CORONA, CALIFORNIA 92878

PROJECT NO. 2849-CR **AUGUST 12, 2021**

GEOTEK

GeoTek, Inc.
1548 North Maple Street, Corona, California 92878
(951) 710-1160 Office (951) 710-1167 Fax www.geotekusa.com

August 12, 2021
Project No. 2849-CR

Warmington Residential
3090 Pullman Street
Costa Mesa, California 92626

Attention: Mr. Bret Ilich

Subject: Geotechnical and Infiltration Evaluation
Proposed Single-Family Residential Development
APN 0143-191-59
Highland Avenue and Medical Center Drive
San Bernardino, San Bernardino County, California

Dear Mr. Ilich:

GeoTek, Inc. (GeoTek) is pleased to provide the results of this geotechnical and infiltration evaluation for the proposed project located in San Bernardino, San Bernardino County, California. This report presents the results of GeoTek's evaluation, discussion of findings, and provides geotechnical recommendations for foundation design and construction.

Based upon review and evaluation, site development appears feasible from a geotechnical viewpoint provided that the recommendations included in this report are incorporated into the design and construction phases of the project.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to contact GeoTek.

Respectfully submitted,
GeoTek, Inc.

Bruce A. Hick
GE 2244, Exp. 12/31/22
Geotechnical Engineer

Edward H. LaMont
CEG 1892, Exp. 07/31/22
Principal Geologist

Anna M. Scott
Project Geologist

Distribution: (1) Addressee via email (one PDF file)

G:\Projects\2801 to 2850\2849CR Warmington Residential APN 0143-191-59 San Bernardino\Geotechnical Report\2849CR Geotechnical and Infiltration Evaluation Warmington Residential .doc

TABLE OF CONTENTS

1. PURPOSE AND SCOPE OF SERVICES 1

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT 1

2.1 SITE DESCRIPTION 1
2.2 PROJECT DESCRIPTION 2

3. FIELD EXPLORATION AND LABORATORY TESTING 2

3.1 FIELD EXPLORATION 2
3.2 LABORATORY TESTING 4

4. GEOLOGIC AND SOILS CONDITIONS 4

4.1 REGIONAL SETTING 4
4.2 GENERAL SOIL CONDITIONS 5
4.2.1 Fill 5
4.2.2 Younger Alluvium 5
4.3 SURFACE WATER AND GROUNDWATER 5
4.3.1 Surface Water 5
4.3.2 Groundwater 5
4.4 FAULTING AND SEISMICITY 6
4.4.1 Faulting 6
4.4.2 Seismic Design Parameters 6
4.5 LIQUEFACTION 7
4.6 OTHER SEISMIC HAZARDS 8

5. CONCLUSIONS AND RECOMMENDATIONS 8

5.1 GENERAL 8
5.2 EARTHWORK CONSIDERATIONS 8
5.2.1 General 8
5.2.2 Site Clearing 9
5.2.3 Site Preparation 9
5.2.4 Engineered Fill 9
5.2.5 Transition Lot Condition 10
5.2.6 Oversized Rock Disposal 10
5.2.7 Excavation Characteristics 10
5.2.8 Trench Excavations and Backfill 10
5.2.9 Shrinkage and Bulking 11
5.2.10 Grading Plan Review 11
5.3 DESIGN RECOMMENDATIONS 11
5.3.1 Foundation Design Criteria 11
5.4 RETAINING AND GARDEN WALL DESIGN AND CONSTRUCTION 16
5.5 PRELIMINARY PAVEMENT DESIGN RECOMMENDATIONS 19
5.6 CONCRETE CONSTRUCTION 20
5.6.1 General 20
5.6.2 Concrete Mix Design 20
5.6.3 Concrete Flatwork 20

TABLE OF CONTENTS

5.6.4 Concrete Performance *20*
5.7 PLAN REVIEW AND CONSTRUCTION OBSERVATIONS 21

6. INTENT 22

7. LIMITATIONS 22

8. SELECTED REFERENCES 23

ENCLOSURES

Figure 1 – Site Location Map
Figure 2 – Boring Location Map

Appendix A – Log of Exploratory Borings
Appendix B – Results of Laboratory Testing
Appendix C – Percolation Data & Porchet Calculations
Appendix D – Seismic Settlement Analysis
Appendix E – General Earthwork Grading Guidelines

1. PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to evaluate the geotechnical engineering and geologic conditions at the project site, as outlined in GeoTek's proposal P-0604321-CR, dated June 15, 2021. Services provided for this study included the following:

- Research and review of available geologic data and general information pertinent to the site,
- Site exploration consisting of the excavation, logging, and sampling of five (5) exploratory test borings extending to depths ranging from 16.5 to 51.5 feet below grade,
- Excavation of two (2) additional borings to a depth of about five (5) feet below grade and performing an infiltration test in each boring,
- Laboratory testing of soil samples collected during the field investigation,
- Review and evaluation of site seismicity, and
- Preparation of this geotechnical report which presents GeoTek's findings, conclusions, and recommendations for this site.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

2.1 SITE DESCRIPTION

The approximate 10-acre "L"-shaped project site is located on the south side of West Highland Avenue and Medical Center Drive, approximately 500 feet west of Medical Center Drive, in the City of San Bernardino, San Bernardino County, California (See Figure 1). Access to the site is available from West Highland Avenue, a paved improved street located adjacent to the northern boundary of the site. A dirt trail (extention of North Gardena Street) extending to West Highlnad Drive is present along the northwestern boundary of the site. The site is bordered to the east by a mobile home park, to the south by single-family residences, and to the west by vacant land and a commercial development.

Topographically, the site slopes gently downward to the east at an approximate two (2) percent gradient. Elevation of the western portion of the the site is approximately 1,230 feet with approximately 10 feet of elevation differential across the site.

The site was vacant land at the time of the field exploration. The site was vegetated with a light covering of weeds and grasses with a line of domestic tress trending east-west in the central portion of the site.

2.2 PROJECT DESCRIPTION

Based upon review of the Conceptual Design Plan prepared by KTGY Architecture and Planning, Inc. dated June 10, 2021 (see Figure 2), GeoTek understands the subject property is to be developed with about 72 single-family residential lots and associated infrastructure improvements. Stormwater disposal is to be by means of a stormwater detention basin.

The proposed residential structures are anticipated to be of wood-frame construction, one- to two-stories in height, and incorporate conventional shallow foundations and concrete slab-on-grade floors. It is our understanding that sewage disposal will be by a public sewer. For the purposes of this report, it is assumed maximum column and wall loads will be about 50 kips and 2.5 kips per foot, respectively. Specific site development plans were not provided as of the date of this report. Once actual loads are known that information should be provided to GeoTek to determine if modifications to the recommendations presented in this report are warranted.

If site development differs from the assumptions made herein, the recommendations included in this report should be subject to further review and evaluation. Site development plans should be reviewed by GeoTek when they become available.

3. FIELD EXPLORATION AND LABORATORY TESTING

3.1 FIELD EXPLORATION

The field exploration for this report was conducted on July 26, 2021 and consisted of excavating five (5) geotechnical exploratory borings with a hollow-stem drill rig to depths ranging from about 16.5 to 51.5 feet below grade. The approximate locations of the GeoTek excavations are shown on the Boring Location Map (Figure 2). A geologist from GeoTek logged the excavations and collected soil samples for use in subsequent laboratory testing. The logs of the exploratory borings are included in Appendix A.

Relatively undisturbed soil samples were recovered at various intervals in the geotechnical borings with a California sampler. The California sampler is a 3-inch outside diameter, 2.5-inch inside diameter, split barrel sampler lined with brass rings. The sampler was 18 inches long. The sampler conformed to the requirements of ASTM D 3550. A 140-pound automatic trip hammer was utilized, dropping 30 inches for each blow. The relatively undisturbed samples, together with bulk samples of representative soil types, were returned to the laboratory for testing and evaluation. The California sampler test data are presented on the boring logs in Appendix A.

Percolation Testing

In addition to the geotechnical exploratory borings, two percolation test borings (I-1 and I-2) were excavated in the area of the proposed storm water management basin to depths of about 5 feet. Infiltration/percolation testing was conducted in these borings in general accordance with the requirements of the County of San Bernardino.

The percolation tests consisted of drilling an eight-inch diameter test hole to the desired depth and installing approximately two inches of gravel in the bottom of the hole. A three-inch diameter perforated PVC pipe, wrapped in a filter sock, was placed in the excavations and the annular space was filled with gravel to prevent caving within the boring. Water was then placed in the borings to presoak the holes and percolation testing was performed the following the pre-soak period. Following presoaking it was determined that "sandy soil" criteria was met within both percolation borings. The percolation tests were then performed which consisted of adding water to each test hole and measuring the water drop over a 10-minute period. The water drop was recorded for eight test intervals. Water was added to the test holes after each test interval. The field percolation rates were then converted to an infiltration rate using the Porchet Method.

The results of the conversions indicate infiltration rate range from about 8.49 to 8.74 inches per hour. Copies of the percolation data sheets and the Porchet infiltration rate conversion calculations are presented in Appendix C. No factors of safety were applied to the rates provided. Over the lifetime of the infiltration areas, the infiltration rates may be affected by sediment build up and biological activities, as well as local variations in near surface soil conditions. A suitable factor of safety should be applied to the field rate in designing the infiltration system.

It should be noted that the infiltration rates provided above were performed in relatively undisturbed on-site soils. Infiltration rates will vary and are mostly dependent on the underlying consistency of the site soils and relative density. Infiltration rates may be impacted by weight of equipment travelling over the soils, placement of engineered fill and other various factors. GeoTek assumes no responsibility or liability for the ultimate design or performance of the storm water facility.

3.2 LABORATORY TESTING

Laboratory testing was performed on selected relatively undisturbed ring and bulk samples collected during the field exploration. The purpose of the laboratory testing was to confirm the field classification of the materials encountered and to evaluate their physical properties for use in the engineering design and analysis. Results of the laboratory testing program along with a brief description and relevant information regarding testing procedures are included on the exploratory borings logs included in Appendix A and in Appendix B.

4. GEOLOGIC AND SOILS CONDITIONS

4.1 REGIONAL SETTING

The subject property is situated in the Peninsular Ranges geomorphic province. The Peninsular Ranges province is one of the largest geomorphic units in western North America. It extends approximately 975 miles south of the Transverse Ranges geomorphic province to the tip of Baja California. This province varies in width from about 30 to 100 miles. It is bounded on the west by the Pacific Ocean, on the south by the Gulf of California and on the east by the Colorado Desert Province.

The Peninsular Ranges are essentially a series of northwest-southeast oriented fault blocks. Several major fault zones are found in this province. The Elsinore Fault zone and the San Jacinto Fault zone trend northwest-southeast and are found near the middle of the province. The San Andreas Fault zone borders the northeasterly margin of the province.

More specific to the subject property, the site is located in an area geologically mapped to be underlain by alluvium (Dibblee, T.W. and Minch, J.A., 2004). No active faults are shown in the immediate site vicinity on the maps reviewed for the area.

4.2 GENERAL SOIL CONDITIONS

A brief description of the earth materials encountered is presented in the following section. Based on the site reconnaissance, the exploratory excavations and review of published geologic maps, the area investigated is locally underlain by fill that is over younger alluvium.

4.2.1 Fill

Fill was encountered in most of the exploratory borings to depths ranging from approximately 2.5 to 4.5 feet below existing grade. This (undocumented) fill is likely a result of the historical use of the site for agriculture purposes and the subsequent ground disturbance/tilling that has occurred after. The fill encountered in the exploratory borings generally consisted of silty fine sand and relatively clean sands (SM and SP soil types based upon the Unified Soil Classification System). Greater depths of fill may be present within unexplored areas of the site.

4.2.2 Younger Alluvium

Younger alluvial soils were encountered in the borings beneath the fill soils and extended to the maximum depths explored (51.5 feet). As encountered in the borings, the alluvium consisted of interbedded layers of silty sands and relatively clean sands with variable amounts of gravel (SM and SP soil types based upon the Unified Soil Classification System).

Based on the laboratory test results, the near surface soils have a "very low" expansion potential (ASTM D 4829). Based on the laboratory test results, the near surface soils have a soluble sulfate content of less than 0.1 percent (ASTM D 4327). The test results are provided in Appendix B.

4.3 SURFACE WATER AND GROUNDWATER

4.3.1 Surface Water

If encountered during earthwork operations, surface water on this site is the result of precipitation or possibly some minor surface run-off from the surrounding areas. Overall site area drainage varies due to the site topography and existing improvements. Provisions for surface drainage will need to be accounted for by the project civil engineer.

4.3.2 Groundwater

Groundwater was not encountered within any of the exploratory borings drilled at the site to the maximum depth drilled of 51.5 below the existing ground surface. Based on a review of groundwater depths noted on the State Department of Water Resources Water Data Library website, it is estimated the historic high groundwater depth is in excess of 50 feet below existing grade at the site. Based on the results of the field exploration, review of site area geomorphology and geology, groundwater is not anticipated to adversely affect the proposed improvements.

4.4 FAULTING AND SEISMICITY

4.4.1 Faulting

The geologic structure of the entire California area is dominated mainly by northwest-trending faults associated with the San Andreas system. The site is in a seismically active region. However, the site is not situated within a State of California designated *"Alquist-Priolo"* Earthquake Fault Zone. The nearest known active fault is the San Andreas fault located about 4 miles to the northeast.

4.4.2 Seismic Design Parameters

The site is located at approximately 34.1347 degrees West Latitude and -117.3256 degrees North Longitude. Site spectral accelerations (S_a and S_1) for 0.2 and 1.0 second periods for a Class "D" site, was determined from the SEAOC/OSHPD web interface that utilizes the USGS web services and retrieves the seismic design data and presents that information in a report format. Using the ASCE 7-16 option on the SEAOC/OSHPD website results in the values for S_{M1} and S_{D1} reported as "null-See Section 11.4.8" (of ASCE 7-16). As noted in ASCE 7-16, Section 11.4.8, a site-specific ground motion procedure is recommended for Site Class D when the value S_1 exceeds 0.2. The value S_1 for the subject site exceeds 0.2.

For a site Class D, an exception to performing a site-specific ground motion analysis is allowed in ASCE 7-16 where S_1 exceeds 0.2 provided the value of the seismic response coefficient, Cs, is conservatively calculated by Eq 12.8-2 of ASCE 7-16 for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. 12.8-3 for $T_L \geq T > 1.5T_s$ or Eq. 12.8-4 for $T > T_L$.

The results, based on the 2015 NEHRP and the 2019 CBC, are presented in the following table assuming that the exception as allowed in ASCE 7-16 is applicable. If the exception is deemed not appropriate, a site-specific ground motion analysis will be required.

SITE SEISMIC PARAMETERS	
Mapped 0.2 sec Period Spectral Acceleration, S_S	2.298g
Mapped 1.0 sec Period Spectral Acceleration, S_1	0.919g
Site Coefficient for Site Class "D", F_a	1
Site Coefficient for Site Class "D", F_v	1.7
Maximum Considered Earthquake Spectral Response Acceleration for 0.2 Second, S_{MS}	2.298g
Maximum Considered Earthquake Spectral Response Acceleration for 1.0 Second, S_{M1}	1.561g
5% Damped Design Spectral Response Acceleration Parameter at 0.2 Second, S_{DS}	1.532g
5% Damped Design Spectral Response Acceleration Parameter at 1 second, S_{D1}	1.041g
Peak Ground Acceleration (PGA_M)	1.065g
Seismic Design Category	E

Final selection of the appropriate seismic design coefficients should be made by the project structural engineer based upon the local practices and ordinances, expected building response and desired level of conservatism.

4.5 LIQUEFACTION

Liquefaction describes a phenomenon in which cyclic stresses, produced by earthquake-induced ground motion, create excess pore pressures in relatively cohesionless soils. These soils may thereby acquire a high degree of mobility, which can lead to lateral movement, sliding, consolidation and settlement of loose sediments, sand boils and other damaging deformations. This phenomenon occurs only below the water table, but, after liquefaction has developed, the effects can propagate upward into overlying non-saturated soil as excess pore water dissipates.

The factors known to influence liquefaction potential include soil type and grain size, relative density, groundwater level, confining pressures, and both intensity and duration of ground shaking. In general, materials that are susceptible to liquefaction are loose, saturated granular soils having low fines content under low confining pressures.

The project site is not located within an area mapped by the State of California for liquefaction potential. The County of San Bernardino Land Use Services (Geologic Hazard Maps) has designated the site as not having a potential for liquefaction. Based on the current mapping and the depth to groundwater, it is GeoTek's opinion that the liquefaction potential at the site is very low.

4.6 OTHER SEISMIC HAZARDS

An assessment of the potential "dry" settlement (i.e., settlement above the water table) resulting from seismic shaking of the site was evaluated. For this analysis we used a groundwater depth of 100 feet, a ground acceleration (PGAM) of 1.07g and a mean earthquake magnitude of 7.3. The ground acceleration and earthquake magnitude were obtained from the USGS websites. The computer software program LiquefyPro and the soil profiled from Boring B-1 were used in the analysis. Based on the recommendations provided in this report, engineered fill will be incorporated within the upper six feet of pad grade; this change has been incorporated into the settlement analysis. The results of this analysis indicate a potential ground surface settlement of about 2 inches is possible. A differential seismic settlement of about 1 inch over a 40 foot span is estimated. Based on these estimated magnitudes, ground modification or special foundation design is not deemed necessary. The results of the seismic dry settlement analysis are presented in Appendix E. However, the estimated seismic settlements should be considered in structural design.

Due to the general flat terrain, the potential for seismic induced landslides or lateral spreading is considered nil. The potential for secondary seismic hazards such as a seiche and tsunami is considered negligible due to site elevation and distance from an open body of water.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL

Development of the site appears feasible from a geotechnical engineering viewpoint. The following recommendations should be incorporated into the design and construction phases of development.

5.2 EARTHWORK CONSIDERATIONS

5.2.1 General

Earthwork and grading should be performed in accordance with the applicable grading ordinances of the County of San Bernardino, City of San Bernardino and the 2019 California Building Code (CBC), and recommendations contained in this report. The Grading Guidelines included in Appendix D outline general procedures and do not anticipate all site-specific situations. In the event of conflict, the recommendations presented in the text of this report should supersede those contained in Appendix E.

5.2.2 Site Clearing

Initial site preparation should commence with removal of debris, deleterious materials and vegetation within the limits of the planned improvements. These materials should be properly disposed of off-site. Voids resulting from removing any materials should be replaced with engineered fill materials with expansion characteristics similar to the onsite materials.

5.2.3 Site Preparation

Due to the non-uniform nature and thickness of the near-surface undocumented fill and loose condition of the upper younger alluvium, it is recommended that the soils be removed beneath the planned building footprint of the proposed structure to a depth of at least 5 feet below existing natural (below existing fill) grade, or three (3) feet beneath the base of the proposed foundations, whichever is greater. Removal bottoms should be relatively uniform in soil type which is not visibly porous and having an in-place density of at least 85 percent of the soil's maximum dry density as determined by ASTM D 1557 test procedures. A representative of this firm should observe and approve the bottom of all remedial excavations. The lateral extent of this recommended over-excavation should extend at least 5 feet beyond the building or foundation limits.

Following site clearing operations, over-excavation and lowering of site grades, where necessary, it is recommended that the exposed subgrade soils beneath all surface improvements be proof rolled with a heavy rubber-tired piece of construction equipment approved by and in the presence of the geotechnical engineering representative. The proof rolling equipment should possess a minimum weight of 15 tons and proof rolling should include at least 4 passes, two in each perpendicular direction. All soil that ruts or excessively deflects during proof rolling should be removed as recommended by the GeoTek representative. Following proof rolling and removal of any unsuitable bearing soil, the exposed subgrade should be scarified to a depth of about 12 inches, be moisture conditioned to slightly above the soil's optimum moisture content and then be compacted to at least 90 percent of the soil's maximum dry density as determined by ASTM D-1557 test procedures.

5.2.4 Engineered Fill

The on-site soils are generally considered suitable for reuse as engineered fill provided they are free from vegetation, debris, oversized materials (6 inch diameter or greater) and other deleterious material. All areas should be brought to final subgrade elevations with fill materials that are placed and compacted in general accordance with minimum project standards. Engineered fill should be placed in 6-to-8-inch loose lifts, moisture conditioned to slightly above the optimum moisture content and compacted to a minimum relative compaction of 90 percent as determined by ASTM D-1557 test procedures.

If wet soils are encountered during remedial grading, methods for drying soils such as stockpiling or mixing with dry soils may be required to bring the soils to the required moisture content for placement as engineered fill. Placement of engineered fill should be observed and tested on a full-time basis by a GeoTek representative during grading activities.

5.2.5 Transition Lot Condition

Building pads graded with a cut/fill transition should be undercut to reduce the potential for differential settlement. The cut portion of the cut/fill transition should be undercut to a depth of at least 3 feet or one (1) foot below the deepest proposed footing, whichever is deeper, and be backfilled with a properly compacted engineered fill. The bottom of the undercut should be sloped at a minimum of 1 percent toward the adjacent street/parking lot area.

5.2.6 Oversized Rock Disposal

Although unlikely, oversized cobbles, boulders and rock fragments may be encountered during rough grading and utility trench operations. If encountered, on-site disposal of oversized materials is possible, provided the oversized materials are placed as recommended on Plate 4 within Appendix E. Alternatively, over-sized materials can be exported from the site.

5.2.7 Excavation Characteristics

Excavations in the on-site younger alluvium should be readily accomplished with heavy-duty earthmoving or excavating equipment in good operating condition. All excavations should be formed in accordance with current Cal-OSHA requirements.

5.2.8 Trench Excavations and Backfill

Temporary trench excavations within the on-site materials should be stable at a 1:1 inclination for short durations during construction and where cuts do not exceed 15 feet in height. Deeper temporary excavations should be reviewed by GeoTek prior to their planned excavation to determine if supplemental recommendations or analysis are warranted. It is anticipated that temporary cuts to a maximum height of 4 feet can be excavated vertically.

Trench excavations should conform to Cal-OSHA regulations. The contractor should have a competent person, per OSHA requirements, on site during construction to observe conditions and to make the appropriate recommendations.

Utility trench backfill should be compacted to at least 90 percent relative compaction (as determined by ASTM D-1557 test procedures). Under-slab trenches should also be compacted to project specifications. Where applicable, based on jurisdictional requirements, the top 12 inches of backfill below subgrade for road pavements should be compacted to at least 95 percent relative compaction. On-site materials may not be suitable for use as bedding material but should be suitable as backfill provided particles larger than 6 inches are removed.

Compaction should be achieved with a mechanical compaction device. Ponding or jetting of trench backfill is not recommended. If backfill soils have dried out, they should be properly moisture conditioned prior to placement in trenches.

5.2.9 Shrinkage and Bulking

For planning purposes, a shrinkage loss of about 10 to 15 percent is anticipated for excavations within the undocumented fill/younger alluvium at the site. Several factors will impact earthwork balancing on the site, including shrinkage, trench spoil from utilities and footing excavations, as well as the accuracy of topography. Shrinkage and bulking are primarily dependent upon the degree of compactive effort achieved during construction, depth of fill and underlying site conditions.

A subsidence loss of up to about 0.2 foot is estimated for the site.

Site balance areas should be available in order to adjust project grades, depending on actual field conditions at the conclusion of earthwork construction.

5.2.10 Grading Plan Review

Upon completion of the site grading plans, it is recommended that those plans be provided to GeoTek for review. Based on that review, some modifications to the recommendations provided in this report may be necessary.

5.3 DESIGN RECOMMENDATIONS

5.3.1 Foundation Design Criteria

The soils are classified as having a "very low" expansion potential in accordance with ASTM D 4829. GeoTek understands that post-tensioned foundations may be used for this site. Since the CBC indicates Post Tensioning Institute (PTI) design methodology is intended for expansive soils conditions, which do not apply to this project, no e_m or y_m parameters as used in the PTI methodology are provided. The foundation elements for the proposed structures should bear entirely in engineered fill soils and should be designed in accordance with the *2019 California Building Code (CBC).* The following design recommendations for post-tensioned foundations for this project are provided:

MINIMUM DESIGN REQUIREMENTS FOR POST-TENSIONED FOUNDATIONS	
Design Parameter	"Very Low" Expansion Potential 0≤EI≤20
Foundation Depth or Minimum Perimeter Beam Depth (inches below the lowest adjacent grade)	One- and Two-Stories – 12
Minimum Foundation Width (inches)*	One- to Two-Stories – 12
Minimum Slab Thickness (inches)	4 – Actual
Presaturation of Subgrade Soil (Percent of Optimum/Depth in Inches)	Minimum of 100% of the optimum moisture content to a depth of at least 12 inches prior to placing concrete

*Greater depths and widths may be required per the structural design. Interior footing depths should be at least 12 inches below interior finished grade for 1-2 story buildings. Interior pad footings should possess a minimum width of 24 inches.

An allowable bearing capacity of 2,000 pounds per square foot (psf) may be used for design of building wall footings. This value may be increased by 400 psf for each additional 12 inches of embedment depth and by 200 psf for each additional 12 inches in width to a maximum of 3,000 psf. The allowable bearing capacity may be increased by one-third when considering short-term wind and/or seismic loads.

Based upon review, a modulus of subgrade reaction (E_1) of 250 pci may be used in the design of the post-tensioned slab foundation. It should be noted that this value is based upon standard one foot plate load tests. Depending upon the design methodology and foundation geometry this value may need to be modified by the following:

$$E_s = E_1 \left((B+1)/2B\right)^2$$

where: Es = design modulus
B = footing width

Based on the expansion index testing performed for this report and visual examination of the site soils, site soils possess a "very low" (0-20) expansion potential (ASTM D4829). Therefore, it is GeoTek's opinion that conventional foundations supported by engineered fill may be used for this site. Foundation design criteria for a conventional foundation system, in general conformance with the 2019 CBC, are presented herein. These are typical design criteria and are not intended to supersede the design by the structural engineer. A summary of GeoTek's preliminary foundation design recommendations for conventional foundations is presented in the table below:

Design Parameter	"Very Low" Expansion Potential (0≤EI≤20)
Foundation Depth or Minimum Perimeter Beam Depth (inches below lowest adjacent grade)	12 - One- and -two Stories
Minimum Foundation Width (Inches)*	12
Minimum Slab Thickness (actual)	4 inches
Minimum Slab Reinforcing	6" x 6" – W2.9/W2.9 welded wire fabric placed in middle of slab or No. 3 bars at 18-inch centers.
Minimum Footing Reinforcement	Two No. 4 Reinforcing Bars, one top and one bottom
Presaturation of Subgrade Soil (Percent of Optimum)	Minimum 100% to a depth of 12 inches prior to placement of concrete

*Code minimums per Table 1809.7 of the 2019 CBC.

It should be noted that the criteria provided are based on soil support characteristics only. The structural engineer should design the slab and beam reinforcement based on actual loading conditions.

The following criteria for design of foundations are preliminary and should be re-evaluated based on the results additional laboratory testing of samples obtained at/near finish pad grade.

5.3.1.1 An allowable bearing capacity of 2,000 pounds per square foot (psf) may be used for design of continuous and perimeter footings 12 inches deep and 12 inches wide, and pad footings 24 inches square and 12 inches deep. This allowable soil bearing capacity may be increased by 300 psf for each additional foot of footing depth and 300 psf for each additional foot of footing width to a maximum value of 4,000 psf. An increase of one-third may be applied when considering short-term live loads (e.g., seismic and wind loads).

5.3.1.2 Structural foundations should be designed in accordance with the 2019 CBC, and to withstand a total static settlement of 1 inch and maximum differential static settlement of one-half of the total settlement over a horizontal distance of 40 feet.

5.3.1.3 The passive earth pressure may be computed as an equivalent fluid having a density of 300 psf per foot of depth, to a maximum earth pressure of 2,500 psf for footings founded on engineered fill or competent native soil. A coefficient of friction between soil and concrete of 0.35 may be used with dead load forces. When combining passive pressure and frictional resistance, the passive pressure component should be reduced by one-third. The upper one foot of soil should be ignored in the passive pressure calculations unless the surface is covered with pavements.

5.3.1.4 A grade beam, a minimum of 12 inches wide and 12 inches deep, should be utilized across large entrances. The base of the grade beam should be at the same elevation as the bottom of the adjoining footings.

5.3.1.5 A moisture and vapor retarding system should be placed below slabs-on-grade where moisture migration through the slab is undesirable. Guidelines for these are provided in the 2019 California Green Building Standards Code (CALGreen) Section 4.505.2, the 2019 CBC Section 1907.1 and ACI 360R-10. The vapor retarder design and construction should also meet the requirements of ASTM E 1643. A portion of the vapor retarder design should be the implementation of a moisture vapor retardant membrane.

It should be realized that the effectiveness of the vapor retarding membrane can be adversely impacted as a result of construction related punctures (e.g., stake penetrations, tears, punctures from walking on the vapor retarder placed atop the underlying aggregate layer, etc.). These occurrences should be limited as much as possible during construction. Thicker membranes are generally more resistant to accidental puncture than thinner ones. Products specifically designed for use as moisture/vapor retarders may also be more puncture resistant. Although the CBC specifies a 6-mil vapor retarder membrane, it is GeoTek's opinion that a minimum 10 mil thick membrane with joints properly overlapped and sealed should be considered, unless otherwise specified by the slab design professional. The membrane should consist of Stego wrap or the equivalent.

Moisture and vapor retarding systems are intended to provide a certain level of resistance to vapor and moisture transmission through the concrete, but do not eliminate it. The acceptable level of moisture transmission through the slab is to a large extent based on the type of flooring used and environmental conditions. Ultimately, the vapor retarding system should be comprised of suitable elements to limited migration of water and reduce transmission of water vapor through the slab to acceptable levels. The selected elements should have suitable properties (i.e., thickness, composition, strength, and permeability) to achieve the desired performance level.

Moisture retarders can reduce, but not eliminate, moisture vapor rise from the underlying soils up through the slab. Moisture retarder systems should be designed and constructed in accordance with applicable American Concrete Institute, Portland Cement Association, Post-Tensioning Concrete Institute, ASTM and California Building Code requirements and guidelines.

GeoTek recommends that a qualified person, such as the flooring contractor, structural engineer, architect, and/or other experts specializing in moisture control within the building be consulted to evaluate the general and specific moisture and vapor transmission paths and associated potential impact on the proposed construction. That person (or persons) should provide recommendations relative to the slab moisture and vapor retarder systems and for migration of potential adverse impact of moisture vapor transmission on various components of the structures, as deemed appropriate.

In addition, the recommendations in this report and GeoTek's services in general are not intended to address mold prevention; since GeoTek, along with geotechnical consultants in general, do not practice in the area of mold prevention. If specific recommendations addressing potential mold issues are desired, then a professional mold prevention consultant should be contacted.

5.3.1.6 It is recommended that control joints be placed in two directions spaced approximately 24 to 36 times the thickness of the slab in inches. These joints are a widely accepted means to control cracks and should be reviewed by the project structural engineer.

5.3.2 Miscellaneous Foundation Recommendations

5.3.2.1 To reduce moisture penetration beneath the slab on grade areas, utility trench excavations should be backfilled with engineered fill, lean concrete or concrete slurry where they intercept the perimeter footing or thickened slab edge.

5.3.2.2 Soils from the footing excavations should not be placed in the slab-on-grade areas unless properly compacted and tested. The excavations should be free of loose/sloughed materials and be neatly trimmed at the time of concrete placement.

5.3.3 Foundation Setbacks

Minimum setbacks for all foundations should comply with the 2019 CBC or City of San Bernardino requirements, whichever is more stringent. Improvements not conforming to these setbacks are subject to the increased likelihood of excessive lateral movements and/or differential settlements. If large enough, these movements can compromise the integrity of the improvements. The top outside edge of all footings should be set back a minimum of H/3 (where H is the slope height) from the face of any descending slope. The setback should be at least five feet and need not exceed 40 feet.

5.3.4 Soil Corrosivity

The soil resistivity at this site was tested in the laboratory on a sample collected during the field investigation. The results of the testing indicate that the on-site soils are considered "mildly corrosive" (14,070 ohm-cm) (Roberge, 2000) to buried ferrous metal in accordance with current standards used by corrosion engineers. Recommendations for protection of buried ferrous metal should be provided by a corrosion engineer. Additional corrosion testing should be performed at the time of site grading to assess the corrosion of potential of the as-graded soils.

5.3.5 Soil Sulfate Content

The sulfate content was determined in the laboratory on a sample collected during the field investigation. The results indicate that the water-soluble sulfate result is less than 0.1 percent by weight, which is considered "negligible" as per Table 4.2.1 of ACI 318. Based on the test results and Table 4.3.1 of ACI 318, no special recommendations for concrete are required for this project due to soil sulfate exposure.

5.4 RETAINING AND GARDEN WALL DESIGN AND CONSTRUCTION

5.4.1.1 General Design Criteria

Recommendations presented in this report apply to typical masonry or concrete vertical retaining walls to a maximum height of up to six (6) feet. Additional review and recommendations should be requested for higher walls. These are typical design criteria and are not intended to supersede the design by the structural engineer.

Retaining wall foundations should be embedded a minimum of 18 inches into engineered fill. Retaining wall foundations should be designed in accordance with Section 5.3 of this report. Structural needs may govern and should be evaluated by the project structural engineer.

All earth retention structure plans, as applicable, should be reviewed by this office prior to finalization.

Earthwork considerations, site clearing and remedial earthwork for all earth retention structures should meet the requirements of this report, unless specifically provided otherwise, or more stringent requirements or recommendations are made by the designer. The backfill material placement for all earth retention structures should meet the requirement of Section 5.2.4 in this report.

In general, cantilever earth retention structures, which are designed to yield at least 0.001H, where H is equal to the height of the earth retention structure, may be designed using the "active" condition. Rigid earth retention structures (including but not limited to rigid walls, and walls braced at top, such as typical basement walls) should be designed using the "at-rest" condition.

In addition to the design lateral forces due to retained earth, surcharges due to improvements, such as an adjacent building or traffic loading, should be considered in the design of the earth retention structures. Loads applied within a 1:1 (horizontal:vertical) projection from the surcharge on the stem of the earth retention structure should be considered in the design.

Final selection of the appropriate design parameters should be made by the designer of the earth retention structures.

5.4.1.2 Cantilevered Walls

The recommendations presented below are for cantilevered retaining walls up to six (6) feet high. Active earth pressure may be used for retaining wall design, provided the top of the wall is not restrained from minor deflections. An equivalent fluid pressure approach may be used to compute the horizontal pressure against the wall. Appropriate fluid unit weights are given below for specific slope gradients of the retained material. These do not include other superimposed loading conditions such as traffic, structures, seismic events, or adverse geologic conditions.

ACTIVE EARTH PRESSURES	
Surface Slope of Retained Materials (horizontal:vertical)	Equivalent Fluid Pressure (pcf) Select Backfill* and Native Soils
Level	35
2:1	60

*The design pressures assume the backfill material has an expansion index less than or equal to 20. Backfill zone includes area between back of the wall to a plane (1:1 horizontal : vertical) up from bottom of the wall foundation (on the backside of the wall) to the ground surface.

For walls with a retained height greater than 6 feet, an incremental seismic pressure should be included into the wall design. Where needed, it is recommended that an equivalent fluid pressure of 16 pcf be included into the wall design to account for seismic loading conditions. This pressure may be applied as an inverted triangular distribution.

5.4.1.3 Retaining Wall Backfill and Drainage

The wall backfill should also include a minimum one (1) foot wide section of ¾- to 1-inch clean crushed rock (or an approved equivalent). The rock should be placed immediately adjacent to the back of the wall and extend up from a back drain to within approximately 24 inches of the finish grade. The upper 24 inches should consist of compacted on-site materials. The rock should be separated from the earth with filter fabric. The presence of other materials might necessitate revision to the parameters provided and modification of the wall designs. The backfill materials should be placed in lifts no greater than eight (8) inches in thickness and compacted to a minimum of 90% relative compaction as determined by ASTM D 1557 test procedures. Proper surface drainage needs to be provided and maintained.

As an alternative to the drain, rock and fabric, a pre-manufactured wall drainage product (example: Mira Drain 6000 or approved equivalent) may be used behind the retaining wall. The wall drainage product should extend from the base of the wall to within two (2) feet of the ground surface. The subdrain should be placed in direct contact with the wall drainage product.

Retaining walls should be provided with an adequate pipe and gravel back drain system to help prevent buildup of hydrostatic pressures. Backdrains should consist of a four (4)-inch diameter perforated collector pipe (Schedule 40, SDR 35, or approved equivalent) embedded in a minimum of one (1) cubic foot per linear foot of ¾- to 1-inch clean crushed rock or an approved equivalent, wrapped in filter fabric (Mirafi 140N or an approved equivalent). The drain system should be connected to a suitable outlet. Waterproofing of site walls should be performed where moisture migration through the walls is undesirable.

5.4.1.4 Restrained Retaining Walls

Retaining walls that will be restrained at the top that support level backfill or that have reentrant or male corners, should be designed for an equivalent at-rest fluid pressure of 55 pcf, plus any applicable surcharge loading. For areas of male or reentrant corners, the restrained wall design should extend a minimum distance of twice the height of the wall laterally from the corner, or a distance otherwise determined by the project structural engineer.

5.4.1.5 Other Design Considerations

- Wall design should consider the additional surcharge loads from superjacent slopes and/or footings, where appropriate.
- No backfill should be placed against concrete until minimum design strengths are evident by compression tests of cylinders.
- The retaining wall footing excavations, backcuts, and backfill materials should be approved by the project geotechnical engineer or their authorized representative.
- Positive separations should be provided in garden walls at horizontal distances not exceeding 20 feet.

5.5 PRELIMINARY PAVEMENT DESIGN RECOMMENDATIONS

Although planned final grades beneath the street improvements within the site are not yet known, the following preliminary pavement design recommendations are based on Traffic Indexes of 5.5 for interior streets and 10.0 for Highland Avenue as designated by the City of San Bernardino. Preliminary pavement thickness design is based on the CalTrans Highway Design Manual (2018). An R-value of 50 has been assumed for the preliminary design of the project pavement sections. Once the traffic loading information becomes more defined, revision to the pavement design recommendations may be warranted. It is recommended that the final pavement design be based on R-value testing of the as-graded subgrade soils within the pavement areas.

Based on the assumptions noted above the following preliminary pavement recommendations are provided for the site:

PRELIMINARY MINIMUM PAVEMENT SECTION		
Traffic Index	Thickness of Asphalt Concrete (inches)	Thickness of Aggregate Base (inches)
5.5 (Interior Streets)	3.0	4
10.0 (Highland Avenue)	4.0 5.0	11 9.5

Traffic Indices (TIs) used in the pavement design should provide a pavement life of approximately 20 years with a normal amount of flexible pavement maintenance. Irrigation adjacent to pavements, without a deep curb or other cutoff to separate landscaping from the paving may result in premature pavement failure. Traffic parameters used for design were selected based upon engineering judgment and not upon information furnished to us such as an equivalent wheel load analysis or a traffic study.

All base material and the upper 12 inches of subgrade should be compacted to at least 95 percent of the material's maximum dry density as determined by ASTM D 1557 test procedures. All materials and methods of construction should conform to the requirements of the City of San Bernardino.

5.6 CONCRETE CONSTRUCTION

5.6.1 General

Concrete construction should follow the 2019 CBC and ACI guidelines regarding design, mix placement and curing of the concrete. If desired, GeoTek could provide quality control testing of the concrete during construction.

5.6.2 Concrete Mix Design

As discussed in Section 5.3.5, no special recommendations for concrete are required for this project due to soil sulfate exposure. Additional testing should be performed during grading so that specific recommendations can be formulated based on the as-graded conditions.

5.6.3 Concrete Flatwork

Exterior concrete flatwork is often one of the most visible aspects of site development. They are typically given the least level of quality control, being considered "non-structural" components. Cracking of these features is common due to various factors. While cracking usually does not affect the structural performance of the concrete, it is unsightly. It is recommended that the same standards of care be applied to these features as to the structure itself.

Flatwork should consist of a minimum four-inch (actual) thick concrete and the use of temperature and shrinkage control reinforcement is suggested. The project structural engineer should provide final design recommendations.

5.6.4 Concrete Performance

Concrete cracks should be expected. These cracks can vary from sizes that are hairline to more than 1/8 inch in width. Most cracks in concrete while unsightly do not significantly impact long-term performance. While it is possible to take measures (proper concrete mix, placement, curing, control joints, etc.) to reduce the extent and size of cracks that occur, some cracking will occur despite the best efforts to minimize it. Concrete undergoes chemical processes that are dependent on a wide range of variables, which are difficult, at best, to control. Concrete, while seemingly a stable material, is subject to internal expansion and contraction due to external changes over time.

One of the simplest means to control cracking is to provide weakened control joints for cracking to occur along. These do not prevent cracks from developing; they simply provide a relief point for the stresses that develop. These joints are a widely accepted means to control cracks but are not always effective. Control joints are more effective the more closely spaced they are. GeoTek suggests that control joints be placed in two orthogonal directions and located a distance apart approximately equal to 24 to 36 times the slab thickness.

5.7 PLAN REVIEW AND CONSTRUCTION OBSERVATIONS

It is recommended that site grading, specifications, and foundation plans be reviewed by this office prior to construction to check for conformance with the recommendations of this report. It is also recommended that GeoTek representatives be present during site grading and foundation construction to observe and document for proper implementation of the geotechnical recommendations. The owner/developer should have GeoTek perform at least the following duties:

- Observe site clearing and grubbing operations for proper removal of all unsuitable materials.
- Observe and test bottom of removals prior to fill placement.
- Evaluate the suitability of on-site and import materials for fill placement and collect soil samples for laboratory testing where necessary.
- Observe the fill for uniformity during placement, including utility trench excavation backfill. Also, test the fill for density, relative compaction and moisture content.
- Observe and probe foundation excavations to confirm suitability of bearing materials with respect to density.

If requested, a construction observation and compaction report can be provided by GeoTek which can comply with the requirements of the governmental agencies having jurisdiction over the project. It is recommended that these agencies be notified prior to commencement of construction so that necessary grading permits can be obtained.

6. INTENT

It is the intent of this report to aid in the design and construction of the proposed development. Implementation of the advice presented in this report is intended to reduce risk associated with construction projects. The professional opinions and geotechnical advice contained in this report are not intended to imply total performance of the project or guarantee that unusual or variable conditions will not be discovered during or after construction.

The scope of GeoTek's evaluation is limited to the area explored that is shown on the Boring Location Map (Figure 2). This evaluation does not and should in no way be construed to encompass any areas beyond the specific area of the proposed construction as indicated to GeoTek by the client. Further, no evaluation of any existing site improvements is included. The scope is based on GeoTek's understanding of the project and the client's needs, GeoTek's proposal (Proposal No. P-0604321-CR) dated June 15, 2021 and geotechnical engineering standards normally used on similar projects in this region.

7. LIMITATIONS

GeoTek's findings are based on site conditions observed and the stated sources. Thus, GeoTek's comments are professional opinions that are limited to the extent of the available data.

GeoTek has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering at this time and location and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report.

Since GeoTek's recommendations are based on the site conditions observed and encountered at the stated times and laboratory testing. Thus, GeoTek's conclusions and recommendations are professional opinions that are limited to the extent of the available data. Observations during construction are important to allow for any change in recommendations found to be warranted. These opinions have been derived in accordance with current standards of practice and no warranty of any kind is expressed or implied. Standards of care/practice are subject to change with time.

8. SELECTED REFERENCES

American Concrete Institute (ACI), 2006, Publication 302.2R-06, Guide for Concrete Slabs That Receive Moisture Sensitive Flooring Materials.

______, 2010, Publications 360R-10, Guide to Design of Slabs-On-Ground.

Bowles, J. E., 1977, "Foundation Analysis and Design", Second Edition.

Bryant, W.A., and Hart, E.W., 2007, Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps, California Geological Survey: Special Publication 42.

California Code of Regulations, Title 24 Part 2, 2019 "California Building Code," 2 volumes.

California Department of Transportation, 2018, "Highway Design Manual", 6th Edition.

Department of the Navy, 1982, "Foundations and Earth Structures", Design Manual 7.2.

Dibblee, T.W. and Minch, J.A., 2004a, "Geologic Map of the Harrison Mountain/north ½ of San Bernardino Quadrangle, San Bernadino and Riverside County, California, Dibblee Geological Foundation Map DF-126, Scale 1:24,000.

GeoTek, Inc., In-house proprietary information.

Peck R. B., Hanson W. H. & Thornburn T. H., 1974, "Foundation Engineering", Second edition.

Roberge, P. R., 2000, "Handbook of Corrosion Engineering".

SEA/OSHPD web service, "Seismic Design Maps" (https://seismicmaps.org)

Terzaghi, K. and Peck, R. B., 1967, "Soil Mechanics in Engineering Practice", Second Edition.

Warmington Residential
Highland and Medical Center Drive
APN 0143-191-59
San Bernardino, San Bernardino County, California

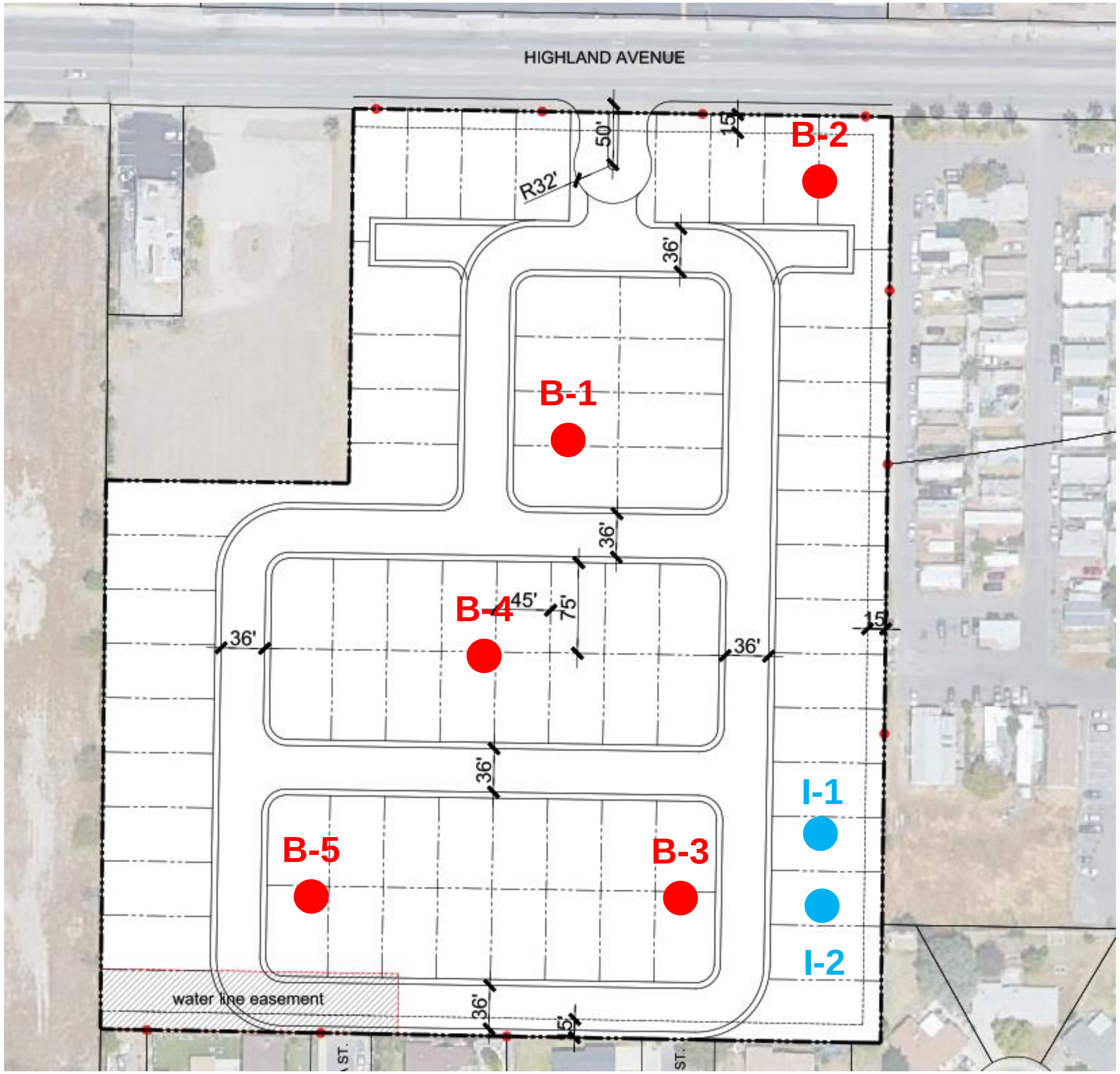
Project No. 2849-CR

NORTH

Figure 1

Site Location Map

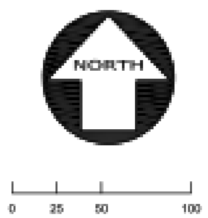
GEOTEK



LEGEND

B-5 — Approximate Location of Boring

I-2 — Approximate Location of Infiltration Boring



Warmington Residential
APN 0143-191-59
San Bernardino, San Bernardino County, California

GeoTek Project No. 2842-CR

GEOTEK

Figure 2

Boring Location Map

APPENDIX A

LOG OF EXPLORATORY BORINGS

Proposed Single-Family Residential Development

Highland Avenue and Medical Center Drive

San Bernardino, San Bernardino County, California

Project No. 2849-CR

GEOTEK

A - FIELD TESTING AND SAMPLING PROCEDURES

The Modified Split-Barrel Sampler (Ring)
The Ring sampler is driven into the ground at various depths in accordance with ASTM D 3550 test procedures. The sampler, with an external diameter of 3.0 inches, is lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sampler is typically driven into the ground 12 or 18 inches with a 140-pound hammer free falling from a height of 30 inches. Blow counts are recorded for every 6 inches of penetration as indicated on the log of boring. The samples are removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

Bulk Samples (Large)
These samples are normally large bags of earth materials over 20 pounds in weight collected from the field by means of hand digging or exploratory cuttings.

Bulk Samples (Small)
These are plastic bag samples which are normally airtight and contain less than 5 pounds in weight of earth materials collected from the field by means of hand digging or exploratory cuttings. These samples are primarily used for determining natural moisture content and classification indices.

B - BORING LOG LEGEND

The following abbreviations and symbols often appear in the classification and description of soil and rock on the log of borings:

SOILS

USCS	Unified Soil Classification System
f-c	Fine to coarse
f-m	Fine to medium

GEOLOGIC

B: Attitudes	Bedding: strike/dip
J: Attitudes	Joint: strike/dip
C: Contact line	
………..	Dashed line denotes USCS material change
———	Solid Line denotes unit / formational change
━━━	Thick solid line denotes end of boring

(Additional denotations and symbols are provided on the boring logs)

GeoTek, Inc.
LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling	**LOGGED BY:**	JD
PROJECT NAME:	APN 0143-191-59	**DRILL METHOD:**	HSA	**OPERATOR:**	Nick
PROJECT NO.:	2849-CR	**HAMMER:**	140 lbs - 30 in	**RIG TYPE:**	CME 75
LOCATION:	San Bernardino, CA			**DATE:**	7/26/2021

BORING NO.: B-1

Depth (ft)	SAMPLES: Sample Type	Blows/6 in.	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Others
					Undocumented Fill:			Maximum Density = 118.5 pcf
	Large Bulk / Ring	4 4 4	R1	SM	Silty f-c SAND, light brown, slightly moist, loose	2.1	101.8	Optimum Moisture = 10.5% Expansion Index = 0 Direct Shear Test
	Large Bulk / Ring	4 5 7	R2	SP	**Alluvium:** F-c SAND, brown, moist, medium dense			
5	Ring	4 10 15	R3		same as above	1.7	104.8	
	Ring	16 26 30	R4		same as above, dense	1.3		
10	Ring	20 22 24	R5		same as above, some gravel	0.5	112.8	
15	Ring	16 19 21	R6	SM	Silty f-c SAND, brown, moist, medium dense			
20	Ring	20 27 29	R7		same as above, dense	2.8	113.3	
25	SPT	14 18 19	S1		same as above, medium dense			
30	SPT	18 24 30	S2	SM/SP	Silty f-c SAND to f-c SAND, light brown, slightly moist, dense	0.8		

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:
AL = Atterberg Limits | EI = Expansion Index | SA = Sieve Analysis | RV = R-Value Test
SR = Sulfate/Resisitivity Test | SH = Shear Test | HC= Consolidation | MD = Maximum Density

GeoTek, Inc.
LOG OF EXPLORATORY BORING

GEOTEK

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling	**LOGGED BY:**	JD
PROJECT NAME:	APN 0143-191-59	**DRILL METHOD:**	HSA	**OPERATOR:**	Nick
PROJECT NO.:	2849-CR	**HAMMER:**	140 lbs - 30 in	**RIG TYPE:**	CME 75
LOCATION:	San Bernardino, CA			**DATE:**	7/26/2021

BORING NO.: B-1 (cont.)

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/6 in.	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Alluvium (cont.):			
35	SPT	11 14 28	S3	SM	Silty f-c SAND, trace gravel, grey, moist, dense			
40	SPT	19 20 24	S4		same as above, dark grey	1.9		
45	SPT	10 27 27	S5		same as above, very dense	4.6		
50	SPT	16 20 28	S6	SM/SW	Silty f SAND to f SAND, brown, moist, dense			
					BORING TERMINATED AT 51.5 FEET			
					No groundwater encountered Boring backfilled with soil cuttings			
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:
AL = Atterberg Limits EI = Expansion Index SA = Sieve Analysis RV = R-Value Test
SR = Sulfate/Resisitivity Test SH = Shear Test HC= Consolidation MD = Maximum Density

GeoTek, Inc.
LOG OF EXPLORATORY BORING

GEOTEK

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling	**LOGGED BY:**	JD
PROJECT NAME:	APN 0143-191-59	**DRILL METHOD:**	HSA	**OPERATOR:**	Nick
PROJECT NO.:	2849-CR	**HAMMER:**	140 lbs - 30 in	**RIG TYPE:**	CME 75
LOCATION:	San Bernardino, CA			**DATE:**	7/26/2021

BORING NO.: B-2

Depth (ft)	SAMPLES: Sample Type	Blows/6 in.	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Others
					Undocumented Fill:			
	▨	4 4 6	R1	SP	F-c SAND, light brown, slightly moist, loose			
					Alluvium:			
5	▨	2 2 4	R2	SW	F-c SAND, brown, moist, loose	4.6	105.4	Collapse Test
	▨	6 9 10	R3	SP	F-c SAND, brown, moist, medium dense	1.3	104.0	
	▨	5 5 7	R4	SM	Silty f-c SAND, brown, moist, medium dense			
10	▨	4 7 8	R5		same as above	3.7	104.2	
15	▨	5 11 12	R6	SP	F-c SAND, brown, moist, medium dense	2.4	105.4	
					BORING TERMINATED AT 16.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
20								
25								
30								

LEGEND

Sample type: ▨ ---Ring ▨ ---SPT ◿ ---Small Bulk ☒ ---Large Bulk ☐ ---No Recovery ▽ ---Water Table

Lab testing: AL = Atterberg Limits EI = Expansion Index SA = Sieve Analysis RV = R-Value Test
SR = Sulfate/Resisitivity Test SH = Shear Test HC= Consolidation MD = Maximum Density

GeoTek, Inc.
LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling	**LOGGED BY:**	JD
PROJECT NAME:	APN 0143-191-59	**DRILL METHOD:**	HSA	**OPERATOR:**	Nick
PROJECT NO.:	2849-CR	**HAMMER:**	140 lbs - 30 in	**RIG TYPE:**	CME 75
LOCATION:	San Bernardino, CA			**DATE:**	7/26/2021

BORING NO.: B-3

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/6 in.	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Undocumented Fill:			
		4 5 4	R1	SM	Silty f-c SAND, brown, slightly moist, loose	0.9		
		5 10 19	R2		same as above, medium dense to dense			
5		9 12 9	R3	SM	**Alluvium:** Silty f-c SAND, trace gravel, grey, slightly moist, medium dense	1.4		
		7 8 11	R4	SP	F-c SAND, brown, moist, medium dense	1.4		
10		6 8 9	R5	SM	Silty f-c SAND, brown, moist, medium dense	5.5	107.1	Collapse Test
15		6 9 17	R6	SM/SP	Silty f-c SAND to f-c SAND, brown, moist, medium dense	5.4	109.6	
					BORING TERMINATED AT 16.5 FEET			
					No groundwater encountered Boring backfilled with soil cuttings			
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling	**LOGGED BY:**	JD
PROJECT NAME:	APN 0143-191-59	**DRILL METHOD:**	HSA	**OPERATOR:**	Nick
PROJECT NO.:	2849-CR	**HAMMER:**	140 lbs - 30 in	**RIG TYPE:**	CME 75
LOCATION:	San Bernardino, CA			**DATE:**	7/26/2021

BORING NO.: B-4

Depth (ft)	Sample Type	Blows/6 in.	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
					Undocumented Fill:			
	Ring	4 5 6	R1	SP	F-c SAND, light brown, slightly moist, loose	0.8		
					Alluvium:			
5	Ring	5 10 12	R2	SP	F-c SAND, some gravel, light brown, moist, medium dense			
	Ring	5 7 7	R3		same as above	1.4		
	Ring	7 8 8	R4	SM/SP	Silty f-c SAND to f-c SAND, brown, moist, medium dense	4.8	114.1	
10	Ring	5 6 6	R5	SM	Silty f-c SAND, brown, moist, medium dense			
15	Ring	4 7 10	R6		same as above	4.7	108.4	
					BORING TERMINATED AT 16.5 FEET			
					No groundwater encountered Boring backfilled with soil cuttings			
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.
LOG OF EXPLORATORY BORING

GEOTEK

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling	**LOGGED BY:**	JD
PROJECT NAME:	APN 0143-191-59	**DRILL METHOD:**	HSA	**OPERATOR:**	Nick
PROJECT NO.:	2849-CR	**HAMMER:**	140 lbs - 30 in	**RIG TYPE:**	CME 75
LOCATION:	San Bernardino, CA			**DATE:**	7/26/2021

BORING NO.: B-5

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/6 in.	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
	Large Bulk				**Undocumented Fill:**			Corrosion Tests
	Ring	3 3 4	R1	SM	Silty f-c SAND, light brown, slightly moist, loose			
	Ring	4 4 5	R2		same as above	1.6	100.3	
5	Ring	3 5 6	R3	SP	**Alluvium:** Silty f-c SAND, light brown, slightly moist, loose	1.5		
	Ring	9 17 17	R4		same as above, moist, dense	1.7		
10	No Recovery	7 17 13	R5		No Recovery			
15	Ring	7 24 19	R6		same as above, trace gravel	4.2		
					BORING TERMINATED AT 16.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:

AL = Atterberg Limits	EI = Expansion Index	SA = Sieve Analysis	RV = R-Value Test
SR = Sulfate/Resisitivity Test	SH = Shear Test	HC= Consolidation	MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

GEOTEK

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling	**LOGGED BY:**	JD
PROJECT NAME:	APN 0143-191-59	**DRILL METHOD:**	HSA	**OPERATOR:**	Nick
PROJECT NO.:	2849-CR	**HAMMER:**	140 lbs - 30 in	**RIG TYPE:**	CME 75
LOCATION:	San Bernardino, CA			**DATE:**	7/26/2021

BORING NO.: I-1

Depth (ft)	SAMPLES: Sample Type	Blows/6 in.	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Others
					Undocumented Fill:			
				SM	Silty f-c SAND, brown, slightly moist			
5					**BORING TERMINATED AT 5 FEET**			
					No groundwater encountered			
					Boring set with pipe, filter sock, and gravel			
10								
15								
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:

AL = Atterberg Limits	EI = Expansion Index	SA = Sieve Analysis	RV = R-Value Test
SR = Sulfate/Resisitivity Test	SH = Shear Test	HC= Consolidation	MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

GEOTEK

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling	**LOGGED BY:**	JD
PROJECT NAME:	APN 0143-191-59	**DRILL METHOD:**	HSA	**OPERATOR:**	Nick
PROJECT NO.:	2849-CR	**HAMMER:**	140 lbs - 30 in	**RIG TYPE:**	CME 75
LOCATION:	San Bernardino, CA			**DATE:**	7/26/2021

BORING NO.: I-2

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/6 in.	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Undocumented Fill:			
				SM	Silty f-c SAND, brown, slightly moist			
5					**BORING TERMINATED AT 5 FEET**			
					No groundwater encountered			
					Boring set with pipe, filter sock, and gravel			
10								
15								
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:

AL = Atterberg Limits	EI = Expansion Index	SA = Sieve Analysis	RV = R-Value Test
SR = Sulfate/Resisitivity Test	SH = Shear Test	HC= Consolidation	MD = Maximum Density

APPENDIX B

RESULTS OF LABORATORY TESTING

Proposed Single-Family Residential Development
Highland Avenue and Medical Center Drive
San Bernardino, San Bernardino County, California
Project No. 2849-CR

GEOTEK

SUMMARY OF LABORATORY TESTING

Classification
Soils were classified visually in general accordance with the Unified Soil Classification System (ASTM Test Method D 2487). The soil classifications are shown on the logs of borings in Appendix A.

Collapse Test
Collapse tests were performed on selected samples of the site soils in general accordance with ASTM D 5333 test procedures. The results of this test are presented graphically in Appendix B.

Direct Shear
Shear testing was performed in a direct shear machine of the strain-control type in general accordance with ASTM D 3080 test procedures. The rate of deformation was approximately 0.035 inch per minute. The sample was sheared under varying confining loads in order to determine the coulomb shear strength parameters, angle of internal friction and cohesion. The tests were performed on soil samples remolded to approximately 90 percent of maximum dry density as determined by ASTM D 1557 test procedures. The shear test results are presented in Appendix B.

Expansion Index
Expansion Index testing was performed one soil samples. Testing was performed in general accordance with ASTM Test Method D 4829. The results of the testing are provided below.

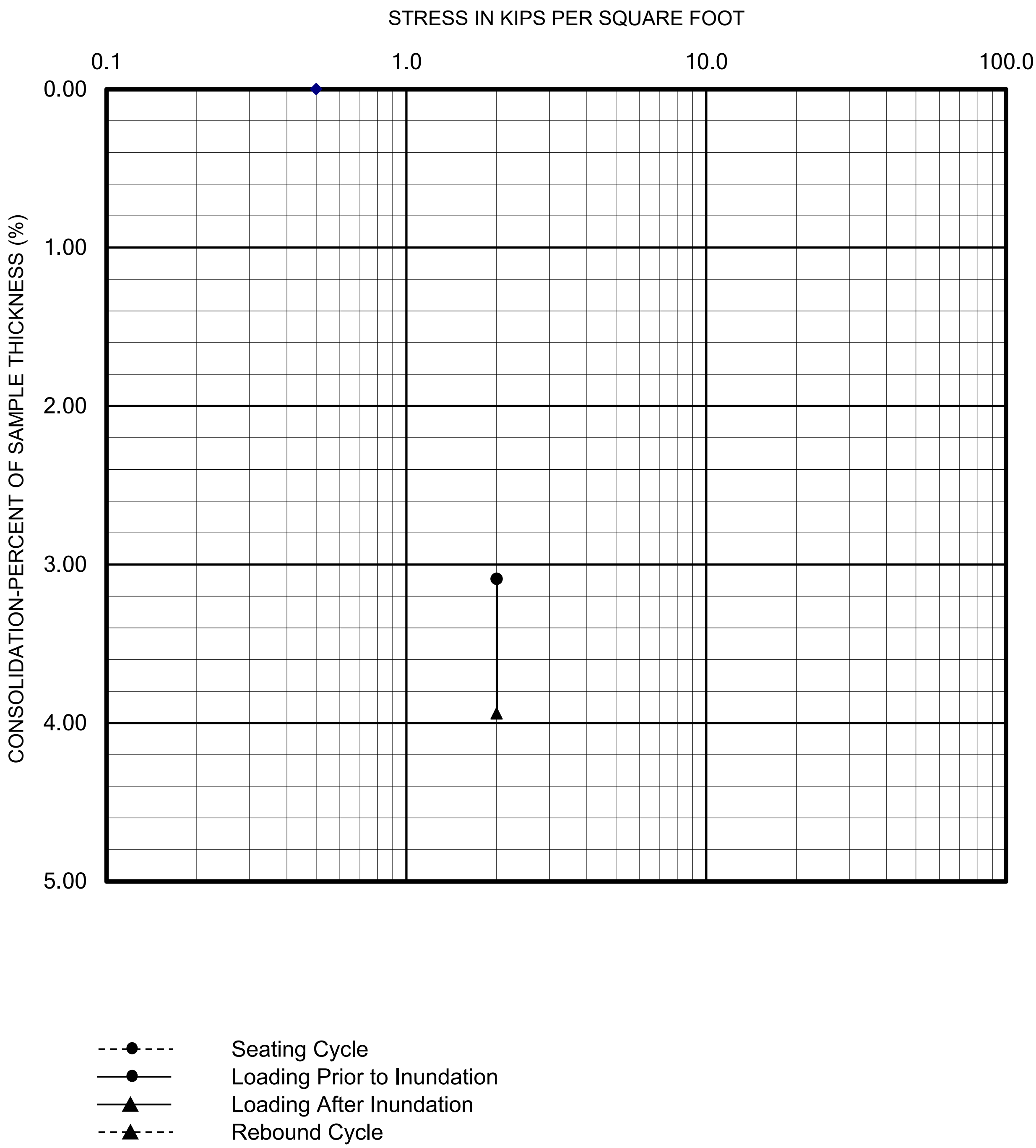
Boring No.	Depth (ft.)	Description	Expansion Index	Classification
B-5	0-5	Silty Sand	0	Very Low

In-Situ Moisture and Density
The natural water content of sampled soils was determined in general accordance with ASTM D 2216 test procedures on samples of the materials recovered from the subsurface exploration. In addition, in-place dry density of the sampled soils was determined in general accordance with ASTM D 2937 test procedures on relatively undisturbed samples to measure the unit weight of the subsurface soils. Results of these tests are shown on the boring logs at the appropriate sample depths in Appendix A.

Moisture-Density Relationship
Laboratory testing was performed on two samples collected during the subsurface exploration. The laboratory maximum dry density and optimum moisture content for the soil type was determined in general accordance with test method ASTM Test Procedure D 1557. The results are presented in Appendix B.

Sulfate Content, Resistivity and Chloride Content
Testing to determine the water-soluble sulfate content was performed in general accordance with ASTM D4327 test procedures. Resistivity testing was completed in general accordance with ASTM G187 test procedures. Testing to determine the chloride content was performed in general accordance with ASTM D4327 test procedures. The results of the testing are provided in Appendix B.

Boring #	Depth (ft.)	pH ASTM D4972	Chloride ASTM D4327 (mg/kg)	Sulfate ASTM D4327 (% by weight)	Resistivity ASTM G187 (ohm-cm)
B-5	0-5	8.4	6.0	0.0021	14,070



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546

GEOTEK

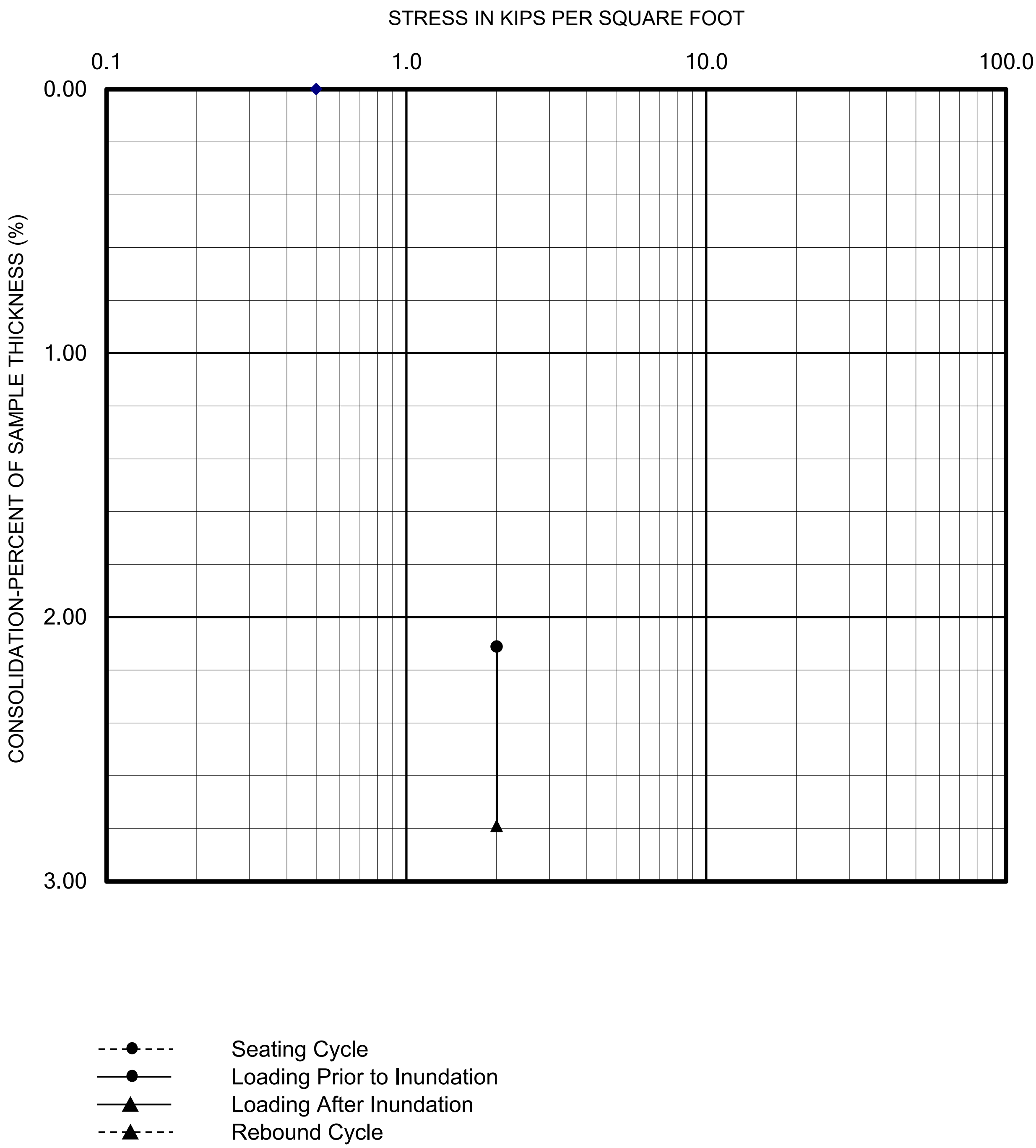
CHECKED BY: RJ	Lab: Corona
PROJECT NO.: 2849-CR	Date: 8-4-21

COLLAPSE REPORT

Sample: B-2 @ 4 feet

Medical Center Drive
San Bernardino, California

Plate B-1



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546

GEOTEK

COLLAPSE REPORT

Sample: B-3 @ 9 feet

Medical Center Drive
San Bernardino, California

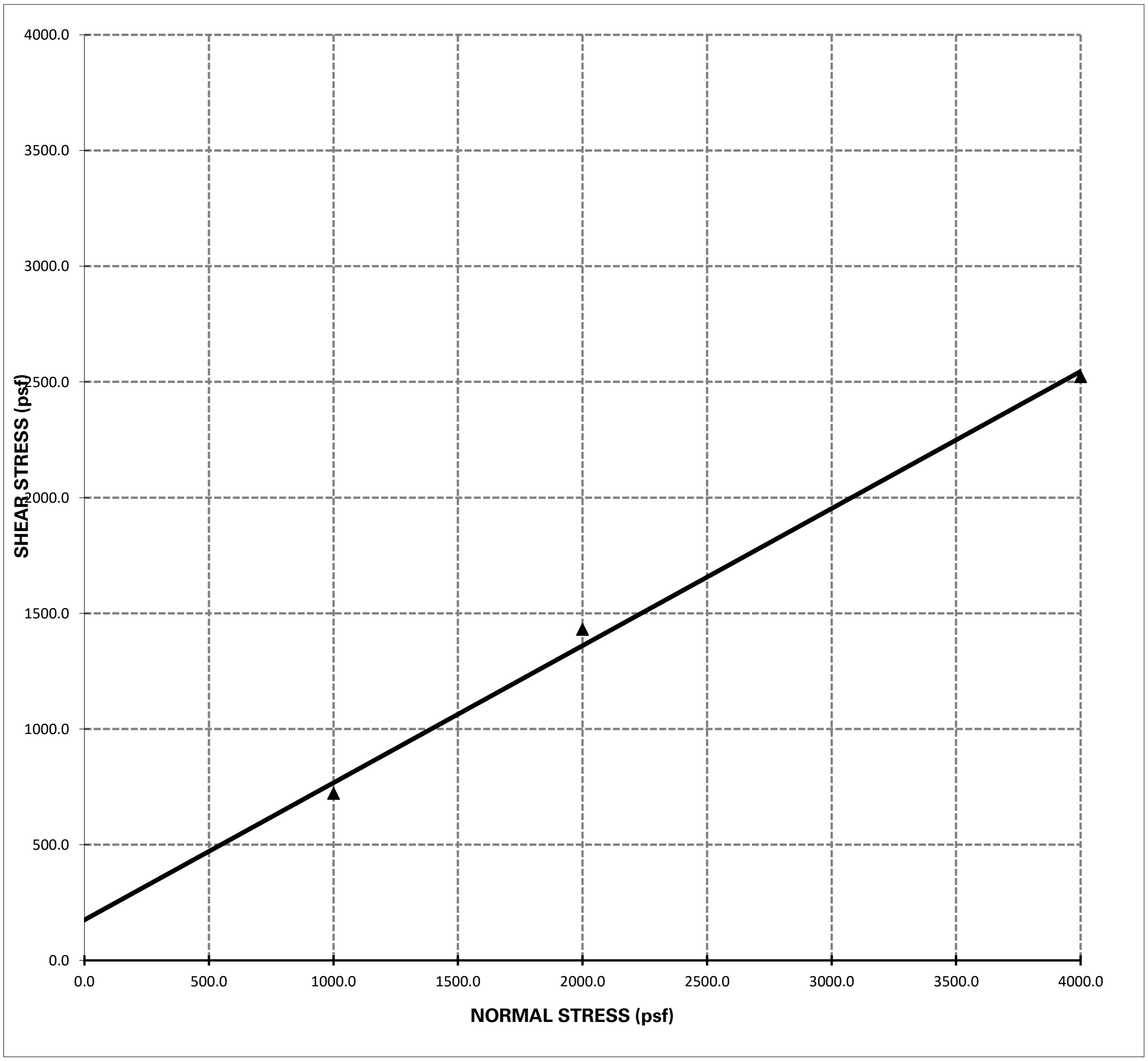
Plate B-2

CHECKED BY: RJ	Lab: Corona
PROJECT NO.: 2849-CR	Date: 8-4-21

DIRECT SHEAR TEST

Project Name: Warmington Residential
Project Number: 2849-CR
Sample Location: B1 @ 0-5'
Date Tested: 8/10/2021

PEAK VALUE

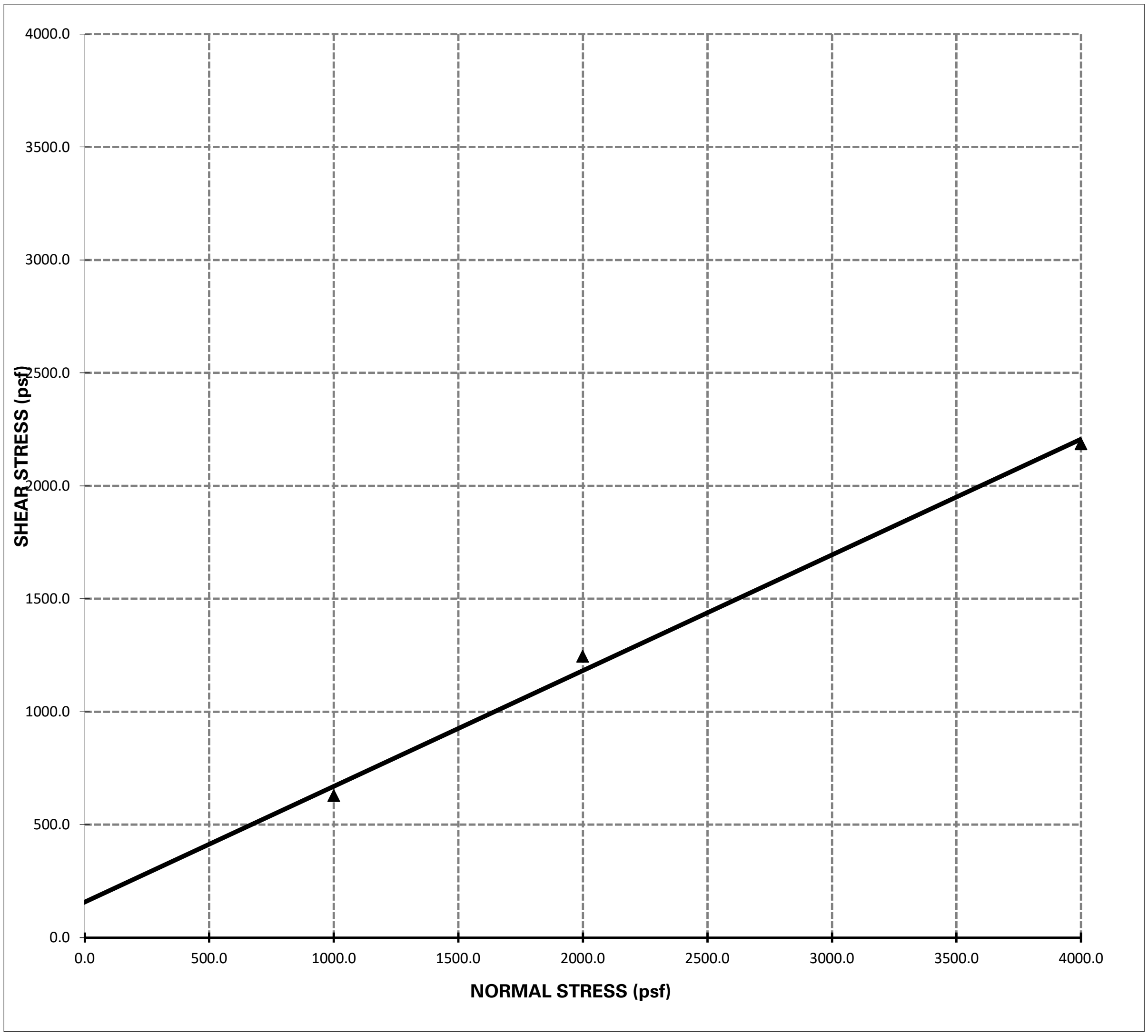


Shear Strength: Φ = 31 ° C = 175 psf

Notes: 1 - The soil specimen used in the shear box was a ring sample remolded to approximately 90% relative compaction from a bulk sample collected during the field investigation.
2 - The above reflect direct shear strength at saturated conditions.
3 - The tests were run at a shear rate of 0.035 in/min.

DIRECT SHEAR TEST

Project Name:	Warmington Residential	***Sample Location:***	B1 @ 0-5'
Project Number:	2849-CR	***Date Tested:***	8/10/2021



Shear Strength: **Φ = 27 °** , **C = 158 psf**

Notes: 1 - The soil specimen used in the shear box was a ring sample remolded to approximately 90% relative compaction from a bulk sample collected during the field investigation.

2 - The above reflect direct shear strength at saturated conditions.

3 - The tests were run at a shear rate of 0.035 in/min.

GEOTEK

EXPANSION INDEX TEST

(ASTM D4829)

Client: Warmington Residential
Project Number: 2849-CR
Project Location: SWC Highland Ave. & Medical Ctr Dr. San Bernardino

Tested/ Checked By: CD Lab No Corona
Date Tested: 8/6/2021
Sample Source: B1 @ 0-5'
Sample Description:

Ring #:______ Ring Dia. : 4.01" Ring Ht.:1"

DENSITY DETERMINATION

A	Weight of compacted sample & ring (gm)	747.1
B	Weight of ring (gm)	363.0
C	Net weight of sample (gm)	**384.1**
D	Wet Density, lb / ft3 (C*0.3016)	**115.8**
E	Dry Density, lb / ft3 (D/1.F)	**104.4**

SATURATION DETERMINATION

F	Moisture Content, %	11.0
G	Specific Gravity, assumed	**2.70**
H	Unit Wt. of Water @ 20°C, (pcf)	**62.4**
I	% Saturation	**48.3**

READINGS

DATE	TIME	READING	
8/6/2021		0.1340	Initial
8/6/2021		0.1330	10 min/Dry
8/7/2021		0.1330	Final

FINAL MOISTURE

Final Weight of wet sample & tare	% Moisture
770.2	**17.0**

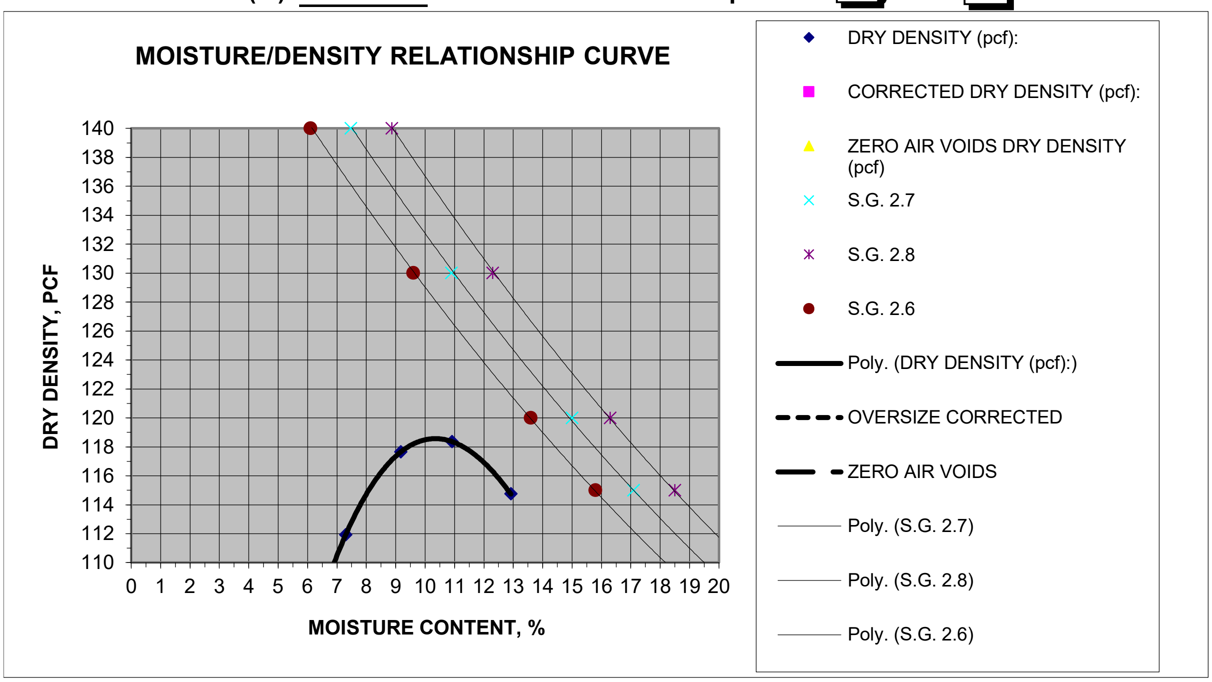
EXPANSION INDEX = **0**

MOISTURE/DENSITY RELATIONSHIP

Client:	Warmington Residential	**Job No.:**	2849-CR
Project:	APN 0143-191-59	**Lab No.:**	Corona
Location:	San Bernardino		
Material Type:	Sand Trace Silt/ F-M Sand		
Material Supplier:	-		
Material Source:	-		
Sample Location:	B1 @ 0-5'		
	-		
Sampled By:	0	**Date Sampled:**	7/27/2021
Received By:	RJ	**Date Received:**	7/27/2021
Tested By:	RL	**Date Tested:**	8/9/2021
Reviewed By:	RJ	**Date Reviewed:**	8/10/2021

Test Procedure: ASTM D1557 **Method:** A

Oversized Material (%): 0.7 **Correction Required:** [ ] yes [x] no



MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf	118.5	**@ Optimum Moisture, %**	10.5
Corrected Maximum Dry Density, pcf		**@ Optimum Moisture, %**	

MATERIAL DESCRIPTION

Grain Size Distribution:

	% Gravel (retained on No. 4)
	% Sand (Passing No. 4, Retained on No. 200)
	% Silt and Clay (Passing No. 200)

Atterberg Limits:

	Liquid Limit, %
	Plastic Limit, %
	Plasticity Index, %

Classification:

Unified Soils Classification: ______

AASHTO Soils Classification: ______

Results Only Soil Testing for SWC Highland Ave Medical Center Or, San Bernardino

August 2, 2021

Prepared for:
Anna Scott
GeoTek, Inc.
1548 North Maple Street
Corona, CA 92280
ascott@geotekusa.com

Project X Job#: S210729D
Client Job or PO#: 2849-CR Warmington Residential

Respectfully Submitted,

Eduardo Hernandez, M.Sc., P.E.
Sr. Corrosion Consultant
NACE Corrosion Technologist #16592
Professional Engineer
California No. M37102
ehernandez@projectxcorrosion.com

Soil Analysis Lab Results

Client: GeoTek, Inc.
Job Name: SWC Highland Ave Medical Center Or, San Bernardino
Client Job Number: 2849-CR Warmington Residential
Project X Job Number: S210729D
August 2, 2021

	Method	ASTM D4327		ASTM D4327		ASTM G187		ASTM D4972	ASTM G200	ASTM D4658	ASTM D4327	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D4327	ASTM D4327
Bore# / Description	**Depth**	**Sulfates** SO_4^{2-}		**Chlorides** Cl^-		**Resistivity**		**pH**	**Redox**	**Sulfide** S^{2-}	**Nitrate** NO_3^-	**Ammonium** NH_4^+	**Lithium** Li^+	**Sodium** Na^+	**Potassium** K^+	**Magnesium** Mg^{2+}	**Calcium** Ca^{2+}	**Fluoride** F_2^-	**Phosphate** PO_4^{3-}
						As Rec'd	Minimum												
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)		(mV)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
2849-CR B5 @	0-5	20.6	0.0021	6.0	0.0006	241,200	14,070	8.4	132	<0.01	0.2	3.0	0.03	16.3	4.9	33.7	210.3	3.1	2.7

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown
Chemical Analysis performed on 1:3 Soil-To-Water extract
PPM = mg/kg (soil) = mg/L (Liquid)

Project X
Corrosion Engineering
Corrosion Control - Soil, Water, and Metallurgy Lab

Lab Request Sheet Chain of Custody
Phone: (213) 928-7213 · Fax (951) 226-1720 · www.projectxcorrosion.com
Ship Samples To: 29990 Technology Dr, Suite 13, Murrieta, CA 92563

Project X Job Number S210729D Geotek 2849-CR SWC Highland Ave 1 Full

IMPORTANT: Please complete Project and Sample Identification Data as you would like it to appear in report & include this form with samples.

Company Name:	Geotek USA	**Contact Name:**	Anna Scott	**Phone No:**	951-205-1653
Mailing Address:	1548 N. Maple St. Corona,CA 92880	**Contact Email:**	AScott@geotekusa.com		
Accounting Contact:		**Invoice Email:**			
Client Project No:	Warmington Residential	**Project Name:**	SWC Highland Ave medical Center Dr, San Bernardino		

P.O. #:		**3-5 Day Standard**	**3 Day Guarantee** 50% mark-up	**24 Hr RUSH** 100% mark-up
(Business Days) Turn Around Time:		X		

Results By: ☐ Phone ☐ Fax ☒ Email

Date & Received by 07/29/21 Alyse a

Special Instructions:

ANALYSIS REQUESTED (Please circle)

	Default Method
Soil Resistivity (Geo Quad, Full Corrosion Series)	ASTM G187 / AASHTO T2888 / Caltrans CTM643
pH (Geo Quad, Full Corrosion Series)	ASTM G51 / AASHTO T 289 / Caltrans CTM643
Sulfate (Geo Quad, Full Corrosion Series)	ASTM D4327 / AASHTO T 290 / Caltrans CTM417
Chloride (Geo Quad, Full Corrosion Series)	ASTM D4327 / AASHTO T 291 / Caltrans CTM422
Redox Potential (Full Corrosion Series)	ASTM G200 / SM 2580B
Sulfide (Full Corrosion Series)	SM 4500-S2
Ammonia (Full Corrosion Series)	ASTM D6919 / SM 4500-NH3
Nitrate (Full Corrosion Series)	ASTM D4327 / SM 4500-NO3
Flouride (Full Corrosion Series)	ASTM D4327
Phosphate (Full Corrosion Series)	ASTM D4327
Lithium (Full Corrosion Series)	ASTM D6919
Sodium (Full Corrosion Series)	ASTM D6919
Potassium (Full Corrosion Series)	ASTM D6919
Magnesium (Full Corrosion Series)	ASTM D6919
Calcium (Full Corrosion Series)	ASTM D6919
BiCarbonate (Full Corrosion Series)	SM 2320B
Full Corrosion Series	
Soil Corrosivity Evaluation Report (Reports)	*Req: Min. 3 Samples, site map, and groundwater info
Water Corrosivity Mini Report (Reports)	*Req: Min. 3 Samples, site map, and groundwater info
Moisture Content	ASTM D2216
Total Alkalinity	SM 2520B
Thermal Resistivity	
Metallurgical Analysis	
Langelier Index	
Puckorius Index	
XRF Elemental Analysis	
Water Hardness	

	SAMPLE ID - BORE #	DESCRIPTION	DEPTH (ft)	DATE COLLECTED	Soil Resistivity	pH	Sulfate	Chloride	Redox Potential	Sulfide	Ammonia	Nitrate	Flouride	Phosphate	Lithium	Sodium	Potassium	Magnesium	Calcium	BiCarbonate	Full Corrosion Series	Soil Corrosivity Evaluation Report	Water Corrosivity Mini Report	Moisture Content	Total Alkalinity	Thermal Resistivity	Metallurgical Analysis	Langelier Index	Puckorius Index	XRF Elemental Analysis	Water Hardness
297 1	2849-CR	B5 @	0-5																		X										
2																															
3																															
4																															
5																															
6																															
7																															
8																															
9																															
10																															
11																															
12																															
13																															
14																															
15																															

APPENDIX C

PERCOLATION DATA SHEETS & PORCHET CALCULATIONS

Proposed Single-Family Residential Development
Highland Avenue and Medical Center Drive
San Bernardino, San Bernardino County, California
Project No. 2849-CR

GEOTEK

Client:	**Warmington Residential**
Project:	**APN 0143-191-59**
Project No:	**2849-CR**
Date:	**7/27/2021**

Boring No. **I-1**

Infiltration Rate (Porchet Method)

Time Interval, Δt =	10
Final Depth to Water, D_F =	51.75
Test Hole Radius, r =	4
Initial Depth to Water, D_O =	40
Total Test Hole Depth, D_T =	60

Equation - $I_t = \dfrac{\Delta H\ (60r)}{\Delta t\ (r+2H_{avg})}$

$H_O = D_T - D_O =$	20
$H_F = D_T - D_F =$	8.25
$\Delta H = \Delta D = H_O - H_F =$	11.75
$Havg = (H_O+H_F)/2 =$	14.125

I_t = 8.74 **Inches pe**

GEOTEK

Client:	**Warmington Residential**
Project:	**APN 0143-191-59**
Project No:	**2849-CR**
Date:	**7/27/2021**

Boring No. **I-2**

Infiltration Rate (Porchet Method)

Time Interval, Δt =	10
Final Depth to Water, D_F =	51.5
Test Hole Radius, r =	4
Initial Depth to Water, D_O =	40
Total Test Hole Depth, D_T =	60

Equation -

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

$H_O = D_T - D_O =$	20
$H_F = D_T - D_F =$	8.5
$\Delta H = \Delta D = H_O - H_F =$	11.5
$Havg = (H_O+H_F)/2 =$	14.25

I_t = 8.49 **Inches pe**

GEOTEK

PERCOLATION DATA SHEET

Project: ______________________

Job No.: 2849-CR

Test Hole No.: I-1

Tested By: DVG

Date: 7/26,27/2021

Depth of Hole As Drilled: 60"

Before Test: 60"

After Test: 60"

Reading No.	Time	Time Interval (Min)	Total Depth of Hole (Inches)	Initial Water Level (Inches)	Final Water Level (Inches)	Δ In Water Level (Inches)	Rate (minutes per inch)	Comments
	—	—	—	—	—	—		PRESOAK 5 GAL 7/26/2021
	1135		60	20				BEGIN 7/27/2021
	1145	10			6 1/2	13 1/2		1ST 25 MIN.
	1147		60	20				
	1157	10			7 1/4	12 3/4		2ND 25 MIN.
	1159		60	20				
	1209	10			7 1/2	12 1/2		1ST 10 MIN.
	1211		60	20				
	1221	10			7 3/4	12 1/4		2ND 10 MIN.
	1223		60	20				
	1233	10			8	12		3RD 10 MIN
	1235		60	20				
	1245	10			8	12		4TH 10 MIN.
	1247		60	20				
	1257	10			8 1/4	11 3/4		5TH 10 MIN.
	1259		60	20				
	109	10			8 1/4	11 3/4		6TH 10 MIN.

PERCOLATION DATA SHEET

Project: ____________________

Test Hole No.: I-2 Tested By: DVG Job No.: 2849-CR.

Date: 7/26,27/2021.

Depth of Hole As Drilled: 60" Before Test: 60" After Test: 60".

Reading No.	Time	Time Interval (Min)	Total Depth of Hole (Inches)	Initial Water Level (Inches)	Final Water Level (Inches)	Δ In Water Level (Inches)	Rate (minutes per inch)	Comments
								PRESOAK 5 GAL
								7/26/2021
	835		60	20				7/27/2021 BEGIN
	845	10			6 3/4	13 1/4		1ST 25 MIN.
	847		60	20				
	857	10			7 1/4	12 3/4		2ND 25 MIN.
	859		60	20				
	909	10			7 1/2	12 1/2		1ST 10 MIN.
	911		60	20				
	921	10			7 1/2	12 1/2		2ND 10 MIN.
	923		60	20				
	933	10			7 3/4	12 1/4		3RD 10 MIN.
	935		60	20				
	945	10			8	12		4TH 10 MIN.
	947		60	20				
	957	10			8 1/4	11 3/4		5TH 10 MIN.
	959		60	20				
	1009	10			8 1/2	11 1/2		6TH 10 MIN.

APPENDIX D

LIQUEFACTION ANALYSIS

Proposed Single-Family Residential Development
Highland Avenue and Medical Center Drive
San Bernardino, San Bernardino County, California
Project No. 2849-CR

GEOTEK

****
LIQUEFACTION ANALYSIS CALCULATION DETAILS

****

Font: Courier New, Regular, Size 8 is recommended for this report.
Licensed to , 8/11/2021 1:44:25 PM

Input File Name: UNTITLED
Title: APN 0143-191-59
Subtitle: Seismic Settlement

Input Data:
Surface Elev.=1235
Hole No.=B-
Depth of Hole=50.00 ft
Water Table during Earthquake= 100.00 ft
Water Table during In-Situ Testing= 100.00 ft
Max. Acceleration=1.07 g
Earthquake Magnitude=7.30
No-Liquefiable Soils: CL, OL are Non-Liq. Soil
1. SPT or BPT Calculation.
2. Settlement Analysis Method: Ishihara / Yoshimine
3. Fines Correction for Liquefaction: Idriss/Seed
4. Fine Correction for Settlement: During Liquefaction*
5. Settlement Calculation in: All zones*
6. Hammer Energy Ratio, Ce = 1.25
7. Borehole Diameter, Cb= 1
8. Sampling Method, Cs= 1
9. User request factor of safety (apply to CSR) , User= 1
   Plot one CSR curve (fs1=User)
10. Average two input data between two Depths: Yes*
* Recommended Options

In-Situ Test Data:

Depth ft	SPT	Gamma pcf	Fines %
1.00	50.00	115.00	20.00
3.00	50.00	115.00	20.00
5.00	50.00	115.00	20.00
7.50	35.00	106.00	10.00
10.00	29.00	113.00	10.00
15.00	25.00	113.00	20.00
20.00	35.00	116.00	20.00

25.00	37.00	116.00	25.00
30.00	54.00	116.00	12.00
35.00	42.00	116.00	20.00
40.00	44.00	116.00	20.00
45.00	54.00	116.00	20.00
50.00	48.00	116.00	20.00

Output Results:
Calculation segment, dz=0.050 ft
User defined Print Interval, dp=1.00 ft

Peak Ground Acceleration (PGA), a_max = 1.07g

CSR Calculation:

Depth ft	gamma pcf	sigma atm	gamma' pcf	sigma' atm	rd	mZ g	a(z) g	CSR	x	fs1 =CSRfs
1.00	115.00	0.054	115.00	0.054	1.00	0.000	1.070	0.69	1.00	0.69
2.00	115.00	0.109	115.00	0.109	1.00	0.000	1.070	0.69	1.00	0.69
3.00	115.00	0.163	115.00	0.163	0.99	0.000	1.070	0.69	1.00	0.69
4.00	115.00	0.217	115.00	0.217	0.99	0.000	1.070	0.69	1.00	0.69
5.00	115.00	0.272	115.00	0.272	0.99	0.000	1.070	0.69	1.00	0.69
6.00	111.40	0.325	111.40	0.325	0.99	0.000	1.070	0.69	1.00	0.69
7.00	107.80	0.377	107.80	0.377	0.98	0.000	1.070	0.68	1.00	0.68
8.00	107.40	0.428	107.40	0.428	0.98	0.000	1.070	0.68	1.00	0.68
9.00	110.20	0.479	110.20	0.479	0.98	0.000	1.070	0.68	1.00	0.68
10.00	113.00	0.532	113.00	0.532	0.98	0.000	1.070	0.68	1.00	0.68
11.00	113.00	0.585	113.00	0.585	0.97	0.000	1.070	0.68	1.00	0.68
12.00	113.00	0.638	113.00	0.638	0.97	0.000	1.070	0.68	1.00	0.68
13.00	113.00	0.692	113.00	0.692	0.97	0.000	1.070	0.67	1.00	0.67
14.00	113.00	0.745	113.00	0.745	0.97	0.000	1.070	0.67	1.00	0.67

15.00	113.00	0.799	113.00	0.799	0.97	0.000	1.070	0.67	1.00	0.67
16.00	113.60	0.852	113.60	0.852	0.96	0.000	1.070	0.67	1.00	0.67
17.00	114.20	0.906	114.20	0.906	0.96	0.000	1.070	0.67	1.00	0.67
18.00	114.80	0.960	114.80	0.960	0.96	0.000	1.070	0.67	1.00	0.67
19.00	115.40	1.014	115.40	1.014	0.96	0.000	1.070	0.66	1.00	0.66
20.00	116.00	1.069	116.00	1.069	0.95	0.000	1.070	0.66	1.00	0.66
21.00	116.00	1.124	116.00	1.124	0.95	0.000	1.070	0.66	1.00	0.66
22.00	116.00	1.179	116.00	1.179	0.95	0.000	1.070	0.66	1.00	0.66
23.00	116.00	1.234	116.00	1.234	0.95	0.000	1.070	0.66	1.00	0.66
24.00	116.00	1.288	116.00	1.288	0.94	0.000	1.070	0.66	1.00	0.66
25.00	116.00	1.343	116.00	1.343	0.94	0.000	1.070	0.65	1.00	0.65
26.00	116.00	1.398	116.00	1.398	0.94	0.000	1.070	0.65	1.00	0.65
27.00	116.00	1.453	116.00	1.453	0.94	0.000	1.070	0.65	1.00	0.65
28.00	116.00	1.508	116.00	1.508	0.93	0.000	1.070	0.65	1.00	0.65
29.00	116.00	1.562	116.00	1.562	0.93	0.000	1.070	0.65	1.00	0.65
30.00	116.00	1.617	116.00	1.617	0.93	0.000	1.070	0.65	1.00	0.65
31.00	116.00	1.672	116.00	1.672	0.92	0.000	1.070	0.64	1.00	0.64
32.00	116.00	1.727	116.00	1.727	0.91	0.000	1.070	0.64	1.00	0.64
33.00	116.00	1.782	116.00	1.782	0.91	0.000	1.070	0.63	1.00	0.63
34.00	116.00	1.837	116.00	1.837	0.90	0.000	1.070	0.62	1.00	0.62
35.00	116.00	1.891	116.00	1.891	0.89	0.000	1.070	0.62	1.00	0.62
36.00	116.00	1.946	116.00	1.946	0.88	0.000	1.070	0.61	1.00	0.61
37.00	116.00	2.001	116.00	2.001	0.87	0.000	1.070	0.61	1.00	0.61
38.00	116.00	2.056	116.00	2.056	0.86	0.000	1.070	0.60	1.00	0.60
39.00	116.00	2.111	116.00	2.111	0.86	0.000	1.070	0.60	1.00	0.60

40.00	116.00	2.165	116.00	2.165	0.85	0.000	1.070	0.59	1.00	0.59
41.00	116.00	2.220	116.00	2.220	0.84	0.000	1.070	0.58	1.00	0.58
42.00	116.00	2.275	116.00	2.275	0.83	0.000	1.070	0.58	1.00	0.58
43.00	116.00	2.330	116.00	2.330	0.82	0.000	1.070	0.57	1.00	0.57
44.00	116.00	2.385	116.00	2.385	0.82	0.000	1.070	0.57	1.00	0.57
45.00	116.00	2.440	116.00	2.440	0.81	0.000	1.070	0.56	1.00	0.56
46.00	116.00	2.494	116.00	2.494	0.80	0.000	1.070	0.56	1.00	0.56
47.00	116.00	2.549	116.00	2.549	0.79	0.000	1.070	0.55	1.00	0.55
48.00	116.00	2.604	116.00	2.604	0.78	0.000	1.070	0.54	1.00	0.54
49.00	116.00	2.659	116.00	2.659	0.78	0.000	1.070	0.54	1.00	0.54
50.00	116.00	2.714	116.00	2.714	0.77	0.000	1.070	0.53	1.00	0.53

CSR is based on water table at 100.00 during earthquake

CRR Calculation from SPT or BPT data:

Depth ft	SPT	Cebs	Cr	sigma' atm	Cn	(N1)60	Fines %	d(N1)60	(N1)60f	CRR7.5
1.00	50.00	1.25	0.75	0.054	1.70	79.69	20.00	9.95	89.63	0.50
2.00	50.00	1.25	0.75	0.109	1.70	79.69	20.00	9.95	89.63	0.50
3.00	50.00	1.25	0.75	0.163	1.70	79.69	20.00	9.95	89.63	0.50
4.00	50.00	1.25	0.75	0.217	1.70	79.69	20.00	9.95	89.63	0.50
5.00	50.00	1.25	0.75	0.272	1.70	79.69	20.00	9.95	89.63	0.50
6.00	44.00	1.25	0.75	0.325	1.70	70.12	16.00	6.55	76.68	0.50
7.00	38.00	1.25	0.75	0.377	1.63	58.01	12.00	3.39	61.40	0.50
8.00	33.80	1.25	0.75	0.428	1.53	48.46	10.00	1.92	50.38	0.50

9.00	31.40	1.25	0.85	0.479	1.44	48.21	10.00	1.91	50.12	0.50
10.00	29.00	1.25	0.85	0.532	1.37	42.26	10.00	1.78	44.04	0.50
11.00	28.20	1.25	0.85	0.585	1.31	39.17	12.00	2.79	41.96	0.50
12.00	27.40	1.25	0.85	0.638	1.25	36.44	14.00	3.75	40.18	0.50
13.00	26.60	1.25	0.85	0.692	1.20	33.98	16.00	4.60	38.58	0.50
14.00	25.80	1.25	0.85	0.745	1.16	31.75	18.00	5.34	37.10	0.50
15.00	25.00	1.25	0.95	0.799	1.12	33.22	20.00	6.25	39.47	0.50
16.00	27.00	1.25	0.95	0.852	1.08	34.73	20.00	6.37	41.11	0.50
17.00	29.00	1.25	0.95	0.906	1.05	36.18	20.00	6.49	42.67	0.50
18.00	31.00	1.25	0.95	0.960	1.02	37.57	20.00	6.60	44.17	0.50
19.00	33.00	1.25	0.95	1.014	0.99	38.91	20.00	6.71	45.61	0.50
20.00	35.00	1.25	0.95	1.069	0.97	40.20	20.00	6.81	47.00	0.50
21.00	35.40	1.25	0.95	1.124	0.94	39.65	21.00	7.20	46.85	0.50
22.00	35.80	1.25	0.95	1.179	0.92	39.16	22.00	7.57	46.73	0.50
23.00	36.20	1.25	0.95	1.234	0.90	38.70	23.00	7.94	46.65	0.50
24.00	36.60	1.25	0.95	1.288	0.88	38.29	24.00	8.30	46.59	0.50
25.00	37.00	1.25	0.95	1.343	0.86	37.91	25.00	8.65	46.56	0.50
26.00	40.40	1.25	0.95	1.398	0.85	40.57	22.40	7.88	48.45	0.50
27.00	43.80	1.25	0.95	1.453	0.83	43.15	19.80	6.95	50.10	0.50
28.00	47.20	1.25	1.00	1.508	0.81	48.05	17.20	6.01	54.06	0.50
29.00	50.60	1.25	1.00	1.562	0.80	50.60	14.60	4.70	55.30	0.50
30.00	54.00	1.25	1.00	1.617	0.79	53.08	12.00	3.23	56.31	0.50
31.00	51.60	1.25	1.00	1.672	0.77	49.88	13.60	4.08	53.96	0.50
32.00	49.20	1.25	1.00	1.727	0.76	46.80	15.20	4.86	51.66	0.50
33.00	46.80	1.25	1.00	1.782	0.75	43.83	16.80	5.54	49.37	0.50

34.00	44.40	1.25	1.00	1.837	0.74	40.95	18.40	6.14	47.09	0.50
35.00	42.00	1.25	1.00	1.891	0.73	38.18	20.00	6.65	44.82	0.50
36.00	42.40	1.25	1.00	1.946	0.72	37.99	20.00	6.63	44.62	0.50
37.00	42.80	1.25	1.00	2.001	0.71	37.82	20.00	6.62	44.44	0.50
38.00	43.20	1.25	1.00	2.056	0.70	37.66	20.00	6.61	44.27	0.50
39.00	43.60	1.25	1.00	2.111	0.69	37.51	20.00	6.59	44.11	0.50
40.00	44.00	1.25	1.00	2.165	0.68	37.38	20.00	6.58	43.96	0.50
41.00	46.00	1.25	1.00	2.220	0.67	38.59	20.00	6.68	45.27	0.50
42.00	48.00	1.25	1.00	2.275	0.66	39.78	20.00	6.77	46.55	0.50
43.00	50.00	1.25	1.00	2.330	0.66	40.95	20.00	6.87	47.81	0.50
44.00	52.00	1.25	1.00	2.385	0.65	42.09	20.00	6.96	49.05	0.50
45.00	54.00	1.25	1.00	2.440	0.64	43.22	20.00	7.05	50.26	0.50
46.00	52.80	1.25	1.00	2.494	0.63	41.79	20.00	6.93	48.72	0.50
47.00	51.60	1.25	1.00	2.549	0.63	40.40	20.00	6.82	47.22	0.50
48.00	50.40	1.25	1.00	2.604	0.62	39.04	20.00	6.72	45.76	0.50
49.00	49.20	1.25	1.00	2.659	0.61	37.72	20.00	6.61	44.33	0.50
50.00	48.00	1.25	1.00	2.714	0.61	36.42	20.00	6.51	42.93	0.50

CRR is based on water table at 100.00 during In-Situ Testing

Factor of Safety, - Earthquake Magnitude= 7.30:

Depth ft	sigC' atm	CRR7.5	x Ksig	=CRRv	x MSF	=CRRm	CSRfs	F.S.=CRRm/CSRfs
1.00	0.04	0.50	1.00	0.50	1.07	0.54	0.69	5.00
2.00	0.07	0.50	1.00	0.50	1.07	0.54	0.69	5.00
3.00	0.11	0.50	1.00	0.50	1.07	0.54	0.69	5.00
4.00	0.14	0.50	1.00	0.50	1.07	0.54	0.69	5.00
5.00	0.18	0.50	1.00	0.50	1.07	0.54	0.69	5.00
6.00	0.21	0.50	1.00	0.50	1.07	0.54	0.69	5.00

7.00	0.25	0.50	1.00	0.50	1.07	0.54	0.68	5.00
8.00	0.28	0.50	1.00	0.50	1.07	0.54	0.68	5.00
9.00	0.31	0.50	1.00	0.50	1.07	0.54	0.68	5.00
10.00	0.35	0.50	1.00	0.50	1.07	0.54	0.68	5.00
11.00	0.38	0.50	1.00	0.50	1.07	0.54	0.68	5.00
12.00	0.41	0.50	1.00	0.50	1.07	0.54	0.68	5.00
13.00	0.45	0.50	1.00	0.50	1.07	0.54	0.67	5.00
14.00	0.48	0.50	1.00	0.50	1.07	0.54	0.67	5.00
15.00	0.52	0.50	1.00	0.50	1.07	0.54	0.67	5.00
16.00	0.55	0.50	1.00	0.50	1.07	0.54	0.67	5.00
17.00	0.59	0.50	1.00	0.50	1.07	0.54	0.67	5.00
18.00	0.62	0.50	1.00	0.50	1.07	0.54	0.67	5.00
19.00	0.66	0.50	1.00	0.50	1.07	0.54	0.66	5.00
20.00	0.69	0.50	1.00	0.50	1.07	0.54	0.66	5.00
21.00	0.73	0.50	1.00	0.50	1.07	0.54	0.66	5.00
22.00	0.77	0.50	1.00	0.50	1.07	0.54	0.66	5.00
23.00	0.80	0.50	1.00	0.50	1.07	0.54	0.66	5.00
24.00	0.84	0.50	1.00	0.50	1.07	0.54	0.66	5.00
25.00	0.87	0.50	1.00	0.50	1.07	0.54	0.65	5.00
26.00	0.91	0.50	1.00	0.50	1.07	0.54	0.65	5.00
27.00	0.94	0.50	1.00	0.50	1.07	0.54	0.65	5.00
28.00	0.98	0.50	1.00	0.50	1.07	0.54	0.65	5.00
29.00	1.02	0.50	1.00	0.50	1.07	0.54	0.65	5.00
30.00	1.05	0.50	1.00	0.50	1.07	0.53	0.65	5.00
31.00	1.09	0.50	0.99	0.50	1.07	0.53	0.64	5.00
32.00	1.12	0.50	0.99	0.49	1.07	0.53	0.64	5.00
33.00	1.16	0.50	0.98	0.49	1.07	0.53	0.63	5.00
34.00	1.19	0.50	0.98	0.49	1.07	0.52	0.62	5.00
35.00	1.23	0.50	0.97	0.49	1.07	0.52	0.62	5.00
36.00	1.27	0.50	0.97	0.48	1.07	0.52	0.61	5.00
37.00	1.30	0.50	0.96	0.48	1.07	0.51	0.61	5.00
38.00	1.34	0.50	0.96	0.48	1.07	0.51	0.60	5.00
39.00	1.37	0.50	0.95	0.48	1.07	0.51	0.60	5.00
40.00	1.41	0.50	0.95	0.47	1.07	0.51	0.59	5.00
41.00	1.44	0.50	0.94	0.47	1.07	0.50	0.58	5.00
42.00	1.48	0.50	0.94	0.47	1.07	0.50	0.58	5.00
43.00	1.51	0.50	0.93	0.47	1.07	0.50	0.57	5.00
44.00	1.55	0.50	0.93	0.46	1.07	0.50	0.57	5.00
45.00	1.59	0.50	0.92	0.46	1.07	0.49	0.56	5.00
46.00	1.62	0.50	0.92	0.46	1.07	0.49	0.56	5.00
47.00	1.66	0.50	0.91	0.46	1.07	0.49	0.55	5.00
48.00	1.69	0.50	0.91	0.45	1.07	0.49	0.54	5.00
49.00	1.73	0.50	0.90	0.45	1.07	0.48	0.54	5.00
50.00	1.76	0.50	0.90	0.45	1.07	0.48	0.53	5.00

* F.S.<1: Liquefaction Potential Zone. (If above water table: F.S.=5)
^ No-liquefiable Soils or above Water Table.
(F.S. is limited to 5, CRR is limited to 2,   CSR is limited to 2)

CPT convert to SPT for Settlement Analysis:
Fines Correction for Settlement Analysis:

Depth ft	Ic	qc/N60	qc1 atm	(N1)60	Fines %	d(N1)60	(N1)60s
1.00	-	-	-	89.63	20.00	0.00	89.63
2.00	-	-	-	89.63	20.00	0.00	89.63
3.00	-	-	-	89.63	20.00	0.00	89.63
4.00	-	-	-	89.63	20.00	0.00	89.63
5.00	-	-	-	89.63	20.00	0.00	89.63
6.00	-	-	-	76.68	16.00	0.00	76.68
7.00	-	-	-	61.40	12.00	0.00	61.40
8.00	-	-	-	50.38	10.00	0.00	50.38
9.00	-	-	-	50.12	10.00	0.00	50.12
10.00	-	-	-	44.04	10.00	0.00	44.04
11.00	-	-	-	41.96	12.00	0.00	41.96
12.00	-	-	-	40.18	14.00	0.00	40.18
13.00	-	-	-	38.58	16.00	0.00	38.58
14.00	-	-	-	37.10	18.00	0.00	37.10
15.00	-	-	-	39.47	20.00	0.00	39.47
16.00	-	-	-	41.11	20.00	0.00	41.11
17.00	-	-	-	42.67	20.00	0.00	42.67
18.00	-	-	-	44.17	20.00	0.00	44.17
19.00	-	-	-	45.61	20.00	0.00	45.61
20.00	-	-	-	47.00	20.00	0.00	47.00
21.00	-	-	-	46.85	21.00	0.00	46.85
22.00	-	-	-	46.73	22.00	0.00	46.73
23.00	-	-	-	46.65	23.00	0.00	46.65
24.00	-	-	-	46.59	24.00	0.00	46.59
25.00	-	-	-	46.56	25.00	0.00	46.56
26.00	-	-	-	48.45	22.40	0.00	48.45
27.00	-	-	-	50.10	19.80	0.00	50.10
28.00	-	-	-	54.06	17.20	0.00	54.06
29.00	-	-	-	55.30	14.60	0.00	55.30
30.00	-	-	-	56.31	12.00	0.00	56.31
31.00	-	-	-	53.96	13.60	0.00	53.96
32.00	-	-	-	51.66	15.20	0.00	51.66
33.00	-	-	-	49.37	16.80	0.00	49.37
34.00	-	-	-	47.09	18.40	0.00	47.09
35.00	-	-	-	44.82	20.00	0.00	44.82
36.00	-	-	-	44.62	20.00	0.00	44.62
37.00	-	-	-	44.44	20.00	0.00	44.44
38.00	-	-	-	44.27	20.00	0.00	44.27
39.00	-	-	-	44.11	20.00	0.00	44.11
40.00	-	-	-	43.96	20.00	0.00	43.96
41.00	-	-	-	45.27	20.00	0.00	45.27
42.00	-	-	-	46.55	20.00	0.00	46.55
43.00	-	-	-	47.81	20.00	0.00	47.81
44.00	-	-	-	49.05	20.00	0.00	49.05
45.00	-	-	-	50.26	20.00	0.00	50.26

46.00	-	-	-	48.72	20.00	0.00	48.72
47.00	-	-	-	47.22	20.00	0.00	47.22
48.00	-	-	-	45.76	20.00	0.00	45.76
49.00	-	-	-	44.33	20.00	0.00	44.33
50.00	-	-	-	42.93	20.00	0.00	42.93

(N1)60s has been fines corrected in liquefaction analysis, therefore d(N1)60=0.
Fines=NoLiq means the soils are not liquefiable.

Settlement of Saturated Sands:
Settlement Analysis Method: Ishihara / Yoshimine

Depth	CSRsf	/ MSF*	=CSRm	F.S.	Fines	(N1)60s	Dr	ec	dsz	dsp	S
ft					%		%	%	in.	in.	in.

No Settlement of Saturated Sands

Settlement of Saturated Sands=0.000 in.
qc1 and (N1)60 is after fines correction in liquefaction analysis
dsz is per each segment, dz=0.05 ft
dsp is per each print interval, dp=1.00 ft
S is cumulated settlement at this depth

Settlement of Unsaturated Sands:

Depth	sigma'	sigC'	(N1)60s	CSRsf	Gmax	g*Ge/Gm	g_eff	ec7.5	Cec	ec	dsz	dsp	S
ft	atm	atm			atm			%		%	in.	in.	in.
49.95	2.71	1.76	43.00	0.53	2077.18	7.0E-4	0.3220	0.1018	1.01	0.1027	1.23E-3	0.001	0.001
49.00	2.66	1.73	44.33	0.54	2078.06	6.9E-4	0.3122	0.0987	1.01	0.0996	1.19E-3	0.023	0.024
48.00	2.60	1.69	45.76	0.54	2078.38	6.8E-4	0.3020	0.0955	1.01	0.0963	1.16E-3	0.023	0.048
47.00	2.55	1.66	47.22	0.55	2078.07	6.8E-4	0.2921	0.0924	1.01	0.0932	1.12E-3	0.023	0.070
46.00	2.49	1.62	48.72	0.56	2077.15	6.7E-4	0.2823	0.0893	1.01	0.0900	1.08E-3	0.022	0.092
45.00	2.44	1.59	50.26	0.56	2075.59	6.6E-4	0.2727	0.0862	1.01	0.0870	1.04E-3	0.021	0.114

	44.00	2.38	1.55	49.05	0.57	2035.49	6.6E-4	0.2784	0.0881	1.01
0.0888	1.07E-3	0.021	0.135							
	43.00	2.33	1.51	47.81	0.57	1994.93	6.7E-4	0.2843	0.0899	1.01
0.0907	1.09E-3	0.022	0.156							
	42.00	2.28	1.48	46.55	0.58	1953.87	6.7E-4	0.8230	0.2603	1.01
0.2625	3.15E-3	0.046	0.202							
	41.00	2.22	1.44	45.27	0.58	1912.29	6.8E-4	0.8563	0.2708	1.01
0.2731	3.28E-3	0.064	0.267							
	40.00	2.17	1.41	43.96	0.59	1870.17	6.8E-4	0.8916	0.2820	1.01
0.2844	3.41E-3	0.067	0.334							
	39.00	2.11	1.37	44.11	0.60	1848.43	6.8E-4	0.8689	0.2748	1.01
0.2771	3.33E-3	0.067	0.401							
	38.00	2.06	1.34	44.27	0.60	1826.46	6.8E-4	0.8444	0.2670	1.01
0.2693	3.23E-3	0.066	0.467							
	37.00	2.00	1.30	44.44	0.61	1804.27	6.7E-4	0.8184	0.2588	1.01
0.2610	3.13E-3	0.064	0.530							
	36.00	1.95	1.27	44.62	0.61	1781.84	6.7E-4	0.7910	0.2501	1.01
0.2523	3.03E-3	0.062	0.592							
	35.00	1.89	1.23	44.82	0.62	1759.16	6.6E-4	0.7623	0.2411	1.01
0.2431	2.92E-3	0.059	0.651							
	34.00	1.84	1.19	47.09	0.62	1762.24	6.5E-4	0.6757	0.2137	1.01
0.2155	2.59E-3	0.055	0.706							
	33.00	1.78	1.16	49.37	0.63	1763.27	6.4E-4	0.6026	0.1906	1.01
0.1922	2.31E-3	0.049	0.755							
	32.00	1.73	1.12	51.66	0.64	1762.31	6.2E-4	0.5401	0.1708	1.01
0.1722	2.07E-3	0.044	0.798							
	31.00	1.67	1.09	53.96	0.64	1759.51	6.1E-4	0.4861	0.1537	1.01
0.1550	1.86E-3	0.039	0.837							
	30.00	1.62	1.05	56.31	0.65	1755.09	6.0E-4	0.4392	0.1389	1.01
0.1401	1.68E-3	0.035	0.873							
	29.00	1.56	1.02	55.30	0.65	1714.77	5.9E-4	0.4222	0.1335	1.01
0.1347	1.62E-3	0.033	0.905							
	28.00	1.51	0.98	54.06	0.65	1671.70	5.9E-4	0.4079	0.1290	1.01
0.1301	1.56E-3	0.032	0.937							
	27.00	1.45	0.94	50.10	0.65	1600.04	5.9E-4	0.4251	0.1344	1.01
0.1356	1.63E-3	0.033	0.970							
	26.00	1.40	0.91	48.45	0.65	1552.15	5.9E-4	0.4146	0.1311	1.01
0.1322	1.59E-3	0.032	1.002							
	25.00	1.34	0.87	46.56	0.65	1501.37	5.9E-4	0.4068	0.1287	1.01
0.1297	1.56E-3	0.031	1.033							
	24.00	1.29	0.84	46.59	0.66	1470.73	5.8E-4	0.3753	0.1187	1.01
0.1197	1.44E-3	0.030	1.063							
	23.00	1.23	0.80	46.65	0.66	1439.68	5.6E-4	0.3454	0.1092	1.01
0.1102	1.32E-3	0.028	1.091							
	22.00	1.18	0.77	46.73	0.66	1408.19	5.5E-4	0.3173	0.1003	1.01
0.1012	1.21E-3	0.025	1.116							
	21.00	1.12	0.73	46.85	0.66	1376.22	5.4E-4	1.0000	0.3162	1.01
0.3189	3.83E-3	0.053	1.169							
	20.00	1.07	0.69	47.00	0.66	1343.72	5.3E-4	1.0000	0.3162	1.01
0.3189	3.83E-3	0.077	1.245							

19.00	1.01	0.66	45.61	0.66	1295.88	5.2E-4	1.0000	0.3162	1.01	0.3189	3.83E-3	0.077	1.322
18.00	0.96	0.62	44.17	0.67	1247.24	5.1E-4	1.0000	0.3162	1.01	0.3189	3.83E-3	0.077	1.399
17.00	0.91	0.59	42.67	0.67	1197.73	5.1E-4	1.0000	0.3162	1.01	0.3189	3.83E-3	0.077	1.475
16.00	0.85	0.55	41.11	0.67	1147.27	5.0E-4	1.0000	0.3162	1.01	0.3189	3.83E-3	0.077	1.552
15.00	0.80	0.52	39.47	0.67	1095.76	4.9E-4	0.8965	0.2936	1.01	0.2961	3.55E-3	0.073	1.624
14.00	0.75	0.48	37.10	0.67	1036.81	4.8E-4	0.8316	0.3194	1.01	0.3221	3.87E-3	0.085	1.709
13.00	0.69	0.45	38.58	0.67	1012.12	4.6E-4	0.6157	0.2146	1.01	0.2164	2.60E-3	0.063	1.773
12.00	0.64	0.41	40.18	0.68	985.55	4.4E-4	0.4556	0.1441	1.01	0.1453	1.74E-3	0.042	1.815
11.00	0.59	0.38	41.96	0.68	957.15	4.1E-4	0.3364	0.1064	1.01	0.1073	1.29E-3	0.030	1.845
10.00	0.53	0.35	44.04	0.68	927.23	3.9E-4	1.0000	0.3162	1.01	0.3189	3.83E-3	0.031	1.875
9.00	0.48	0.31	50.12	0.68	918.78	3.5E-4	1.0000	0.3162	1.01	0.3189	3.83E-3	0.077	1.952
8.00	0.43	0.28	50.38	0.68	869.59	3.4E-4	1.0000	0.3162	1.01	0.3189	3.83E-3	0.077	2.028
7.00	0.38	0.25	61.40	0.68	872.26	3.0E-4	0.2973	0.0940	1.01	0.0948	1.14E-3	0.056	2.084
6.00	0.33	0.21	76.68	0.69	872.32	2.6E-4	0.0851	0.0269	1.01	0.0271	3.26E-4	0.011	2.096
5.00	0.27	0.18	89.63	0.69	839.84	2.2E-4	0.0478	0.0151	1.01	0.0153	1.83E-4	0.005	2.101
4.00	0.22	0.14	89.63	0.69	751.18	2.0E-4	0.0781	0.0247	1.01	0.0249	2.99E-4	0.004	2.105
3.00	0.16	0.11	89.63	0.69	650.54	1.7E-4	0.0389	0.0123	1.01	0.0124	1.49E-4	0.004	2.108
2.00	0.11	0.07	89.63	0.69	531.16	1.4E-4	0.0268	0.0085	1.01	0.0086	1.03E-4	0.002	2.111
1.00	0.05	0.04	89.63	0.69	375.59	1.0E-4	0.0201	0.0063	1.01	0.0064	7.68E-5	0.002	2.113

Settlement of Unsaturated Sands=2.113 in.
dsz is per each segment, dz=0.05 ft
dsp is per each print interval, dp=1.00 ft
S is cumulated settlement at this depth

Total Settlement of Saturated and Unsaturated Sands=2.113 in.
Differential Settlement=1.056 to 1.394 in.

Units: Unit: qc, fs, Stress or Pressure = atm (1.0581tsf); Unit Weight =

pcf; Depth = ft; Settlement = in.

---

1 atm (atmosphere) = 1.0581 tsf(1 tsf = 1 ton/ft2 = 2 kip/ft2)
1 atm (atmosphere) = 101.325 kPa(1 kPa = 1 kN/m2 = 0.001 Mpa)

SPT	Field data from Standard Penetration Test (SPT)
BPT	Field data from Becker Penetration Test (BPT)
qc	Field data from Cone Penetration Test (CPT) [atm (tsf)]
fs	Friction from CPT testing [atm (tsf)]
Rf	Ratio of fs/qc (%)
gamma	Total unit weight of soil
gamma'	Effective unit weight of soil
Fines	Fines content [%]
D50	Mean grain size
Dr	Relative Density
sigma	Total vertical stress [atm]
sigma'	Effective vertical stress [atm]
sigC'	Effective confining pressure [atm]
rd	Acceleration reduction coefficient by Seed
a_max.	Peak Ground Acceleration (PGA) in ground surface
mZ	Linear acceleration reduction coefficient X depth
a_min.	Minimum acceleration under linear reduction, mZ
CRRv	CRR after overburden stress correction, CRRv=CRR7.5 * Ksig
CRR7.5	Cyclic resistance ratio (M=7.5)
Ksig	Overburden stress correction factor for CRR7.5
CRRm	After magnitude scaling correction CRRm=CRRv * MSF
MSF	Magnitude scaling factor from M=7.5 to user input M
CSR	Cyclic stress ratio induced by earthquake
CSRfs	CSRfs=CSR*fs1 (Default fs1=1)
fs1	First CSR curve in graphic defined in #9 of Advanced page
fs2	2nd CSR curve in graphic defined in #9 of Advanced page
F.S.	Calculated factor of safety against liquefaction F.S.=CRRm/CSRsf
Cebs	Energy Ratio, Borehole Dia., and Sampling Method Corrections
Cr	Rod Length Corrections
Cn	Overburden Pressure Correction
(N1)60	SPT after corrections, (N1)60=SPT * Cr * Cn * Cebs
d(N1)60	Fines correction of SPT
(N1)60f	(N1)60 after fines corrections, (N1)60f=(N1)60 + d(N1)60
Cq	Overburden stress correction factor
qc1	CPT after Overburden stress correction
dqc1	Fines correction of CPT
qc1f	CPT after Fines and Overburden correction, qc1f=qc1 + dqc1
qc1n	CPT after normalization in Robertson's method
Kc	Fine correction factor in Robertson's Method
qc1f	CPT after Fines correction in Robertson's Method
Ic	Soil type index in Suzuki's and Robertson's Methods
(N1)60s	(N1)60 after settlement fines corrections
CSRm	After magnitude scaling correction for Settlement

calculation CSRm=CSRsf / MSF*

CSRfs — Cyclic stress ratio induced by earthquake with user inputed fs

MSF* — Scaling factor from CSR, MSF*=1, based on Item 2 of Page C.

ec	Volumetric strain for saturated sands
dz	Calculation segment, dz=0.050 ft
dsz	Settlement in each segment, dz
dp	User defined print interval
dsp	Settlement in each print interval, dp
Gmax	Shear Modulus at low strain
g_eff	gamma_eff, Effective shear Strain
g*Ge/Gm	gamma_eff * G_eff/G_max, Strain-modulus ratio
ec7.5	Volumetric Strain for magnitude=7.5
Cec	Magnitude correction factor for any magnitude
ec	Volumetric strain for unsaturated sands, ec=Cec * ec7.5
NoLiq	No-Liquefy Soils

References:

1. NCEER Workshop on Evaluation of Liquefaction Resistance of Soils. Youd, T.L., and Idriss, I.M., eds., Technical Report NCEER 97-0022.

SP117. Southern California Earthquake Center. Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California. University of Southern California. March 1999.

2. RECENT ADVANCES IN SOIL LIQUEFACTION ENGINEERING AND SEISMIC SITE RESPONSE EVALUATION, Paper No. SPL-2, PROCEEDINGS: Fourth International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, San Diego, CA, March 2001.

3. RECENT ADVANCES IN SOIL LIQUEFACTION ENGINEERING: A UNIFIED AND CONSISTENT FRAMEWORK, Earthquake Engineering Research Center, Report No. EERC 2003-06 by R.B Seed and etc. April 2003.

Note: Print Interval you selected does not show complete results. To get complete results, you should select 'Segment' in Print Interval (Item 12, Page C).

APPENDIX E

GENERAL EARTHWORK GRADING GUIDELINES

Proposed Single-Family Residential Development
Highland Avenue and Medical Center Drive
San Bernardino, San Bernardino County, California
Project No. 2849-CR

GEOTEK

GENERAL GRADING GUIDELINES

Guidelines presented herein are intended to address general construction procedures for earthwork construction. Specific situations and conditions often arise which cannot reasonably be discussed in general guidelines, when anticipated these are discussed in the text of the report. Often unanticipated conditions are encountered which may necessitate modification or changes to these guidelines. It is GeoTek's hope that these will assist the contractor to complete the project more efficiently by providing a reasonable understanding of the procedures that would be expected during earthwork and the testing and observation used to evaluate those procedures.

General

Grading should be performed to at least the minimum requirements of governing agencies, Chapters 18 and 33 of the Uniform Building Code, CBC (2019) and the guidelines presented below.

Preconstruction Meeting

A preconstruction meeting should be held prior to site earthwork. Any questions the contractor has regarding GeoTek's recommendations, general site conditions, apparent discrepancies between reported and actual conditions and/or differences in procedures the contractor intends to use should be brought up at that meeting. The contractor (including the main onsite representative) should review GeoTek's report and these guidelines in advance of the meeting. Any comments the contractor may have regarding these guidelines should be brought up at that meeting.

Grading Observation and Testing

1. Observation of the fill placement should be provided by GeoTek's representative during grading. Verbal communication during the course of each day will be used to inform the contractor of test results. The contractor should receive a copy of the "Daily Field Report" indicating results of field density tests that day. If GeoTek's representative does not provide the contractor with these reports, GeoTek's office should be notified.
2. Testing and observation procedures are, by their nature, specific to the work or area observed and location of the tests taken, variability may occur in other locations. The contractor is responsible for the uniformity of the grading operations; GeoTek's observations and test results are intended to evaluate the contractor's overall level of efforts during grading. The contractor's personnel are the only individuals participating in all aspect of site work. Compaction testing and observation should not be considered as relieving the contractor's responsibility to properly compact the fill.
3. Cleanouts, processed ground to receive fill, key excavations, and subdrains should be observed by GeoTek's representative prior to placing any fill. It will be the contractor's responsibility to notify GeoTek's representative or office when such areas are ready for observation.

4. Density tests may be made on the surface material to receive fill, as considered warranted by this firm.
5. In general, density tests would be made at maximum intervals of two feet of fill height or every 1,000 cubic yards of fill placed. Criteria will vary depending on soil conditions and size of the fill. More frequent testing may be performed. In any case, an adequate number of field density tests should be made to evaluate the required compaction and moisture content is generally being obtained.
6. Laboratory testing to support field test procedures will be performed, as considered warranted, based on conditions encountered (e.g., change of material sources, types, etc.) Every effort will be made to process samples in the laboratory as quickly as possible and in progress construction projects are GeoTek's first priority. However, laboratory workloads may cause in delays and some soils may require a **minimum of 48 to 72 hours to complete test procedures**. Whenever possible, GeoTek's representative(s) should be informed in advance of operational changes that might result in different source areas for materials.
7. Procedures for testing of fill slopes are as follows:
   a) Density tests should be taken periodically during grading on the flat surface of the fill, three to five feet horizontally from the face of the slope.
   b) If a method other than over building and cutting back to the compacted core is to be employed, slope compaction testing during construction should include testing the outer six inches to three feet in the slope face to determine if the required compaction is being achieved.
8. Finish grade testing of slopes and pad surfaces should be performed after construction is complete.

Site Clearing

1. All vegetation, and other deleterious materials, should be removed from the site. If material is not immediately removed from the site it should be stockpiled in a designated area(s) well outside of all current work areas and delineated with flagging or other means. Site clearing should be performed in advance of any grading in a specific area.
2. Efforts should be made by the contractor to remove all organic or other deleterious material from the fill, as even the most diligent efforts may result in the incorporation of some materials. This is especially important when grading is occurring near the natural grade. All equipment operators should be aware of these efforts. Laborers may be required as root pickers.
3. Nonorganic debris or concrete may be placed in deeper fill areas provided the procedures used are observed and found acceptable by GeoTek's representative.

Treatment of Existing Ground

1. Following site clearing, all surficial deposits of alluvium and colluvium as well as weathered or creep effected bedrock, should be removed unless otherwise specifically indicated in the text of this report.
2. In some cases, removal may be recommended to a specified depth (e.g., flat sites where partial alluvial removals may be sufficient). The contractor should not exceed these depths unless directed otherwise by GeoTek's representative.
3. Groundwater existing in alluvial areas may make excavation difficult. Deeper removals than indicated in the text of the report may be necessary due to saturation during winter months.
4. Subsequent to removals, the natural ground should be processed to a depth of six inches, moistened to near optimum moisture conditions and compacted to fill standards.
5. Exploratory backhoe or dozer trenches still remaining after site removal should be excavated and filled with compacted fill if they can be located.

Fill Placement

1. Unless otherwise indicated, all site soil and bedrock may be reused for compacted fill; however, some special processing or handling may be required (see text of report).
2. Material used in the compacting process should be evenly spread, moisture conditioned, processed, and compacted in thin lifts six (6) to eight (8) inches in compacted thickness to obtain a uniformly dense layer. The fill should be placed and compacted on a nearly horizontal plane, unless otherwise found acceptable by GeoTek's representative.
3. If the moisture content or relative density varies from that recommended by this firm, the contractor should rework the fill until it is in accordance with the following:
    a) Moisture content of the fill should be at or above optimum moisture. Moisture should be evenly distributed without wet and dry pockets. Pre-watering of cut or removal areas should be considered in addition to watering during fill placement, particularly in clay or dry surficial soils. The ability of the contractor to obtain the proper moisture content will control production rates.
    b) Each six-inch layer should be compacted to at least 90 percent of the maximum dry density in compliance with the testing method specified by the controlling governmental agency. In most cases, the testing method is ASTM Test Designation D 1557.
4. Rock fragments less than eight inches in diameter may be utilized in the fill, provided:
    a) They are not placed in concentrated pockets;
    b) There is a sufficient percentage of fine-grained material to surround the rocks;
    c) The distribution of the rocks is observed by, and acceptable to, GeoTek's representative.

5. Rocks exceeding eight (8) inches in diameter should be taken off site, broken into smaller fragments, or placed in accordance with recommendations of this firm in areas designated suitable for rock disposal. On projects where significant large quantities of oversized materials are anticipated, alternate guidelines for placement may be included. If significant oversize materials are encountered during construction, these guidelines should be requested.
6. In clay soil, dry or large chunks or blocks are common. If in excess of eight (8) inches minimum dimension, then they are considered as oversized. Sheepsfoot compactors or other suitable methods should be used to break up blocks. When dry, they should be moisture conditioned to provide a uniform condition with the surrounding fill.

Slope Construction

1. The contractor should obtain a minimum relative compaction of 90 percent out to the finished slope face of fill slopes. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment.
2. Slopes trimmed to the compacted core should be overbuilt by at least three (3) feet with compaction efforts out to the edge of the false slope. Failure to properly compact the outer edge results in trimming not exposing the compacted core and additional compaction after trimming may be necessary.
3. If fill slopes are built "at grade" using direct compaction methods, then the slope construction should be performed so that a constant gradient is maintained throughout construction. Soil should not be "spilled" over the slope face nor should slopes be "pushed out" to obtain grades. Compaction equipment should compact each lift along the immediate top of slope. Slopes should be back rolled or otherwise compacted at approximately every 4 feet vertically as the slope is built.
4. Corners and bends in slopes should have special attention during construction as these are the most difficult areas to obtain proper compaction.
5. Cut slopes should be cut to the finished surface. Excessive undercutting and smoothing of the face with fill may necessitate stabilization.

UTILITY TRENCH CONSTRUCTION AND BACKFILL

Utility trench excavation and backfill is the contractor’s responsibility. The geotechnical consultant typically provides periodic observation and testing of these operations. While efforts are made to make sufficient observations and tests to verify that the contractors’ methods and procedures are adequate to achieve proper compaction, it is typically impractical to observe all backfill procedures. As such, it is critical that the contractor use consistent backfill procedures.

Compaction methods vary for trench compaction and experience indicates many methods can be successful. However, procedures that "worked" on previous projects may or may not prove effective on a given site. The contractor(s) should outline the procedures proposed, so that we may discuss them **prior** to construction. We will offer comments based on GeoTek's knowledge of site conditions and experience.

1. Utility trench backfill in slopes, structural areas, in streets and beneath flat work or hardscape should be brought to at least optimum moisture and compacted to at least 90 percent of the laboratory standard. Soil should be moisture conditioned prior to placing in the trench.
2. Flooding and jetting are not typically recommended or acceptable for native soils. Flooding or jetting may be used with select sand having a Sand Equivalent (SE) of 30 or higher. This is typically limited to the following uses:
   a) shallow (12 + inches) under slab interior trenches and,
   b) as bedding in pipe zone.

   The water should be allowed to dissipate prior to pouring slabs or completing trench compaction.
3. Care should be taken not to place soils at high moisture content within the upper three feet of the trench backfill in street areas, as overly wet soils may impact subgrade preparation. Moisture may be reduced to 2% below optimum moisture in areas to be paved within the upper three feet below sub grade.
4. Sand backfill should not be allowed in exterior trenches adjacent to and within an area extending below a 1:1 projection from the outside bottom edge of a footing unless it is similar to the surrounding soil.
5. Trench compaction testing is generally at the discretion of the geotechnical consultant. Testing frequency will be based on trench depth and the contractors' procedures. A probing rod would be used to assess the consistency of compaction between tested areas and untested areas. If zones are found that are considered less compact than other areas, this would be brought to the contractor's attention.

JOB SAFETY

General

Personnel safety is a primary concern on all job sites. The following summaries are safety considerations for use by all GeoTek employees on multi-employer construction sites. On ground personnel are at highest risk of injury and possible fatality on grading construction projects. The company recognizes that construction activities will vary on each site and that job site safety is the contractor's responsibility. However, it is, imperative that all personnel be safety conscious to avoid accidents and potential injury.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of GeoTek's field personnel on grading and construction projects.

1. Safety Meetings: GeoTek's field personnel are directed to attend the contractor's regularly scheduled safety meetings.
2. Safety Vests: Safety vests are provided for and are to be worn by GeoTek's personnel while on the job site.
3. Safety Flags: Safety flags are provided to GeoTek's field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

In the event that the contractor's representative observes any of GeoTek's personnel not following the above, we request that it be brought to the attention of GeoTek's office.

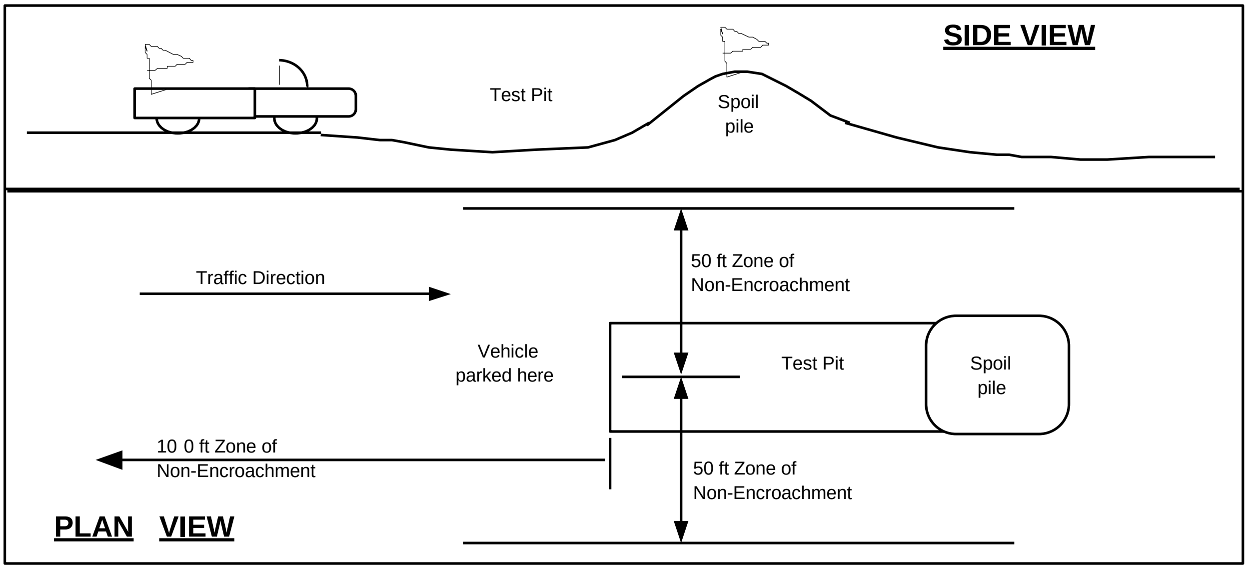
Test Pits Location, Orientation and Clearance

The technician is responsible for selecting test pit locations. The primary concern is the technician's safety. However, it is necessary to take sufficient tests at various locations to obtain a representative sampling of the fill. As such, efforts will be made to coordinate locations with the grading contractors authorized representatives (e.g., dump man, operator, supervisor, grade checker, etc.), and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractors authorized representative should direct excavation of the pit and safety during the test period. Again, safety is the paramount concern.

Test pits should be excavated so that the spoil pile is placed away from oncoming traffic. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates that the fill be maintained in a drivable condition. Alternatively, the contractor may opt to park a piece of equipment in front of test pits, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits (see diagram below). No grading equipment should enter this zone during the test procedure. The zone should extend outward to the sides approximately 50 feet from the center of the test pit and 100 feet in the direction of traffic flow. This zone is established both for safety and to avoid excessive ground vibration, which typically decreases test results.

TEST PIT SAFETY PLAN



Slope Tests

When taking slope tests, the technician should park their vehicle directly above or below the test location on the slope. The contractor's representative should effectively keep all equipment at a safe operation distance (e.g., 50 feet) away from the slope during testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location.

Trench Safety

It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed. Trenches for all utilities should be excavated in accordance with CAL-OSHA and any other applicable safety standards. Safe conditions will be required to enable compaction testing of the trench backfill.

All utility trench excavations in excess of 5 feet deep, which a person enters, are to be shored or laid back. Trench access should be provided in accordance with OSHA standards. GeoTek personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

GeoTek personnel are directed not to enter any excavation which;

1. is 5 feet or deeper unless shored or laid back,
2. exit points or ladders are not provided,
3. displays any evidence of instability, has any loose rock or other debris which could fall into the trench, or

4. displays any other evidence of any unsafe conditions regardless of depth.

If the contractor fails to provide safe access to trenches for compaction testing, GeoTek company policy requires that the soil technician withdraws and notifies their supervisor. The contractor's representative will then be contacted in an effort to affect a solution. All backfill not tested due to safety concerns or other reasons is subject to reprocessing and/or removal.

Procedures

In the event that the technician's safety is jeopardized or compromised as a result of the contractor's failure to comply with any of the above, the technician is directed to inform both the developer's and contractor's representatives. If the condition is not rectified, the technician is required, by company policy, to immediately withdraw and notify their supervisor. The contractor's representative will then be contacted in an effort to affect a solution. No further testing will be performed until the situation is rectified. Any fill placed in the interim can be considered unacceptable and subject to reprocessing, recompaction or removal.

In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor bring this to technicians' attention and notify GeoTek project manager or office. Effective communication and coordination between the contractors' representative and the field technician(s) is strongly encouraged in order to implement the above safety program and safety in general.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

Educational Material

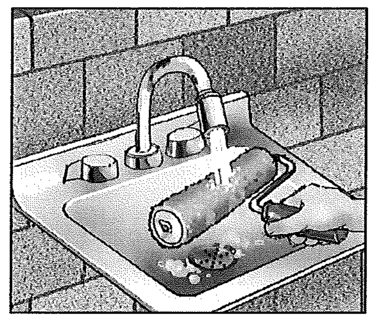
STORMWATER
Pollution Prevention

PAINTING

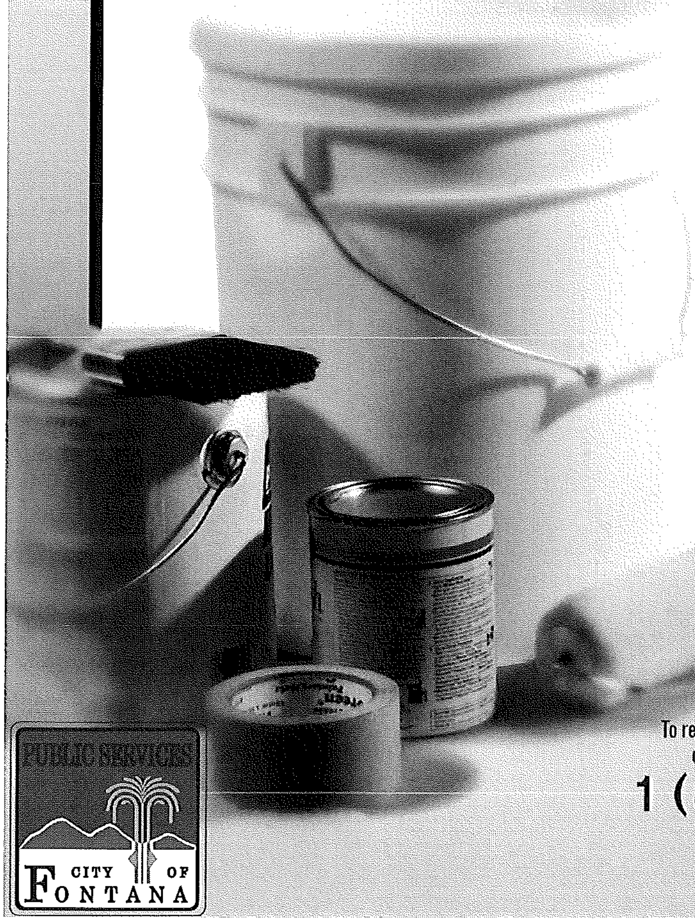
Paints, solvents, adhesives and other toxic chemicals used in painting often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect our health.

Water-Based Paints
Use water-based paints whenever possible. They are less toxic than oil-based paints and easier to clean up. Look for products labeled "latex" or "cleans with water."

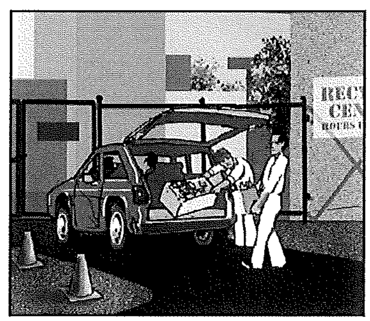
Paint Removal
Sweep up paint stripping residue, chips and dust instead of hosing into the street and dispose of them safely at a household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.



Painting Cleanup
Never clean brushes or rinse paint containers in the street, gutter or near a storm drain. Clean water-based paints in the sink. Clean oil-based paints with thinner, which can be reused by putting it in a jar to settle out the paint particles and then pouring off the clear liquid for future use. Wrap dried paint residue in newspaper and dispose of it in the trash.



Exterior Paint Removal
When stripping or cleaning building exteriors with high-pressure water, block nearby storm drains and divert washwater onto a designated dirt area. Ask your local wastewater treatment authority if you can collect building cleaning water and discharge it to the sewer.



Recycling Paint
Recycle leftover paint at a household hazardous waste collection facility, save it for touch ups or give it to someone who can use it, like a theatre group, school, city or community organization.

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

PUBLIC SERVICES

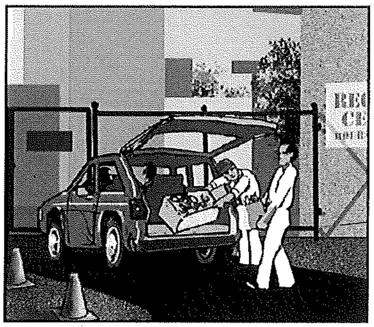
CITY OF FONTANA

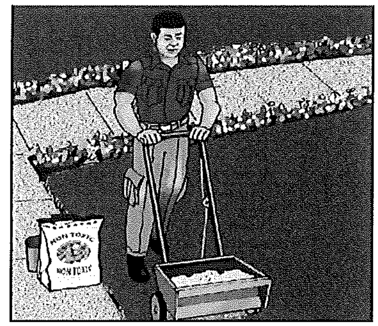
San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

HOME & GARDEN

Yard waste and household toxics like paints and pesticides often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.

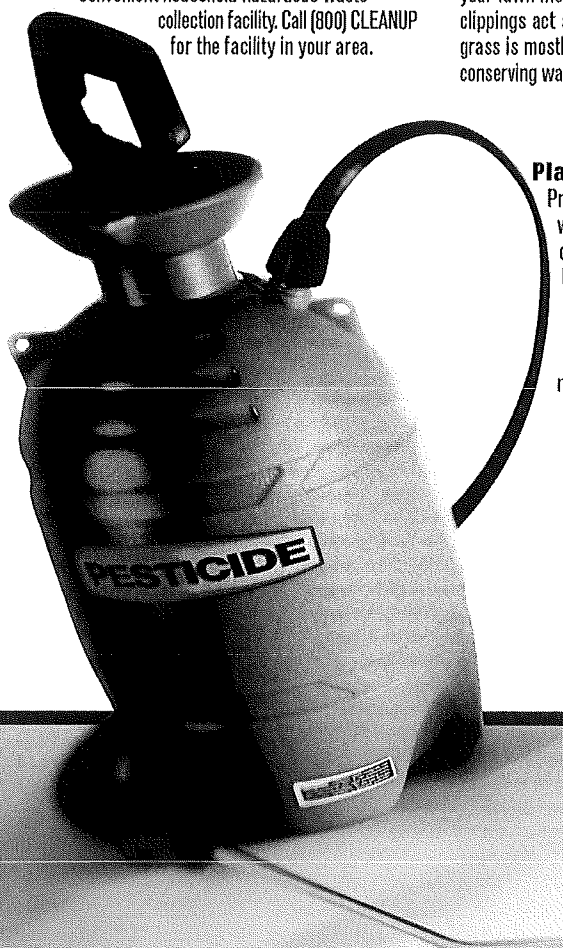




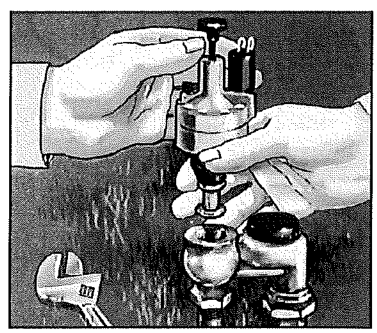
Recycle Household Hazardous Waste
Household products like paint, pesticides, solvents and cleaners are too dangerous to dump and too toxic to trash. Take them to be recycled at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

Disposing of Yard Waste
Recycle leaves, grass clippings and other yard waste, instead of blowing, sweeping or hosing into the street. Try grasscycling, leaving grass clippings on your lawn instead of using a grass catcher. The clippings act as a natural fertilizer, and because grass is mostly water, it also irrigates your lawn, conserving water.

Use Fertilizers & Pesticides Safely
Fertilizers and pesticides are often carried into the storm drain system by sprinkler runoff. Try using organic or non-toxic alternatives. If you use chemical fertilizers or pesticides, avoid applying near curbs and driveways and never apply before a rain.



Planting in the Yard
Produce less yard waste and save water by planting low maintenance, drought-tolerant trees and shrubs. Using drip irrigation, soaker hoses or micro-spray systems for flower beds and vegetation can also help reduce your water bill and prevent runoff.



Use Water Wisely
Cut your water costs and prevent runoff by controlling the amount of water and direction of sprinklers. The average lawn needs about an inch of water a week, including rainfall, or 10 to 20 minutes of watering. A half-inch per week is enough for fall and spring. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff.

PUBLIC SERVICES
CITY OF FONTANA

To report illegal dumping or for more information on stormwater pollution prevention, call:

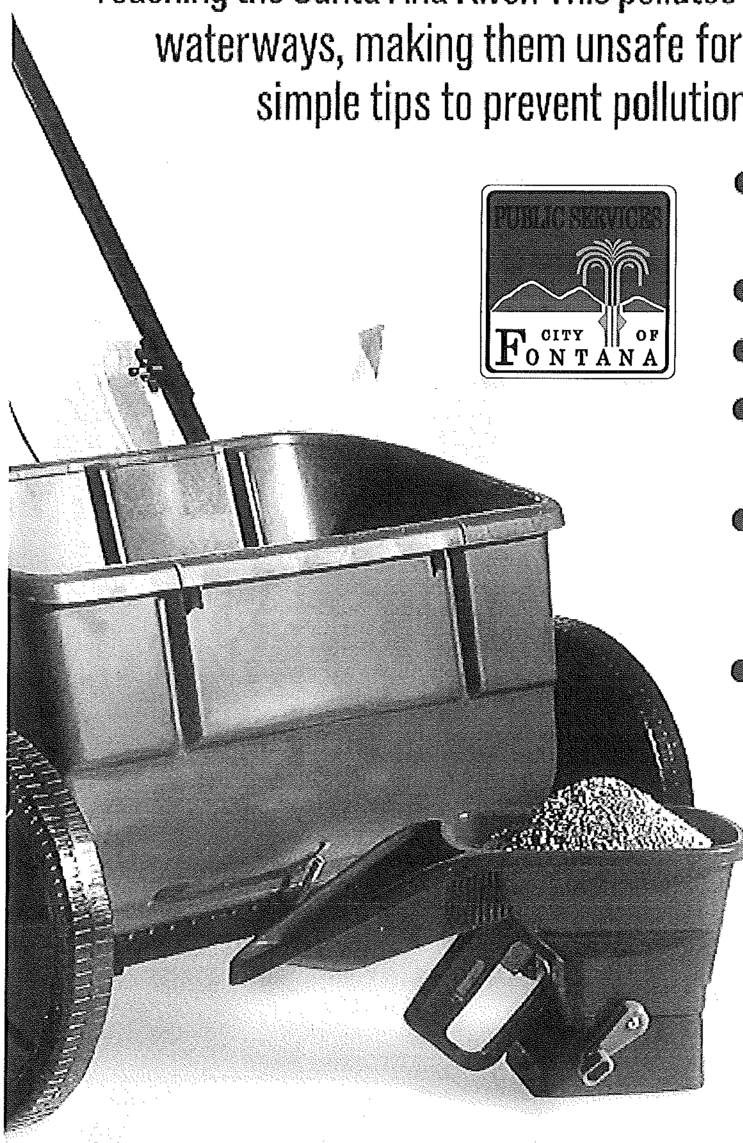
1 (800) CLEANUP

www.1800cleanup.org

San Bernardino County STORMWATER PROGRAM

Fertilizer Tips to Prevent Pollution

Water that runs off your lawn and garden can carry excess fertilizer into the San Bernardino County storm drain system, and it does not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health:



PUBLIC SERVICES
CITY OF FONTANA

- Read the product label and follow the directions carefully, using only as directed.
- Avoid applying near driveways or gutters.
- Never apply fertilizer before a rain.
- Store fertilizers and chemicals in a covered area and in sealed, waterproof containers.
- Take unwanted lawn or garden chemicals to a household hazardous waste collection facility. Call (800) 253-2687.
- Use non-toxic products for your garden and lawn whenever possible.

San Bernardino County STORMWATER PROGRAM

To report illegal dumping or for more information on Stormwater pollution prevention, call:

1 (800) CLEANUP

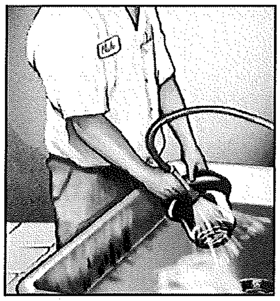
www.1800cleanup.org

STORMWATER

Pollution Prevention

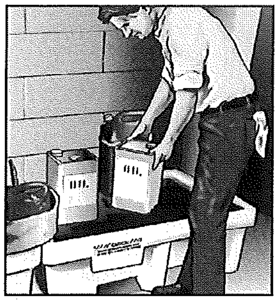
AUTO MAINTENANCE

Oil, grease, anti-freeze and other toxic automotive fluids often make their way into the San Bernardino County storm drain system, and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



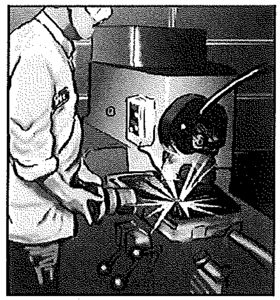
Cleaning Auto Parts

Scrape parts with a wire brush or use a bake oven rather than liquid cleaners. Arrange drip pans, drying racks and drain boards so that fluids are directed back into the parts washer or the fluid holding tank. Do not wash parts or equipment in a shop sink, parking lot, driveway or street.



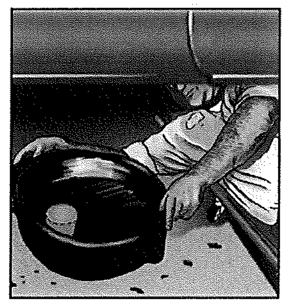
Storing Hazardous Waste

Keep your liquid waste segregated. Many fluids can be recycled via hazardous waste disposal companies if they are not mixed. Store all materials under cover with spill containment or inside to prevent contamination of rainwater runoff.



Metal Grinding and Polishing

Keep a bin under your lathe or grinder to capture metal filings. Send uncontaminated filings to a scrap metal recycler for reclamation. Store metal filings in a covered container or indoors.

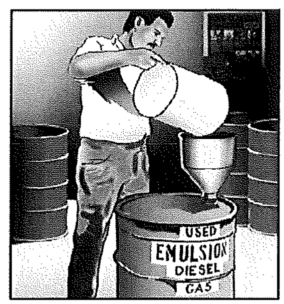


Preventing Leaks and Spills

Place drip pans underneath to capture fluids. Use absorbent cleaning agents instead of water to clean work areas.

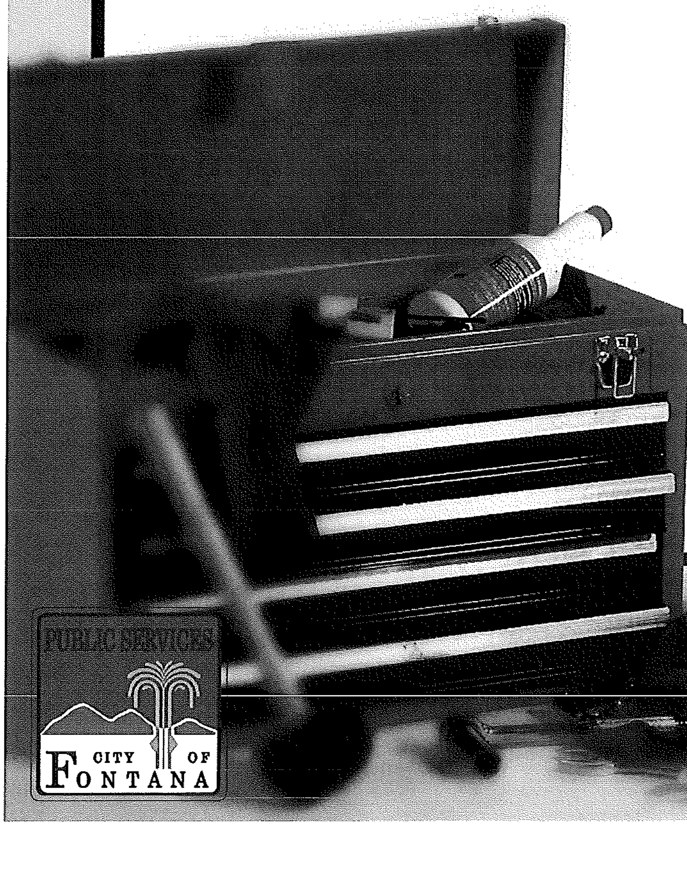
Cleaning Spills

Use dry methods for spill cleanup (sweeping, absorbent materials). Follow your hazardous materials response plan, as filed with your local fire department or other hazardous materials authority. Be sure that all employees are aware of the plan and are capable of implementing each phase. To report serious toxic spills, call 911.



Proper Disposal of Hazardous Waste

Recycle used motor oil and oil filters, anti-freeze and other hazardous automotive fluids, batteries, tires and metal filings collected from grinding or polishing auto parts. Contact a licensed hazardous waste hauler. For more recycling information, call (909) 386-8401.



PUBLIC SERVICES

CITY OF FONTANA

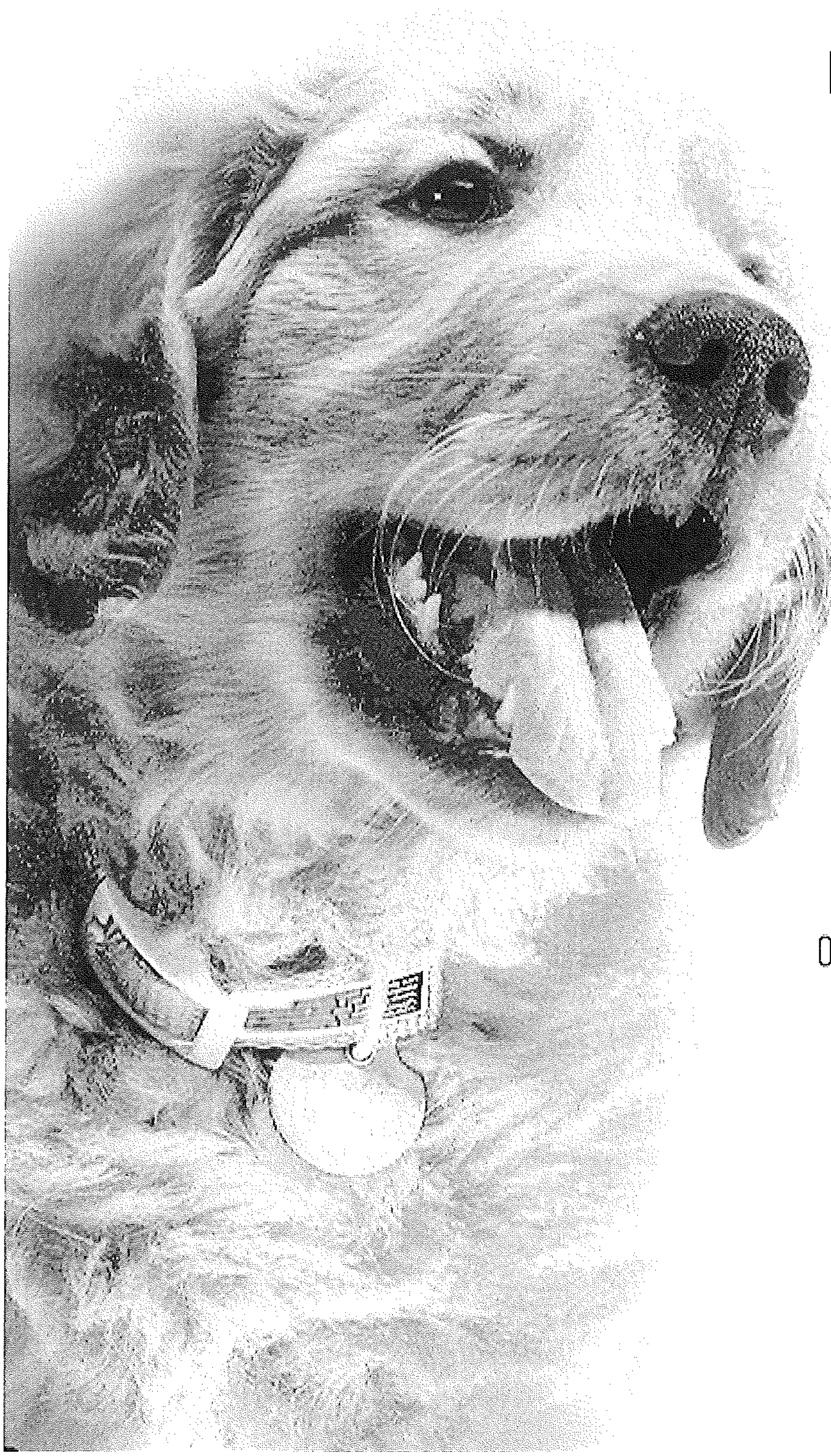
To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

San Bernardino County STORMWATER PROGRAM

Pick up after your pooch to curb pollution.



Maybe you weren't aware, but dog waste left on the ground gets into storm drains, polluting rivers, lakes and beaches.

The bacteria and risk of disease threatens the health of our kids and communities. Wherever you live in San Bernardino County, this pollution is a problem. The answer? Pick up after your dog, to help prevent pollution and protect our health. It's in your hands.

PUBLIC SERVICES
CITY OF FONTANA

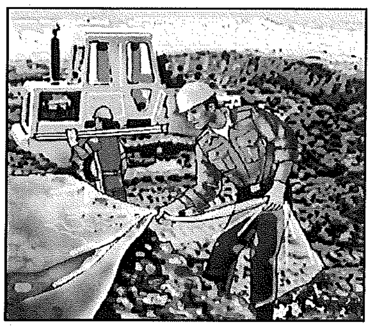
San Bernardino County
STORMWATER PROGRAM

STORMWATER

Pollution Prevention

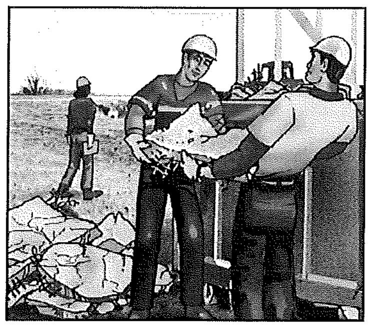
FRESH CONCRETE & MORTAR APPLICATION

Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



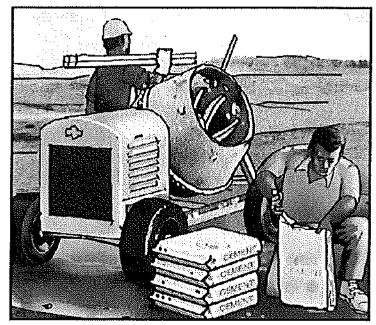
Storing Materials

Keep construction materials and debris away from the street, gutter and storm drains. Secure open bags of cement and cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.



Ordering Materials & Recycling Waste

Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. When breaking up paving, recycle the pieces at a crushing company. You can also recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. Call (909) 386-8401 for recycling and disposal information.

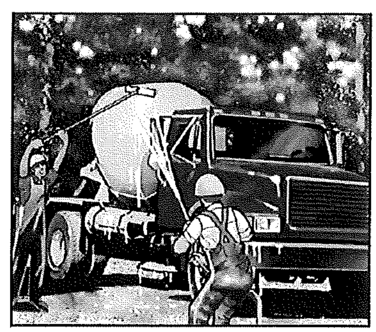


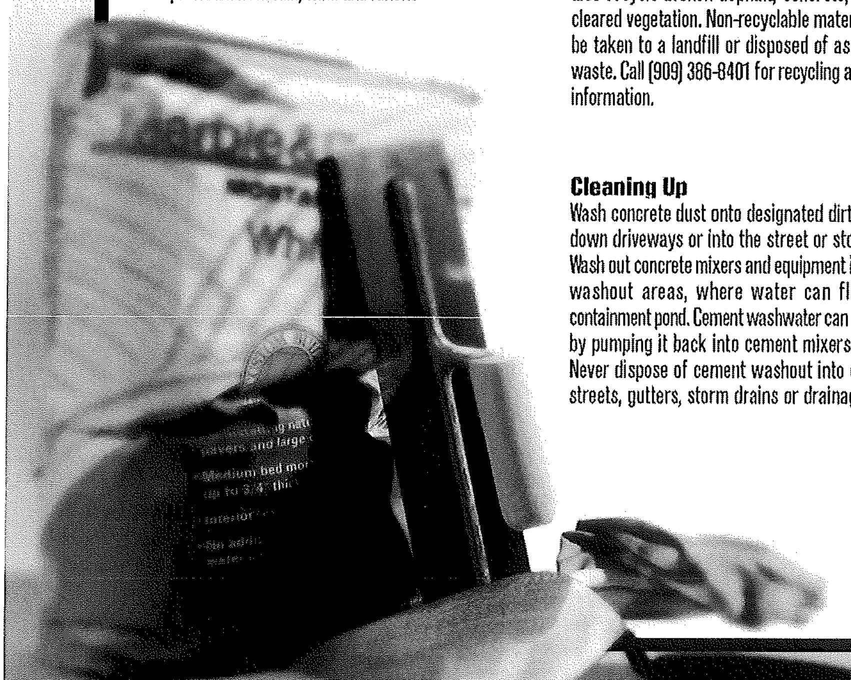
During Construction

Schedule excavation and grading during dry weather. Prevent mortar and cement from entering the street and storm drains by placing erosion controls. Setup small mixers on tarps or drop cloths, for easy cleanup of debris. Never bury waste material. Recycle or dispose of it as hazardous waste.

Cleaning Up

Wash concrete dust onto designated dirt areas, not down driveways or into the street or storm drains. Wash out concrete mixers and equipment in specified washout areas, where water can flow into a containment pond. Cement washwater can be recycled by pumping it back into cement mixers for reuse. Never dispose of cement washout into driveways, streets, gutters, storm drains or drainage ditches.





PUBLIC SERVICES
CITY OF FONTANA

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

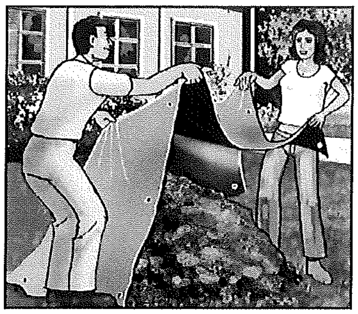
San Bernardino County STORMWATER PROGRAM

STORMWATER

Pollution Prevention

HOME REPAIR & REMODELING

Paints, solvents, adhesives and other toxic substances used in home repair and remodeling often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.



Construction Projects

Keep construction debris away from the street, gutter and storm drains. Schedule grading and excavation projects for dry weather. Cover excavated material and stockpiles of soil, sand or gravel, protected from rain, wind and runoff. Prevent erosion by planting fast-growing annual and perennial grass, which can shield and bind soil.

Recycle Household Hazardous Waste

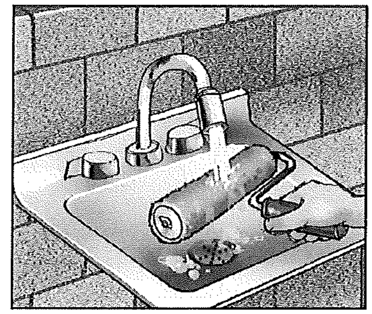
Household cleaners, paint and other home improvement products like wallpaper and tile adhesives are too toxic to trash. Recycle them instead, at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

Landscaping & Gardening

Avoid applying fertilizers or pesticide near curbs and driveways, and store covered, protected from rain, wind and runoff. Try using organic or non-toxic alternatives. Reduce runoff and lower your water bill by using drip irrigation, soaker hoses or micro-spray systems. Recycle leaves instead of blowing, sweeping or raking them into the street, gutter or storm drain.

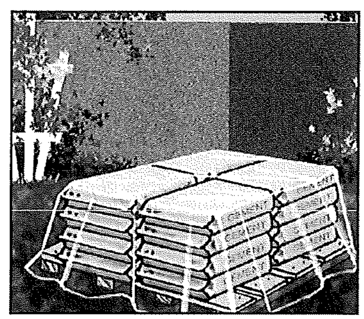
Paint Removal

Paint stripping residue, chips and dust from marine paints and paints containing lead or tributyl tin are hazardous wastes. Sweep them up instead of hosing into the street and dispose of them safely at a household hazardous waste collection facility.



Painting Cleanup

Avoid cleaning brushes or rinsing paint containers in the street, gutter or near a storm drain. Clean water-based paints in the sink. Clean oil-based paints with thinner, which you can filter and reuse. Recycle leftover paint at a household hazardous waste collection facility, save it for touch ups or give it to someone who can use it, like a theatre group, school, city or community organization.



Concrete and Masonry

Store bags of cement and plaster away from gutters and storm drains, and cover them to protect against rain, wind and runoff. Sweep or scoop up cement washout or concrete dust instead of hosing into driveways, streets, gutters or storm drains.

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

PUBLIC SERVICES
CITY OF FONTANA

San Bernardino County STORMWATER PROGRAM

BMP Fact Sheets

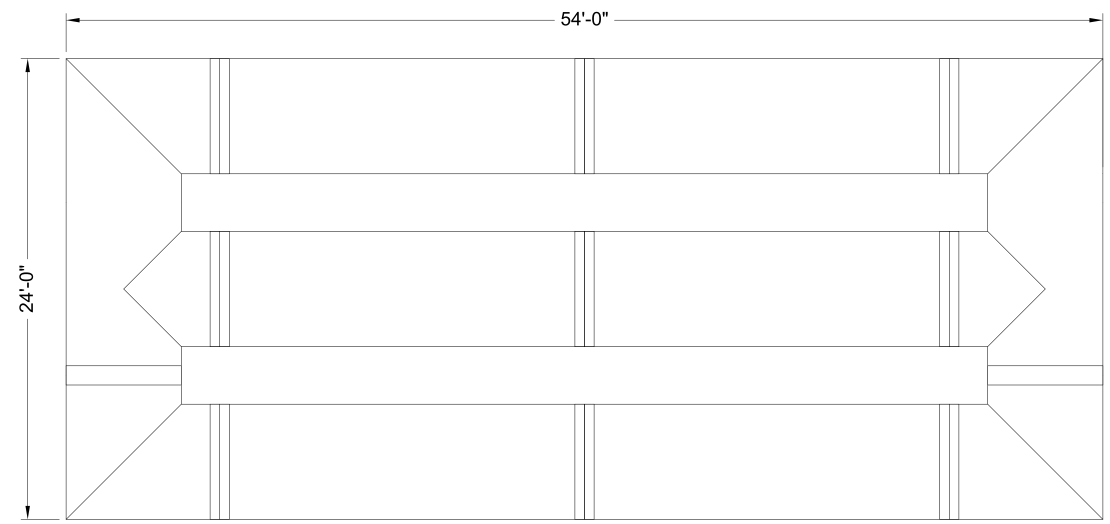
PROJECT SUMMARY

CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 174 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = 7,050 cf.
- PIPE STORAGE VOLUME = 4,920 cf.
- BACKFILL STORAGE VOLUME = 2,255 cf.
- TOTAL STORAGE PROVIDED = 7,174 cf.

PIPE DETAILS
- DIAMETER = 72 IN.
- CORRUGATION = 5x1
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 36 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 9 IN.



ASSEMBLY
SCALE: 1" = 10'

NOTES

- ALL RISER AND STUB DIMENSIONS ARE TO CENTERLINE. ALL ELEVATIONS, DIMENSIONS, AND LOCATIONS OF RISERS AND INLETS, SHALL BE VERIFIED BY THE ENGINEER OF RECORD PRIOR TO RELEASING FOR FABRICATION.
- ALL FITTINGS AND REINFORCEMENT COMPLY WITH ASTM A998.
- ALL RISERS AND STUBS ARE $2\frac{2}{3}$" x $\frac{1}{2}$" CORRUGATION AND 16 GAGE UNLESS OTHERWISE NOTED.
- RISERS TO BE FIELD TRIMMED TO GRADE.
- QUANTITY OF PIPE SHOWN DOES NOT PROVIDE EXTRA PIPE FOR CONNECTING THE SYSTEM TO EXISTING PIPE OR DRAINAGE STRUCTURES. OUR SYSTEM AS DETAILED PROVIDES NOMINAL INLET AND/OR OUTLET PIPE STUB FOR CONNECTION TO EXISTING DRAINAGE FACILITIES. IF ADDITIONAL PIPE IS NEEDED IT IS THE RESPONSIBILITY OF THE CONTRACTOR.
- BAND TYPE TO BE DETERMINED UPON FINAL DESIGN.
- THE PROJECT SUMMARY IS REFLECTIVE OF THE DYODS DESIGN, QUANTITIES ARE APPROX. AND SHOULD BE VERIFIED UPON FINAL DESIGN AND APPROVAL. FOR EXAMPLE, TOTAL EXCAVATION DOES NOT CONSIDER ALL VARIABLES SUCH AS SHORING AND ONLY ACCOUNTS FOR MATERIAL WITHIN THE ESTIMATED EXCAVATION FOOTPRINT.
- THESE DRAWINGS ARE FOR CONCEPTUAL PURPOSES AND DO NOT REFLECT ANY LOCAL PREFERENCES OR REGULATIONS. PLEASE CONTACT YOUR LOCAL CONTECH REP FOR MODIFICATIONS.

C:\EXPORTS\TEMPLATES\CMP_V5.DWG 10/18/2019 10:02 AM

DATE	REVISION DESCRIPTION	BY

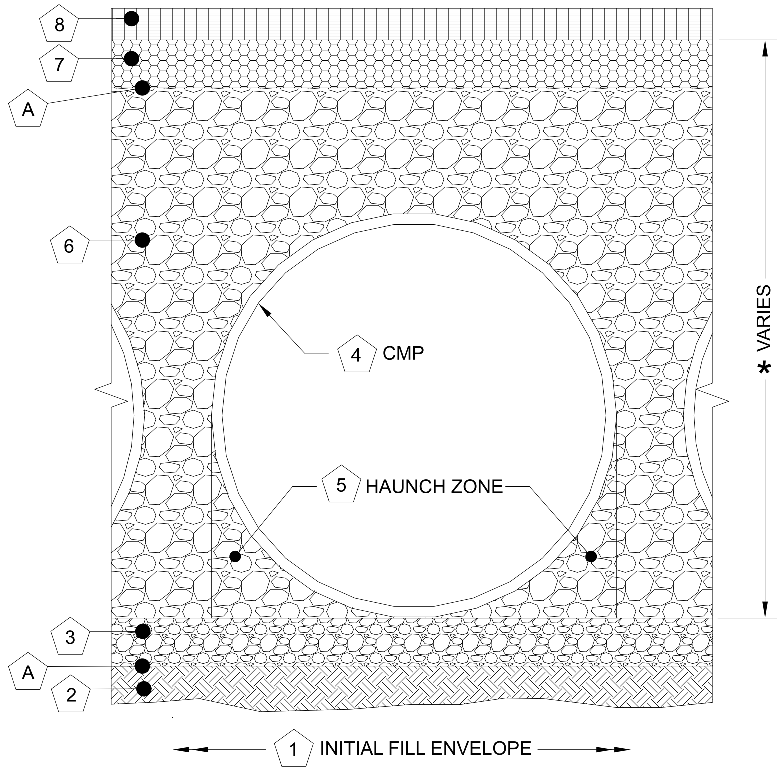
CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH® CMP DETENTION SYSTEMS

CONTECH **DYODS** DRAWING

DYO10714 Warmington
Retention System-Medical Center Dr
Fontana, CA
DETENTION SYSTEM

PROJECT No.: 6662	SEQ. No.: 10714	DATE: 9/30/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		



Infiltration Systems - CMP Infiltration & CMP Perforated Drainage Pipe				
	Material Location	Description	Material Designation	Designation
8	Rigid or Flexible Pavement (if applicable)			
7	Road Base (if applicable			
A	Geotextile Layer	Non-Woven Geotextile	CONTECH C-40 or C-45	Engineer Decision for consideration to prevent soil migration into varying soil types. Wrap the trench only.
6	Backfill	Infiltration pipe systems have a pipe perforation sized of 3/8" diameter. An open graded, free draining stone, with a particle size of ½" – 2 ½" diameter is recommended.	AASHTO M 145-A-1 or AASHTO M 43 - 3, 4	Material shall be worked into the pipe haunches by means of shovel-slicing, rodding, air-tamper, vibratory rod, or other effective methods. 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 his representative is satisfied with the level of compaction"
3	Bedding Stone	Well graded granular bedding material w/maximum particle size of 3"	AASHTO M43 - 3,357,4,467, 5, 56, 57	For soil aggregates larger than 3/8" a dedicated bedding layer is not required for CMP. Pipe may be placed on the trench bottom comprised of native suitable well graded & granular material. For Arch pipes it is recommended to be shaped to a relatively flat bottom or fine-grade the foundation to a slight v-shape. Soil aggregates less than 3/8" and unsuitable material should be over-excavated and re-placed with a 4"-6" layer of well graded & granular stone per the material designation.
A	Geotextile Layer	None	None	Contech does not recommend geotextiles be placed under the invert of Infiltration systems due to the propensity for geotextiles to clog over time.
*	Note: The listed AASHTO designations are for gradation only. The stone must also be angular and clean.			

1 MINIMUM WIDTH DEPENDS ON SITE CONDITIONS AND ENGINEERING JUDGEMENT.

FOUNDATION/BEDDING PREPARATION

2 PRIOR TO PLACING THE BEDDING, THE FOUNDATION MUST BE CONSTRUCTED TO A UNIFORM AND STABLE GRADE. IN THE EVENT THAT UNSUITABLE FOUNDATION MATERIALS ARE ENCOUNTERED DURING EXCAVATION, THEY SHALL BE REMOVED AND BROUGHT BACK TO THE GRADE WITH A FILL MATERIAL AS APPROVED BY THE ENGINEER.

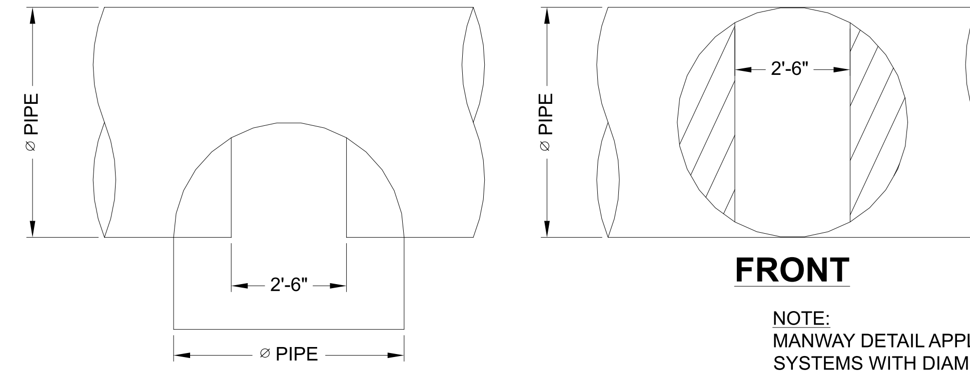
5 HAUNCH ZONE MATERIAL SHALL BE PLACED AND UNIFORMLY COMPACTED WITHOUT SOFT SPOTS.

BACKFILL

MATERIAL SHALL BE PLACED IN 8"-10" MAXIMUM LIFTS. INADEQUATE COMPACTION CAN LEAD TO EXCESSIVE DEFLECTIONS WITHIN THE SYSTEM AND SETTLEMENT OF THE SOILS OVER THE SYSTEM. BACKFILL SHALL BE PLACED SUCH THAT THERE IS NO MORE THAN A TWO-LIFT DIFFERENTIAL BETWEEN THE SIDES OF ANY PIPE IN THE SYSTEM AT ALL TIMES DURING THE BACKFILL PROCESS. BACKFILL SHALL BE ADVANCED ALONG THE LENGTH OF THE SYSTEM AT THE SAME RATE TO AVOID DIFFERENTIAL LOADING ON ANY PIPES IN THE SYSTEM.

EQUIPMENT USED TO PLACE AND COMPACT THE BACKFILL SHALL BE OF A SIZE AND TYPE SO AS NOT TO DISTORT, DAMAGE, OR DISPLACE THE PIPE. ATTENTION MUST BE GIVEN TO PROVIDING ADEQUATE MINIMUM COVER FOR SUCH EQUIPMENT. MAINTAIN BALANCED LOADING ON ALL PIPES IN THE SYSTEM DURING ALL SUCH OPERATIONS.

OTHER ALTERNATE BACKFILL MATERIAL MAY BE ALLOWED DEPENDING ON SITE SPECIFIC CONDITIONS. REFER TO TYPICAL BACKFILL DETAIL FOR MATERIAL REQUIRED.



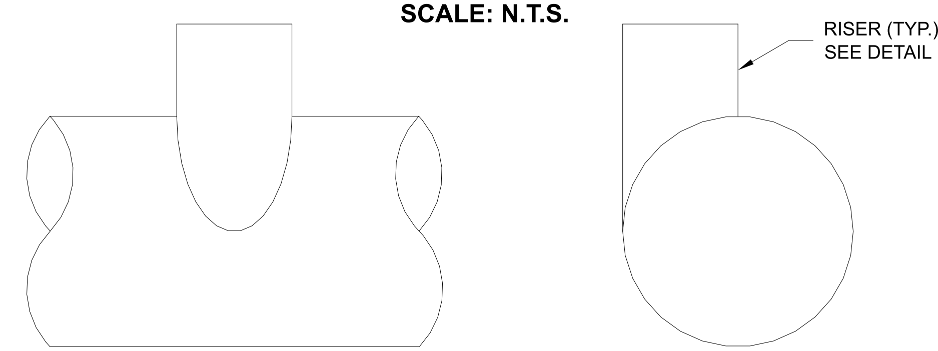
PLAN

FRONT

NOTE:
MANWAY DETAIL APPLICABLE FOR CMP SYSTEMS WITH DIAMETERS 48" AND LARGER. MANWAYS MAY BE REQUIRED ON SMALLER SYSTEMS DEPENDING ON ACTUAL SITE SPECIFIC CONDITIONS.

TYPICAL MANWAY DETAIL

SCALE: N.T.S.



ELEVATION

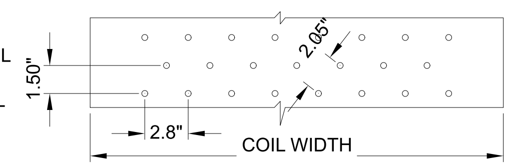
END

NOTE:
LADDERS ARE OPTIONAL AND ARE NOT REQUIRED FOR ALL SYSTEMS.

TYPICAL RISER DETAIL

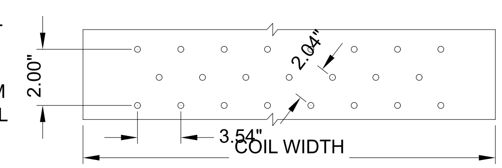
SCALE: N.T.S.

2 2/3" x 1/2" CORRUGATION - STEEL AND ALUMINUM CMP EDGE SPACING EQUAL ON BOTH SIDES



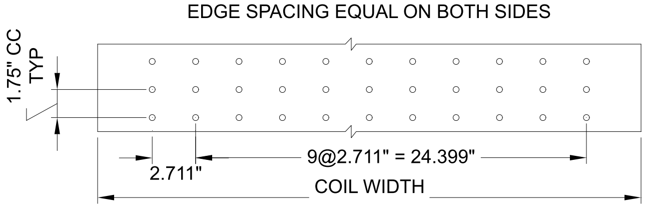
OPEN AREA = 3.76 SQ IN/SQ FT

3" x 1" CORRUGATION - STEEL AND ALUMINUM CMP (COIL PROVIDED FROM CONTECH LANTANA, FL PLANT)



OPEN AREA = 4.16 SQ IN/SQ FT

5" x 1" CORRUGATION - STEEL ONLY EDGE SPACING EQUAL ON BOTH SIDES



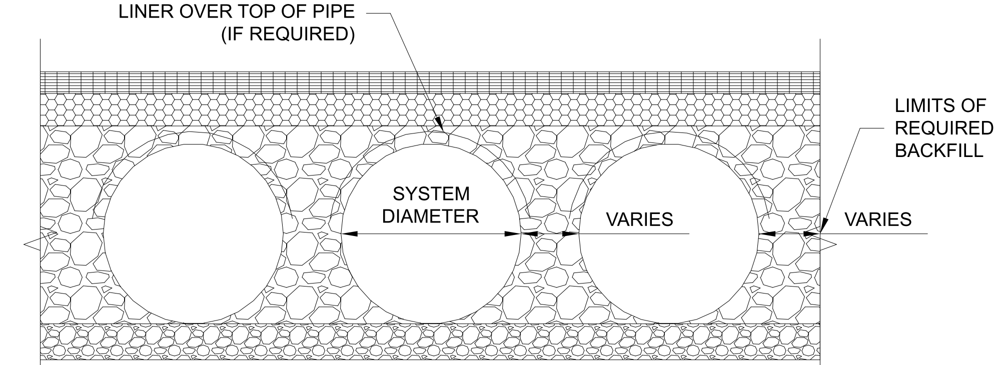
OPEN AREA = 3.33 SQ IN/SQ FT

NOTES:

1. PERFORATIONS MEET AASHTO AND ASTM SPECIFICATIONS.
2. PERFORATION OPEN AREA PER SQUARE FOOT OF PIPE IS BASED ON THE NOMINAL DIAMETER AND LENGTH OF PIPE.
3. ALL DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES.
4. ALL HOLES ⌀3/8".

TYPICAL PERFORATION DETAIL

SCALE: N.T.S.



TYPICAL SECTION VIEW

LINER OVER ROWS

SCALE: N.T.S.

NOTE: IF SALTING AGENTS FOR SNOW AND ICE REMOVAL ARE USED ON OR NEAR THE PROJECT, AN HDPE MEMBRANE LINER IS RECOMMENDED WITH THE SYSTEM. THE IMPERMEABLE LINER IS INTENDED TO HELP PROTECT THE SYSTEM FROM THE POTENTIAL ADVERSE EFFECTS THAT MAY RESULT FROM A CHANGE IN THE SURROUNDING ENVIRONMENT OVER A PERIOD OF TIME. PLEASE REFER TO THE CORRUGATED METAL PIPE DETENTION DESIGN GUIDE FOR ADDITIONAL INFORMATION.

DATE	REVISION DESCRIPTION	BY

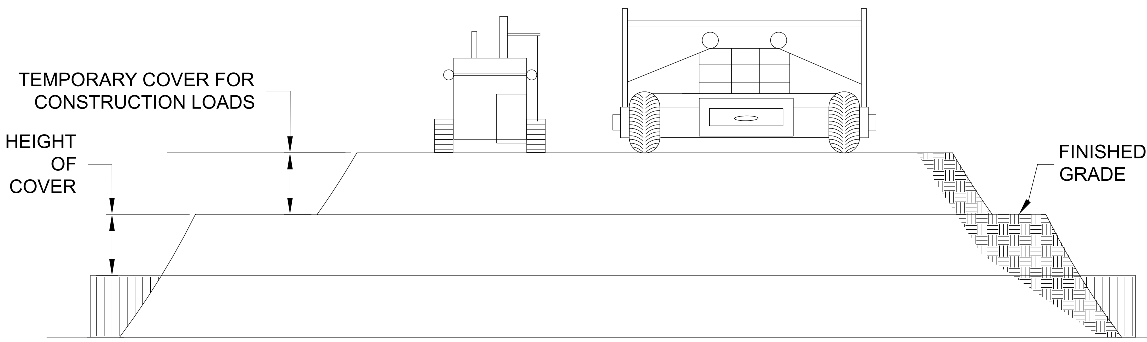
CONTECH ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH CMP DETENTION SYSTEMS

CONTECH
DYODS
DRAWING

DYO10714 Warmington
Retention System-Medical Center Dr
Fontana, CA
DETENTION SYSTEM

PROJECT No.: 6662	SEQ. No.: 10714	DATE: 9/30/2021
DESIGNED: DYO		DRAWN: DYO
CHECKED: DYO		APPROVED: DYO
SHEET NO.: D2		



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

SCALE: N.T.S.

SPECIFICATION FOR DESIGNED DETENTION SYSTEM:

SCOPE
THIS SPECIFICATION COVERS THE MANUFACTURE AND INSTALLATION OF THE DESIGNED DETENTION SYSTEM DETAILED IN THE PROJECT PLANS.

MATERIAL
THE MATERIAL SHALL CONFORM TO THE APPLICABLE REQUIREMENTS LISTED BELOW:

ALUMINIZED TYPE 2 STEEL COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M-274 OR ASTM A-92.

THE GALVANIZED STEEL COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M-218 OR ASTM A-929.

THE POLYMER COATED STEEL COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M-246 OR ASTM A-742.

THE ALUMINUM COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M-197 OR ASTM B-744.

CONSTRUCTION LOADS
CONSTRUCTION LOADS MAY BE HIGHER THAN FINAL LOADS. FOLLOW THE MANUFACTURER'S OR NCSPA GUIDELINES.

PIPE
THE PIPE SHALL BE MANUFACTURED IN ACCORDANCE TO THE APPLICABLE REQUIREMENTS LISTED BELOW:

ALUMINIZED TYPE 2: AASHTO M-36 OR ASTM A-760

GALVANIZED: AASHTO M-36 OR ASTM A-760

POLYMER COATED: AASHTO M-245 OR ASTM A-762

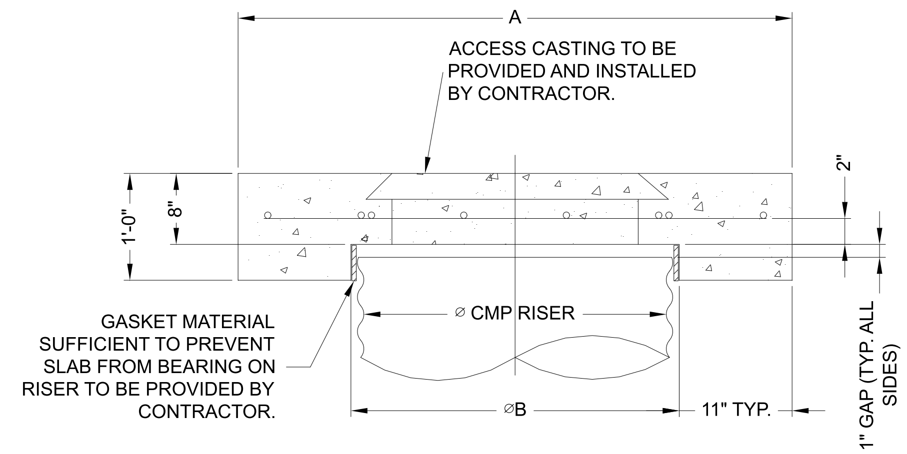
ALUMINUM: AASHTO M-196 OR ASTM B-745

HANDLING AND ASSEMBLY
SHALL BE IN ACCORDANCE WITH NCSP'S (NATIONAL CORRUGATED STEEL PIPE ASSOCIATION) FOR ALUMINIZED TYPE 2, GALVANIZED OR POLYMER COATED STEEL. SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS FOR ALUMINUM PIPE.

INSTALLATION
SHALL BE IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, SECTION 26, DIVISION II DIVISION II OR ASTM A-798 (FOR ALUMINIZED TYPE 2, GALVANIZED OR POLYMER COATED STEEL) OR ASTM B-788 (FOR ALUMINUM PIPE) 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.

NOTE:
THESE DRAWINGS ARE FOR CONCEPTUAL PURPOSES AND DO NOT REFLECT ANY LOCAL PREFERENCES OR REGULATIONS. PLEASE CONTACT YOUR LOCAL CONTECH REP FOR MODIFICATIONS.

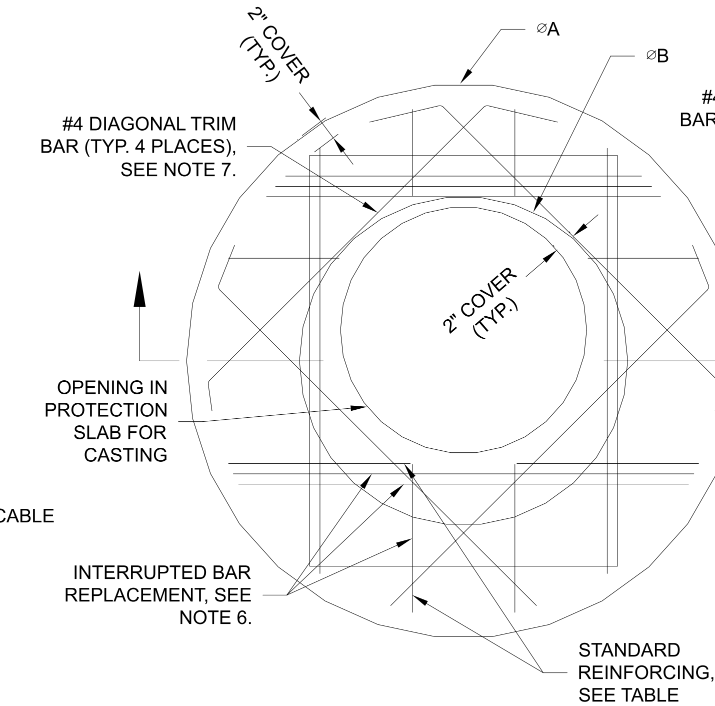


SECTION VIEW

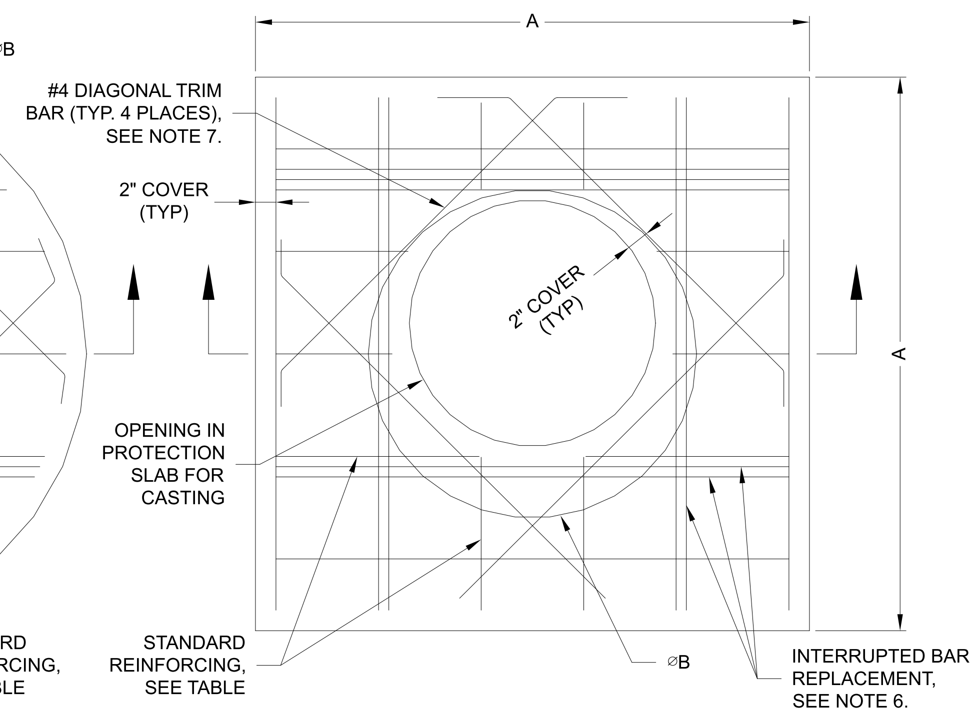
REINFORCING TABLE

⌀ CMP RISER	A	⌀ B	REINFORCING	**BEARING PRESSURE (PSF)
24"	⌀ 4' 4'X4'	26"	#5 @ 12" OCEW #5 @ 12" OCEW	2,410 1,780
30"	⌀ 4'-6" 4'-6" X 4'-6"	32"	#5 @ 12" OCEW #5 @ 12" OCEW	2,120 1,530
36"	⌀ 5' 5' X 5'	38"	#5 @ 10" OCEW #5 @ 10" OCEW	1,890 1,350
42"	⌀ 5'-6" 5'-6" X 5'-6"	44"	#5 @ 10" OCEW #5 @ 9" OCEW	1,720 1,210
48"	⌀ 6' 6' X 6'	50"	#5 @ 9" OCEW #5 @ 8" OCEW	1,600 1,100

** ASSUMED SOIL BEARING CAPACITY



ROUND OPTION PLAN VIEW



SQUARE OPTION PLAN VIEW

NOTES:

1. DESIGN IN ACCORDANCE WITH AASHTO, 17th EDITION.
2. DESIGN LOAD HS25.
3. EARTH COVER = 1' MAX.
4. CONCRETE STRENGTH = 3,500 psi
5. REINFORCING STEEL = ASTM A615, GRADE 60.
6. PROVIDE ADDITIONAL REINFORCING AROUND OPENINGS EQUAL TO THE BARS INTERRUPTED, HALF EACH SIDE. ADDITIONAL BARS TO BE IN THE SAME PLANE.
7. TRIM OPENING WITH DIAGONAL #4 BARS, EXTEND BARS A MINIMUM OF 12" BEYOND OPENING, BEND BARS AS REQUIRED TO MAINTAIN BAR COVER.
8. PROTECTION SLAB AND ALL MATERIALS TO BE PROVIDED AND INSTALLED BY CONTRACTOR.
9. DETAIL DESIGN BY DELTA ENGINEERING, BINGHAMTON, NY.

MANHOLE CAP DETAIL

SCALE: N.T.S.

C:\EXPORTS\TEMPLATES\CMP_V5.DWG 10/18/2019 10:02 AM

DATE	REVISION DESCRIPTION	BY

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH® CMP DETENTION SYSTEMS

CONTECH **DYODS** DRAWING

DYO10714 Warmington
Retention System-Medical Center Dr
Fontana, CA
DETENTION SYSTEM

PROJECT No.: 6662	SEQ. No.: 10714	DATE: 9/30/2021
DESIGNED: DYO		DRAWN: DYO
CHECKED: DYO		APPROVED: DYO
SHEET NO.: D3		

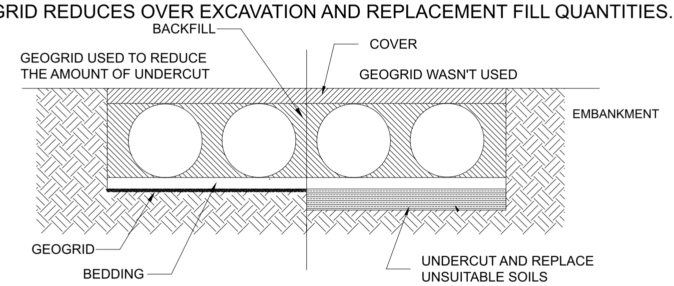
CMP DETENTION INSTALLATION GUIDE

PROPER INSTALLATION OF A FLEXIBLE UNDERGROUND DETENTION SYSTEM WILL ENSURE LONG-TERM PERFORMANCE. THE CONFIGURATION OF THESE SYSTEMS OFTEN REQUIRES SPECIAL CONSTRUCTION PRACTICES THAT DIFFER FROM CONVENTIONAL FLEXIBLE PIPE CONSTRUCTION. CONTECH ENGINEERED SOLUTIONS STRONGLY SUGGESTS SCHEDULING A PRE-CONSTRUCTION MEETING WITH YOUR LOCAL SALES ENGINEER TO DETERMINE IF ADDITIONAL MEASURES, NOT COVERED IN THIS GUIDE, ARE APPROPRIATE FOR YOUR SITE.

FOUNDATION

CONSTRUCT A FOUNDATION THAT CAN SUPPORT THE DESIGN LOADING APPLIED BY THE PIPE AND ADJACENT BACKFILL WEIGHT AS WELL AS MAINTAIN ITS INTEGRITY DURING CONSTRUCTION.

IF SOFT OR UNSUITABLE SOILS ARE ENCOUNTERED, REMOVE THE POOR SOILS DOWN TO A SUITABLE DEPTH AND THEN BUILD UP TO THE APPROPRIATE ELEVATION WITH A COMPETENT BACKFILL MATERIAL. THE STRUCTURAL FILL MATERIAL GRADATION SHOULD NOT ALLOW THE MIGRATION OF FINES, WHICH CAN CAUSE SETTLEMENT OF THE DETENTION SYSTEM OR PAVEMENT ABOVE. IF THE STRUCTURAL FILL MATERIAL IS NOT COMPATIBLE WITH THE UNDERLYING SOILS AN ENGINEERING FABRIC SHOULD BE USED AS A SEPARATOR. IN SOME CASES, USING A STIFF REINFORCING GEOGRID REDUCES OVER EXCAVATION AND REPLACEMENT FILL QUANTITIES.

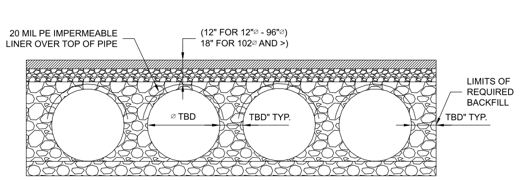


GRADE THE FOUNDATION SUBGRADE TO A UNIFORM OR SLIGHTLY SLOPING GRADE. IF THE SUBGRADE IS CLAY OR RELATIVELY NON-POROUS AND THE CONSTRUCTION SEQUENCE WILL LAST FOR AN EXTENDED PERIOD OF TIME, IT IS BEST TO SLOPE THE GRADE TO ONE END OF THE SYSTEM. THIS WILL ALLOW EXCESS WATER TO DRAIN QUICKLY, PREVENTING SATURATION OF THE SUBGRADE.

GEOMEMBRANE BARRIER

A SITE'S RESISTIVITY MAY CHANGE OVER TIME WHEN VARIOUS TYPES OF SALTING AGENTS ARE USED, SUCH AS ROAD SALTS FOR DEICING AGENTS. IF SALTING AGENTS ARE USED ON OR NEAR THE PROJECT SITE, A GEOMEMBRANE BARRIER IS RECOMMENDED WITH THE SYSTEM. THE GEOMEMBRANE LINER IS INTENDED TO HELP PROTECT THE SYSTEM FROM THE POTENTIAL ADVERSE EFFECTS THAT MAY RESULT FROM THE USE OF SUCH AGENTS INCLUDING PREMATURE CORROSION AND REDUCED ACTUAL SERVICE LIFE.

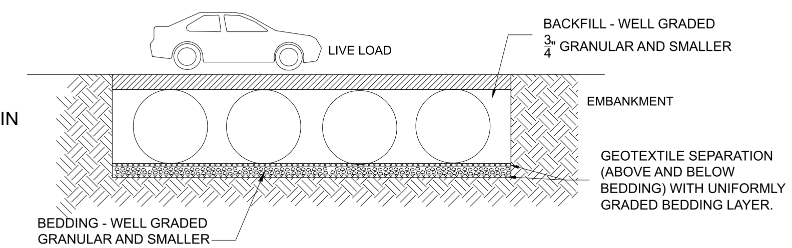
THE PROJECT'S ENGINEER OF RECORD IS TO EVALUATE WHETHER SALTING AGENTS WILL BE USED ON OR NEAR THE PROJECT SITE, AND USE HIS/HER BEST JUDGEMENT TO DETERMINE IF ANY ADDITIONAL PROTECTIVE MEASURES ARE REQUIRED. BELOW IS A TYPICAL DETAIL SHOWING THE PLACEMENT OF A GEOMEMBRANE BARRIER FOR PROJECTS WHERE SALTING AGENTS ARE USED ON OR NEAR THE PROJECT SITE.



IN-SITU TRENCH WALL

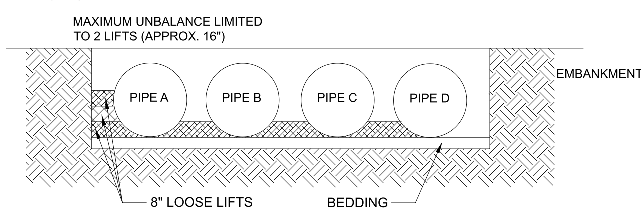
IF EXCAVATION IS REQUIRED, THE TRENCH WALL NEEDS TO BE CAPABLE OF SUPPORTING THE LOAD THAT THE PIPE SHEDS AS THE SYSTEM IS LOADED. IF SOILS ARE NOT CAPABLE OF SUPPORTING THESE LOADS, THE PIPE CAN DEFLECT. PERFORM A SIMPLE SOIL PRESSURE CHECK USING THE APPLIED LOADS TO DETERMINE THE LIMITS OF EXCAVATION BEYOND THE SPRING LINE OF THE OUTER MOST PIPES.

IN MOST CASES THE REQUIREMENTS FOR A SAFE WORK ENVIRONMENT AND PROPER BACKFILL PLACEMENT AND COMPACTION TAKE CARE OF THIS CONCERN.



BACKFILL PLACEMENT

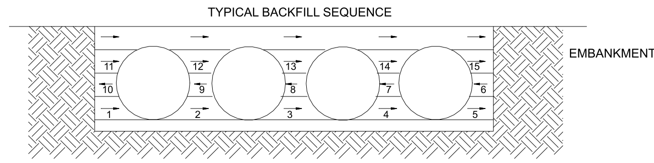
MATERIAL SHALL BE WORKED INTO THE PIPE HAUNCHES BY MEANS OF SHOVEL-SLICING, RODDING, AIR TAMPER, VIBRATORY ROD, OR OTHER EFFECTIVE METHODS.



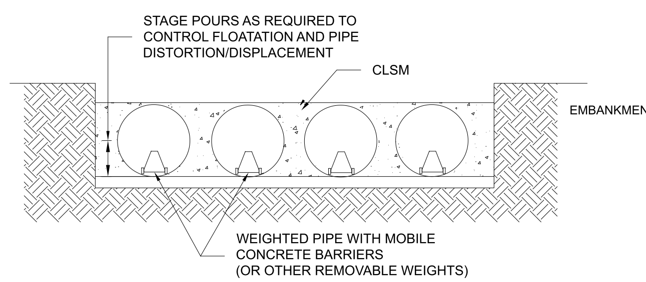
IF AASHTO T99 PROCEDURES ARE DETERMINED INFEASIBLE BY THE GEOTECHNICAL ENGINEER OF RECORD, COMPACTION IS CONSIDERED ADEQUATE WHEN NO FURTHER YIELDING OF THE MATERIAL IS OBSERVED UNDER THE COMPACTOR, OR UNDER FOOT, AND THE GEOTECHNICAL ENGINEER OF RECORD (OR REPRESENTATIVE THEREOF) IS SATISFIED WITH THE LEVEL OF COMPACTION.

FOR LARGE SYSTEMS, CONVEYOR SYSTEMS, BACKHOES WITH LONG REACHES OR DRAGLINES WITH STONE BUCKETS MAY BE USED TO PLACE BACKFILL. ONCE MINIMUM COVER FOR CONSTRUCTION LOADING ACROSS THE ENTIRE WIDTH OF THE SYSTEM IS REACHED, ADVANCE THE EQUIPMENT TO THE END OF THE RECENTLY PLACED FILL, AND BEGIN THE SEQUENCE AGAIN UNTIL THE SYSTEM IS COMPLETELY BACKFILLED. THIS TYPE OF CONSTRUCTION SEQUENCE PROVIDES ROOM FOR STOCKPILED BACKFILL DIRECTLY BEHIND THE BACKHOE, AS WELL AS THE MOVEMENT OF CONSTRUCTION TRAFFIC. MATERIAL STOCKPILES ON TOP OF THE BACKFILLED DETENTION SYSTEM SHOULD BE LIMITED TO 8- TO 10-FEET HIGH AND MUST PROVIDE BALANCED LOADING ACROSS ALL BARRELS. TO DETERMINE THE PROPER COVER OVER THE PIPES TO ALLOW THE MOVEMENT OF CONSTRUCTION EQUIPMENT SEE TABLE 1, OR CONTACT YOUR LOCAL CONTECH SALES ENGINEER.

TYPICAL BACKFILL SEQUENCE



WHEN FLOWABLE FILL IS USED, YOU MUST PREVENT PIPE FLOATATION. TYPICALLY, SMALL LIFTS ARE PLACED BETWEEN THE PIPES AND THEN ALLOWED TO SET-UP PRIOR TO THE PLACEMENT OF THE NEXT LIFT. THE ALLOWABLE THICKNESS OF THE CLSM LIFT IS A FUNCTION OF A PROPER BALANCE BETWEEN THE UPLIFT FORCE OF THE CLSM, THE OPPOSING WEIGHT OF THE PIPE, AND THE EFFECT OF OTHER RESTRAINING MEASURES. THE PIPE CAN CARRY LIMITED FLUID PRESSURE WITHOUT PIPE DISTORTION OR DISPLACEMENT, WHICH ALSO AFFECTS THE CLSM LIFT THICKNESS. YOUR LOCAL CONTECH SALES ENGINEER CAN HELP DETERMINE THE PROPER LIFT THICKNESS.

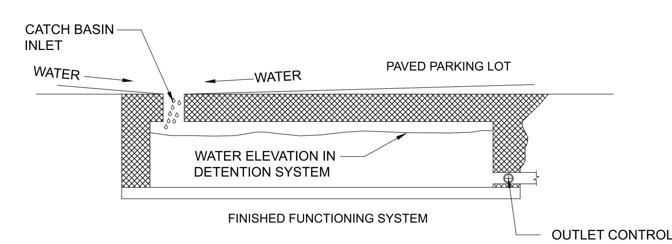


CONSTRUCTION LOADING

TYPICALLY, THE MINIMUM COVER SPECIFIED FOR A PROJECT ASSUMES H-20 LIVE LOAD. BECAUSE CONSTRUCTION LOADS OFTEN EXCEED DESIGN LIVE LOADS, INCREASED TEMPORARY MINIMUM COVER REQUIREMENTS ARE NECESSARY. SINCE CONSTRUCTION EQUIPMENT VARIES FROM JOB TO JOB, IT IS BEST TO ADDRESS EQUIPMENT SPECIFIC MINIMUM COVER REQUIREMENTS WITH YOUR LOCAL CONTECH SALES ENGINEER DURING YOUR PRE-CONSTRUCTION MEETING.

ADDITIONAL CONSIDERATIONS

BECAUSE MOST SYSTEMS ARE CONSTRUCTED BELOW-GRADE, RAINFALL CAN RAPIDLY FILL THE EXCAVATION; POTENTIALLY CAUSING FLOATATION AND MOVEMENT OF THE PREVIOUSLY PLACED PIPES. TO HELP MITIGATE POTENTIAL PROBLEMS, IT IS BEST TO START THE INSTALLATION AT THE DOWNSTREAM END WITH THE OUTLET ALREADY CONSTRUCTED TO ALLOW A ROUTE FOR THE WATER TO ESCAPE. TEMPORARY DIVERSION MEASURES MAY BE REQUIRED FOR HIGH FLOWS DUE TO THE RESTRICTED NATURE OF THE OUTLET PIPE.



CMP DETENTION SYSTEM INSPECTION AND MAINTENANCE

UNDERGROUND STORMWATER DETENTION AND INFILTRATION SYSTEMS MUST BE INSPECTED AND MAINTAINED AT REGULAR INTERVALS FOR PURPOSES OF PERFORMANCE AND LONGEVITY.

INSPECTION

INSPECTION IS THE KEY TO EFFECTIVE MAINTENANCE OF CMP DETENTION SYSTEMS AND IS EASILY PERFORMED. CONTECH RECOMMENDS ONGOING, ANNUAL INSPECTIONS. SITES WITH HIGH TRASH LOAD OR SMALL OUTLET CONTROL ORIFICES MAY NEED MORE FREQUENT INSPECTIONS. THE RATE AT WHICH THE SYSTEM COLLECTS POLLUTANTS WILL DEPEND MORE ON SITE SPECIFIC ACTIVITIES RATHER THAN THE SIZE OR CONFIGURATION OF THE SYSTEM.

INSPECTIONS SHOULD BE PERFORMED MORE OFTEN IN EQUIPMENT WASHDOWN AREAS, IN CLIMATES WHERE SANDING AND/OR SALTING OPERATIONS TAKE PLACE, AND IN OTHER VARIOUS INSTANCES IN WHICH ONE WOULD EXPECT HIGHER ACCUMULATIONS OF SEDIMENT OR ABRASIVE/ CORROSIVE CONDITIONS. A RECORD OF EACH INSPECTION IS TO BE MAINTAINED FOR THE LIFE OF THE SYSTEM

MAINTENANCE

CMP DETENTION SYSTEMS SHOULD BE CLEANED WHEN AN INSPECTION REVEALS ACCUMULATED SEDIMENT OR TRASH IS CLOGGING THE DISCHARGE ORIFICE.

ACCUMULATED SEDIMENT AND TRASH CAN TYPICALLY BE EVACUATED THROUGH THE MANHOLE OVER THE OUTLET ORIFICE. IF MAINTENANCE IS NOT PERFORMED AS RECOMMENDED, SEDIMENT AND TRASH MAY ACCUMULATE IN FRONT OF THE OUTLET ORIFICE. MANHOLE COVERS SHOULD BE SECURELY SEATED FOLLOWING CLEANING ACTIVITIES. CONTECH SUGGESTS THAT ALL SYSTEMS BE DESIGNED WITH AN ACCESS/INSPECTION MANHOLE SITUATED AT OR NEAR THE INLET AND THE OUTLET ORIFICE. SHOULD IT BE NECESSARY TO GET INSIDE THE SYSTEM TO PERFORM MAINTENANCE ACTIVITIES, ALL APPROPRIATE PRECAUTIONS REGARDING CONFINED SPACE ENTRY AND OSHA REGULATIONS SHOULD BE FOLLOWED.

ANNUAL INSPECTIONS ARE BEST PRACTICE FOR ALL UNDERGROUND SYSTEMS. DURING THIS INSPECTION, IF EVIDENCE OF SALTING/DE-ICING AGENTS IS OBSERVED WITHIN THE SYSTEM, IT IS BEST PRACTICE FOR THE SYSTEM TO BE RINSED, INCLUDING ABOVE THE SPRING LINE SOON AFTER THE SPRING THAW AS PART OF THE MAINTENANCE PROGRAM FOR THE SYSTEM.

MAINTAINING AN UNDERGROUND DETENTION OR INFILTRATION SYSTEM IS EASIEST WHEN THERE IS NO FLOW ENTERING THE SYSTEM. FOR THIS REASON, IT IS A GOOD IDEA TO SCHEDULE THE CLEANOUT DURING DRY WEATHER.

THE FOREGOING INSPECTION AND MAINTENANCE EFFORTS HELP ENSURE UNDERGROUND PIPE SYSTEMS USED FOR STORMWATER STORAGE CONTINUE TO FUNCTION AS INTENDED BY IDENTIFYING RECOMMENDED REGULAR INSPECTION AND MAINTENANCE PRACTICES. INSPECTION AND MAINTENANCE RELATED TO THE STRUCTURAL INTEGRITY OF THE PIPE OR THE SOUNDNESS OF PIPE JOINT CONNECTIONS IS BEYOND THE SCOPE OF THIS GUIDE.

C:\EXPORTS\TEMPLATES\CMP_V5.DWG 10/18/2019 10:02 AM

DATE	REVISION DESCRIPTION	BY

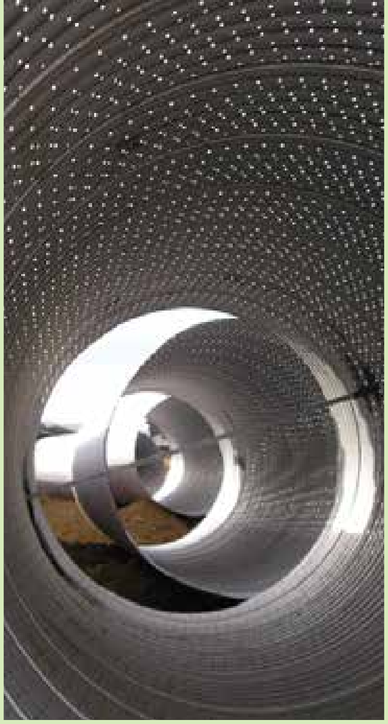
CONTECH ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH CMP DETENTION SYSTEMS

CONTECH DYODS DRAWING

DYO10714 Warmington
Retention System-Medical Center Dr
Fontana, CA
DETENTION SYSTEM

PROJECT No.: 6662	SEQ. No.: 10714	DATE: 9/30/2021
DESIGNED: DYO		DRAWN: DYO
CHECKED: DYO		APPROVED: DYO
SHEET NO.: D4		

CONTECH®
ENGINEERED SOLUTIONS

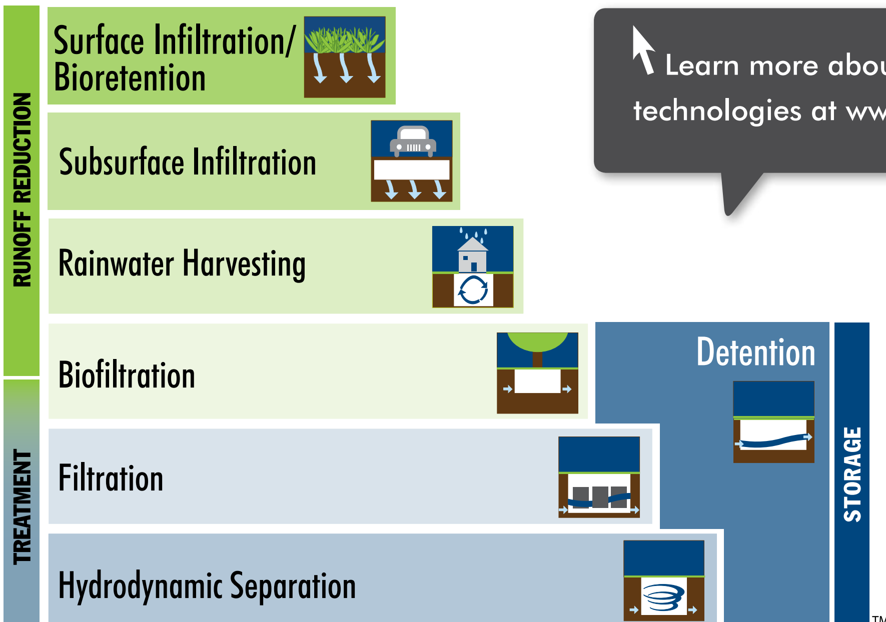
Corrugated Metal Pipe Infiltration System

Solutions Guide™

Stormwater Solutions from Contech

Selecting the Right Stormwater Solution Just Got Easier...

It's simple to choose the right stormwater solution to achieve your goals with the Contech Stormwater Solutions Staircase. First, select the runoff reduction practices that are most appropriate for your site, paying particular attention to pretreatment needs. If the entire design storm cannot be retained, select a treatment best management practice (BMP) for the balance. Finally, select a detention system to address any outstanding downstream erosion.



Learn more about all of our stormwater technologies at www.ContechES.com/stormwater

DYODS Design Your Own Detention or Infiltration System

The Contech Design Your Own Detention System (DYODS®) tool fully automates the layout process for stormwater detention and infiltration systems and produces CAD and PDF files that can be used for creating plans and specs, and for estimating total installed costs.

To use the *Design Your Own Detention or Infiltration System* tool, visit: www.ContechES.com/dyods

Subsurface Infiltration as a Stormwater Management Strategy

The only sure way to eliminate stormwater pollution is to eliminate stormwater runoff. In recognition of this fact, Green Infrastructure and Low Impact Development based stormwater management regulations prioritizing runoff reduction have proliferated throughout the United States.

Where site conditions allow, infiltration is typically the most cost effective and reliable runoff reduction approach. In urban environments where there are competing demands for land, subsurface infiltration can provide many of the benefits of landscape based systems but without requiring dedicated land area. Infiltration systems are commonly comprised of a pretreatment component designed to remove sediment, trash, and oil, followed by plastic, metal or concrete storage units surrounded by permeable stone creating a high voids storage gallery. Infiltration systems are typically designed to support vehicular loading and to withstand lateral pressures from surrounding soil that allows the overlying land to be used for virtually any non-building application.

Subsurface infiltration meets the objectives of LID by reducing runoff with the added benefit of saving land space in urban environments.

LID benefits include runoff volume reduction, peak flow control, ground water recharge, and water quality improvement.

CMP infiltration is used at Pitzer College in Claremont, California.

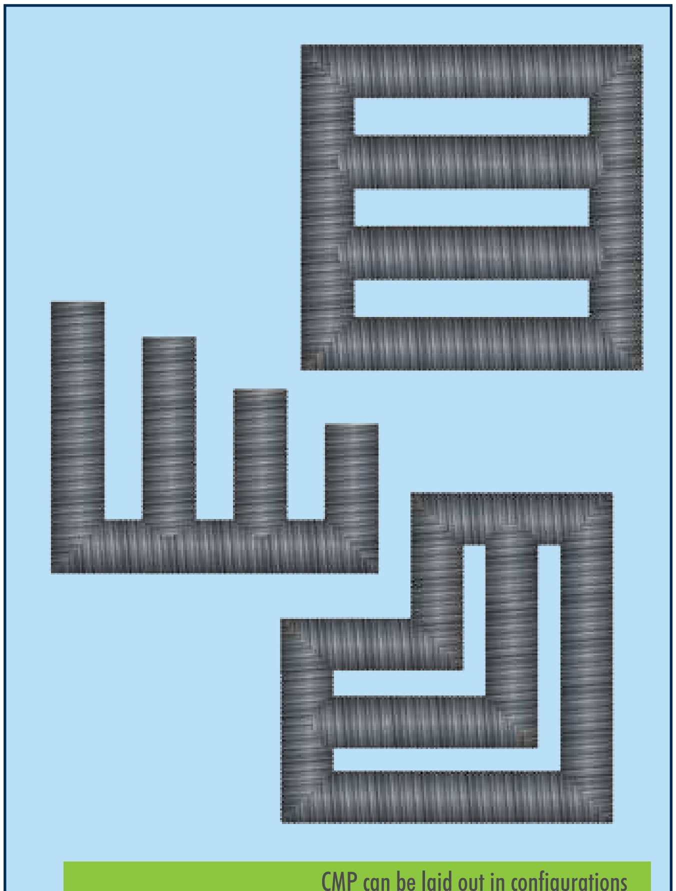
CMP – the "Go To" Material for Subsurface Infiltration

The purpose of the storage vessel is to hold stormwater runoff underground while allowing it to infiltrate the surrounding soil. For the majority of applications, corrugated metal pipe (CMP) is the "go to" material for subsurface infiltration.

- 75+ year service life guidance for certain materials/ coatings in recommended environments.* Please refer to the Corrugated Metal Pipe Detention Design Guide for additional information.
- Various pipe coatings and materials are available to accommodate site-specific needs: Aluminized Steel Type 2 (ALT2), Galvanized, CORLIX® Aluminum, and Polymer Coated.
- Wide range of gages, corrugations, and shapes, in diameters 12" – 144".
- Pipe can be fully or partially perforated for infiltration, retention, or groundwater recharge applications.
- Custom access risers and manifolds provide direct access for maintenance.
- Outlet control devices can be incorporated within the system, eliminating the need for a separate structure.
- Customizable - a variety of fittings allow CMP to match most layout configurations.
- May be designed for heavy loading and high maximum cover.
- Contributes to LEED points.
- Available locally; quick turnaround time.
- The most economical installed solution.

With its low cost, a wide variety of diameters, layout configurations, and materials, no other material can match CMP's flexibility and versatility.

* Service life guidance provided by National Corrugated Steel Pipe Association (NCSPA) and/or AK Steel Corporation. See NCSPA.org website or consult your engineer of record for additional information on service life, recommended environments and field studies on various materials and coatings. Corrosive environments, such as seawater and road/de-icing salt infiltration, and other environments with pH and resistivity outside of the recommended range may cause premature corrosion and reduce actual service life. Because site conditions vary, Contech does not guaranty or warrant service life guidance for materials and coatings.



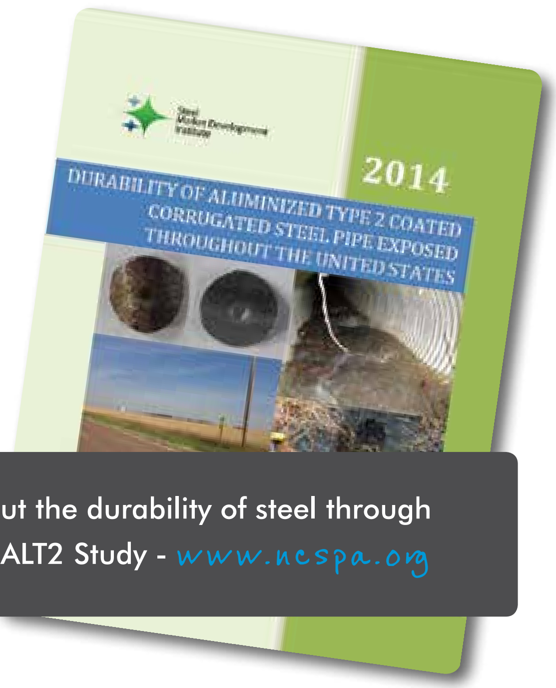
CMP can be laid out in configurations not achievable with other materials.

A wide range of CMP diameters and coatings are available to meet site specific needs.

Addressing the Question of Longevity

Some engineers are hesitant to use corrugated metal pipe (CMP) for infiltration because they have heard about CMP drainage culverts that have corroded due to abrasion. Factors affecting longevity differ between culvert and infiltration applications. Culverts experience high velocity flows carrying abrasive sediment, which can wear off galvanized coatings used in older CMP culverts. Infiltration systems are designed for storage rather than conveyance, so velocity and abrasive forces are minimized. In addition, improved CMP coatings, such as Aluminized Type 2 (ALT2), are more abrasion resistant and have demonstrated superior in-ground performance against abrasion in long-term durability studies. Field studies also have indicated that ALT2 coating may extend service life in wider pH and resistivity ranges than galvanized coatings. Confirming and maintaining recommended environmental conditions helps ensure system longevity projected by the long term studies. Finally, properly designed infiltration systems include pretreatment, flow control and a stone backfill envelope that can reduce exposure to abrasion.

CMP has a proven service life



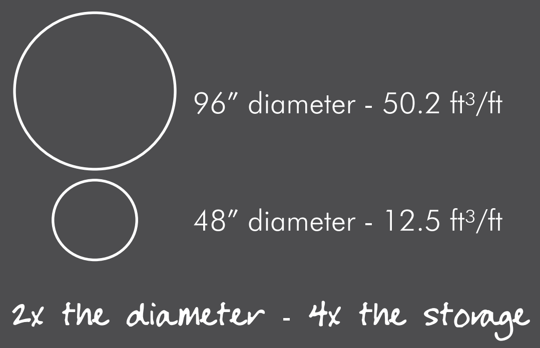
Learn more about the durability of steel through the recent NCSPA ALT2 Study - www.ncspa.org

- National Corrugated Steel Pipe Association (NCSPA) service life guidance of 75+ years for certain materials/coatings in recommended environments.
- CMP infiltration systems can be designed to meet HS-20 or greater load requirements with proper depths of cover.
- With low flows, CMP infiltration systems have little susceptibility to abrasion inside the pipe that holds stormwater runoff.
- Various pipe coatings and materials are available to accommodate site-specific needs: Aluminized Steel Type 2 (ALT2), Galvanized, CORLIX® Aluminum, and Polymer Coated.
- CMP infiltration systems are to be surrounded by clean crushed rock to provide increased storage capacity and reduce contact with native soils. The entire system may be wrapped with fabric or liner on the sides and top to help further reduce contact with native soils.
- CMP infiltration systems may be used in wide range of recommended environments. AK Steel Corporation's field studies and technical guidance indicate 75 year service life guidance for 16 gage ALT2 for pH of 5-9 and resistivity greater than 1,500 ohm-cm and 100 year service life guidance for 16 gage ALT2 for pH of 6-8 and resistivity greater than 5,000 ohm-cm.
- Corrosive environments, such as seawater and road/de-icing salt infiltration, acidic minewater, and sanitary sewage, and other environments with pH and resistivity outside of the recommended range may cause premature corrosion and reduce actual service life.
- Infiltration systems are to be inspected and maintained in accordance with Contech's guidelines. See Corrugated Metal Pipe Detention Design Guide for additional information on CMP infiltration systems.

Maximizing Vertical Space: Every Inch Counts

One of the most overlooked advantages of CMP is its ability to maximize vertical storage space.

Increasing the depth of a CMP infiltration system allows for more water storage in the same footprint. For example, doubling the diameter of pipe yields four times as much storage volume in the pipe. This provides a significant cost savings per cubic foot of storage. In addition, more vertical storage space means a smaller footprint, less excavation, and lower project costs.



Contech's Corrugated Metal Pipe Detention systems maximize vertical storage space.

Sizing

Round Pipe – CMP → 6-in to 144-in

Diameter (inches)	Volume (ft^3/ft)	Min. Cover Height	Diameter (inches)	Volume (ft^3/ft)	Min. Cover Height
12	.78	12″	78	33.2	12″
15	1.22	12″	84	38.5	12″
18	1.76	12″	90	44.2	12″
21	2.40	12″	96	50.3	12″
24	3.14	12″	102	56.8	18″
30	4.9	12″	108	63.6	18″
36	7.1	12″	114	70.9	18″
42	9.6	12″	120	78.5	18″
48	12.6	12″	126	86.6	18″
54	15.9	12″	132	95.0	18″
60	19.6	12″	138	103.9	18″
66	23.8	12″	144	113.1	18″
72	28.3	12″			

The Need for Effective Pretreatment

Infiltration systems have multiple components, and one of the most important is pretreatment. The purpose of a pretreatment device is to prolong the life of the infiltration system by removing debris and sediment that can collect on the invert and within the stone backfill voids. Pretreatment will maintain the efficiency of an infiltration system as well as extend the life cycle, therefore preventing a premature replacement. Pretreatment also offers these additional benefits:

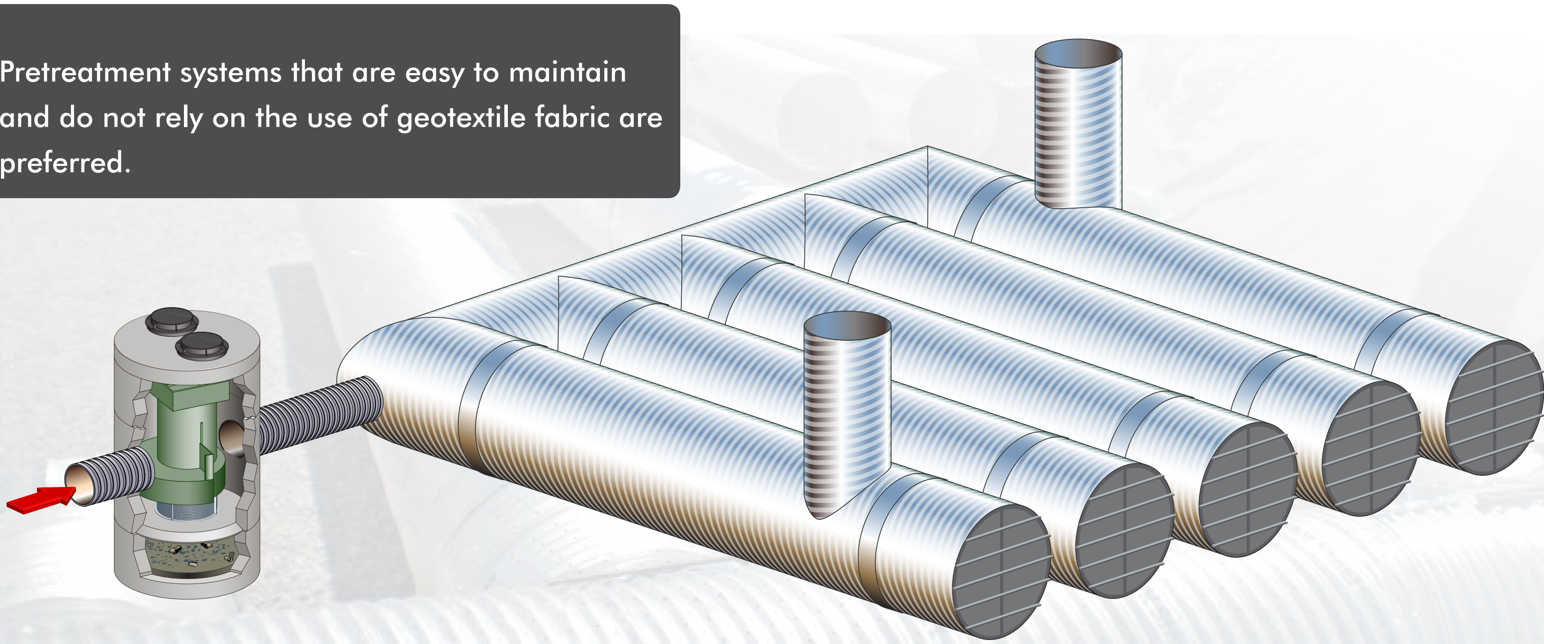
- Easier to clean and maintain compared to the infiltration system itself.
- Cost savings due to the extended service life of the system.
- Removing trash and debris protects downstream outlet control structures from clogging.

Pretreatment Design Considerations

When choosing a pretreatment system, it is important to consider the following:

- Downstream outlet control structures may require protection from a pretreatment device that screens trash and debris.
- Pretreatment system selection depends on pollutant targets. Trash, debris, and larger particles can be removed with hydrodynamic separators. Removing high percentages of fine particles and associated heavy metals and nutrients requires filtration.
- Reduced long term maintenance or replacement cost of the infiltration system can help justify pretreatment construction costs.
- Inlet and pipe layout will influence the number and type of pretreatment systems used. A combination of different systems may be appropriate for the various inlet locations and flows.

Pretreatment systems that are easy to maintain and do not rely on the use of geotextile fabric are preferred.

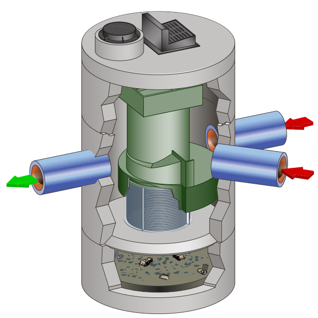


Learn more at www.ContechES.com/cmp-detention

Pretreatment Options

Contech offers a number of pretreatment options, all of which will extend the life of subsurface infiltration systems and improve water quality. The type of system chosen will depend on a number of factors including footprint, soil conditions, local regulations, and the desired level of pretreatment.

CDS provides direct access to cleaning, and the built-in high flow bypass weir eliminates the need for a separate bypass structure.

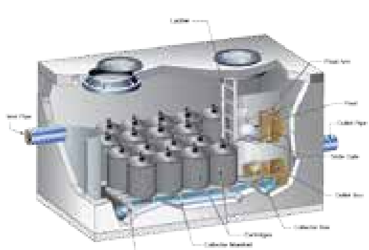


Hydrodynamic Separation

Hydrodynamic Separation (HDS) provides a basic level of pretreatment by capturing and retaining trash and debris, sediment, and oil from stormwater runoff.

CDS®

The CDS uses a combination of swirl concentration and indirect screening and is the only non-blocking screening technology available in an HDS system.



Filtration

Filtration provides a higher level of pretreatment and improved water quality by removing trash and debris, oil, fine solids, and dissolved pollutants such as metals, hydrocarbons, and nutrients.

Filterra® Bioretention System

Filterra is an engineered bioretention system that has been optimized for high volume/flow treatment and high pollutant removal.

The Stormwater Management StormFilter®

The StormFilter system is comprised of a structure that houses rechargeable, media-filled cartridges. The media can be customized to target site-specific pollutants.

Jellyfish® Filter

The Jellyfish filter uses membrane filtration in a compact footprint to remove a high level and a wide variety of stormwater pollutants such as fine particulates, oil, trash and debris, metals, and nutrients.

Alternative Materials for Subsurface Infiltration

There may be instances where alternative materials are needed for subsurface infiltration due to site specific needs.

Plastic Chambers

Plastic chambers are best suited to shallow depth applications; minimum cover is 18 inches, and maximum cover is 96 inches. Some benefits of chambers are:

- Chambers may be beneficial for sites with limited vertical storage.
- Lightweight and installed by hand.
- Heavy equipment is not required to set units into place.
- Centralized stocking locations for short lead times.

Concrete Structures/Vaults

Some concrete structures and vaults are best suited for high loading applications such as railroads or airports. Concrete units are also ideal in corrosive environments or areas with high salinity. Some benefits of concrete structures are:

- Wide range of spans and heights.
- Greater underground infiltration storage in a smaller footprint.
- Ample and easy maintenance access.
- Fast installation.

Project Profiles: CMP Infiltration Systems in Action

Edie and Lew Wasserman Building, UCLA

Westwood, California

- The new six-story, 100,000 square foot Edie and Lew Wasserman Building was built on a very dense site that needed to meet sustainability requirements.
- The design needed to maximize infiltration volume, match existing inverts, and work around existing utilities.
- The stormwater management systems included a CDS pretreatment system and a CMP infiltration system using 57′ of 72″ perforated CMP.
- Perforated CMP was selected to avoid utilities, minimize excavation, meet the City of LA LID requirements, contribute to the building's LEED certification, and to provide space for the buildings "outdoor room" and gardens.

Creative Office Space

El Segundo, California

- A stormwater infiltration solution was needed for a new group of office buildings.
- The owner wanted to maximize the use of the parking area in the urban setting.
- The site had a tight footprint and multiple utility constraints, requiring the design of five separate systems.
- A total of 860 LF of perforated CMP was installed providing of 25,265 CF of storage.
- Perforated CMP was selected for its design flexibility, cost effectiveness, and ease of installation.

City Center Regional Stormwater Facility

Mountlake Terrace, Washington

- The city of Mountlake Terrace, Washington needed a new stormwater retention facility to provide stormwater treatment and downstream flood control.
- There was limited footprint for 80,000 CF of runoff, and the system was required to be very deep, with about 15′ of cover.
- Engineers designed a system consisting of a CDS pretreatment system in front of 800 linear feet of 120″ diameter, perforated, aluminized type 2 CMP that allows the runoff to slowly infiltrate the surrounding soil.
- Perforated CMP was selected for its ability to accommodate the deep bury, the relatively small footprint, and cost effectiveness.

The Right Partner Can Make All the Difference

Regardless of your project's objectives and constraints, our team of stormwater design engineers, regulatory managers, and local stormwater consultants are here to provide you with expert advice and assistance. If your goal is to eliminate or detain runoff, you can rely on Contech for a wide range of subsurface infiltration, detention, and rainwater harvesting solutions. If treatment is needed, our landscape-based biofiltration or subsurface filtration designs can fit into virtually any site and can be tailored to address specific pollutants.

At every stage of your project, count on Contech to provide engineering services including:

- Regulatory guidance and permitting assistance
- Preliminary standard details and/or site specific final CAD drawings and specifications
- Low Impact Development design assistance
- Engineering calculations for hydraulics/hydrology, rainwater harvesting, and detention/retention
- Online "Design Your Own" tools
- Review of preliminary site design, feasibility screening, and layout assistance
- Value engineering – cost estimates and options analysis
- Pre-construction support, project scheduling, and contractor coordination
- Installation and construction support
- Maintenance support:
    - » Guidance manuals
    - » Demonstrations
    - » Qualified contractor identification

The result: an efficient design process, the right product, greater land space savings, and faster permitting. The entire Contech stormwater team welcomes the opportunity to work with you on your stormwater projects.

To get started, please visit www.conteches.com/localresources or call us at 800-338-1122.

Dig Deeper

Find all the information you need at www.ContechES.com, including field and laboratory test results, approvals, brochures, design guides, standard details, and specifications within the product section of our site.

Connect with Us

We're here to make your job easier – and that includes being able to get in touch with us when you need to. Go to www.ContechES.com/ConnectwithContech.

While you're there, be sure to check out our upcoming seminar schedule or request an in-house technical presentation.

Start a Project

If you are ready to begin a project, contact your local representative to get started. Or you can check out our design toolbox for all our online resources at www.ContechES.com/designtoolbox.

Links to Stormwater Tools:

To use the Land Value Calculator, visit: www.ContechES.com/lvc
(Look under the Stormwater Management section to download the Land Value Calculator)

To use the Design Your Own Detention System tool, visit: www.ContechES.com/dyods

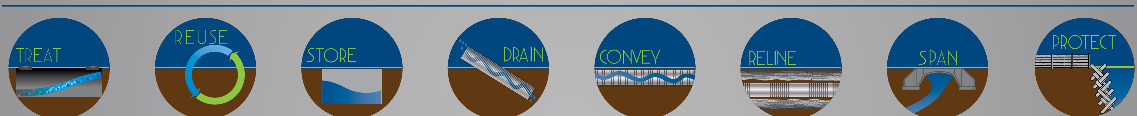
To use the Design Your Own Hydrodynamic Separator tool, visit: www.ContechES.com/dyohds

To use the Rainwater Harvesting Runoff Reduction Calculator tool, visit: www.ContechES.com/rwh-calculator

To use the LID Site Planner , visit: www.ContechES.com/LIDsiteplanner

CONTECH® ENGINEERED SOLUTIONS

COMPLETE SITE SOLUTIONS



Stormwater Solutions
Helping to satisfy stormwater management requirements on land development projects
- Stormwater Treatment
- Detention/Infiltration
- Rainwater Harvesting
- Biofiltration/Bioretention

Pipe Solutions
Meeting project needs for durability, hydraulics, corrosion resistance, and stiffness
- Corrugated Metal Pipe (CMP)
- Steel Reinforced Polyethylene (SRPE)
- High Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)

Structures Solutions
Providing innovative options and support for crossings, culverts, and bridges
- Plate, Precast & Truss bridges
- Hard Armor
- Retaining Walls
- Tunnel Liner Plate

CONTECH® ENGINEERED SOLUTIONS

Get Social With Us!

We print our brochures entirely on Forest Stewardship Council certified paper. FSC certification ensures that the paper in our brochures contain fiber from well-managed and responsibly harvested forests that meet strict environmental and socioeconomic standards.

FSC

CMP Infiltration Bro 5M 2/17

Description

Retention/irrigation refers to the capture of stormwater runoff in a holding pond and subsequent use of the captured volume for irrigation of landscape of natural pervious areas. This technology is very effective as a stormwater quality practice in that, for the captured water quality volume, it provides virtually no discharge to receiving waters and high stormwater constituent removal efficiencies. This technology mimics natural undeveloped watershed conditions wherein the vast majority of the rainfall volume during smaller rainfall events is infiltrated through the soil profile. Their main advantage over other infiltration technologies is the use of an irrigation system to spread the runoff over a larger area for infiltration. This allows them to be used in areas with low permeability soils.

Capture of stormwater can be accomplished in almost any kind of runoff storage facility, ranging from dry, concrete-lined ponds to those with vegetated basins and permanent pools. The pump and wet well should be automated with a rainfall sensor to provide irrigation only during periods when required infiltration rates can be realized. Generally, a spray irrigation system is required to provide an adequate flow rate for distributing the water quality volume (LCRA, 1998). Collection of roof runoff for subsequent use (rainwater harvesting) also qualifies as a retention/irrigation practice.

This technology is still in its infancy and there are no published reports on its effectiveness, cost, or operational requirements. The guidelines presented below should be considered tentative until additional data are available.

California Experience

This BMP has never been implemented in California, only in the Austin, Texas area. The use there is limited to watersheds where no increase in pollutant load is allowed because of the sensitive nature of the watersheds.

Advantages

- Pollutant removal effectiveness is high, accomplished primarily by: (1) sedimentation in the primary storage facility; (2) physical filtration of particulates through the soil profile; (3) dissolved constituents uptake in the vegetative root zone by the soil-resident microbial community.

Design Considerations

- Soil for Infiltration
- Area Required
- Slope
- Environmental Side-effects

Targeted Constituents

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

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

FLEXSTORM® CATCH-IT® REUSABLE INLET PROTECTION

SPECIFY WITH CONFIDENCE

State DOTs and Municipalities across the country now have a universal structural BMP to address the issue of storm sewer inlet protection: FLEXSTORM CATCH-IT Inlet Filters—the temporary *and* reusable solution.

The FLEXSTORM CATCH-IT system is the preferred choice for temporary inlet protection and storm water runoff control. FLEXSTORM CATCH-IT Inlet Filters will fit any drainage structure and are equipped with high-efficiency filter bags. Whether you're the specifier or the user, it's clear to see how FLEXSTORM CATCH-IT Inlet Filters outperform the competition.

APPLICATIONS:

DOT	Road Construction
Commercial	Parking Lots
Industrial	Maintenance
Residential Developments	

FEATURES:

- **Configurable:** steel frames configured and guaranteed to fit ANY storm drainage structure
- **Adjustable:** although shipped to fit your inlet, rectangular framing may be field adjusted in 1/2" increments if necessary
- **Reusable:** galvanized framing will last year after year in harsh conditions, while geotextile filter bags are easily replaced after several years of use
- **Effective:** works below grade; overflow feature allows streets to drain with full bag; third party testing results of the FX filter bag show 82% Filtration Efficiency
- **Affordable:** low per-unit cost; installs in seconds; easily maintained with Universal Removal Tool (no machinery required)

BENEFITS:

- Reduce jobsite flooding and keep projects running
- Minimize residential complaints with cleaner, dryer streets during all construction phases
- Prevent hazardous road icing conditions by eliminating ponding at curb inlets
- Significantly reduce cleanup costs
- Prevent siltation and pollution of rivers, lakes, and ponds
- Helps prevent fines; NPDES PHASE II Compliant
- Lowest cost alternative for the highest level of Inlet Protection
- Available through 5,000 ADS distributors nationwide
- Ships within 48 hours

ADS Service:
ADS representatives are committed to providing you with the answers to all your questions, including selecting the proper filter, specifications, installation and more. Also try the ADS FLEXSTORM Online Product Configurator at www.inletfilters.com

*The Most **Advanced** Name in Drainage Systems®*

FLEXSTORM CATCH-IT INLET FILTERS SPECIFICATION

IDENTIFICATION

The installer shall inspect the plans and/or worksite to determine the quantity of each drainage structure casting type. The foundry casting number, exact grate size and clear opening size, or other information will be necessary to finalize the FLEXSTORM part number and dimensions. The units are shipped to the field configured precisely to fit the identified drainage structure.

MATERIAL AND PERFORMANCE

The FLEXSTORM Inlet Filter system is comprised of a corrosion resistant steel frame and a replaceable geotextile filter bag attached to the frame with a stainless steel locking band. The filter bag hangs suspended at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment. The standard Woven Polypropylene FX filter bags are rated for 200 gpm/sqft with a removal efficiency of 82% when filtering a USDA Sandy Loam sediment load. The Post Construction PC filter bags are rated for 137 gpm/sqft and have been 3rd party tested at 99% TSS removal to 110 micron and 97% TPH removal of used motor oil hydrocarbon mix.

INSTALLATION

Remove the grate from the casting or concrete drainage structure. Clean the ledge (lip) of the casting frame or drain- age structure to ensure it is free of stone and dirt. Drop in the FLEXSTORM Inlet Filter through the clear opening and be sure the suspension hangers rest firmly on the inside ledge (lip) of the casting. Replace the grate and confirm it is elevated no more than 1/8", which is the thickness of the steel hangers. For wall mount units, follow instructions for attaching the stainless steel mounting brackets using the provided concrete fasteners.

INSPECTION FREQUENCY

Construction site inspection should occur following each 1/2" or more rain event. Post Construction inspections should occur three times per year (every four months) in areas with mild year round rainfall and four times per year (every three months Feb-Nov) in areas with summer rains before and after the winter snowfall season. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than three times per year.

MAINTENANCE GUIDELINES

Empty the filter bag if more than half filled with sediment and debris, or as directed by the Engineer. Remove the grate, engage the lifting bars or handles with the FLEXSTORM Removal Tool, and lift from the drainage structure. Dispose of the sediment or debris as directed by the Engineer or Maintenance Contract in accordance with EPA guidelines.

As an alternative, an industrial vacuum may be used to collect the accumulated sediment. Remove any caked on silt from the sediment bag and reverse flush the bag with medium spray for optimal filtration. Replace the bag if torn or punctured to 1/2" diameter or greater on the lower half of the bag.

FILTER BAG REPLACEMENT

Remove the bag by loosening or cutting off the clamping band. Take the new filter bag, which is equipped with a stainless steel worm drive clamping band, and use a screw driver to tighten the bag around the frame channel. Ensure the bag is secure and that there is no slack around the perimeter of the band.

Lift Handles ease installation and maintenance

Replaceable Sediment Bag

1/8" thick steel hangers& channels; precision stampings **configured to fit each individual casting**

CAD drawings, work instructions and test reports on website: ***www.inletfilters.com***

For more information on FLEXSTORM Inlet Filters and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710
Try the ADS FLEXSTORM Online Product Configurator at www.inletfilters.com.

The Most Advanced Name in Drainage Systems®

Advanced Drainage Systems, Inc.
1-800-821-6710 www.ads-pipe.com

FLEXSTORM www.inletfilters.com

Description

Retention/irrigation refers to the capture of stormwater runoff in a holding pond and subsequent use of the captured volume for irrigation of landscape of natural pervious areas. This technology is very effective as a stormwater quality practice in that, for the captured water quality volume, it provides virtually no discharge to receiving waters and high stormwater constituent removal efficiencies. This technology mimics natural undeveloped watershed conditions wherein the vast majority of the rainfall volume during smaller rainfall events is infiltrated through the soil profile. Their main advantage over other infiltration technologies is the use of an irrigation system to spread the runoff over a larger area for infiltration. This allows them to be used in areas with low permeability soils.

Capture of stormwater can be accomplished in almost any kind of runoff storage facility, ranging from dry, concrete-lined ponds to those with vegetated basins and permanent pools. The pump and wet well should be automated with a rainfall sensor to provide irrigation only during periods when required infiltration rates can be realized. Generally, a spray irrigation system is required to provide an adequate flow rate for distributing the water quality volume (LCRA, 1998). Collection of roof runoff for subsequent use (rainwater harvesting) also qualifies as a retention/irrigation practice.

This technology is still in its infancy and there are no published reports on its effectiveness, cost, or operational requirements. The guidelines presented below should be considered tentative until additional data are available.

California Experience

This BMP has never been implemented in California, only in the Austin, Texas area. The use there is limited to watersheds where no increase in pollutant load is allowed because of the sensitive nature of the watersheds.

Advantages

- Pollutant removal effectiveness is high, accomplished primarily by: (1) sedimentation in the primary storage facility; (2) physical filtration of particulates through the soil profile; (3) dissolved constituents uptake in the vegetative root zone by the soil-resident microbial community.

Design Considerations

- Soil for Infiltration
- Area Required
- Slope
- Environmental Side-effects

Targeted Constituents

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

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

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.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

Designing New Installations

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

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.

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

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

Conserve Natural Areas during Landscape Planning

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

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.

- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.

- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.

- Promote natural vegetation by using parking lot islands and other landscaped areas.

- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.

- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

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

Protection of Slopes and Channels during Landscape Design

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

Redeveloping Existing Installations

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

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

Other Resources

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

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

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

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

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

Roof Runoff Controls SD-11

Rain Garden

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

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

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

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

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

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

Dry wells and Infiltration Trenches

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

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

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

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

Pop-up Drainage Emitter

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

Foundation Planting

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

Redeveloping Existing Installations

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

Supplemental Information

Examples

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

Other Resources

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

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

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

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.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

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

Redeveloping Existing Installations

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

Other Resources

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

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

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

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

Storm Drain Signage SD-13

Design Objectives

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

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

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

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

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

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

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

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

– 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.

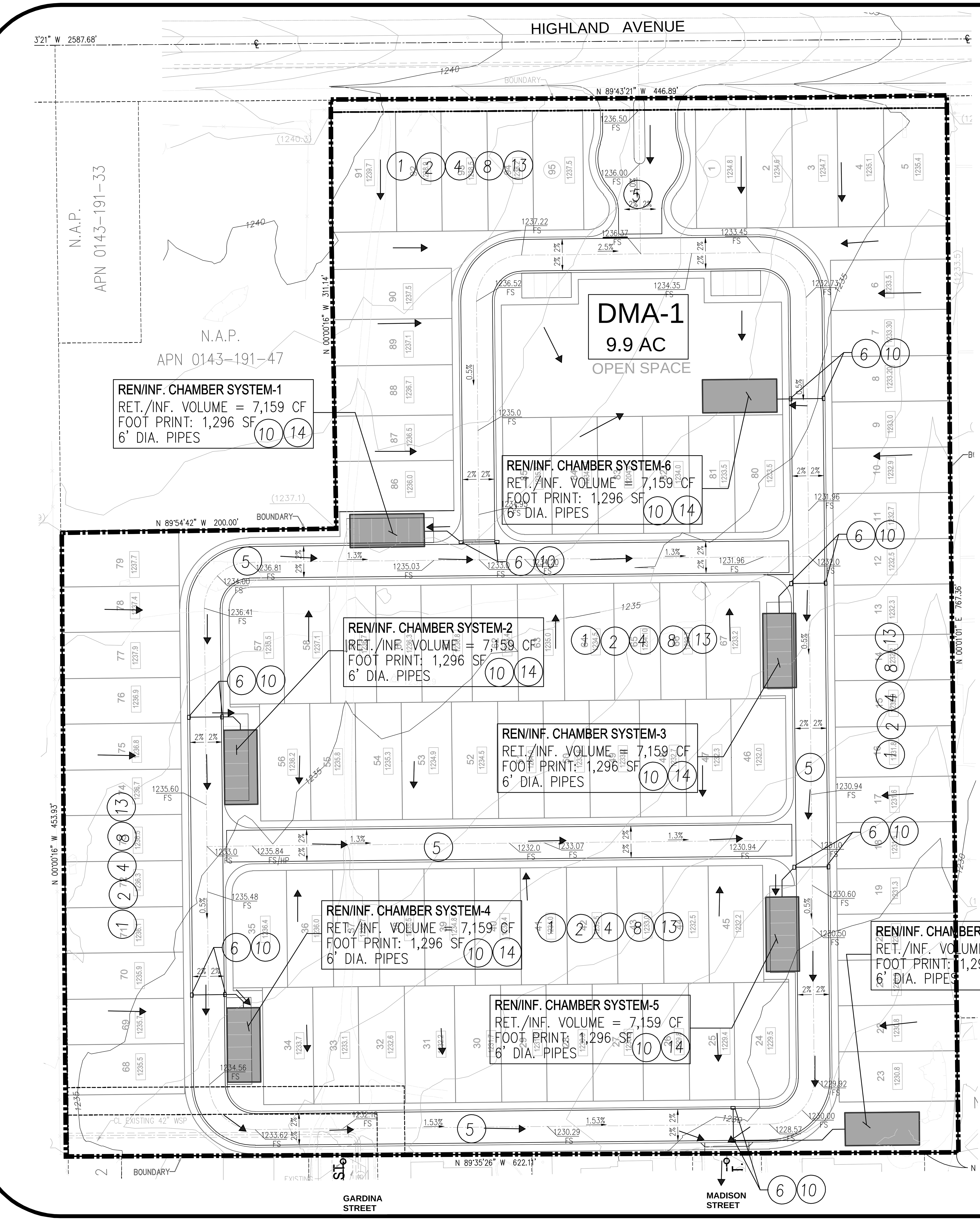
Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

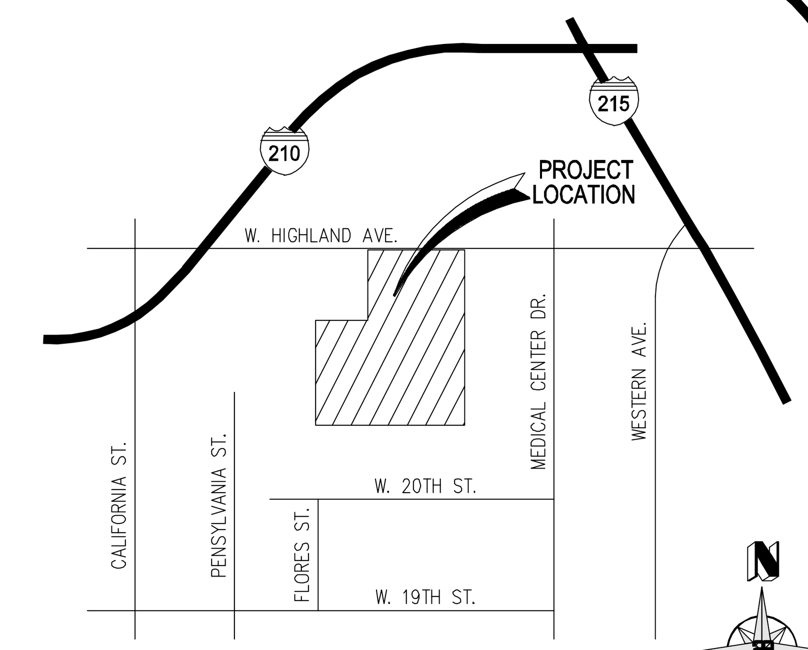
Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

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

Site Plan

(WQMP Exhibit)





VICINITY MAP
NOT TO SCALE

DRAINAGE AREA	PROPOSED BMP	AREA (AC)	DESIGN CAPTURE VOL. (CF)	PROVIDED VOL. (CF)	TOTAL MITIGATED VOLUME (CF)
DMA-1	CONTECH CHAMBER SYSTEM 1 TO 7	9.9	31,682	50,253	50,253

DCV ACHEIVED WITH PROPOSED BMPs: 158%

BMP LIST:

1. EDUCATION OF PROPERTY OWNERS
2. HARDSCAPE AREA (CONCRETE PAVING)
3. LANDSCAPE AREA
4. TRAINING/EDUCATION PROGRAM
5. STREET/DRIVE WAY SWEEPING/VACUUMING
6. COMMON AREA CATCH BASIN INSPECTION
7. LANDSCAPE PLANNING (SD-10)
8. ROOF RUNOFF CONTROLS (SD-11)
9. EFFICIENT IRRIGAION (SD-12)
10. STORM DRAIN SIGNAGE (SD-13) PER CASQA STANDARD
11. OVERFLOW SPILLWAY
12. ENERGY DISSIPATERS
13. TRASH STORAGE AREAS (SD-32)
14. UNDERGROUND INFILTRATION/DETENTION CHAMBER SYSTEM (TC-11) * (6' DIA CONTECH CHAMBER SYSTEM)
15. GRATE INLET FILTER INSERT- ADS FLEXSTORM FILTER INSERT
16. 3-FT V-GUTTER PER CITY STD. PLAN 201.

* WQMP BMP NOT TO BE MODIFIED IN FUTURE
NO CLAY IN TOP 12" OF SOIL

GRAPHIC SCALE
40 0 20 40 80 160
(IN FEET)
1 INCH = 40 FT.

Prepared By:
ALLARD ENGINEERING
Civil Engineering - Land Surveying - Land Planning
16866 Seville Avenue
Fontana, California 92335
(909) 356-1815 Fax (909) 356-1795

Prepared For:
WARMINGTON RESIDENTIAL
3090 PULLMAN STREET
COSTA MESA, CA 92626
PH: (714) 557-5511

CITY OF SAN BERNARDINO, CA

WQMP EXHIBIT

W. HIGHLAND AVE / MEDICAL CENTER DR RESIDENTIAL

Filename: I:\Warmington Homes\Medical Center Drive San Bernardino\DWG's\ENTITLEMENT\EXHIBIT\WQMP.dwg