Appendix 1: Maps and Site Plans

Location Map, WQMP Site Plan and Receiving Waters Map

Appendix 2: Construction Plans

Grading and Drainage Plans

Appendix 3: Soils Information

Geotechnical Study and Other Infiltration Testing Data

INFILTRATION BASIN 1 AMENDED SOIL SPECIFICATIONS

- AMENDED SOIL TO HAVE A PH BETWEEN 5.5 TO 6.5., ORGANIC CONTENT BETWEEN 1.5% TO 3%, SAND CONTENT BETWEEN 45% TO 60%, AND CLAY CONTENT LOWER THAN 12%.

  CONTRACTOR SHALL SUBMIT SOIL TESTS RESULTS TO ENGINEER, ONE TEST PER BIO-CELL. TEST SHALL INCLUDE THE FOLLOWING:

  1) GRANULOMETRIC ANALYSIS (SAND, SILT AND CLAY) PER WEIGHT (SAND BETWEEN 45-60%; CLAY LESS THAN 12%)
  2) PH (5.5 TO 6.5)
  3) PERCENTAGE OR ORGANIC MATTER IN THE SOIL (1.5% TO 3%)
  4) DETERMINATION OF SOLUBLE SALT CONTENT (LESS THAN 500 PPM)
  5) SATURATED HYDRAULIC CONDUCTIVITY TEST (HIGHER THAN 0.5 IN/HR)
  6) DEPTH OF REMOVAL: 2.5 FEET

- MULCH PER LANDSCAPE PLANS AND SPECIFICATIONS. CONTRACTOR SHALL NOT ADD TOP SOIL TO INFILTRATION AREAS.

Letter from soils engineer forthcoming, he is preparing it as part of his soils investigation that will be included w/ Final

October 27, 2015

Project No. 15101-01

TO: Steven Walker Communities
7111 Indiana Avenue, Suite 300
Riverside, California 92504

SUBJECT: Basic Soil Infiltration Testing Report, Hawthorn Heights Project, Single-Family Homes, APN 227-130-025, City of Riverside, California

Introduction

This report provides a summary of the geotechnical engineering services conducted to support evaluation of the feasibility of infiltration at the subject site. The purpose of our services was to complete four insitu infiltration tests utilizing percolation testing procedure in boreholes to evaluate the feasibility of infiltration for disposal of stormwater runoff following the falling head method.

Available Documents

A site plan prepared by SDH and Associates was provided to us for 56 lot subdivision. The plan shows three possible locations for an infiltration basin(s).

Proposed Soil Infiltration Facility

Tentatively infiltration basin(s) are proposed.

Scope of Services

GeoMat Testing Laboratories, Inc. was retained to provide geotechnical engineering services to support the project. Our scope of work consisted of the following specific tasks:

1) Drill deep exploratory borehole.

2) Complete four infiltration tests at the site utilizing the shallow boring percolation testing per Riverside County Environmental Health Department procedures. The tests were completed in general accordance with the falling head method.

3) Complete laboratory gradation analysis and testing of selected soil sample.

4) Complete data analysis.

5) Preparation of this report summarizing our findings, conclusions, and recommendations. The report includes:

- Site plan showing the location of exploratory borehole and infiltration tests.
- Summary of site conditions observed at the testing locations.
- Results of the laboratory testing.
- Discussion of the results of insitu infiltration testing.
- A discussion of the surficial soil and anticipated groundwater conditions at the site.
- Evaluation of the feasibility of infiltration.
- Recommendations for infiltration facility.

Existing Site Conditions

Currently, the subject site is a vacated elementary school site. School buildings, school building equipment, asphalt and concrete pavement, school yard, storage sheds, etc. remains onsite. The site area is approximately 7(±) acres. The site is bordered from the north by Indiana Avenue, the south by railroad tracks, the east by group of older single family homes, and the west by vacant land. Indiana Avenue is a fully developed road.

Groundwater

Groundwater study is not within the scope of this work. Groundwater was not observed in the test borings at the time of field exploration. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations. Depth to groundwater is not expected to impact site development

State Department of Water Resources shows shallowest groundwater on November 2011 at 29.6 feet (elevation 754.5) below ground surface in well 339251N1174342W001.

The well measuring program for regional water Districts maintained by Hydrologist Steven Mains shows shallowest groundwater On January 2001 at 43 feet (elevation 768.3) below ground surface in well 3S5W07J002S and at 46.1 feet (elevation 759.6) below ground surface on June 2006 in well 3S5W18B.

The USGS Groundwater Watch website (http://groundwaterwatch.usgs.gov/countymap) was searched for groundwater records; none found.

The potential for rain or irrigation water locally seeping through from adjacent areas cannot be precluded. Our experience indicates that surface or near-surface groundwater conditions can develop in areas where groundwater conditions did not exist prior to site development, especially in areas where a substantial increase in surface water infiltration results from landscape irrigation and stormwater infiltration systems.

In addition, changes in local or regional water and management patterns, or both, can significantly raise the water table or create zones of perched water. We therefore recommend that landscape irrigation be kept to the minimum necessary to maintain plant vigor and any leaking pipes/sprinklers, etc. should be promptly repaired.

The depth to the groundwater may fluctuate with seasonal changes and from one year to the next. We have no way of predicting future groundwater levels or perched water due to increase in surface water infiltration from rainfall or from landscape irrigation. Subdrains, horizontal drains, toe drains, French drains, heel drains or other devices may be recommended in future for graded areas that exhibit nuisance water seepage, past evidence for shallow water, or areas with a potential for future shallow/surface water

Exploratory Boreholes

One deep exploratory borehole was drilled on October 24, 2015 to a maximum depth of 15 feet below ground surface. The boreholes were drilled utilizing a CME 45 drill rig equipped with 6 inch hollow stem augers. A field engineer from this office observed the drilling and prepared the boring logs. The logs of the boreholes are included with this report.

Soil Sampling and Laboratory Testing

Bulk soil samples were obtained from the bottom of percolation holes for laboratory classification. Laboratory sieve analysis was performed for the collected soil samples. The soil classifications are in conformance with the Unified Soil Classifications System (USCS), as outlined in the Classification and Symbols Chart (Appendix B).

A summary of our laboratory testing is presented in Appendix C.

Percolation Testing Method

The four test holes were drilled with a mobile drill rig. A 3-inch-diameter perforated PVC casing wrapped with filter fabric was placed in the borehole. Pea gravel was placed below and around the pipe for stability of the borehole.

The boreholes were presoaked prior to the percolation testing. Presoaking was conducted using five gallon water bottles. Five gallons of water was absorbed in few minutes in test holes P-2, P-3, and P-4. Additional presoaking water was introduced to facilitate for reasonable test reading interval. Based on field observations and testing, the material was evaluated to be permeable and met the sandy soil criteria. Infiltration testing was conducted on the same day after presoaking. Infiltration testing was conducted for at least one hour with readings taken 10 minutes apart from a fixed reference point. The measurements were taken by filling up the test hole with water and allowing the water to percolate. The drop of water level was recorded every 10 minutes. A wrist watch was used to record the time measurements.

Test hole P-1 did not meet the sandy soil criteria. Infiltration testing for this test hole was conducted the next day after presoaking. Testing was conducted for six hours with readings taken 30 minutes apart from a fixed reference point. The measurements were taken by filling up the test hole with water and allowing the water to percolate. The drop of water level was recorded every 30 minutes. A wrist watch was used to record the time measurements.

Infiltration Test Results

Infiltration tests were conducted betywеen 43 and 67 inches below ground surface. The following summarizes the result of the infiltration feasibility study.

Test No.	Depth Below Surface	Percolation Rate (in/hr)	Adjusted Infiltration Rate (in/hr)	% Passing No. 200 Sieve
P-1	43"	7.5	0.8	44
P-2	45"	24	2.5	42
P-3	52"	22.5	2.3	46
P-4	67"	72	10.3	48

The percolation rate is the rate in horizontal and vertical direction. This rate is adjusted using Porchet Method for horizontal water infiltration. Refer to Appendix D for test results.

A safety factor should be applied to this rate by the design engineer. Safety factor discussion is in the following paragraph.

Factors of Safety

Long-term infiltration rates may be reduced significantly by factors such as soil variability and inaccuracy in the infiltration rate measurement. The correction factor for site variability is between 3 and 10. Safety factors for operating the system, maintenance, siltation, biofouling, etc. should also be considered by the design civil engineer at his discretion. Minimum safety factor required by the County of Riverside for tests conducted when deep exploratory borehole has been drilled at the site is 3.

Conclusions/Recommendations

- In our opinion, water infiltration at the site is expected to be fast in the upper five feet of soil.
- The test results may be utilized when the bottom of the infiltration system will be located within the alluvial soil observed/tested. Should this system be located in a different soil type, the infiltration characteristics will be different than those observed during the infiltration testing. The infiltration rate recommended above is based on the assumption that only clean water will be introduced to the subsurface profile. Any fines, debris, or organic materials could significantly impact the infiltration rate.
- The planned infiltration system should extend vertically into native soil.
- Infiltration water should not be allowed to saturate subgrade of pavement, and shallow concrete structures including curb and gutter's subgrade soils. We recommend installing Stego wrap 15 mil barrier sheeting (or equivalent) around shallow concrete structures (ie curb, gutter, etc.) to the depth of proposed sub-base reservoir of porous pavement. The intent is to minimize saturating subgrades of such items.

- Filter fabric should be used whenever aggregates are placed against native soils.
- Please note that soils in infiltration areas should not be subject to compaction during construction.
- The proposed system by the civil engineer should be constructed and maintained in accordance with manufacturer guidelines.

An important consideration for infiltration facilities is that, during construction, great care must be taken not to reduce the infiltrative capacity of the soil in the facility through compaction by heavy equipment or by using the infiltration area as a sediment trap.

Infiltration facilities should be constructed late in the site development after soils (that might erode and clog the units) have been stabilized, or should be protected (by flagging) until site work is completed.

Infiltration facilities should be sited with the following guidelines:

INFILTRATION FACILITY SETBACKS	
Setback From	Distance
Property Lines and Public Right of Way	5 feet
Foundations	15 feet or within a 1:1 plane drawn up from the bottom of foundation
Slopes	H/2, 5 feet minimum (H: is slope height)
Private drinking water wells	100 feet

Ferrous metal pipes should be protected from potential corrosion by bituminous coating, etc. We recommend that all utility pipes be nonmetallic and/or corrosion resistant. Recommendations should be verified by soluble sulfate and corrosion testing of soil samples obtained from specific locations during construction.

If applicable, four to six inch diameter observation well(s), with locking cap, extending vertically into the system's bottom is suggested as an observation point. Observation well(s) should be checked regularly and after large storm event. Once performance stabilizes, frequency of monitoring may be reduced.

GeoMat Testing Laboratories should observe the basin excavation. Additional laboratory testing including but not limited to grain size analysis, sand equivalent, sulfate content, etc should be conducted during construction.

Use of this Report

This report was prepared for the exclusive use of the addressee and his consultants for specific application to the proposed site. The use by others, or for the purposes other than intended, is at the user's sole risk.

The findings, conclusions, and recommendations presented herein are based on our understanding of the project and on subsurface conditions observed during our site work. Within the limitations of scope, schedule, and budget, the conclusions and recommendations presented in this report were prepared in accordance with generally accepted geotechnical engineering principles and practices in the area at the time the report was prepared. We make no other warranty either expressed or implied.

We appreciate this opportunity to provide geotechnical services on this project and look forward to assisting the Project Team as the design progresses. If you have any questions or comments regarding the information contained in this report, or if we may be of further services, please call us at (951) 688-5400.

Submitted for GeoMat Testing Laboratories, Inc.

Haytham Nabilsi, GE 2375
Principal Engineer

Art Martinez
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
HAYTHAM NABILSI
No. 2375
Exp. 12/31/16
GEOTECHNICAL
STATE OF CALIFORNIA

Distribution: [3] Addressee

Attachments:	Figure 1	Site Location Map
	Plate 1	Infiltration Test Location Map
	Appendix A	References
	Appendix B	Exploratory Borehole Logs
	Appendix C	Laboratory Test Results
	Appendix D	Infiltration Data/Graph

DELORME

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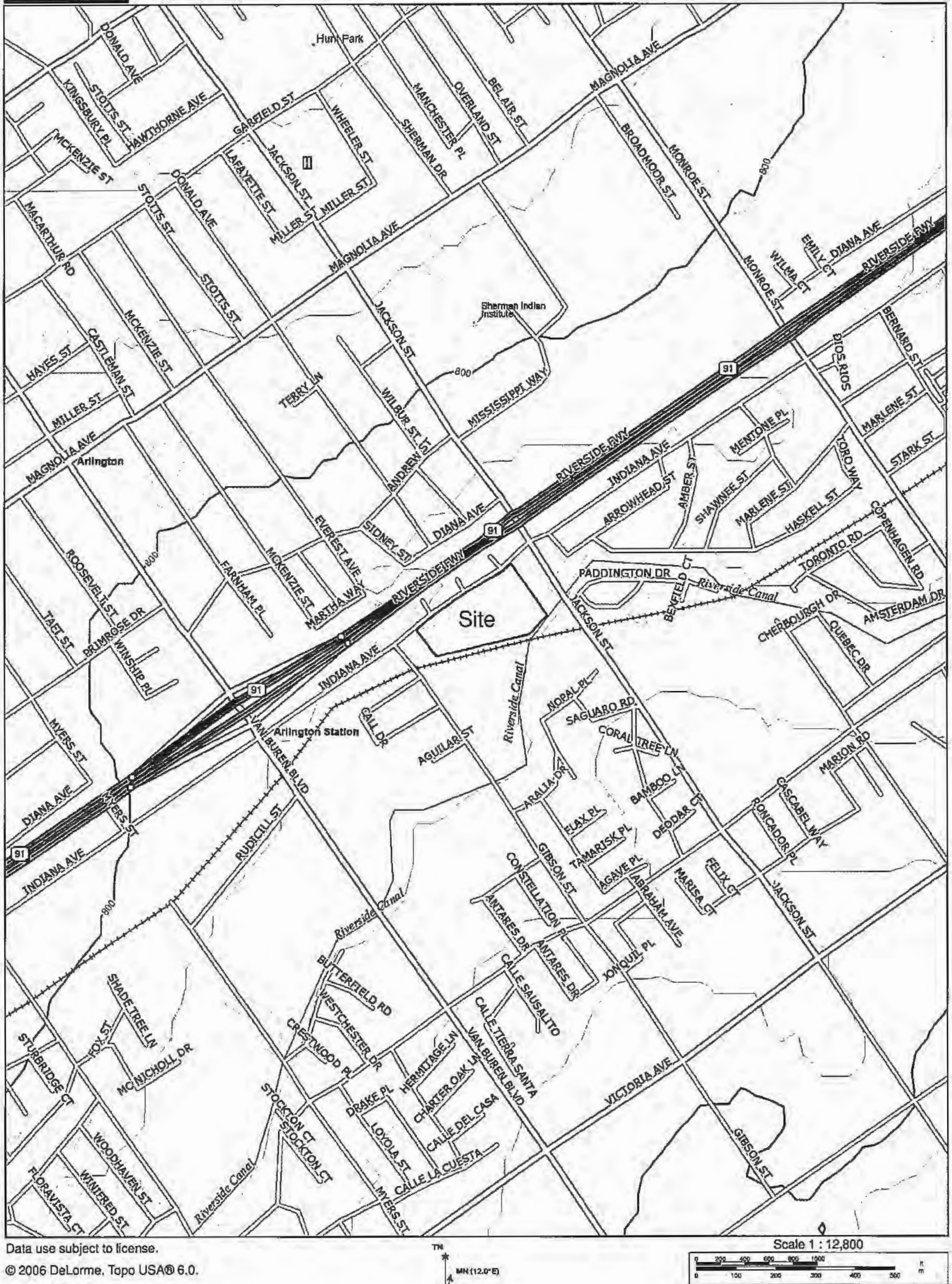


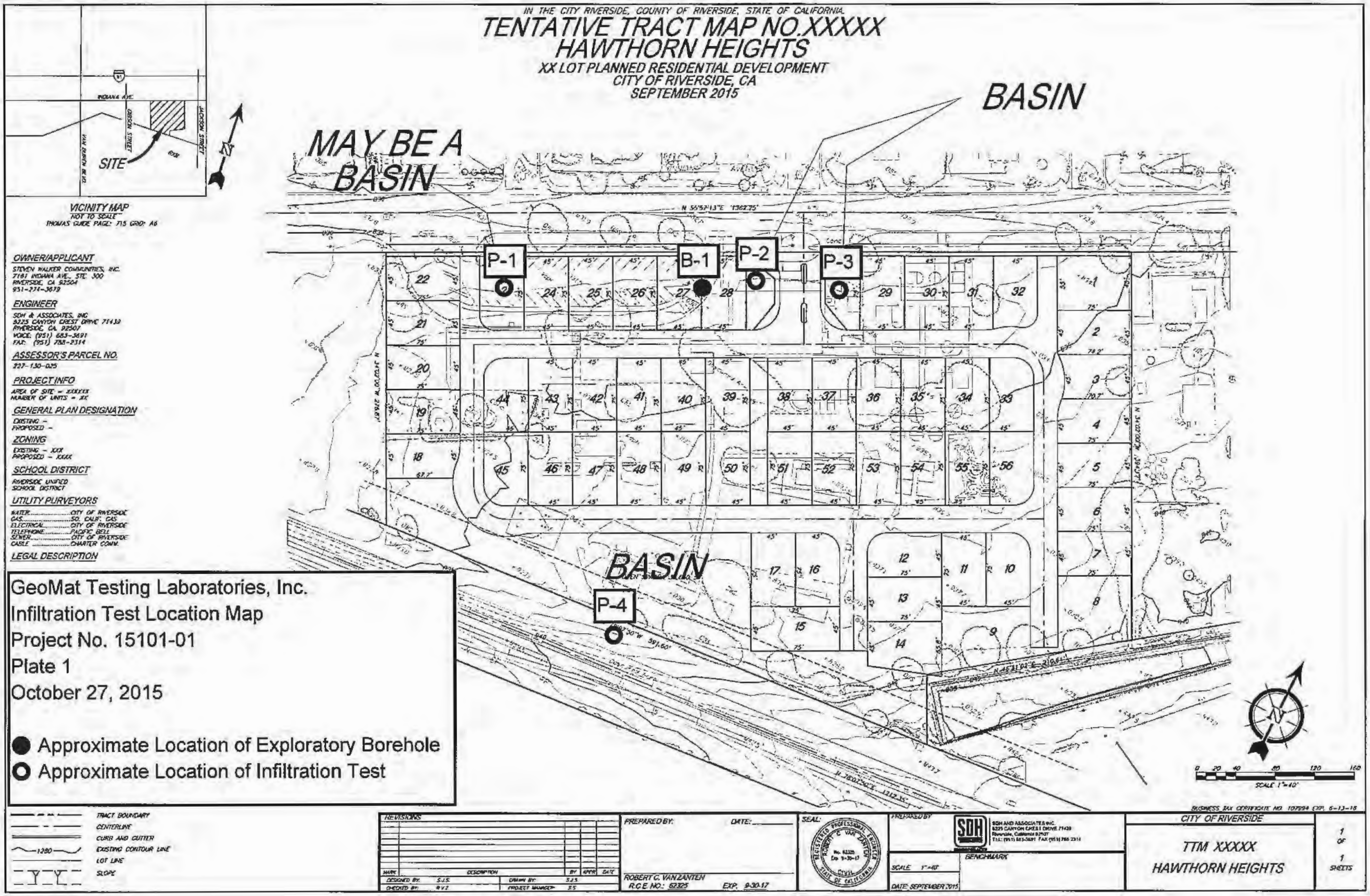
Data use subject to license.

www.delorme.com

Scale 1 : 12,800

1" = 1,066.7 ft

Data Zoom 14-0



IN THE CITY RIVERSIDE, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA
TENTATIVE TRACT MAP NO.XXXXX
HAWTHORN HEIGHTS
XX LOT PLANNED RESIDENTIAL DEVELOPMENT
CITY OF RIVERSIDE, CA
SEPTEMBER 2015
BASIN
MAY BE A BASIN
BASIN
P-1
B-1
P-2
P-3
P-4
SITE
VICINITY MAP
NOT TO SCALE
OWNER/APPLICANT
ENGINEER
ASSESSOR'S PARCEL NO.
PROJECT INFO
GENERAL PLAN DESIGNATION
ZONING
SCHOOL DISTRICT
UTILITY PURVEYORS
LEGAL DESCRIPTION
GeoMat Testing Laboratories, Inc.
Infiltration Test Location Map
Project No. 15101-01
Plate 1
October 27, 2015
Approximate Location of Exploratory Borehole
Approximate Location of Infiltration Test
TRACT BOUNDARY
CENTERLINE
CURB AND GUTTER
EXISTING CONTOUR LINE
LOT LINE
SLOPE
REVISIONS
PREPARED BY:
DATE:
ROBERT C. VANZANTEN
R.C.E NO.: 52325
EXP. 9-30-17
SEAL:
PREPARED BY
SDH
BENCHMARK
SCALE 1"=40'
DATE: SEPTEMBER 2015
CITY OF RIVERSIDE
TTM XXXXX
HAWTHORN HEIGHTS
1 OF 1 SHEETS

Appendix A

GeoMat

REFERENCES

SDH and Associates, Site Plan Showing 56 single family lots.

Riverside County, Stormwater Quality Best Management Practice, Design Handbook, July 21, 2006

Riverside County, Design handbook for Low Impact Development Best management Pactices, September 2011.

Riverside County, Water Quality Management Plan For Urban Runoff, Santa Ana River Region, Santa Margarita River Region, September 17, 2004

California Stormwater Quality Association, Stormwater Best Management Practice, Handbook, Jan. 2003.

California Department of Transportation, Stormwater Quality Handbook, Project Training and Design Guide, Sacramento, 2000.

California Department of Transportation, Stormwater Quality Handbook, Project Planning and Design Guide, Sacramento, 2005.

Federal Highway Administration, Urban Design Drainage Manual, Washington DC, 1996

Water Quality Control Plan, Santa Ana River Basin (8), California Regional Water Quality Control Board, Santa Ana Region, 1995,

Massmann, JW, Butchart, and S Stolar, Infiltration Characteristics, Performance, and Design of Stormwater Facilities, Final Research Report, Research Project TI 803, Task 12, Washington DOT 2003.

Soilvision Systems, A Knowledge-Based Soils Database, Murray Fredlund, Canada, 2004.

US Environmental Protection Agency, Storm water Technology Fact Sheet, Infiltration Trench, EPA 832-F-99-019, 1999.

California Stormwater Quality Association (QASCA), California Stormwater BMP Handbook, Infiltration Trench, TC-10 Design Considerations

BMP Handbook, Part B, Planning Activities, Stormwater Mitigation Measures, Watershed Protection Division, City of Los Angeles.

Appendix B

GENERAL NOTES

DRILLING NOTES

WATER LEVEL MEASUREMENTS

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels is not possible with only short-term observations.

WATER LEVEL OBSERVATION DESIGNATION

W.D.	While Drilling
A.B.	After Boring
B.C.R.	Before Casing Removal
A.C.R.	After Casing Removal
24 hr.	Water level taken approximately 24 hrs. after boring completion

DRILLING AND SAMPLING SYMBOLS

AS	Auger Sample
CS	Continuous Sampler
DB	Diamond Bit -NX unless otherwise noted
HA	Hand Auger
HS	Hollow Stem Auger
PA	Power Auger
RB	Rock Bit
SS*	Split-Barrel
ST	Shelby Tube - 2" (51mm) unless otherwise noted
WB	Wash Bore
CR	Calfornia Ring Sampler 3" O.D., Lined with 2.5"X1" Rings

*The Standard Penetration Test is conducted in conjunction with the split-barrel sampling procedure. The "N" value corresponds to the number of blows required to drive the last 1 foot (0.3m) of an 18 in. (0.46m) long, 2 in. (51mm) O.D. split-barrel sampler with a 140 lb. (63.5 kg) hammer falling a distance of 30 in. (0.76m). The Standard Penetration Test is carried out according to ASTM D-1586. (See "N" Value below.)

SOIL PROPERTIES & DESCRIPTIONS

TEXTURE

PARTICLE	SIZE	
Clay	< 0.002 mm	(< 0.002 mm)
Silt	< #200 Sieve	(0.075 mm)
Sand	#4 to #200 Sieve	(4.75 to 0.075 mm)
Gravel	3 in. to #4 Sieve	(75 mm to 4.75 mm)
Cobbles	12 in. to 3 in.	(300 mm to 75 mm)
Boulders	> 12 in.	(300 mm)

COMPOSITION

SAND & GRAVEL

Description	% by Dry Weight
trace	< 15
with	15 - 29
modifer	> 30

FINES

Description	% by Dry Weight
trace	< 5
with	5 - 12
modifier	> 12

Soil descriptions are based on the Unified Soil Classification System (USCS) as outlined in ASTM Designations D-2487 and D-2488. The USCS group symbol shown on the boring logs correspond to the group names listed below. The description includes soil constituents, consistency, relative density, color and other appropriate descriptive terms. Geologic description of bedrock, when encountered, also is shown in the description column.

GROUP SYMBOL	GROUP NAME	GROUP SYMBOL	GROUP NAME
GW	Well Graded Gravel	CL	Lean Clay
GP	Poorly Graded Gravel	ML	Silt
GM	Silty Gravel	OL	Organic Clay or Silt
GC	Clayey Gravel	CH	Fat Clay
SW	Well Graded Sand	MH	Elastic Silt
SP	Poorly Graded Sand	OH	Organic Clay or Silt
SM	Silty Sand	PT	Peat
SC	Clayey Sand	CL-CH	Lean to Fat Clay

COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (Qu) (psf)	(kPa)
Very Soft	< 500	(< 24)
Soft	500 - 1000	(24 - 48)
Medium	1001 - 2000	(48 - 96)
Stiff	2001 - 4000	(96 - 192)
Very Stiff	4001 - 8000	(192 - 383)
Hard	> 8001	(> 383)

PLASTICITY

Description	Liquid Limit (%)
Lean	< 45%
Lean to Fat	45 to 49%
Fat	≥ 50%

Cohessive Soils

Consistenacy	"N" value
Very Soft	<2
Soft	2-4
Medium	4-8
Stiff (Firm)	8-15
Very Stiff (Very Firm)	15-30
Hard	>30

COHESIONLESS SOILS

RELATIVE DENSITY	"N" VALUE*
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 49
Very Dense	≥ 50

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD)**

DESCRIPTION OF ROCK QUALITY	RQD (%)
Very Poor	0 - 25
Poor	25 - 50
Fair	50 - 75
Good	75 - 90
Excellent	90 - 100

**RQD is defined as the total length of sound core pieces, 4 inches (102mm) or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

DEGREE OF WEATHERING

Slightly Weathered	Slight decomposition of parent material in joints and seams.
Weathered	Well-developed and decomposed joints and seams.
Highly Weathered	Rock highly decomposed, may be extremely broken.

SOLUTION AND VOID CONDITIONS

Solid	Contains no voids.
Vuggy	Containing small pits or cavities < 1/2" (13mm).
Porous	Containing numerous voids which may be interconnected.
Cavernous	Containing cavities, sometimes quite large.

When classification of rock materials has been estimated from disturbed samples, core samples and petrographic analysis may reveal other rock types.

HARDNESS & DEGREE OF CEMENTATION

LIMESTONE

Hard	Difficult to scratch with knife.
Moderately Hard	Can scratch with knife but not with fingernail.
Soft	Can be scratched with fingernail.

SHALE

Hard	Can scratch with knife but not with fingernail.
Moderately Hard	Can be scratched with fingernail.
Soft	Can be molded easily with fingers.

SANDSTONE

Well Cemented	Capable of scratching a knife blade.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken apart easily with fingers.

BEDDING CHARACTERISTICS

TERM	THICKNESS (inches)	THICKNESS (mm)
Very Thick Bedded	> 36	> 915
Thick Bedded	12 - 36	305 - 915
Medium Bedded	4 - 12	102 - 305
Thin Bedded	1 - 4	25 - 102
Very Thin Bedded	0.4 - 1	10 - 25
Laminated	0.1 - 0.4	2.5 - 10
Thinly Laminated	< 0.1	< 2.5

Bedding Planes	Planes dividing the individual layers, beds or strata of rocks.
Joint	Fracture in rock, generally more or less vertical or transverse to the bedding.
Seam	Applies to bedding plane with an unspecified degree of weathering.

BORHOLE LOG

BH-1

		Sheet	1 OF 1
		Date	10/24/2015
Project No.	15101-01	Drilling Co.	GeoMat
Project	Steven Walker Homes - Hawthorne Heights	Sampler	Cal Mod. And SPT
Client	Steven Walker Homes	Method	Hollow Stem
Location	APN 227-130-025, Riverside, California	Hammer Type	140 lb
Coodinate		Surface Elev.	
Notes		Total Depth	15'

Type/Symbol	Casing	Split Spoon	Ring Sampler	Cutting	Date	Time	Water Depth (ft)	Casing Size (in)	Casing Depth (ft)	Hole Depth (ft)	Symbol
I.D.		S	R	C							
O.D.					10/24/2015		None				
Length											
Hammer Wt.											
Hammer Fall											

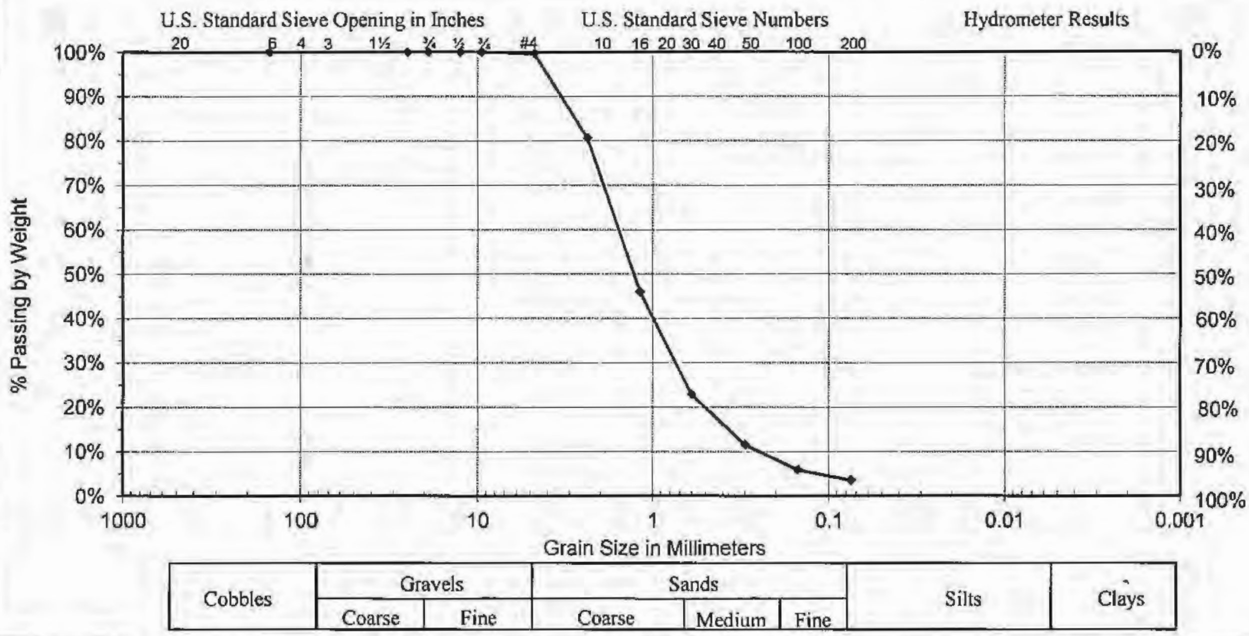
Depth Below Surface (ft)	Elevation (ft)	Graphic	Soil Sample: Type	Soil Sample: Number	Soil Sample: Symbol	Soil Sample: Depth	Blows: 0-152.4 mm	Blows: 152.4-304.8 mm	Blows: 304.8-457.2 mm	N-Value	N60	(N1)60	VISUAL MATERIAL CLASSIFICATION AND REMARKS	Moisture (%)	Dry Density (pcf)	Test
0													**SILTY SAND (SM)**			
1													medium brown silty sand, moist			
2																
3																
4																
5			R				4	5	7	8			loose	8	124	
6													becoming more coarse grained			
7																
8													**WELL-GRADED SAND (SW)**			
9													gray-brown sand with silt, dry			
10			R				5	8	11	12			medium dense	2	111	
11													% Passing No. 200 Sieve = 3			
12																
13																
14													**SILTY SAND (SM)**			
15			S				8	10	10	20			medium brown silty sand, moist	6		
16													medium dense			
17													% Passing No. 200 Sieve = 21			
18																
19																
20																
21																
22																
23																
24																

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

Appendix C

GeoMat

LABORATORY TEST RESULTS



Date: 10/24/15
Sample #:
Sample ID: B-1 @ 10'
Source: Cal Ring
Project: Steven Walker Communities - Hawthorne Heights
Location: APN: 227-130-025
Boring #: B-1
Depth: 10'

D_{10} = 0.26
D_{30} = 0.78
D_{60} = 1.66
C_C = 1.40
C_U = 6.35
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SW, Well-graded Sand

Specifications
custom specs 1

Fineness Modulus
3.34

% Gravel
0.49%
% Sand
96.10%
% Silt & Clay
3.41%
Sample Moisture
1.9%

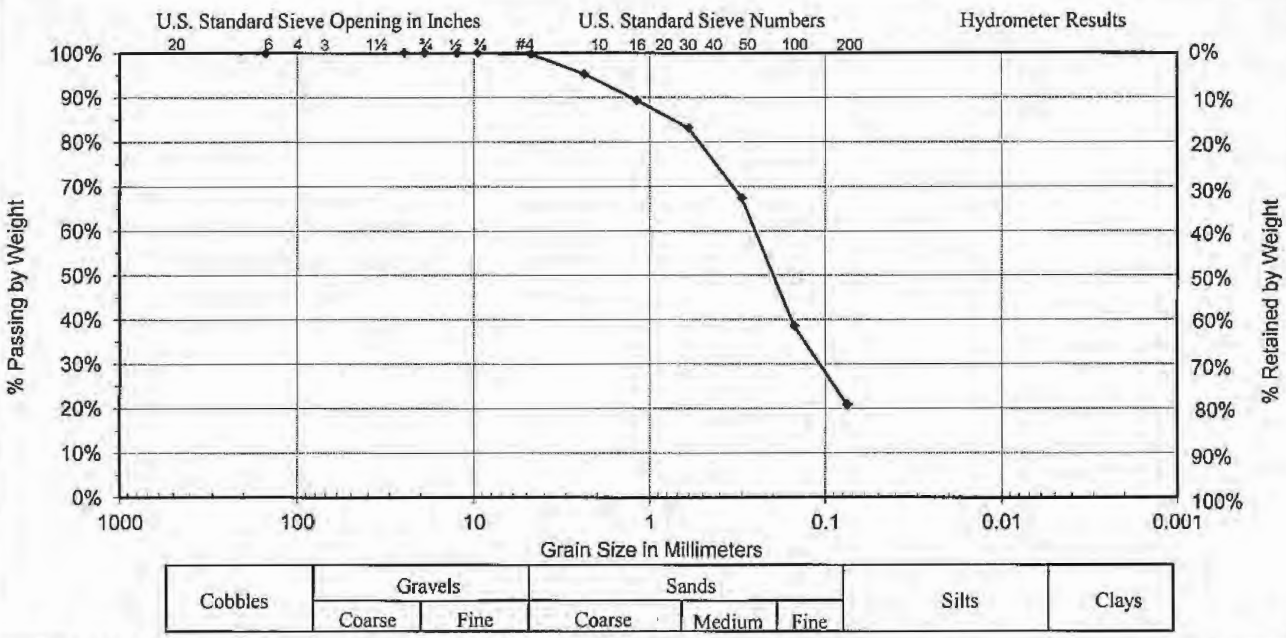
Coarse Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.7%		
#4	4.75	99.5%	99.5%		

Fines Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	99.5%	99.5%		
#8	2.360	80.5%	80.5%		
#10	2.000		69.9%		
#16	1.180	45.9%	45.9%		
#20	0.850		32.8%		
#30	0.600	22.8%	22.8%		
#40	0.425		16.2%		
#50	0.300	11.5%	11.5%		
#60	0.250		9.6%		
#80	0.180		6.9%		
#100	0.150	5.8%	5.8%		
#140	0.106		4.4%		
#170	0.090		3.9%		
#200	0.075	3.4%	3.4%		
#270	0.053				

LABORATORY TEST RESULTS

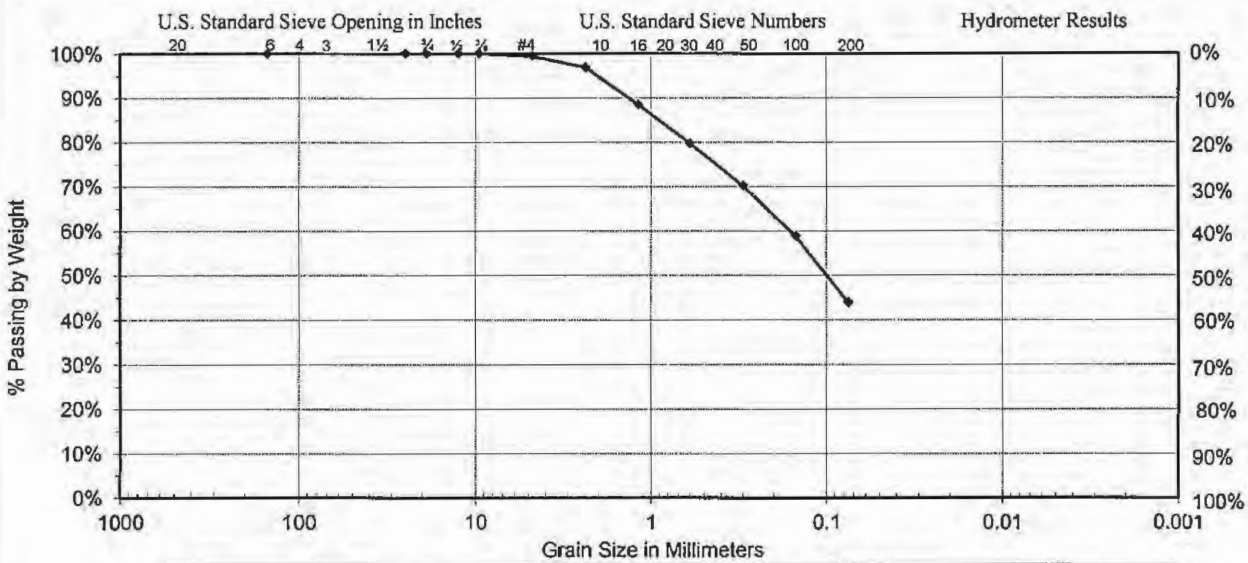


Date: 10/24/15	D_{10} = 0.04	**Classification**	% Gravel
Sample #:	D_{30} = 0.11	SM, Silty Sand	0.26%
Sample ID: B-1 @ 15'	D_{60} = 0.26		% Sand
Source: Standard	C_C = 1.38	**Specifications**	79.01%
Project: Steven Walker Communities - Hawthorne Heights	C_U = 7.25	custom specs 1	% Silt & Clay
Location: APN: 227-130-025	Liquid Limit= n/a		20.72%
Boring #: B-1	Plastic Limit= n/a	Fineness Modulus	Sample Moisture
Depth: 15'	Plasticity Index= n/a	1.27	6.4%

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.8%		
#4	4.75	99.7%	99.7%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	99.7%	99.7%		
#8	2.360	95.2%	95.2%		
#10	2.000		93.4%		
#16	1.180	89.2%	89.2%		
#20	0.850		85.7%		
#30	0.600	83.1%	83.1%		
#40	0.425		73.9%		
#50	0.300	67.3%	67.3%		
#60	0.250		57.6%		
#80	0.180		44.1%		
#100	0.150	38.4%	38.4%		
#140	0.106		28.0%		
#170	0.090		24.3%		
#200	0.075	20.7%	20.7%		
#270	0.053				

LABORATORY TEST RESULTS



Cobbles	Gravels		Sands			Silts	Clays
	Coarse	Fine	Coarse	Medium	Fine		

Date: 10/24/15	D_{10} = 0.02	**Classification**	% Gravel
Sample #:	D_{30} = 0.05	SM, Silty Sand	0.60%
Sample ID: P-1 @ 43"	D_{60} = 0.17		% Sand
Source: Bulk	C_C = 0.92	**Specifications**	55.58%
Project: Steven Walker Communities - Hawthorne Heights	C_U = 9.77	custom specs 1	% Silt & Clay
Location: APN: 227-130-025	Liquid Limit= n/a		43.82%
Boring #: P-1	Plastic Limit= n/a	Fineness Modulus	Sample Moisture
Depth: 43"	Plasticity Index= n/a	1.07	7.9%

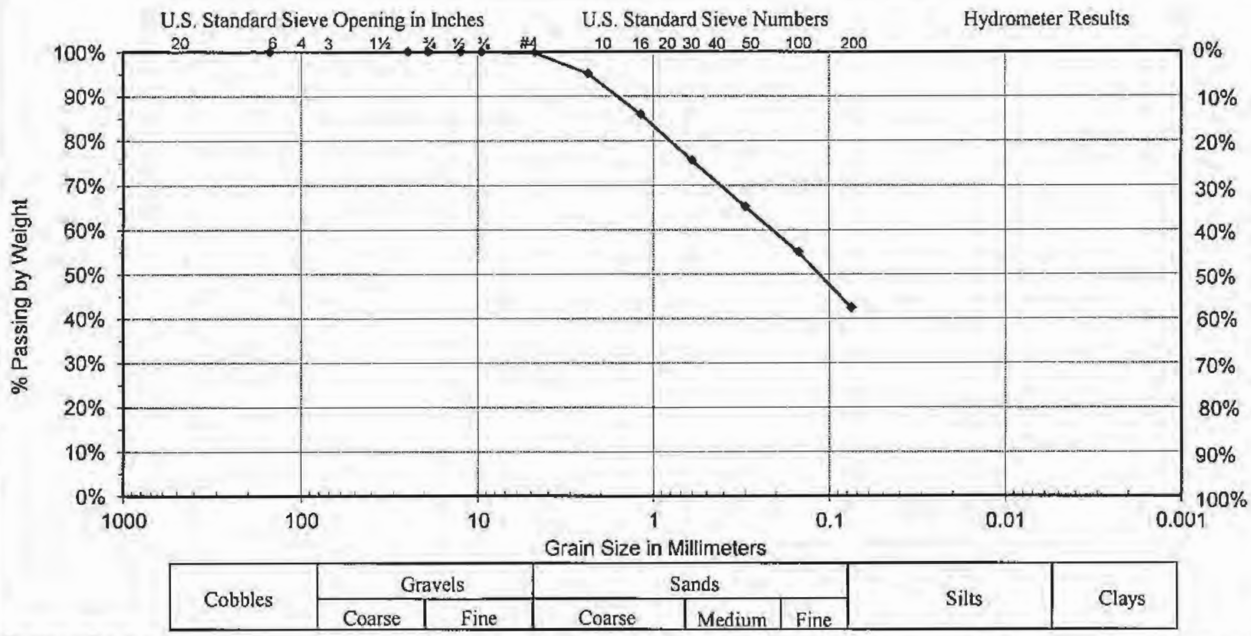
Coarse Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.6%		
#4	4.75	99.4%	99.4%		

Fines Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	99.4%	99.4%		
#8	2.360	96.9%	96.9%		
#10	2.000		94.3%		
#16	1.180	88.4%	88.4%		
#20	0.850		83.5%		
#30	0.600	79.7%	79.7%		
#40	0.425		74.1%		
#50	0.300	70.1%	70.1%		
#60	0.250		66.3%		
#80	0.180		61.0%		
#100	0.150	58.7%	58.7%		
#140	0.106		50.0%		
#170	0.090		46.8%		
#200	0.075	43.8%	43.8%		
#270	0.053				

LABORATORY TEST RESULTS



Date: 10/24/15
Sample #:
Sample ID: P-2 @ 45"
Source: Bulk
Project: Steven Walker Communities - Hawthorne Heights
Location: APN: 227-130-025
Boring #: P-2
Depth: 45"

D_{10} = 0.02
D_{30} = 0.05
D_{60} = 0.22
C_C = 0.71
C_U = 12.69
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SM, Silty Sand

Specifications
custom specs 1

Fineness Modulus
1.24

% Gravel
0.27%
% Sand
57.39%
% Silt & Clay
42.34%
Sample Moisture
6.7%

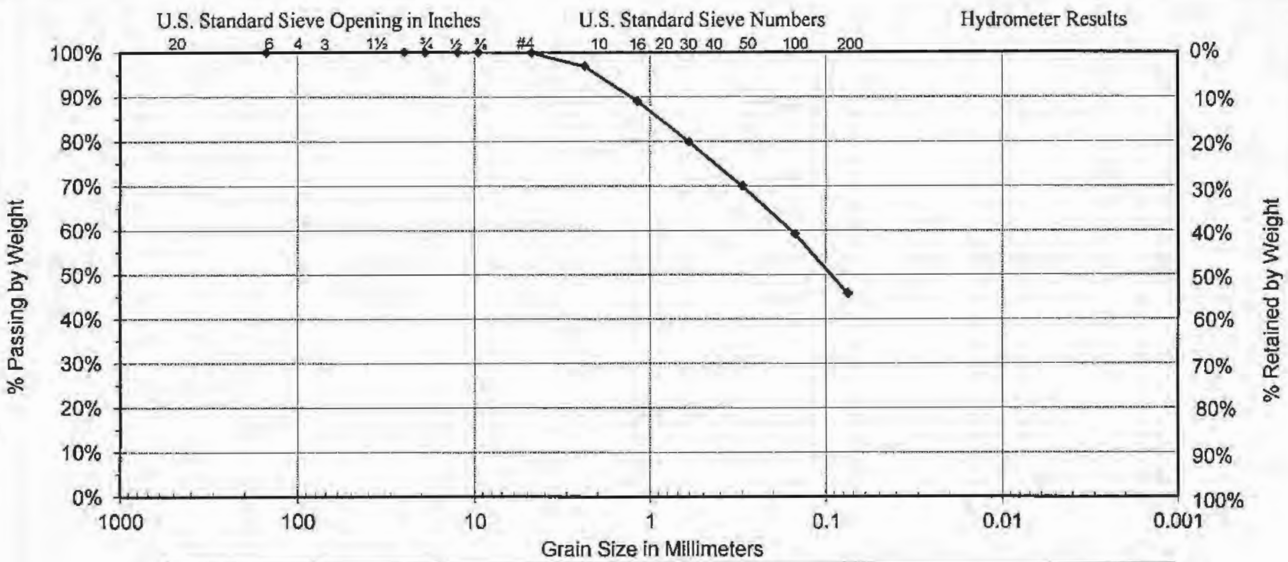
Coarse Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.8%		
#4	4.75	99.7%	99.7%		

Fines Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	99.7%	99.7%		
#8	2.360	95.0%	95.0%		
#10	2.000		92.2%		
#16	1.180	85.9%	85.9%		
#20	0.850		80.0%		
#30	0.600	75.5%	75.5%		
#40	0.425		69.5%		
#50	0.300	65.1%	65.1%		
#60	0.250		61.7%		
#80	0.180		56.9%		
#100	0.150	54.9%	54.9%		
#140	0.106		47.5%		
#170	0.090		44.9%		
#200	0.075	42.3%	42.3%		
#270	0.053				

LABORATORY TEST RESULTS



Cobbles	Gravels		Sands			Silts	Clays
	Coarse	Fine	Coarse	Medium	Fine		

Date : 10/24/15
Sample #:
Sample ID: P-3 @ 52"
Source: Bulk
Project: Steven Walker Communities - Hawthorne Heights
Location: APN: 227-130-025
Boring #: P-3
Depth: 52"

D_{10} = 0.02
D_{30} = 0.05
D_{60} = 0.16
C_C = 0.91
C_U = 9.91
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SM, Silty Sand

Specifications
custom specs 1

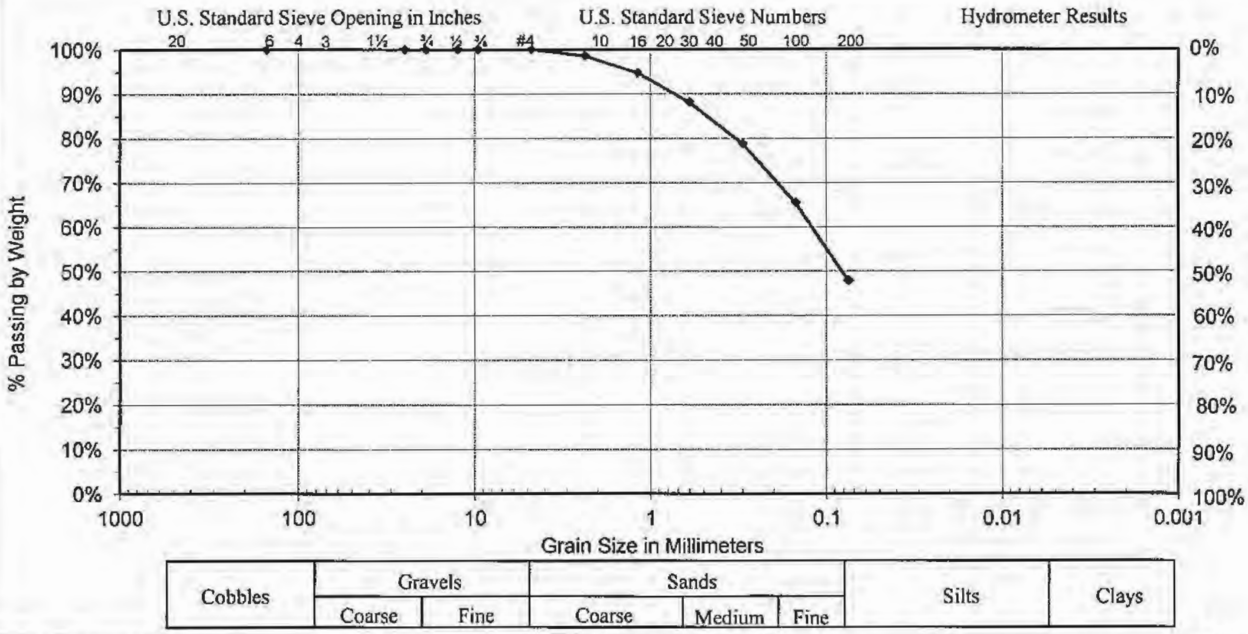
Fineness Modulus
1.06

% Gravel
0.16%
% Sand
54.22%
% Silt & Clay
45.61%
Sample Moisture
6.5%

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.9%		
#4	4.75	99.8%	99.8%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	99.8%	99.8%		
#8	2.360	96.8%	96.8%		
#10	2.000		94.4%		
#16	1.180	89.0%	89.0%		
#20	0.850		83.8%		
#30	0.600	79.8%	79.8%		
#40	0.425		74.0%		
#50	0.300	69.9%	69.9%		
#60	0.250		66.3%		
#80	0.180		61.2%		
#100	0.150	59.1%	59.1%		
#140	0.106		51.2%		
#170	0.090		48.3%		
#200	0.075	45.6%	45.6%		
#270	0.053				

LABORATORY TEST RESULTS



Date: 10/24/15	D_{10} = 0.02	**Classification**		% Gravel
Sample #:	D_{30} = 0.05	SM, Silty Sand		0.00%
Sample ID: P-4 @ 67"	D_{60} = 0.13			% Sand
Source: Bulk	C_C = 1.11	**Specifications**		52.27%
Project: Steven Walker Communities - Hawthorne Heights	C_U = 8.10	custom specs 1		% Silt & Clay
Location: APN: 227-130-025	Liquid Limit= n/a			47.73%
Boring #: P-4	Plastic Limit= n/a	Fineness Modulus		Sample Moisture
Depth: 67"	Plasticity Index= n/a	0.75		**4.2%**

Coarse Section		Actual Cumulative	Interpolated Cumulative			**Fines Section**		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Metric	Percent Passing	Percent Passing	Specs Max	Specs Min	Sieve Size US	Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%			#4	4.750	100.0%	100.0%		
4.00"	100.00		100.0%			#8	2.360	98.5%	98.5%		
3.00"	75.00		100.0%			#10	2.000		97.4%		
2.50"	63.00		100.0%			#16	1.180	94.7%	94.7%		
2.00"	50.00		100.0%			#20	0.850		90.9%		
1.75"	45.00		100.0%			#30	0.600	88.0%	88.0%		
1.50"	37.50		100.0%			#40	0.425		82.5%		
1.25"	31.50		100.0%			#50	0.300	78.6%	78.6%		
1.00"	25.00	100.0%	100.0%			#60	0.250		74.2%		
7/8"	22.40		100.0%			#80	0.180		68.0%		
3/4"	19.00	100.0%	100.0%			#100	0.150	65.4%	65.4%		
5/8"	16.00		100.0%			#140	0.106		55.0%		
1/2"	12.50	100.0%	100.0%			#170	0.090		51.3%		
3/8"	9.50	100.0%	100.0%			#200	0.075	47.7%	47.7%		
1/4"	6.30		100.0%			#270	0.053				
#4	4.75	100.0%	100.0%								

Appendix D

PERCOLATION TEST - P-1

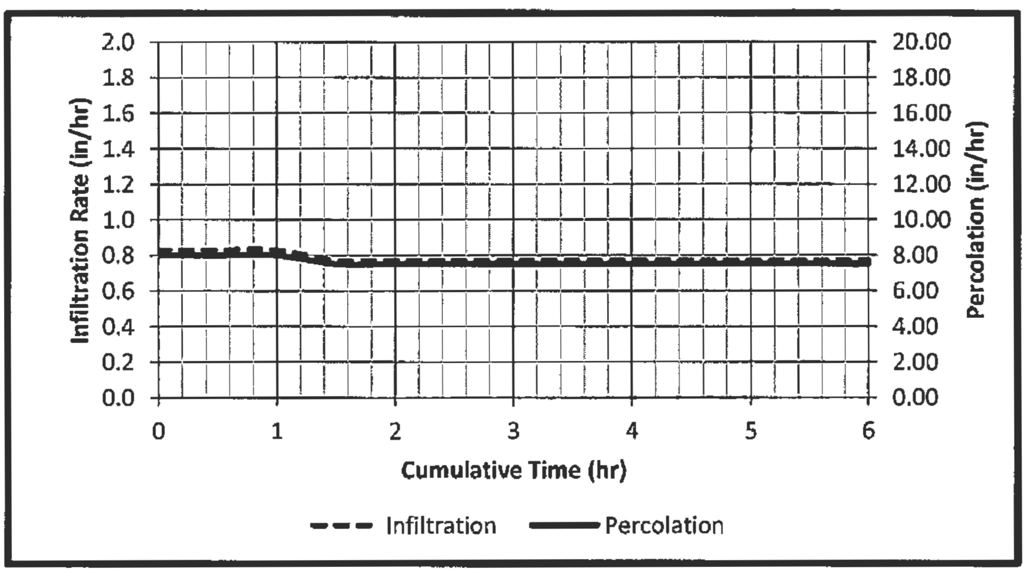
Project No.	15110-01	Project Name	Hawthorne Hills School Site
Proj. Location	Indaian Avenue, Riverside		

Drilling Date	10/24/2015	Soak Date	10/24/2015	Soak Method	5 gallons
Testing Date	10/25/2015	Borehole Size (in)	6	Test Depth (in)	43

CRITERIA	TIME	TIME INTERVAL (min)	D_0, INITIAL DEPTH TO WATER (in)	D_f, FINAL DEPTH TO WATER (in)	ΔH, WATER DROP (in)	AVERAGE WETTED DEPTH (in)	PERC RATE (min/in)	PERC RATE (in/hr)	CORECTED* INFILTRATION RATE (in/hr)
Sandy Soil Criteria									
Percolation Test Data	0:00:00	0:30:00	28	32	4	13	7.5	8.0	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	32	4	13	7.5	8.0	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							
	0:00:00	0:30:00	28	31.75	3.75	13.125	8.0	7.5	0.8
	0:30:00	30.00							

*Porchet Method

Cumulative Time (hr)	Percolation (in/hr)	Infiltration (in/hr
0	8.00	0.8
0.50	8.00	0.8
1.00	8.00	0.8
1.50	7.50	0.8
2.00	7.50	0.8
2.50	7.50	0.8
3.00	7.50	0.8
3.50	7.50	0.8
4.00	7.50	0.8
4.50	7.50	0.8
5.00	7.50	0.8
5.50	7.50	0.8
6.00	7.50	0.8



PERCOLATION TEST - P-2

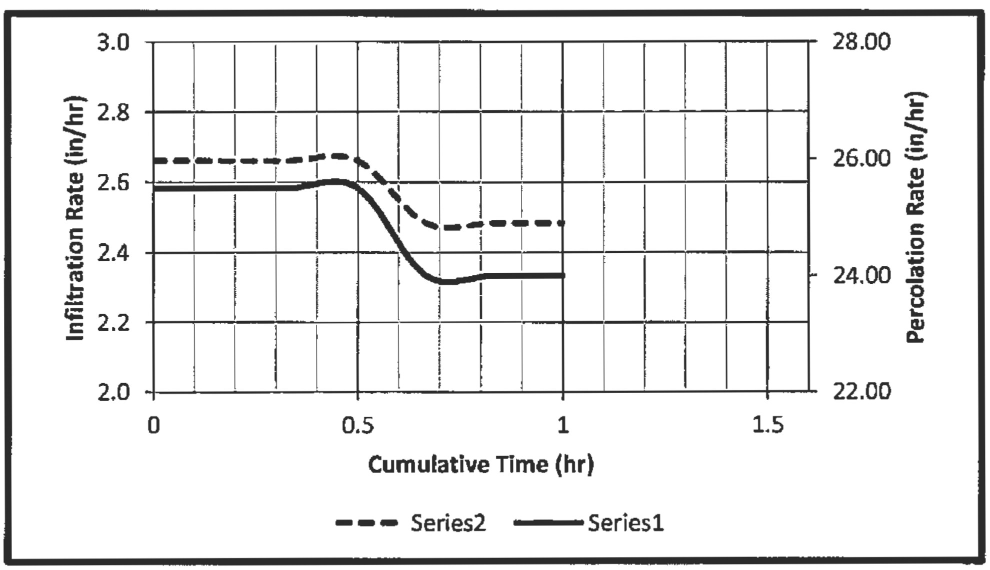
Project No.	15101-01	Project Name	Hawthorne Hills School Site		
Project Location	Indiana Avenue, Riverside				
Drilling Date	10/24/2015	Soak Date	10/24/2015		5 gallons
Testing Date	10/24/2015	Borehole Size (in)	6	Depth (in)	45

All field measurements in inches and time measurement in minutes: seconds

CRITERIA	TIME	TIME INTERVAL	H_o INITIAL WATER HEIGHT	ΔH WATER DROP	H_f FINAL WATER HEIGHT	D_o INITIAL DEPTH TO WATER	D_f FINAL DEPTH TO WATER	H_{ave} AVERAGE HEAD HEIGHT	PERC RATE (in/hr)	CORECTED* INFILTRATION RATE (in/hr)
Sandy Soil Criteria	0:00:00 0:25:00	0:25:00 25.00	15	9	6	30	39	10.5	21.6	
	0:00:00 0:25:00	0:25:00 25.00	15	8	7	30	38	11	19.2	
Percolation Test Data	0:00:00 12:10:00	12:10:00 10.00	15	4.25	10.75	30	34.25	12.875	25.5	2.7
	12:00:00 12:10:00	0:10:00 10.00	15	4.25	10.75	30	34.25	12.875	25.5	2.7
	12:00:00 12:10:00	0:10:00 10.00	15	4.25	10.75	30	34.25	12.875	25.5	2.7
	12:00:00 12:10:00	0:10:00 10.00	15	4	11	30	34	13	24.0	2.5
	12:00:00 12:10:00	0:10:00 10.00	15	4	11	30	34	13	24.0	2.5
	12:00:00 12:10:00	0:10:00 10.00	15	4	11	30	34	13	24.0	2.5

*Porchet Method

Cmltv. Time (hr)	Perc. (in/hr)	Inf. (in/hr)
0	25.50	2.7
0.17	25.50	2.7
0.33	25.50	2.7
0.50	25.50	2.7
0.67	24.00	2.5
0.83	24.00	2.5
1.00	24.00	2.5



PERCOLATION TEST - P-3

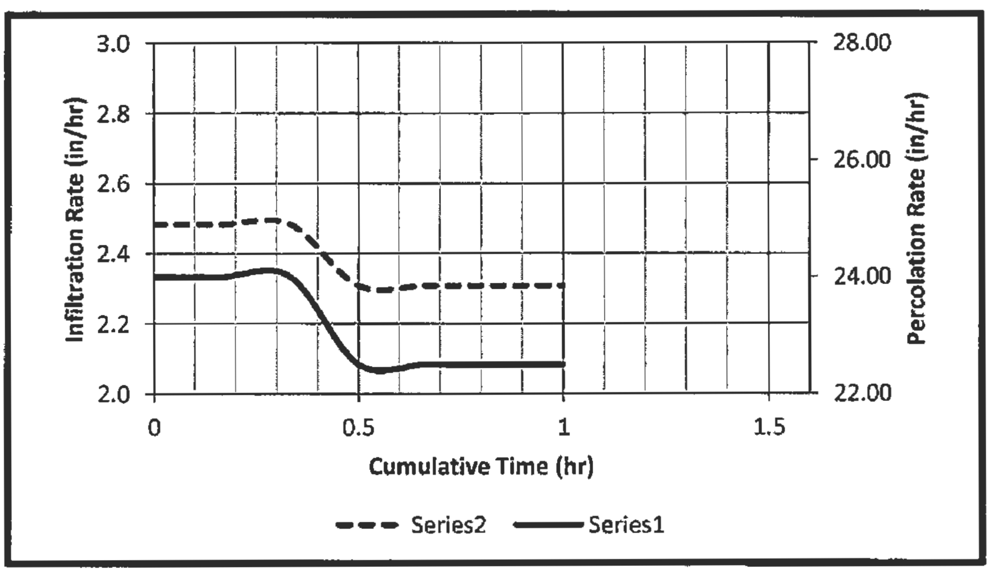
Project No.	15101-01	Project Name	Hawthorne Hills School Site		
Project Location	Indiana Avenue, Riverside				
Drilling Date	10/24/2015	Soak Date	10/24/2015		5 gallons
Testing Date	10/24/2015	Borehole Size (in)	6	Depth (in)	52

All field measurements in inches and time measurement in minutes: seconds

CRITERIA	TIME	TIME INTERVAL	H_o INITIAL WATER HEIGHT	ΔH WATER DROP	H_f FINAL WATER HEIGHT	D_o INITIAL DEPTH TO WATER	D_f FINAL DEPTH TO WATER	H_{ave} AVERAGE HEAD HEIGHT	PERC RATE (in/hr)	CORECTED* INFILTRATION RATE (in/hr)
Sandy Soil Criteria	0:00:00 0:25:00	0:25:00 25.00	15	10	5	37	47	10	24.0	
	0:00:00 0:25:00	0:25:00 25.00	15	8.5	6.5	37	45.5	10.75	20.4	
Percolation Test Data	0:00:00 12:10:00	12:10:00 10.00	15	4	11	37	41	13	24.0	2.5
	12:00:00 12:10:00	0:10:00 10.00	15	4	11	37	41	13	24.0	2.5
	12:00:00 12:10:00	0:10:00 10.00	15	3.75	11.25	37	40.75	13.125	22.5	2.3
	12:00:00 12:10:00	0:10:00 10.00	15	3.75	11.25	37	40.75	13.125	22.5	2.3
	12:00:00 12:10:00	0:10:00 10.00	15	3.75	11.25	37	40.75	13.125	22.5	2.3
	12:00:00 12:10:00	0:10:00 10.00	15	3.75	11.25	37	40.75	13.125	22.5	2.3

*Porchet Method

Cmltv. Time (hr)	Perc. (in/hr)	Inf. (in/hr)
0	24.00	2.5
0.17	24.00	2.5
0.33	24.00	2.5
0.50	22.50	2.3
0.67	22.50	2.3
0.83	22.50	2.3
1.00	22.50	2.3



PERCOLATION TEST - P-4

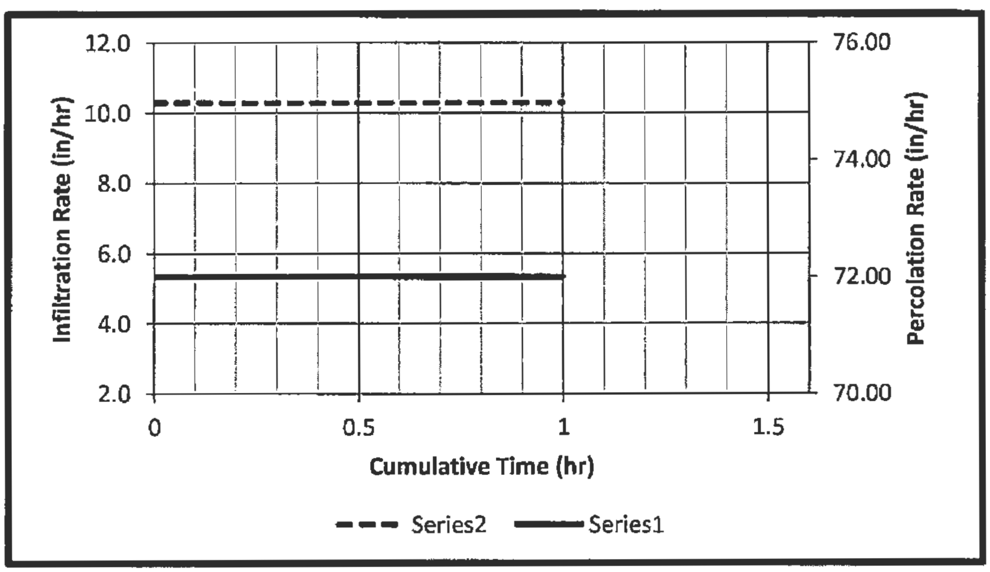
Project No.	15101-01	Project Name	Hawthorne Hills School Site		
Project Location	Indiana Avenue, Riverside				
Drilling Date	10/24/2015	Soak Date	10/24/2015		5 gallons
Testing Date	10/24/2015	Borehole Size (in)	6	Depth (in)	67

All field measurements in inches and time measurement in minutes: seconds

CRITERIA	TIME	TIME INTERVAL	H_o INITIAL WATER HEIGHT	ΔH WATER DROP	H_f FINAL WATER HEIGHT	D_o INITIAL DEPTH TO WATER	D_f FINAL DEPTH TO WATER	H_{ave} AVERAGE HEAD HEIGHT	PERC RATE (in/hr)	CORECTED* INFILTRATION RATE (in/hr)
Sandy Soil Criteria	0:00:00 0:12:00	0:12:00 12.00	15	15	0	52	67	7.5	75.0	
	0:00:00 0:13:00	0:13:00 13.00	15	15	0	52	67	7.5	69.2	
Percolation Test Data	0:00:00 12:10:00	12:10:00 10.00	15	12	3	52	64	9	72.0	10.3
	12:00:00 12:10:00	0:10:00 10.00	15	12	3	52	64	9	72.0	10.3
	12:00:00 12:10:00	0:10:00 10.00	15	12	3	52	64	9	72.0	10.3
	12:00:00 12:10:00	0:10:00 10.00	15	12	3	52	64	9	72.0	10.3
	12:00:00 12:10:00	0:10:00 10.00	15	12	3	52	64	9	72.0	10.3
	12:00:00 12:10:00	0:10:00 10.00	15	12	3	52	64	9	72.0	10.3

*Porchet Method

Cmltv. Time (hr)	Perc. (in/hr)	Inf. (in/hr)
0	72.00	10.3
0.17	72.00	10.3
0.33	72.00	10.3
0.50	72.00	10.3
0.67	72.00	10.3
0.83	72.00	10.3
1.00	72.00	10.3



Appendix 4: Historical Site Conditions

Phase I Environmental Site Assessment or Other Information on Past Site Use

Appendix 5: LID Infeasibility

LID Technical Infeasibility Analysis

Appendix 6: BMP Design Details

BMP Sizing, Design Details and other Supporting Documentation

Santa Ana Watershed - BMP Design Volume, V_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

(Note this worksheet shall only be used in conjunction with BMP designs from the LID BMP Design Handbook)

Company Name SDH & Associates, Inc. Date 11/1/2015

Designed by Dane Sommers Case No

Company Project Number/Name TTM 37032

BMP Identification

BMP NAME / ID B.M.P. 1

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E D_{85}= 0.54 inches

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	Design Storm Depth (in)	Design Capture Volume, V_{BMP} (cubic feet)	Proposed Volume on Plans (cubic feet)
DMA 1A	4500	Mixed Surface Types	1	0.89	4014			
DMA 1B	5855	Ornamental Landscaping	0.1	0.11	646.7			
DMA. 2A	7500	Mixed Surface Types	1	0.89	6690			
DMA 2B	8805	Ornamental Landscaping	0.1	0.11	972.6			
DMA 3	10653	Concrete or Asphalt	1	0.89	9502.5			
DMA 4	1095	Concrete or Asphalt	1	0.89	976.7			
DMA 10A	9000	Mixed Surface Types	1	0.89	8028			
DMA 10B	10332	Ornamental Landscaping	0.1	0.11	1141.3			
BMP 1	3265	Ornamental Landscaping	0.1	0.11	360.6			
	61005	Total			32332.4	0.54	1455	1,527

Notes:

Infiltration Basin - Design Procedure (Rev. 03-2012)	BMP ID [redacted]	Legend: [redacted]
mpany Name: [redacted]		Date: [redacted]
Designed by: [redacted]		County/City Case No.: [redacted]

Design Volume

a) Tributary area (BMP subarea) A_T = [redacted] acres

b) Enter V_{BMP} determined from Section 2.1 of this Handbook V_{BMP}= [redacted] ft^3

Maximum Depth

a) Infiltration rate I = [redacted] in/hr

b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook) FS = [redacted]

c) Calculate D_1 $$D_1 = \frac{I\ (in/hr) \times 72\ hrs}{12\ (in/ft) \times FS}$$ D_1 = [redacted] ft

d) Enter the depth of freeboard (at least 1 ft) [redacted] ft

e) Enter depth to historic high ground water (measured from **top** of basin) [redacted] ft

f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin) [redacted] ft

g) D_2 is the smaller of:

Depth to groundwater - (10 ft + freeboard) and
Depth to impermeable layer - (5 ft + freeboard) D_2 = [redacted] ft

h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet D_{MAX}= [redacted] ft

Basin Geometry

a) Basin side slopes (no steeper than 4:1) z = [redacted] :1

b) Proposed basin depth (excluding freeboard) d_B = [redacted] ft

c) Minimum bottom surface area of basin ($A_S = V_{BMP}/d_B$) A_S = [redacted] ft^2

d) Proposed Design Surface Area A_D = [redacted] ft^2

Forebay

a) Forebay volume (minimum 0.5% V_{BMP}) Volume = [redacted] ft^3

b) Forebay depth (height of berm/splashwall. 1 foot min.) Depth = [redacted] ft

c) Forebay surface area (minimum) Area = [redacted] ft^2

d) Full height notch-type weir Width (W) = [redacted] in

Notes: [redacted]

Santa Ana Watershed - BMP Design Volume, V_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name SDH & Associates, Inc.

Date 11/1/2015

Designed by Dane Sommers

Case No

Company Project Number/Name TTM 37032

BMP Identification

BMP NAME / ID B.M.P. 2

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E

D_{85}= 0.54 inches

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	Design Storm Depth (in)	Design Capture Volume, V_{BMP} (cubic feet)	Proposed Volume on Plans (cubic feet)
DMA 5	7603	Concrete or Asphalt	1	0.89	6781.9			
DMA 11A	9000	Mixed Surface Types	1	0.89	8028			
DMA 11B	11616	Ornamental Landscaping	0.1	0.11	1283.1			
BMP 2	1742	Ornamental Landscaping	0.1	0.11	192.4			
	29961	Total			16285.4	0.54	732.8	1746

Notes:

Infiltration Basin - Design Procedure (Rev. 03-2012)	BMP ID [redacted]	Legend: [redacted]
mpany Name: [redacted]		Date: [redacted]
Designed by: [redacted]		County/City Case No.: [redacted]

Design Volume

a) Tributary area (BMP subarea) A_T = [redacted] acres

b) Enter V_{BMP} determined from Section 2.1 of this Handbook V_{BMP}= [redacted] ft^3

Maximum Depth

a) Infiltration rate I = [redacted] in/hr

b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook) FS = [redacted]

c) Calculate D_1 $D_1 = \dfrac{I \text{ (in/hr)} \times 72 \text{ hrs}}{12 \text{ (in/ft)} \times FS}$ D_1 = [redacted] ft

d) Enter the depth of freeboard (at least 1 ft) [redacted] ft

e) Enter depth to historic high ground water (measured from **top** of basin) [redacted] ft

f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin) [redacted] ft

) D_2 is the smaller of:

Depth to groundwater - (10 ft + freeboard) and
Depth to impermeable layer - (5 ft + freeboard) D_2= [redacted] ft

h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet D_{MAX}= [redacted] ft

Basin Geometry

a) Basin side slopes (no steeper than 4:1) z = [redacted] :1

b) Proposed basin depth (excluding freeboard) d_B = [redacted] ft

c) Minimum bottom surface area of basin (A_S= V_{BMP}/d_B) A_S = [redacted] ft^2

d) Proposed Design Surface Area A_D= [redacted] ft^2

Forebay

a) Forebay volume (minimum 0.5% V_{BMP}) Volume = [redacted] ft^3

b) Forebay depth (height of berm/splashwall. 1 foot min.) Depth = [redacted] ft

c) Forebay surface area (minimum) Area = [redacted] ft^2

Full height notch-type weir Width (W) = [redacted] in

Notes: [redacted]

Santa Ana Watershed - BMP Design Volume, V_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name SDH & Associates, Inc. Date 11/1/2015

Designed by Dane Sommers Case No

Company Project Number/Name TTM 37032

BMP Identification

BMP NAME / ID B.M.P. 3

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E D_{85}= 0.54 inches

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	Design Storm Depth (in)	Design Capture Volume, V_{BMP} (cubic feet)	Proposed Volume on Plans (cubic feet)
DMA 7A	4500	Mixed Surface Types	1	0.89	4014			
DMA 7B	8647	Ornamental Landscaping	0.1	0.11	955.1			
DMA 8	6032	Concrete or Asphalt	1	0.89	5380.5			
DMA 9A	6000	Mixed Surface Types	1	0.89	5352			
DMA 9B	10415	Ornamental Landscaping	0.1	0.11	1150.4			
BMP 3	2066	Ornamental Landscaping	0.1	0.11	228.2			
	37660	Total			17080.2	0.54	768.6	1,565

Notes:

Infiltration Basin - Design Procedure (Rev. 03-2012)	BMP ID [redacted]	Legend: [redacted]
mpany Name: [redacted]		Date: [redacted]
Designed by: [redacted]		County/City Case No.: [redacted]

Design Volume

a) Tributary area (BMP subarea)	A_T = [redacted]	acres
b) Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}= [redacted]	ft^3

Maximum Depth

a) Infiltration rate	I = [redacted]	in/hr
b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook)	FS = [redacted]	
c) Calculate D_1 $\quad D_1 = \dfrac{I\ (in/hr) \times 72\ hrs}{12\ (in/ft) \times FS}$	D_1 = [redacted]	ft
d) Enter the depth of freeboard (at least 1 ft)	[redacted]	ft
e) Enter depth to historic high ground water (measured from **top** of basin)	[redacted]	ft
f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin)	[redacted]	ft
g) D_2 is the smaller of: Depth to groundwater - (10 ft + freeboard) and Depth to impermeable layer - (5 ft + freeboard)	D_2= [redacted]	ft
h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet	D_{MAX}= [redacted]	ft

Basin Geometry

a) Basin side slopes (no steeper than 4:1)	z = [redacted]	:1
b) Proposed basin depth (excluding freeboard)	d_B = [redacted]	ft
c) Minimum bottom surface area of basin (A_S= V_{BMP}/d_B)	A_S = [redacted]	ft^2
d) Proposed Design Surface Area	A_D= [redacted]	ft^2

Forebay

a) Forebay volume (minimum 0.5% V_{BMP})	Volume = [redacted]	ft^3
b) Forebay depth (height of berm/splashwall. 1 foot min.)	Depth = [redacted]	ft
c) Forebay surface area (minimum)	Area = [redacted]	ft^2
d) Full height notch-type weir	Width (W) = [redacted]	in

Notes: [redacted]

Santa Ana Watershed - BMP Design Volume, V_{BMP}
(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

(Note this worksheet shall only be used in conjunction with BMP designs from the LID BMP Design Handbook)

Company Name SDH & Associates, Inc. Date 11/1/2015
Designed by Dane Sommers Case No
Company Project Number/Name TTM 37032

BMP Identification

BMP NAME / ID B.M.P. 4

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E D_{85}= 0.54 inches

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	Design Storm Depth (in)	Design Capture Volume, V_{BMP} (cubic feet)	Proposed Volume on Plans (cubic feet)
DMA 12A	3000	Mixed Surface Types	1	0.89	2676			
DMA 12B	3296	Ornamental Landscaping	0.1	0.11	364.1			
DMA 13A	18000	Mixed Surface Types	1	0.89	16056			
DMA 13B	22216	Ornamental Landscaping	0.1	0.11	2453.9			
DMA 14A	18000	Mixed Surface Types	1	0.89	16056			
DMA 14B	27750	Ornamental Landscaping	0.1	0.11	3065.2			
DMA 15	24413	Mixed Surface Types	1	0.89	21776.4			
DMA 16	21810	Ornamental Landscaping	0.1	0.11	2409.1			
DMA 17	7522	Ornamental Landscaping	0.1	0.11	830.9			
BMP 4	17031	Ornamental Landscaping	0.1	0.11	1881.2			
	163038	Total			67568.8	0.54	3040.6	7,705

Notes:

Infiltration Basin - Design Procedure (Rev. 03-2012)	BMP ID [redacted]	Legend: [redacted]
ɔmpany Name: [redacted]		Date: [redacted]
Designed by: [redacted]		County/City Case No.: [redacted]

Design Volume

a) Tributary area (BMP subarea) — $A_T =$ [redacted] acres

b) Enter V_{BMP} determined from Section 2.1 of this Handbook — $V_{BMP} =$ [redacted] ft^3

Maximum Depth

a) Infiltration rate — $I =$ [redacted] in/hr

b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook) — $FS =$ [redacted]

c) Calculate D_1 — $D_1 = \dfrac{I\ (in/hr) \times 72\ hrs}{12\ (in/ft) \times FS}$ — $D_1 =$ [redacted] ft

d) Enter the depth of freeboard (at least 1 ft) — [redacted] ft

e) Enter depth to historic high ground water (measured from **top** of basin) — [redacted] ft

f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin) — [redacted] ft

ɡ) D_2 is the smaller of:

Depth to groundwater - (10 ft + freeboard) and
Depth to impermeable layer - (5 ft + freeboard) — $D_2 =$ [redacted] ft

h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet — $D_{MAX} =$ [redacted] ft

Basin Geometry

a) Basin side slopes (no steeper than 4:1) — $z =$ [redacted] :1

b) Proposed basin depth (excluding freeboard) — $d_B =$ [redacted] ft

c) Minimum bottom surface area of basin ($A_S = V_{BMP}/d_B$) — $A_S =$ [redacted] ft^2

d) Proposed Design Surface Area — $A_D =$ [redacted] ft^2

Forebay

a) Forebay volume (minimum 0.5% V_{BMP}) — Volume = [redacted] ft^3

b) Forebay depth (height of berm/splashwall. 1 foot min.) — Depth = [redacted] ft

c) Forebay surface area (minimum) — Area = [redacted] ft^2

ˈ) Full height notch-type weir — Width (W) = [redacted] in

Notes: [redacted]

	2 year – 24 hour		
	Pre-condition	**Post-condition**	**% Difference**
Time of Concentration	5.8	9.2	64% increase
Volume (Cubic Feet)	19,473	22,859	17% increase
Note: In the Post Development Condition, all runoff will be retained onsite, therefore the number above does not reflect the quantity of runoff which is being discharged.			

	2 years - 24 hour		
	Pre-condition	**Post-condition**	**% Difference**
Time of Concentration	5.8	9.2	64% Increase
Volume, V (Cubic Feet)	19,473	19,473	0% Increase
Runoff, Q (cfs)	1.68	1.68	0% Increase
Area, A (acres)	6.78	6.78	N/A
Impervious Area (acres)	3.1	3	3.2% Decrease
Coefficient of Runoff, C	0.46	0.46	0% Increase
Rainfall Intensity, I (in/hr)	0.54	0.54	N/A
Precipitation Depth , P(in.)	1.72	1.72	N/A

Runoff, Q=C*I*A

Volume, V=(C*P*A)/12

Appendix 8: Source Control

Pollutant Sources/Source Control Checklist

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Shown on WQMP Drawings	3 Permanent Controls—Listed in WQMP Table and Narrative	4 Operational BMPs—Included in WQMP Table and Narrative
❑ **A.** On-site storm drain inlets	❑ Locations of inlets.	❑ Mark all inlets with the words "Only Rain Down the Storm Drain" or similar. Catch Basin Markers may be available from the Riverside County Flood Control and Water Conservation District, call 951.955.1200 to verify.	❑ Maintain and periodically repaint or replace inlet markings. ❑ Provide stormwater pollution prevention information to new site owners, lessees, or operators. ❑ See applicable operational BMPs in Fact Sheet SC-44, "Drainage System Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com ❑ Include the following in lease agreements: "Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains."
❑ **B.** Interior floor drains and elevator shaft sump pumps		❑ State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.	❑ Inspect and maintain drains to prevent blockages and overflow.
❑ **C.** Interior parking garages		❑ State that parking garage floor drains will be plumbed to the sanitary sewer.	❑ Inspect and maintain drains to prevent blockages and overflow.

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Shown on WQMP Drawings	3 Permanent Controls—Listed in WQMP Table and Narrative	4 Operational BMPs—Included in WQMP Table and Narrative
☐ **D1.** Need for future indoor & structural pest control		☐ Note building design features that discourage entry of pests.	☐ Provide Integrated Pest Management information to owners, lessees, and operators.
☒ **D2.** Landscape/ Outdoor Pesticide Use	☒ Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained. ☒ Show self-retaining landscape areas, if any. ☒ Show stormwater treatment and hydrograph modification management BMPs. (See instructions in Chapter 3, Step 5 and guidance in Chapter 5.)	State that final landscape plans will accomplish all of the following. ☒ Preserve existing native trees, shrubs, and ground cover to the maximum extent possible. ☒ Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution. ☒ Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions. ☒ Consider using pest-resistant plants, especially adjacent to hardscape. ☒ To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.	☒ Maintain landscaping using minimum or no pesticides. ☒ See applicable operational BMPs in "What you should know for.....Landscape and Gardening" at http://rcflood.org/stormwater/ ☒ Provide IPM information to new owners, lessees and operators.

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Shown on WQMP Drawings**	3 **Permanent Controls—Listed in WQMP Table and Narrative**	4 **Operational BMPs—Included in WQMP Table and Narrative**
❑ **E.** Pools, spas, ponds, decorative fountains, and other water features.	❑ Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet. (Exception: Public pools must be plumbed according to County Department of Environmental Health Guidelines.)	If the Co-Permittee requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.	❑ See applicable operational BMPs in "Guidelines for Maintaining Your Swimming Pool, Jacuzzi and Garden Fountain" at http://rcflood.org/stormwater/
❑ **F.** Food service	❑ For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment. ❑ On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.	❑ Describe the location and features of the designated cleaning area. ❑ Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.	❑ See the brochure, "The Food Service Industry Best Management Practices for: Restaurants, Grocery Stores, Delicatessens and Bakeries" at http://rcflood.org/stormwater/ Provide this brochure to new site owners, lessees, and operators.
❑ **G.** Refuse areas	❑ Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas. ❑ If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area. ❑ Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.	❑ State how site refuse will be handled and provide supporting detail to what is shown on plans. ❑ State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.	❑ State how the following will be implemented: Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Shown on WQMP Drawings	3 Permanent Controls—Listed in WQMP Table and Narrative	4 Operational BMPs—Included in WQMP Table and Narrative
❑ **H.** Industrial processes.	❑ Show process area.	❑ If industrial processes are to be located on site, state: "All process activities to be performed indoors. No processes to drain to exterior or to storm drain system."	❑ See Fact Sheet SC-10, "Non-Stormwater Discharges" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com See the brochure "Industrial & Commercial Facilities Best Management Practices for: Industrial, Commercial Facilities" at http://rcflood.org/stormwater/

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Shown on WQMP Drawings**	**3** **Permanent Controls—Listed in WQMP Table and Narrative**	**4** **Operational BMPs—Included in WQMP Table and Narrative**
❑ **I.** Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.)	❑ Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or run-off from area. ❑ Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults. ❑ Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.	Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains. Where appropriate, reference documentation of compliance with the requirements of Hazardous Materials Programs for: ▪ Hazardous Waste Generation ▪ Hazardous Materials Release Response and Inventory ▪ California Accidental Release (CalARP) ▪ Aboveground Storage Tank ▪ Uniform Fire Code Article 80 Section 103(b) & (c) 1991 ▪ Underground Storage Tank www.cchealth.org/groups/hazmat/	❑ See the Fact Sheets SC-31, "Outdoor Liquid Container Storage" and SC-33, "Outdoor Storage of Raw Materials " in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Shown on WQMP Drawings**	3 **Permanent Controls—Listed in WQMP Table and Narrative**	4 **Operational BMPs—Included in WQMP Table and Narrative**
❑ **J.** Vehicle and Equipment Cleaning	❑ Show on drawings as appropriate: (1) Commercial/industrial facilities having vehicle/equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses. (2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited on-site and hoses are provided with an automatic shut-off to discourage such use). (3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer. (4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.	❑ If a car wash area is not provided, describe any measures taken to discourage on-site car washing and explain how these will be enforced.	Describe operational measures to implement the following (if applicable): ❑ Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system. Refer to "Outdoor Cleaning Activities and Professional Mobile Service Providers" for many of the Potential Sources of Runoff Pollutants categories below. Brochure can be found at http://rcflood.org/stormwater/ ❑ Car dealerships and similar may rinse cars with water only.

1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Shown on WQMP Drawings	3 Permanent Controls—Listed in WQMP Table and Narrative	4 Operational BMPs—Included in WQMP Table and Narrative
❑ K. Vehicle/Equipment Repair and Maintenance	❑ Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to prevent run-on and runoff of stormwater. ❑ Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas. ❑ Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.	❑ State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area. ❑ State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements. ❑ State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.	In the Stormwater Control Plan, note that all of the following restrictions apply to use the site: ❑ No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains. ❑ No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately. ❑ No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment. Refer to "Automotive Maintenance & Car Care Best Management Practices for Auto Body Shops, Auto Repair Shops, Car Dealerships, Gas Stations and Fleet Service Operations". Brochure can be found at http://rcflood.org/stormwater/ Refer to Outdoor Cleaning Activities and Professional Mobile Service Providers for many of the Potential Sources of Runoff Pollutants categories below. Brochure can be found at http://rcflood.org/stormwater/

1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Shown on WQMP Drawings**	3 **Permanent Controls—Listed in WQMP Table and Narrative**	4 **Operational BMPs—Included in WQMP Table and Narrative**
❑ **L.** Fuel Dispensing Areas	❑ Fueling areas[6] shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable. ❑ Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area[1].] The canopy [or cover] shall not drain onto the fueling area.		❑ The property owner shall dry sweep the fueling area routinely. ❑ See the Fact Sheet SD-30 , "Fueling Areas" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

[6] The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Shown on WQMP Drawings	3 Permanent Controls—Listed in WQMP Table and Narrative	4 Operational BMPs—Included in WQMP Table and Narrative
❑ M. Loading Docks	❑ Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct stormwater away from the loading area. Water from loading dock areas shall be drained to the sanitary sewer, or diverted and collected for ultimate discharge to the sanitary sewer. ❑ Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation. ❑ Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.		❑ Move loaded and unloaded items indoors as soon as possible. ❑ See Fact Sheet SC-30, "Outdoor Loading and Unloading," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Shown on WQMP Drawings	3 Permanent Controls—Listed in WQMP Table and Narrative	4 Operational BMPs—Included in WQMP Table and Narrative
❑ **N.** Fire Sprinkler Test Water		❑ Provide a means to drain fire sprinkler test water to the sanitary sewer.	❑ See the note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com
O. Miscellaneous Drain or Wash Water or Other Sources ❑ Boiler drain lines ❑ Condensate drain lines ❑ Rooftop equipment ❑ Drainage sumps ❑ Roofing, gutters, and trim. ❑ Other sources		❑ Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system. ❑ Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system. ❑ Rooftop equipment with potential to produce pollutants shall be roofed and/or have secondary ❑ Any drainage sumps on-site shall feature a sediment sump to reduce pumped water. ❑ Avoid roofing, gutters, and trim unprotected metals that may leach into runoff. Include controls for other sources as specified by local reviewer.	

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Shown on WQMP Drawings	3 Permanent Controls—Listed in WQMP Table and Narrative	4 Operational BMPs—Included in WQMP Table and Narrative
❑ **P.** Plazas, sidewalks, and parking lots.			❑ Sweep plazas, sidewalks, and parking lots regularly to prevent accumulation of litter and debris. Collect debris from pressure washing to prevent entry into the storm drain system. Collect washwater containing any cleaning agent or degreaser and discharge to the sanitary sewer not to a storm drain.

Appendix 9: O&M

Operation and Maintenance Plan and Documentation of Finance, Maintenance and Recording Mechanisms

To be included in Final WQMP

Appendix 10: Educational Materials

Appendix of Included Materials

- *RCFC Homeowner Education Material*
- *SD-10 – Site Design and Landscape Planning*
- *SD-11 – Roof Runoff Controls*
- *SD-12 – Efficient Irrigation*
- *TC-11 – Infiltration Basin*
- *TC-30 – Vegetated Swale*

What is stormwater runoff?

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

Why is stormwater ... a problem?

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

The effects of pollution

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

- Sediment can cloud the water and make it difficult or impossible for aquatic plants to grow. Sediment also can destroy aquatic habitats.
- Excess nutrients can cause algae blooms. When algae die, they sink to the bottom and decompose in a process that removes oxygen from the water. Fish and other aquatic organisms can't exist in water with low dissolved oxygen levels.
- Bacteria and other pathogens can wash into swimming areas and create health hazards, often making beach closures necessary.

- Debris—plastic bags, six-pack rings, bottles, and cigarette butts—washed into waterbodies can choke, suffocate, or disable aquatic life like ducks, fish, turtles, and birds.
- Household hazardous wastes like insecticides, pesticides, paint, solvents, used motor oil, and other auto fluids can poison aquatic life. Land animals and people can become sick or die from eating diseased fish and shellfish or ingesting polluted water.
- Polluted stormwater often affects drinking water sources. This, in turn, can affect human health and increase drinking water treatment costs.

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

Lawn care

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

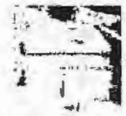
- Don't overwater your lawn. Consider using a soaker hose instead of a sprinkler.
- Use pesticides and fertilizers sparingly. When use is necessary, use these chemicals in the recommended amounts. Use organic mulch or safer pest control methods whenever possible.
- Compost or mulch yard waste. Don't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

Auto care

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

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

Septic systems



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

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

Pet waste

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

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

Education is essential to changing people's behavior. Signs and markers near storm drains warn residents that pollutants entering the drains will be carried untreated into a local waterbody.

Residential landscaping

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

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

Rain Gardens and Grassy Swales—Specially designed areas planted with native plants can provide natural places for rainwater to collect and soak into the ground. Rain from rooftop areas or paved areas can be diverted into these areas rather than into storm drains.

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

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

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

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

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

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

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

Improperly managed logging operations can result in erosion and sedimentation.

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

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

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

Helpful telephone numbers and links:

Riverside County Stormwater Protection Partners

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

REPORT ILLEGAL STORM DRAIN DISPOSAL
1-800-506-2555 or e-mail us at
fcnpdes@rcflood.org

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

Online resources include:

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

Stormwater Pollution

What you should know for...

Outdoor Cleaning Activities and Professional Mobile Service Providers

Storm drain pollution prevention information for:

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

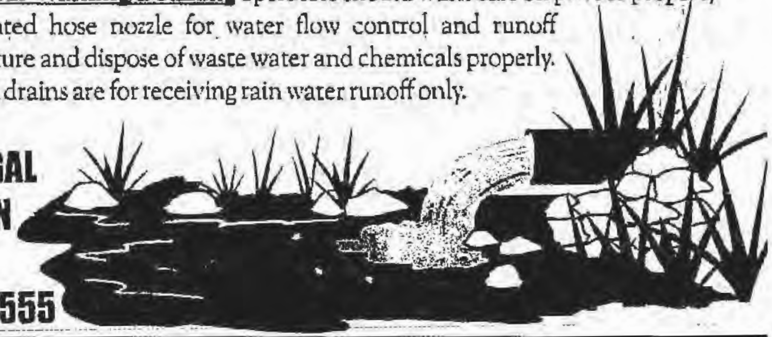
Do you know where street flows actually go?

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

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

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

REPORT ILLEGAL STORM DRAIN DISPOSAL 1-800-506-2555



Help Protect Our Waterways!

Use these guidelines for Outdoor Cleaning Activities and Wash Water Disposal

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

Best Management Practices

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

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

Simple solutions for both light and heavy duty jobs:

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

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

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

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

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

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

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

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

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

Using Cleaning Agents

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

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

Think Water Conservation

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

Screening Wash Water

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

Drain Inlet Protection & Collection of Wash Water

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

Concrete/Coring/Saw Cutting and Drilling Projects

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

Site Design & Landscape Planning SD-10

Design Objectives

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

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

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

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

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

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

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

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

Dry wells and Infiltration Trenches

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

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

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

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

Pop-up Drainage Emitter

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

Foundation Planting

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

Redeveloping Existing Installations

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

Supplemental Information

Examples

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

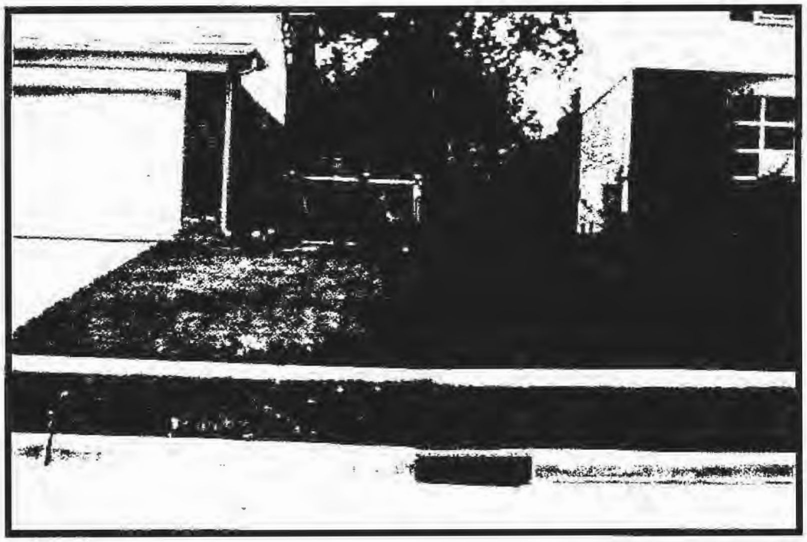
Other Resources

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

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

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

Efficient Irrigation



Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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

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CALIFORNIA STORMWATER

- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.

- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:

  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff

  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect

  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible

  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth

- Employ other comparable, equally effective methods to reduce irrigation water runoff.

Redeveloping Existing Installations

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

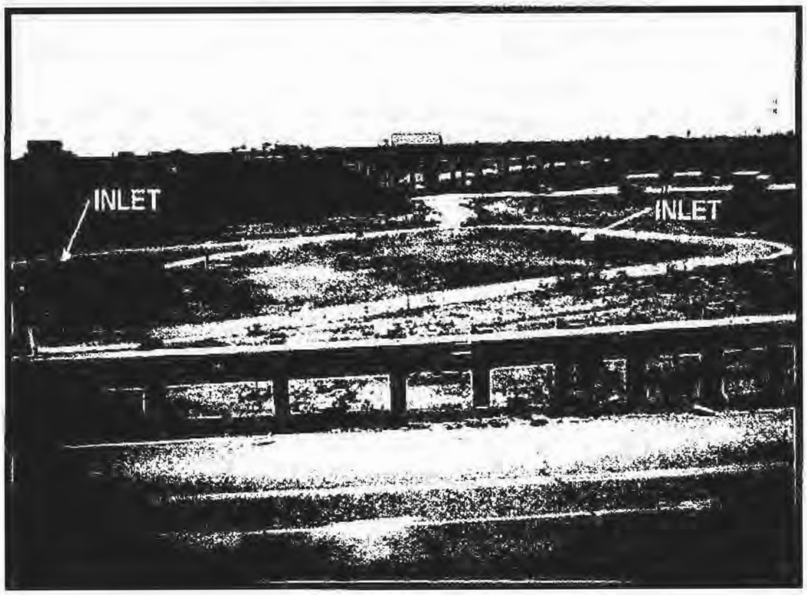
Other Resources

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

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

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

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



Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

Targeted Constituents

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

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

Description

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

California Experience

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

Advantages

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

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

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

Limitations

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

Design and Sizing Guidelines

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

Construction/Inspection Considerations

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

Performance

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

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

Siting Criteria

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

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

- Determine soil type (consider RCS soil type 'A, B or C' only) from mapping and consult USDA soil survey tables to review other parameters such as the amount of silt and clay, presence of a restrictive layer or seasonal high water table, and estimated permeability. The soil should not have more than 30% clay or more than 40% of clay and silt combined. Eliminate sites that are clearly unsuitable for infiltration.

- Groundwater separation should be at least 3 m from the basin invert to the measured ground water elevation. There is concern at the state and regional levels of the impact on groundwater quality from infiltrated runoff, especially when the separation between groundwater and the surface is small.

- Location away from buildings, slopes and highway pavement (greater than 6 m) and wells and bridge structures (greater than 30 m). Sites constructed of fill, having a base flow or with a slope greater than 15% should not be considered.

- Ensure that adequate head is available to operate flow splitter structures (to allow the basin to be offline) without ponding in the splitter structure or creating backwater upstream of the splitter.

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

Secondary Screening Based on Site Geotechnical Investigation

- At least three in-hole conductivity tests shall be performed using USBR 7300-89 or Bouwer-Rice procedures (the latter if groundwater is encountered within the boring), two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m. The tests shall measure permeability in the side slopes and the bed within a depth of 3 m of the invert.

- The minimum acceptable hydraulic conductivity as measured in any of the three required test holes is 13 mm/hr. If any test hole shows less than the minimum value, the site should be disqualified from further consideration.

- Exclude from consideration sites constructed in fill or partially in fill unless no silts or clays are present in the soil boring. Fill tends to be compacted, with clays in a dispersed rather than flocculated state, greatly reducing permeability.

- The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Additional Design Guidelines

(1) Basin Sizing - The required water quality volume is determined by local regulations or sufficient to capture 85% of the annual runoff.

(2) Provide pretreatment if sediment loading is a maintenance concern for the basin.

(3) Include energy dissipation in the inlet design for the basins. Avoid designs that include a permanent pool to reduce opportunity for standing water and associated vector problems.

(4) Basin invert area should be determined by the equation:

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

where A = Basin invert area (m^2)

WQV = water quality volume (m^3)

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

t = drawdown time (48 hr)

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

Maintenance

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

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

Cost

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about $2 per ft (adjusted for inflation) of storage for a 0.25-acre basin (SWRPC, 1991). As with other BMPs, these published cost estimates may deviate greatly from what might be incurred at a specific site. For instance, Caltrans spent about $18/ft^3 for the two infiltration basins constructed in southern California, each of which had a water quality volume of about 0.34 ac.-ft. Much of the higher cost can be attributed to changes in the storm drain system necessary to route the runoff to the basin locations.

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

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

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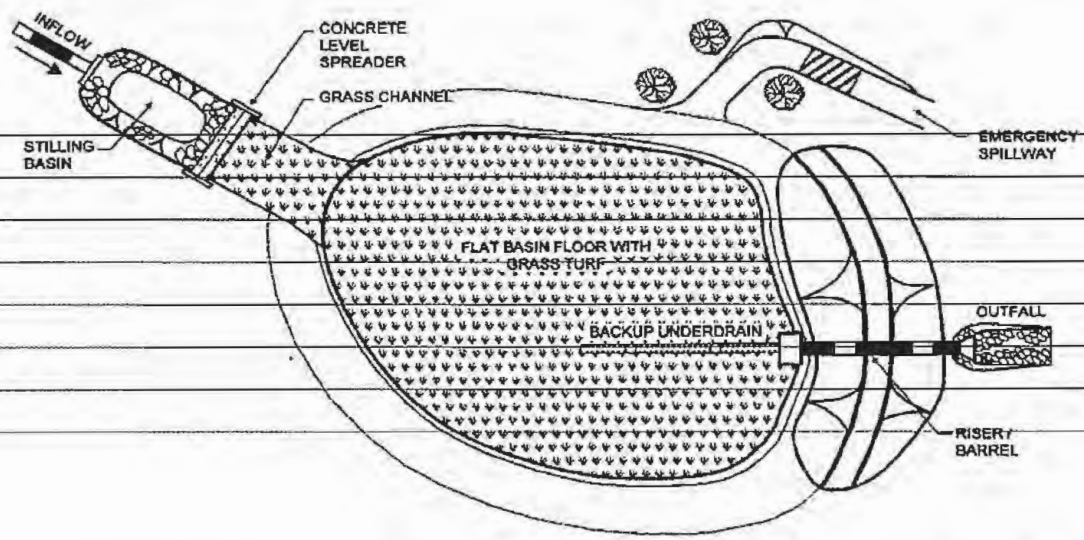
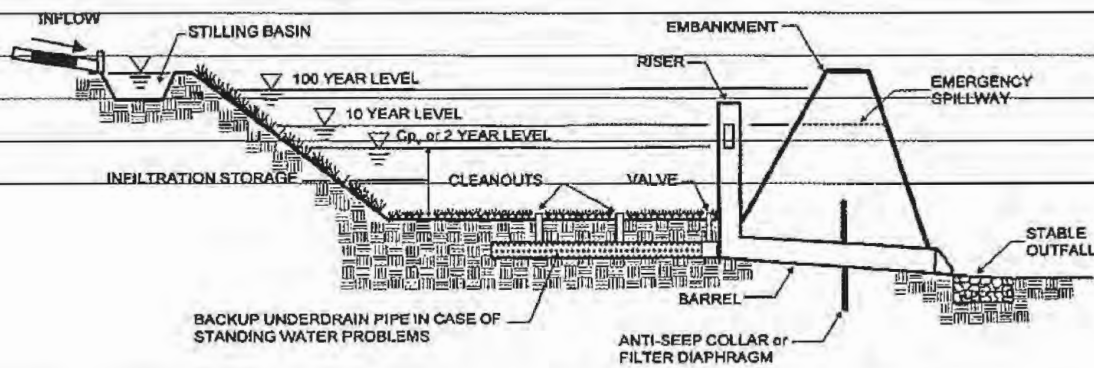


PLAN VIEW



PROFILE