Appendix I

Project Specific Water Quality Management Plan

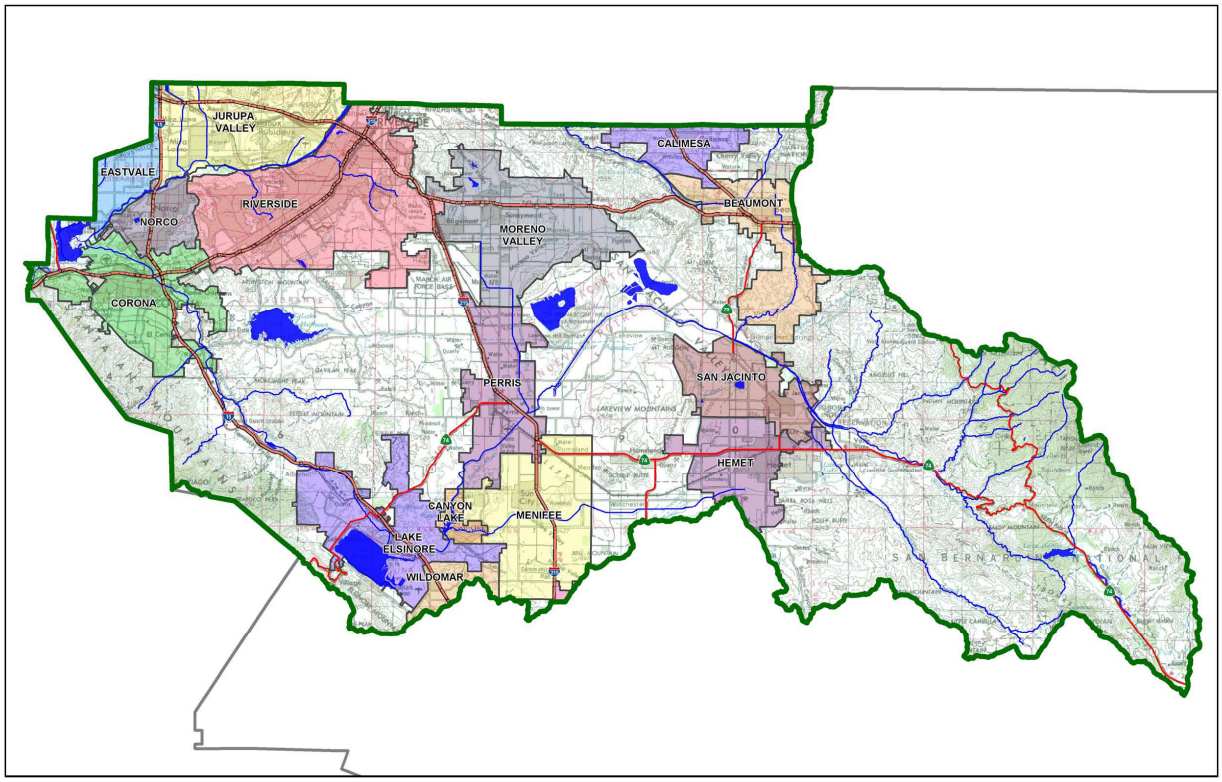
Project Specific Water Quality Management Plan

*A Template for Projects located within the **Santa Ana Watershed** Region of Riverside County*

Project Title: KASSAB TRAVEL CENTER

Development No: PA-2016-00112

Design Review/Case No: PWQMP-2018-00001



☒ **Preliminary**
☐ **Final**

Original Date Prepared: JULY 15, 2017

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December 27, 2018

Prepared for Compliance with
Regional Board Order No. **R8-2010-0033**

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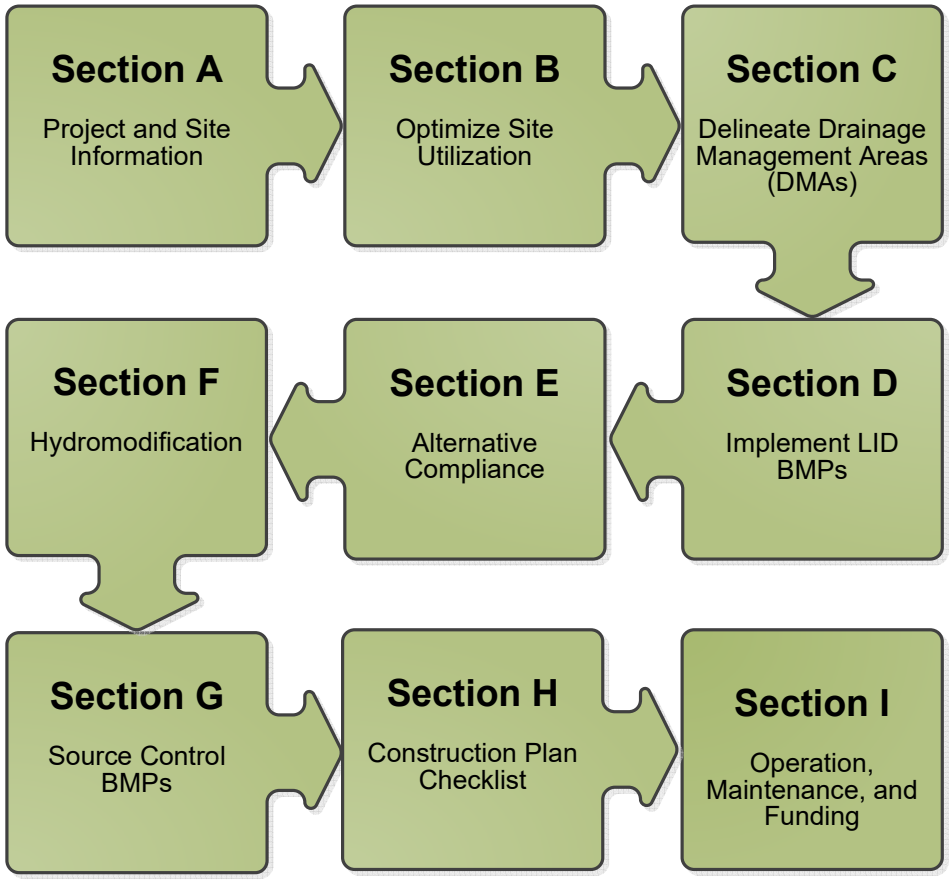
A Brief Introduction

This Project-Specific WQMP Template for the **Santa Ana Region** has been prepared to help guide you in documenting compliance for your project. Because this document has been designed to specifically document compliance, you will need to utilize the WQMP Guidance Document as your "how-to" manual to help guide you through this process. Both the Template and Guidance Document go hand-in-hand, and will help facilitate a well prepared Project-Specific WQMP. Below is a flowchart for the layout of this Template that will provide the steps required to document compliance.



OWNER'S CERTIFICATION

This Project-Specific Water Quality Management Plan (WQMP) has been prepared for Ron Kassab by Moksud Rahman, PE for the Kassab Travel Center facility project.

This WQMP is intended to comply with the requirements of CITY OF LAKE ELSINORE for ORD. # (Municipal Code Section 754.2), which includes the requirement for the preparation and implementation of a Project-Specific WQMP.

The undersigned, while owning the property/project described in the preceding paragraph, shall be responsible for the implementation and funding of this WQMP and will ensure that this WQMP is amended as appropriate to reflect up-to-date conditions on the site. In addition, the property owner accepts responsibility for interim operation and maintenance of Stormwater BMPs until such time as this responsibility is formally transferred to a subsequent owner. This WQMP will be reviewed with the facility operator, facility supervisors, employees, tenants, maintenance and service contractors, or any other party (or parties) having responsibility for implementing portions of this WQMP. At least one copy of this WQMP will be maintained at the project site or project office in perpetuity. The undersigned is authorized to certify and to approve implementation of this WQMP. The undersigned is aware that implementation of this WQMP is enforceable under CITY OF LAKE ELSINORE Water Quality Ordinance (Municipal Code Section 754.2).

"I, the undersigned, certify under penalty of law that the provisions of this WQMP have been reviewed and accepted and that the WQMP will be transferred to future successors in interest."

↗Owner's Signature

12/21/2018

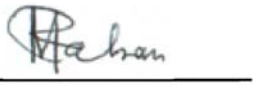
Date

Ron Kassab

Owner's Title/Position

PREPARER'S CERTIFICATION

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan meet the requirements of Regional Water Quality Control Board Order No. **R8-2010-0033** and any subsequent amendments thereto."



Preparer's Signature

Date:

Moksudur Rahman , PE

Professional Civil Engineer

Preparer's Licensure: PE C69263

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Section A: Project and Site Information

PROJECT INFORMATION	
Type of Project:	COMMERCIAL
Planning Area:	I-15 CORRIDOR
Community Name:	LAKE ELSINORE
Development Name:	I-15 CORRIDOR/ NORTH ELSINORE
PROJECT LOCATION	
Latitude & Longitude (DMS): LAT: 33º 41' 41.65" Long: 117º 20' 49.64"	
Project Watershed and Sub-Watershed: Santa Ana River , Temescal Reach	
APN(s): 378-030-007 & 009	
Map Book and Page No.: Page 866 Grid C1 & C2	
PROJECT CHARACTERISTICS	
Proposed or Potential Land Use(s)	Commercial
Proposed or Potential SIC Code(s)	
Area of Impervious Project Footprint (SF)	92,011 SF
Total Area of proposed Impervious Surfaces within the Project Limits (SF)/or Replacement	92,011 SF
Does the project consist of offsite road improvements?	☒ Y ☐ N
Does the project propose to construct unpaved roads?	☐ Y ☒ N
Is the project part of a larger common plan of development (phased project)?	☐ Y ☒ N
EXISTING SITE CHARACTERISTICS	
Total area of existing Impervious Surfaces within the project limits (SF)	0
Is the project located within any MSHCP Criteria Cell?	☐ Y ☒ N
If so, identify the Cell number:	
Are there any natural hydrologic features on the project site?	☐ Y ☒ N
Is a Geotechnical Report attached?	☒ Y ☐ N
If no Geotech. Report, list the NRCS soils type(s) present on the site (A, B, C and/or D)	N/A
What is the Water Quality Design Storm Depth for the project?	0.70

A.1 Maps and Site Plans

When completing your Project-Specific WQMP, include a map of the local vicinity and existing site. In addition, include all grading, drainage, landscape/plant palette and other pertinent construction plans in Appendix 2. At a **minimum**, your WQMP Site Plan should include the following:

- Drainage Management Areas
- Proposed Structural BMPs
- Drainage Path
- Drainage Infrastructure, Inlets, Overflows
- Source Control BMPs
- Buildings, Roof Lines, Downspouts
- Impervious Surfaces
- Standard Labeling

Use your discretion on whether or not you may need to create multiple sheets or can appropriately accommodate these features on one or two sheets. Keep in mind that the Co-Permittee plan reviewer must be able to easily analyze your project utilizing this template and its associated site plans and maps.

A.2 Identify Receiving Waters

Using Table A.1 below, list in order of upstream to downstream, the receiving waters that the project site is tributary to. Continue to fill each row with the Receiving Water's 303(d) listed impairments (if any), designated beneficial uses, and proximity, if any, to a RARE beneficial use. Include a map of the receiving waters in Appendix 1.

Table A.1 Identification of Receiving Waters

Receiving Waters	EPA Approved 303(d) List Impairments	Designated Beneficial Uses	Proximity to RARE Beneficial Use
TEMESCAL WASH	PH, INDICATOR BACTERIA	REC1, REC2, WARM, WILD	RARE (5.4 MILES)
SANTA ANA RIVER	COPPER, LEAD, PATHOGENS, INDICATOR BACTERIA, PATHOGENS	AGR, GWR, REC1, REC2, WARM, WILD, RARE	RARE

A.3 Additional Permits/Approvals required for the Project:

Table A.2 Other Applicable Permits

Agency	Permit Required	
State Department of Fish and Game, 1602 Streambed Alteration Agreement	☐ Y	☒ N
State Water Resources Control Board, Clean Water Act (CWA) Section 401 Water Quality Cert.	☐ Y	☒ N
US Army Corps of Engineers, CWA Section 404 Permit	☐ Y	☐ N
US Fish and Wildlife, Endangered Species Act Section 7 Biological Opinion	☐ Y	☒ N
Statewide Construction General Permit Coverage	☒ Y	☐ N
Statewide Industrial General Permit Coverage	☐ Y	☒ N
Western Riverside MSHCP Consistency Approval (e.g., JPR, DBESP)	☐ Y	☒ N
Other *(please list in the space below as required)* City of Lake Elsinore Grading permit City of Lake Elsinore Building permit	☒ Y	☐ N

If yes is answered to any of the questions above, the Co-Permittee may require proof of approval/coverage from those agencies as applicable including documentation of any associated requirements that may affect this Project-Specific WQMP.

Section B: Optimize Site Utilization (LID Principles)

Review of the information collected in Section 'A' will aid in identifying the principal constraints on site design and selection of LID BMPs as well as opportunities to reduce imperviousness and incorporate LID Principles into the site and landscape design. For example, **constraints** might include impermeable soils, high groundwater, groundwater pollution or contaminated soils, steep slopes, geotechnical instability, high-intensity land use, heavy pedestrian or vehicular traffic, utility locations or safety concerns. **Opportunities** might include existing natural areas, low areas, oddly configured or otherwise unbuildable parcels, easements and landscape amenities including open space and buffers (which can double as locations for bioretention BMPs), and differences in elevation (which can provide hydraulic head). Prepare a brief narrative for each of the site optimization strategies described below. This narrative will help you as you proceed with your LID design and explain your design decisions to others.

The 2010 Santa Ana MS4 Permit further requires that LID Retention BMPs (Infiltration Only or Harvest and Use) be used unless it can be shown that those BMPs are infeasible. Therefore, it is important that your narrative identify and justify if there are any constraints that would prevent the use of those categories of LID BMPs. Similarly, you should also note opportunities that exist which will be utilized during project design. Upon completion of identifying Constraints and Opportunities, include these on your WQMP Site plan in Appendix 1.

Site Optimization

The following questions are based upon Section 3.2 of the WQMP Guidance Document. Review of the WQMP Guidance Document will help you determine how best to optimize your site and subsequently identify opportunities and/or constraints, and document compliance.

Did you identify and preserve existing drainage patterns? If so, how? If not, why?

NO. EXISTING DRAINAGE PATTERN WAS NOT PRESERVE BECAUSE ADJACENT PROPERTIES WOULD NOT ALLOW TO ACCEPT THE INCREASE RUNOFF SO PROJECT WAS DESIGN TO FLOW TOWARDS THE LANDSACPE AREAS THEN OUT TO THE STREETS.

Did you identify and protect existing vegetation? If so, how? If not, why?

NO. WHOLE SITE WILL BE DEVELOPED.

Did you identify and preserve natural infiltration capacity? If so, how? If not, why?

YES, BY CONCENTRATING THE DEVELOPMENT ON PORTIONS OF THE SITE WITH LESS PERMEABLE SOIL AND PRESERVE THE SITE THAT CAN PROMOTE INFILTRATION. SOME LANDSCAPE AREAS ARE CONSIDERED SELF TREATING AREAS WHICH PRESERVE NATURAL INFILTRATION AND SOME AREAS BIORETENTION BMP WILL BE CONSTRUCTED.

Did you identify and minimize impervious area? If so, how? If not, why?

YES, BY INCORPORATING LANDSCAPE AREAS TO MINIMIZE IMPERVIOUS AREAS

Did you identify and disperse runoff to adjacent pervious areas? If so, how? If not, why?

YES, ALL DRAINAGE FLOWS WILL BE CAPTURED BY THE PROPOSED RIBBON GUTTERS TOWARDS TO THE PROPOSED BMPS.

Section C: Delineate Drainage Management Areas (DMAs)

Utilizing the procedure in Section 3.3 of the WQMP Guidance Document which discusses the methods of delineating and mapping your project site into individual DMAs, complete Table C.1 below to appropriately categorize the types of classification (e.g., Type A, Type B, etc.) per DMA for your project site. Upon completion of this table, this information will then be used to populate and tabulate the corresponding tables for their respective DMA classifications.

Table C.1 DMA Classifications

DMA Name or ID	Surface Type(s)[1]	Area (Sq. Ft.)	DMA Type
DMA "A"	Mixed type (A.C pavement, landscape	27,456	TYPE "D"
DMA "B"	Mixed type (A.C pavement, landscape, Roof)	26,397	TYPE "D"
DMA "C"	Landscape	1,457	TYPE "A"
DMA "D"	Mixed type (A.C pavement, landscape	5,536	TYPE "D"
DMA "E"	Mixed type (A.C pavement, landscape	3,383	TYPE "D"
DMA "F"	Mixed type (A.C pavement, landscape, roof)	4,697	TYPE "D"
DMA "G"	Mixed type (A.C pavement, landscape	5,672	TYPE "D"
DMA "H"	Mixed type (A.C pavement, landscape	29,939	TYPE "D"

[1]*Reference Table 2-1 in the WQMP Guidance Document to populate this column*

Table C.2 Type 'A', Self-Treating Areas

DMA Name or ID	Area (Sq. Ft.)	Stabilization Type	Irrigation Type (if any)
DMA "C"	1,457	GRASS VEGETATION	SPRINKLER SYSTEM

Table C.3 Type 'B', Self-Retaining Areas

Self-Retaining Area				**Type 'C' DMAs that are draining to the Self-Retaining Area**		
DMA Name/ ID	Post-project surface type	Area (square feet)	Storm Depth (inches)	DMA Name / ID	[C] from Table C.4 =	Required Retention Depth (inches)
		[A]	[B]		[C]	[D]

$$[D] = [B] + \frac{[B] \cdot [C]}{[A]}$$

Table C.4 Type 'C', Areas that Drain to Self-Retaining Areas

DMA					**Receiving Self-Retaining DMA**		
DMA Name/ ID	Area (square feet)	Post-project surface type	Runoff factor	Product		Area (square feet)	Ratio
	[A]		[B]	[C] = [A] x [B]	DMA name /ID	[D]	[C]/[D]

Table C.5 Type 'D', Areas Draining to BMPs

DMA Name or ID	BMP Name or ID
DMA A	LANDSCAPE AREAS/BIORETENTION
DMA B	BIOFILTRATION (PROPRIETARY)
DMA D	BIORETENTION
DMA E	LANDSCAPE AREAS
DMA F	LANDSCAPE AREAS
DMA G	BIORETENTION
DMA H	LANDSCAPE AREAS/BIORETENTION

Note: More than one drainage management area can drain to a single LID BMP, however, one drainage management area may not drain to more than one BMP.

Section D: Implement LID BMPs

D.1 Infiltration Applicability

Is there an approved downstream 'Highest and Best Use' for stormwater runoff (see discussion in Chapter 2.4.4 of the WQMP Guidance Document for further details)? ☐ Y ☒ N

If yes has been checked, Infiltration BMPs shall not be used for the site. If no, continue working through this section to implement your LID BMPs. It is recommended that you contact your Co-Permittee to verify whether or not your project discharges to an approved downstream 'Highest and Best Use' feature.

Geotechnical Report

A Geotechnical Report or Phase I Environmental Site Assessment may be required by the Copermittee to confirm present and past site characteristics that may affect the use of Infiltration BMPs. In addition, the Co-Permittee, at their discretion, may not require a geotechnical report for small projects as described in Chapter 2 of the WQMP Guidance Document. If a geotechnical report has been prepared, include it in Appendix 3. In addition, if a Phase I Environmental Site Assessment has been prepared, include it in Appendix 4.

Is this project classified as a small project consistent with the requirements of Chapter 2 of the WQMP Guidance Document? ☐ Y ☒ N

Infiltration Feasibility

Table D.1 below is meant to provide a simple means of assessing which DMAs on your site support Infiltration BMPs and is discussed in the WQMP Guidance Document in Chapter 2.4.5. Check the appropriate box for each question and then list affected DMAs as applicable. If additional space is needed, add a row below the corresponding answer.

Table D.1 Infiltration Feasibility

Does the project site…	YES	NO
…have any DMAs with a seasonal high groundwater mark shallower than 10 feet?		X
If Yes, list affected DMAs:		
…have any DMAs located within 100 feet of a water supply well?		X
If Yes, list affected DMAs:		
…have any areas identified by the geotechnical report as posing a public safety risk where infiltration of stormwater could have a negative impact?		X
If Yes, list affected DMAs:		
…have measured in-situ infiltration rates of less than 1.6 inches / hour?	X	
If Yes, list affected DMAs: A, B, D, G & H	X	
…have significant cut and/or fill conditions that would preclude in-situ testing of infiltration rates at the final infiltration surface?		X
If Yes, list affected DMAs:		
…geotechnical report identify other site-specific factors that would preclude effective and safe infiltration?		X
Describe here:		

If you answered "Yes" to any of the questions above for any DMA, Infiltration BMPs should not be used for those DMAs and you should proceed to the assessment for Harvest and Use below.

D.2 Harvest and Use Assessment –

Please check what applies*:*

☐ Reclaimed water will be used for the non-potable water demands for the project.

☐Downstream water rights may be impacted by Harvest and Use as approved by the Regional Board (verify with the Copermittee).

☐ The Design Capture Volume will be addressed using Infiltration Only BMPs. In such a case, Harvest and Use BMPs are still encouraged, but it would not be required if the Design Capture Volume will be infiltrated or evapotranspired.

If any of the above boxes have been checked, Harvest and Use BMPs need not be assessed for the site. If neither of the above criteria applies, follow the steps below to assess the feasibility of irrigation use, toilet use and other non-potable uses (e.g., industrial use).

Irrigation Use Feasibility

Complete the following steps to determine the feasibility of harvesting stormwater runoff for Irrigation Use BMPs on your site:

Step 1: Identify the total area of irrigated landscape on the site, and the type of landscaping used.

Total Area of Irrigated Landscape: _____0.29 ac_____

Type of Landscaping (Conservation Design or Active Turf): ___CONSERVATION DESIGN

Step 2: Identify the planned total of all impervious areas on the proposed project from which runoff might be feasibly captured and stored for irrigation use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: 0.25ac

Step 3: Cross reference the Design Storm depth for the project site (see Exhibit A of the WQMP Guidance Document) with the left column of Table 2-3 in Chapter 2 to determine the minimum area of Effective Irrigated Area per Tributary Impervious Area (EIATIA).

Enter your EIATIA factor: 1.32

Step 4: Multiply the unit value obtained from Step 3 by the total of impervious areas from Step 2 to develop the minimum irrigated area that would be required.

Minimum required irrigated area: _____0.33_____AC

Step 5: Determine if harvesting stormwater runoff for irrigation use is feasible for the project by comparing the total area of irrigated landscape (Step 1) to the minimum required irrigated area (Step 4).

Minimum required irrigated area (Step 4)	**Available Irrigated Landscape (Step 1)**
_____0.33_____AC	_____0.29_____ AC

Note: The proposed project cannot meet or exceed the minimum ratio, therefore Harvest and use is not feasible.

Complete the following steps to determine the feasibility of harvesting stormwater runoff for toilet flushing uses on your site:

Step 1: Identify the projected total number of daily toilet users during the wet season, and account for any periodic shut downs or other lapses in occupancy:

Projected Number of Daily Toilet Users: ____35_____

Project Type: COMMERCIAL

Step 2: Identify the planned total of all impervious areas on the proposed project from which runoff might be feasibly captured and stored for toilet use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: 0.25 AC

Step 3: Enter the Design Storm depth for the project site (see Exhibit A) into the left column of Table 2-1 in Chapter 2 to determine the minimum number or toilet users per tributary impervious acre (TUTIA).

Enter your TUTIA factor: 150

Step 4: Multiply the unit value obtained from Step 3 by the total of impervious areas from Step 2 to develop the minimum number of toilet users that would be required.

Minimum number of toilet users: _____37.5_____

Step 5: Determine if harvesting stormwater runoff for toilet flushing use is feasible for the project by comparing the Number of Daily Toilet Users (Step 1) to the minimum required number of toilet users (Step 4).

Minimum required Toilet Users (Step 4)	**Projected number of toilet users (Step 1)**
_____37.5_____	_____35__

Note: The proposed project cannot meet or exceed the minimum demand, therefore Harvest and use is not feasible.

Other Non-Potable Use Feasibility

Are there other non-potable uses for stormwater runoff on the site (e.g. industrial use)? See Chapter 2 of the Guidance for further information. If yes, describe below. If no, write N/A.

N/A

Step 1: Identify the projected average daily non-potable demand, in gallons per day, during the wet season and accounting for any periodic shut downs or other lapses in occupancy or operation.

Average Daily Demand: N/A

Step 2: Identify the planned total of all impervious areas on the proposed project from which runoff might be feasibly captured and stored for the identified non-potable use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: N/A

Step 3: Enter the Design Storm depth for the project site (see Exhibit A) into the left column of Table 2-3 in Chapter 2 to determine the minimum demand for non-potable uses per tributary impervious acre.

Enter the factor from Table 2-3: N/A

Step 4: Multiply the unit value obtained from Step 4 by the total of impervious areas from Step 3 to develop the minimum number of gallons per day of non-potable use that would be required.

Minimum required useN/A

Step 5: Determine if harvesting stormwater runoff for other non-potable use is feasible for the project by comparing the Number of Daily Toilet Users (Step 1) to the minimum required number of toilet users (Step 4).

Minimum required non-potable use (Step 4)	**Projected average daily use (Step 1)**
N/A	N/A

If Irrigation, Toilet and Other Use feasibility anticipated demands are less than the applicable minimum values, Harvest and Use BMPs are not required and you should proceed to utilize LID Bioretention and Biotreatment, unless a site-specific analysis has been completed that demonstrates technical infeasibility as noted in D.3 below.

D.3 Bioretention and Biotreatment Assessment

Other LID Bioretention and Biotreatment BMPs as described in Chapter 2.4.7 of the WQMP Guidance Document are feasible on nearly all development sites with sufficient advance planning.

Select one of the following:

X LID Bioretention/Biotreatment BMPs will be used for some or all DMAs of the project as noted below in Section D.4 (note the requirements of Section 3.4.2 in the WQMP Guidance Document).

☐ A site-specific analysis demonstrating the technical infeasibility of all LID BMPs has been performed and is included in Appendix 5. If you plan to submit an analysis demonstrating the technical infeasibility of LID BMPs, request a pre-submittal meeting with the Copermittee to discuss this option. Proceed to Section E to document your alternative compliance measures.

D.4 Feasibility Assessment Summaries

From the Infiltration, Harvest and Use, Bioretention and Biotreatment Sections above, complete Table D.2 below to summarize which LID BMPs are technically feasible, and which are not, based upon the established hierarchy.

Table D.2 LID Prioritization Summary Matrix

DMA Name/ID	LID BMP Hierarchy				No LID (Alternative Compliance)
	1. Infiltration	2. Harvest and use	3. Bioretention	4. Biotreatment	
DMA A	☐	☐	☒	☐	☐
DMA B	☐	☐	☐	☒	☐
	☐	☐	☐	☐	☐
DMA D	☐	☐	☒	☐	☐
DMA E	☐	☐	☒	☐	☐
DMA F	☐	☐	☒	☐	☐
DMA G	☐		☒		
DMA H			☒		

For those DMAs where LID BMPs are not feasible, provide a brief narrative below summarizing why they are not feasible, include your technical infeasibility criteria in Appendix 5, and proceed to Section E below to document Alternative Compliance measures for those DMAs. Recall that each proposed DMA must pass through the LID BMP hierarchy before alternative compliance measures may be considered.

Insert narrative description here.

D.5 LID BMP Sizing

Each LID BMP must be designed to ensure that the Design Capture Volume will be addressed by the selected BMPs. First**,** calculate the Design Capture Volume for each LID BMP using the V_{BMP} worksheet in Appendix F of the LID BMP Design Handbook. Second**,** design the LID BMP to meet the required V_{BMP} using a method approved by the Copermittee. Utilize the worksheets found in the LID BMP Design Handbook or consult with your Copermittee to assist you in correctly sizing your LID BMPs. Complete Table D.3 below to document the Design Capture Volume and the Proposed Volume for each LID BMP. Provide the completed design procedure sheets for each LID BMP in Appendix 6. You may add additional rows to the table below as needed.

Table D.3 DCV Calculations for LID BMPs

DMA Type/ID	**DMA Area (square feet)**	**Post-Project Surface Type**	**Effective Impervious Fraction, I_f**	**DMA Runoff Factor**	**DMA Areas x Runoff Factor**	***Enter BMP Name / Identifier Here*** ***BIO-RETENTION NO.1***		
	[A]		[B]	[C]	[A] x [C]			
DMA A	*27,456*	*MIXED TYPE*	*0.86*	*0.67*	*18,396*	*Design Storm Depth (in)*	*Design Capture Volume,* **V_{BMP}** *(cubic feet)*	*Proposed Volume on Plans (cubic feet)*
	27,456				18,396	0.70	1080.30	1,140

[B], [C] is obtained as described in Section 2.3.1 of the WQMP Guidance Document

[E] is obtained from Exhibit A in the WQMP Guidance Document

[G] is obtained from a design procedure sheet, such as in LID BMP Design Handbook and placed in Appendix 6

NOTE: THE DMA RUMOFF FACTOR WAS AUTOMATICALLY CALCULATED FRPM THE WORKSHEET FOR CALCULATING THE VOLUME bmp, SEE APPENDIX 6.

						Modular wetlands		
DMA B	26,327	MIXED TYPE	0.96	0.82	21,588	0.70	1267.7	1500

						BIORETENTION		
DMA D	5,536	MIXED TYPE	1.0	0.89	4,927	0.70	288.10	312

+

						BIORETENTION		
DMA E	3,383	A.C PVMT	0.42	0.29	981.07	0.70	60.80	176

						BIORETENTION		
DMA F	4,697	A.C PVMT	0.64	0.44	2066.60	0.70	120.8	121

						BIORETENTION		
DMA G	5,612	A.C PVMT	0.62	0.42	2357	0.70	139.0	176

						BIORETENTION		
DMA H	29,939	MIX TYPE	0.95	.81	24,251	0.70	1409.30	1410

IMPERVIOUS FRACTION CALCULATION

A. DMA-A

TOTAL AREA = 0.63 AC
A.C PAVEMENT = 0.53 AC
LANDSCAPING = 0.10 AC

If= (0.63)(1.0) + (0.53)(1.0) + (0.10)(0.10) / 0.63

IMPERVIOUS FRACTION (If) = 0.86

B. DMA-B

TOTAL AREA = 0.61AC
A.C PAVEMENT and ROOF= 0.58 AC
LANDSCAPING = 0.03 AC

If= (0.58)(1.0) + (0.03)(0.10) /0.61

IMPERVIOUS FRACTION (If) = 0.96

C. DMA-D

TOTAL AREA = 0.12 AC
A.C PAVEMENT=0.12 AC

If= (0.12)(1.0) / 0.12

IMPERVIOUS FRACTION (If) = 1.0

D. DMA-E

TOTAL AREA = 0.11AC
A.C PAVEMENT=0.04
LANDSCAPING = 0.07AC

If= (0.04)(1.0)+(0.07)(0.10) / 0.11

IMPERVIOUS FRACTION (If) = 0.42

E. DMA-F

TOTAL AREA = 0.11 AC
A.C PAVEMENT AND ROOF=0.07

If= 0.07)(1.0) / 0.11

IMPERVIOUS FRACTION (If) = 0.64

F. DMA-G

TOTAL AREA = 0.13 AC
A.C PAVEMENT =0.11
LANDSCAPING = 0.02AC

If= 0.11)(1.0)+(0.02)(0.1) / 0.13

IMPERVIOUS FRACTION (If) = 0.62

G. DMA-H

TOTAL AREA = 0.69 AC
A.C PAVEMENT AND ROOF=0.65
LANDSCAPING=0.04 AC

If= 0.65)(1.0)+(0.04)(0.10) / 0.69

IMPERVIOUS FRACTION (If) = 0.95

Section E: Alternative Compliance (LID Waiver Program)

LID BMPs are expected to be feasible on virtually all projects. Where LID BMPs have been demonstrated to be infeasible as documented in Section D, other Treatment Control BMPs must be used (subject to LID waiver approval by the Copermittee). Check one of the following Boxes:

☒ LID Principles and LID BMPs have been incorporated into the site design to fully address some of the Drainage Management Areas. No alternative compliance measures are required for this project and thus this Section is not required to be completed.

- *Or* -

☐ The following Drainage Management Areas are unable to be addressed using LID BMPs. A site-specific analysis demonstrating technical infeasibility of LID BMPs has been approved by the Co-Permittee and included in Appendix 5. Additionally, no downstream regional and/or sub-regional LID BMPs exist or are available for use by the project. The following alternative compliance measures on the following pages are being implemented to ensure that any pollutant loads expected to be discharged by not incorporating LID BMPs, are fully mitigated.

List DMAs here.

E.1 Identify Pollutants of Concern

Utilizing Table A.1 from Section A above which noted your project's receiving waters and their associated EPA approved 303(d) listed impairments, cross reference this information with that of your selected Priority Development Project Category in Table E.1 below. If the identified General Pollutant Categories are the same as those listed for your receiving waters, then these will be your Pollutants of Concern and the appropriate box or boxes will be checked on the last row. The purpose of this is to document compliance and to help you appropriately plan for mitigating your Pollutants of Concern in lieu of implementing LID BMPs.

Table E.1 Potential Pollutants by Land Use Type

Priority Development Project Categories and/or Project Features (check those that apply)	General Pollutant Categories							
	Bacterial Indicators	Metals	Nutrients	Pesticides	Toxic Organic Compounds	Sediments	Trash & Debris	Oil & Grease
☐ Detached Residential Development	P	N	P	P	N	P	P	P
☐ Attached Residential Development	P	N	P	P	N	P	P	P(2)
☒ Commercial/Industrial Development	P(3)	P	P(1)	P(1)	P(5)	P(1)	P	P
☐ Automotive Repair Shops	N	P	N	N	P(4, 5)	N	P	P
☒ Restaurants (>5,000 ft^2)	P	N	N	N	N	N	P	P
☐ Hillside Development (>5,000 ft^2)	P	N	P	P	N	P	P	P
☒ Parking Lots (>5,000 ft^2)	P(6)	P	P(1)	P(1)	P(4)	P(1)	P	P
☒ Retail Gasoline Outlets	N	P	N	N	P	N	P	P
Project Priority Pollutant(s) of Concern	☒	☒	☐	☐	☐	☐	☐	☐

P = Potential

N = Not Potential

(1) A potential Pollutant if non-native landscaping exists or is proposed onsite; otherwise not expected

(2) A potential Pollutant if the project includes uncovered parking areas; otherwise not expected

(3) A potential Pollutant is land use involving animal waste

(4) Specifically petroleum hydrocarbons

(5) Specifically solvents

(6) Bacterial indicators are routinely detected in pavement runoff

E.2 Stormwater Credits

Projects that cannot implement LID BMPs but nevertheless implement smart growth principles are potentially eligible for Stormwater Credits. Utilize Table 3-8 within the WQMP Guidance Document to identify your Project Category and its associated Water Quality Credit. If not applicable, write N/A.

Table E.2 Water Quality Credits

Qualifying Project Categories	Credit Percentage[2]
Total Credit Percentage[1]	

[1]Cannot Exceed 50%

[2]Obtain corresponding data from Table 3-8 in the WQMP Guidance Document

E.3 Sizing Criteria

After you appropriately considered Stormwater Credits for your project, utilize Table E.3 below to appropriately size them to the DCV, or Design Flow Rate, as applicable. Please reference Chapter 3.5.2 of the WQMP Guidance Document for further information.

Table E.3 Treatment Control BMP Sizing

DMA Type/ID	**DMA Area (square feet)**	**Post-Project Surface Type**	**Effective Impervious Fraction, I_f**	**DMA Runoff Factor**	**DMA Area x Runoff Factor**		***Enter BMP Name / Identifier Here***		
	[A]		[B]	[C]	[A] x [C]				
						Design Storm Depth (in)	*Minimum Design Capture Volume or Design Flow Rate (cubic feet or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	A_T = Σ[A]				Σ= [D]	[E]	$[F] = \frac{[D]x[E]}{[G]}$	[F] X (1-[H])	[I]

[B], [C] is obtained as described in Section 2.3.1 from the WQMP Guidance Document

[E] is obtained from Exhibit A in the WQMP Guidance Document

[G] is for Flow-Based Treatment Control BMPs [G] = 43,560, for Volume-Based Control Treatment BMPs, [G] = 12

[H] is from the Total Credit Percentage as Calculated from Table E.2 above

[I] as obtained from a design procedure sheet from the BMP manufacturer and should be included in Appendix 6

E.4 Treatment Control BMP Selection

Treatment Control BMPs typically provide proprietary treatment mechanisms to treat potential pollutants in runoff, but do not sustain significant biological processes. Treatment Control BMPs must have a removal efficiency of a medium or high effectiveness as quantified below:

- **High**: equal to or greater than 80% removal efficiency
- **Medium**: between 40% and 80% removal efficiency

Such removal efficiency documentation (e.g., studies, reports, etc.) as further discussed in Chapter 3.5.2 of the WQMP Guidance Document, must be included in Appendix 6. In addition, ensure that proposed Treatment Control BMPs are properly identified on the WQMP Site Plan in Appendix 1.

Table E.4 Treatment Control BMP Selection

Selected Treatment Control BMP Name or ID[1]	Priority Pollutant(s) of Concern to Mitigate[2]	Removal Efficiency Percentage[3]
Modular Wetlands	Bacterial Indicators, Metals, Trash & Debris	90%

[1] Treatment Control BMPs must not be constructed within Receiving Waters. In addition, a proposed Treatment Control BMP may be listed more than once if they possess more than one qualifying pollutant removal efficiency.
[2] Cross Reference Table E.1 above to populate this column.
[3] As documented in a Co-Permittee Approved Study and provided in Appendix 6.

Section F: Hydromodification

F.1 Hydrologic Conditions of Concern (HCOC) Analysis

Once you have determined that the LID design is adequate to address water quality requirements, you will need to assess if the proposed LID Design may still create a HCOC. Review Chapters 2 and 3 (including Figure3-7) of the WQMP Guidance Document to determine if your project must mitigate for Hydromodification impacts. If your project meets one of the following criteria which will be indicated by the check boxes below, you do not need to address Hydromodification at this time. However, if the project does not qualify for Exemptions 1, 2 or 3, then additional measures must be added to the design to comply with HCOC criteria. This is discussed in further detail below in Section F.2.

HCOC EXEMPTION 1: The Priority Development Project disturbs less than one acre. The Copermittee has the discretion to require a Project-Specific WQMP to address HCOCs on projects less than one acre on a case by case basis. The disturbed area calculation should include all disturbances associated with larger common plans of development.

Does the project qualify for this HCOC Exemption? ☐ Y ☒ N

If Yes, HCOC criteria do not apply.

HCOC EXEMPTION 2: The volume and time of concentration[1] of storm water runoff for the post-development condition is not significantly different from the pre-development condition for a 2-year return frequency storm (a difference of 5% or less is considered insignificant) using one of the following methods to calculate:

- Riverside County Hydrology Manual
- Technical Release 55 (TR-55): Urban Hydrology for Small Watersheds (NRCS 1986), or derivatives thereof, such as the Santa Barbara Urban Hydrograph Method
- Other methods acceptable to the Co-Permittee

Does the project qualify for this HCOC Exemption? ☐ Y ☒ N

If Yes, report results in Table F.1 below and provide your substantiated hydrologic analysis in Appendix 7.

Table F.1 Hydrologic Conditions of Concern Summary

	2 year – 24 hour		
	Pre-condition	**Post-condition**	**% Difference**
Time of Concentration	N/A	N/A	N/A
Volume (Cubic Feet)	N/A	N/A	N/A

[1] Time of concentration is defined as the time after the beginning of the rainfall when all portions of the drainage basin are contributing to flow at the outlet.

HCOC EXEMPTION 3: All downstream conveyance channels to an adequate sump (for example, Prado Dam, Lake Elsinore, Canyon Lake, Santa Ana River, or other lake, reservoir or naturally erosion resistant feature) that will receive runoff from the project are engineered and regularly maintained to ensure design flow capacity; no sensitive stream habitat areas will be adversely affected; or are not identified on the Co-Permittees Hydromodification Sensitivity Maps.

Does the project qualify for this HCOC Exemption? ☐ Y ☒ N

If Yes, HCOC criteria do not apply and note below which adequate sump applies to this HCOC qualifier:

F.2 HCOC Mitigation

If none of the above HCOC Exemption Criteria are applicable, HCOC criteria is considered mitigated if they meet one of the following conditions:

a. Additional LID BMPS are implemented onsite or offsite to mitigate potential erosion or habitat impacts as a result of HCOCs. This can be conducted by an evaluation of site-specific conditions utilizing accepted professional methodologies published by entities such as the California Stormwater Quality Association (CASQA), the Southern California Coastal Water Research Project (SCCRWP), or other Co-Permittee approved methodologies for site-specific HCOC analysis.

b. The project is developed consistent with an approved Watershed Action Plan that addresses HCOC in Receiving Waters.

c. Mimicking the pre-development hydrograph with the post-development hydrograph, for a 2-year return frequency storm. Generally, the hydrologic conditions of concern are not significant, if the post-development hydrograph is no more than 10% greater than pre-development hydrograph. In cases where excess volume cannot be infiltrated or captured and reused, discharge from the site must be limited to a flow rate no greater than 110% of the pre-development 2-year peak flow.

Be sure to include all pertinent documentation used in your analysis of the items a, b or c in Appendix 7.

HCOC IS MITIGATED BY ACHIEVING CONDITION C. DISCHARGE FROM THE SITE WAS LIMITED TO A FLOW RATE NOT GREATER THAN 10% OF THE PRE-DEVELOPED 2 YEAR PEAK FLOW. SEE APPENDIX 7 FOR SUPPORTING CALCULATIONS.

Section G: Source Control BMPs

Source control BMPs include permanent, structural features that may be required in your project plans — such as roofs over and berms around trash and recycling areas — and Operational BMPs, such as regular sweeping and "housekeeping", that must be implemented by the site's occupant or user. The MEP standard typically requires both types of BMPs. In general, Operational BMPs cannot be substituted for a feasible and effective permanent BMP. Using the Pollutant Sources/Source Control Checklist in Appendix 8, review the following procedure to specify Source Control BMPs for your site:

1. ***Identify Pollutant Sources*:** Review Column 1 in the Pollutant Sources/Source Control Checklist. Check off the potential sources of Pollutants that apply to your site.

2. ***Note Locations on Project-Specific WQMP Exhibit*:** Note the corresponding requirements listed in Column 2 of the Pollutant Sources/Source Control Checklist. Show the location of each Pollutant source and each permanent Source Control BMP in your Project-Specific WQMP Exhibit located in Appendix 1.

3. ***Prepare a Table and Narrative*:** Check off the corresponding requirements listed in Column 3 in the Pollutant Sources/Source Control Checklist. In the left column of Table G.1 below, list each potential source of runoff Pollutants on your site (from those that you checked in the Pollutant Sources/Source Control Checklist). In the middle column, list the corresponding permanent, Structural Source Control BMPs (from Columns 2 and 3 of the Pollutant Sources/Source Control Checklist) used to prevent Pollutants from entering runoff. **Add additional narrative** in this column that explains any special features, materials or methods of construction that will be used to implement these permanent, Structural Source Control BMPs.

4. ***Identify Operational Source Control BMPs:*** To complete your table, refer once again to the Pollutant Sources/Source Control Checklist. List in the right column of your table the Operational BMPs that should be implemented as long as the anticipated activities continue at the site. Copermittee stormwater ordinances require that applicable Source Control BMPs be implemented; the same BMPs may also be required as a condition of a use permit or other revocable Discretionary Approval for use of the site.

Table G.1 Permanent and Operational Source Control Measures

Potential Sources of Runoff pollutants	Permanent Structural Source Control BMPs	Operational Source Control BMPs
On-site storm Drain Inlets	*Mark all Inlets " Only Rain Down the storm drain*	*-Maintain and periodically repaint or replace inlet markings* *-Provide stormwater pollution prevention information to new site owners, lessees or operators* *-Include in Lease agreement: "Tenant shall not allow anyone to discharge anything to storm drains or store or deposit materials so as to create a potential discharge to storm drains".*
Landscape/Outdoor Pesticide Use	*Design Landscaping to Minimize Irrigation and Runoff, to promote*	*Maintain Landscaping using minimum or no pesticides.*

	surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution	
Parking lots, sidewalks, plazas		*Sweep parking lots regularly to prevent accumulation of liter 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 and not to storm drain.* *Sweep plazas, sidewalks and parking lots regularly to prevent accumulation of liter and debris. Collect debris from presuure washing to prevent entry to storm drain system. Collect washwater containing any cleaning agent or degreaser and discharge to sanitary sewer not to storm drain.*
Roofings, Gutters & Trims	Avoid roofing. Gutters & trim made of copper and other unprotected metals that may leach into runoff.	

Section H: Construction Plan Checklist

Populate Table H.1 below to assist the plan checker in an expeditious review of your project. The first two columns will contain information that was prepared in previous steps, while the last column will be populated with the corresponding plan sheets. This table is to be completed with the submittal of your final Project-Specific WQMP.

Table H.1 Construction Plan Cross-reference

BMP No. or ID	BMP Identifier and Description	Corresponding Plan Sheet(s)
BMP NO.1	LANDSCAPE AREA/BIORETENTION	SHT 2 OF GRADING PLANS
BMP NO. 2	BIOCLEAN MODULAR WETLANDS	SHT 2 OF GRADING PLANS
BMP NO.3	LANDSCAPE	SHTC 2 OF GRADING PLAN
BMP NO.4	BIORETENTION	SHT 2 OF GRADING PLAN
BMP NO.5	LANDSCAPE AREA	SHT 2 OF GRADING PLAN
BMP NO.6	LANDSCAPE AREA	SHT 2 OF GRADING PLANS
BMP NO.7	BIORETENTION	SHT 2 OF GRADING PLAN
BMP NO.8	LANDSCAPE AREA/BIORETENTION	SHT 2 OF GRADING PLAN

Note that the updated table — or Construction Plan WQMP Checklist — is **only a reference tool** to facilitate an easy comparison of the construction plans to your Project-Specific WQMP. Co-Permittee staff can advise you regarding the process required to propose changes to the approved Project-Specific WQMP.

Section I: Operation, Maintenance and Funding

The Copermittee will periodically verify that Stormwater BMPs on your site are maintained and continue to operate as designed. To make this possible, your Copermittee will require that you include in Appendix 9 of this Project-Specific WQMP:

1. A means to finance and implement facility maintenance in perpetuity, including replacement cost.
2. Acceptance of responsibility for maintenance from the time the BMPs are constructed until responsibility for operation and maintenance is legally transferred. A warranty covering a period following construction may also be required.
3. An outline of general maintenance requirements for the Stormwater BMPs you have selected.
4. Figures delineating and designating pervious and impervious areas, location, and type of Stormwater BMP, and tables of pervious and impervious areas served by each facility. Geo-locating the BMPs using a coordinate system of latitude and longitude is recommended to help facilitate a future statewide database system.
5. A separate list and location of self-retaining areas or areas addressed by LID Principles that do not require specialized O&M or inspections but will require typical landscape maintenance as noted in Chapter 5, pages 85-86, in the WQMP Guidance. Include a brief description of typical landscape maintenance for these areas.

Your local Co-Permittee will also require that you prepare and submit a detailed Stormwater BMP Operation and Maintenance Plan that sets forth a maintenance schedule for each of the Stormwater BMPs built on your site. An agreement assigning responsibility for maintenance and providing for inspections and certification may also be required.

Details of these requirements and instructions for preparing a Stormwater BMP Operation and Maintenance Plan are in Chapter 5 of the WQMP Guidance Document.

Maintenance Mechanism: Insert text here.

Will the proposed BMPs be maintained by a Home Owners' Association (HOA) or Property Owners Association (POA)?

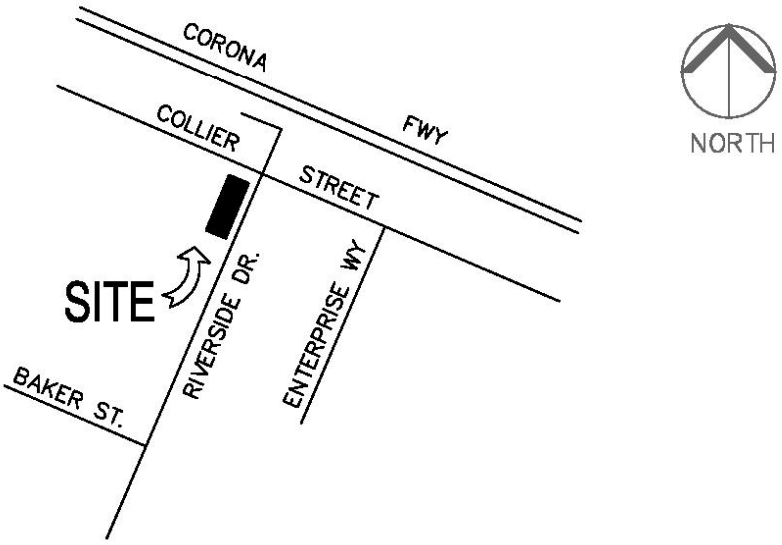
☒ Y ☐ N

Include your Operation and Maintenance Plan and Maintenance Mechanism in Appendix 9. Additionally, include all pertinent forms of educational materials for those personnel that will be maintaining the proposed BMPs within this Project-Specific WQMP in Appendix 10.

THIS SECTION WILL BE ADDRESSED AND COMPLETED AT THE TIME OF FINAL WQMP SUBMITTAL.

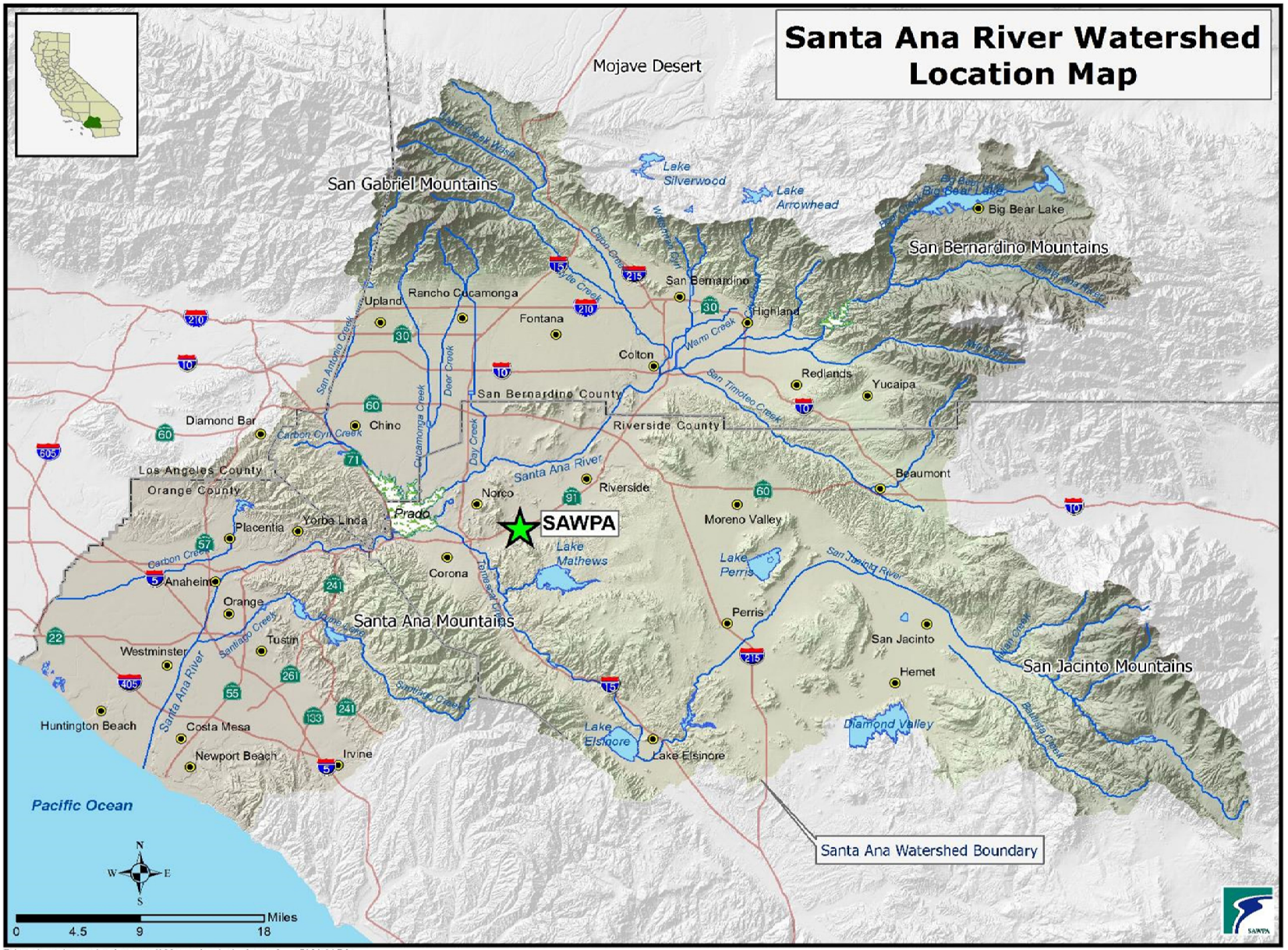
Appendix 1: Maps and Site Plans

Location Map, WQMP Site Plan and Receiving Waters Map



VICINITY MAP:

NOT TO SCALE


Santa Ana River Watershed
Location Map
Mojave Desert
San Gabriel Mountains
San Bernardino Mountains
Santa Ana Mountains
San Jacinto Mountains
Lake Silverwood
Lake Arrowhead
Big Bear Lake
Upland
Rancho Cucamonga
Fontana
San Bernardino
Highland
Colton
Redlands
Yucaipa
San Bernardino County
Riverside County
Chino
Diamond Bar
Los Angeles County
Orange County
Norco
Riverside
Prado
SAWPA
Lake Mathews
Corona
Moreno Valley
Beaumont
Lake Perris
Placentia
Yorba Linda
Anaheim
Orange
Tustin
Westminster
Perris
San Jacinto
Hemet
Lake Elsinore
Diamond Valley
Huntington Beach
Costa Mesa
Newport Beach
Irvine
Pacific Ocean
Santa Ana River
Santa Ana Watershed Boundary
N
W
E
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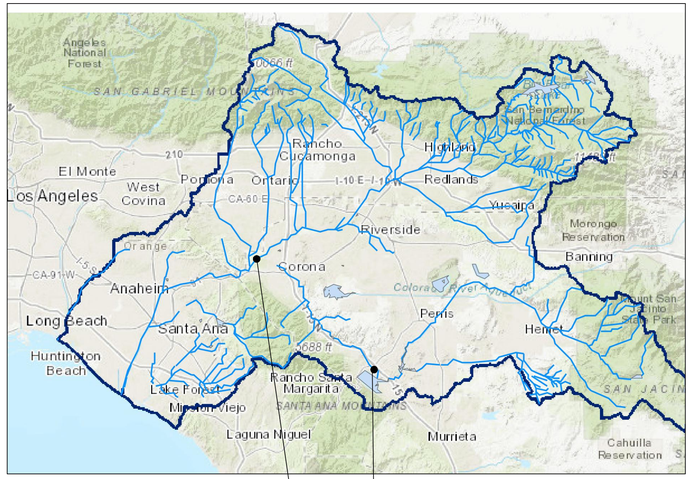
W.Q.M.P SITE PLAN



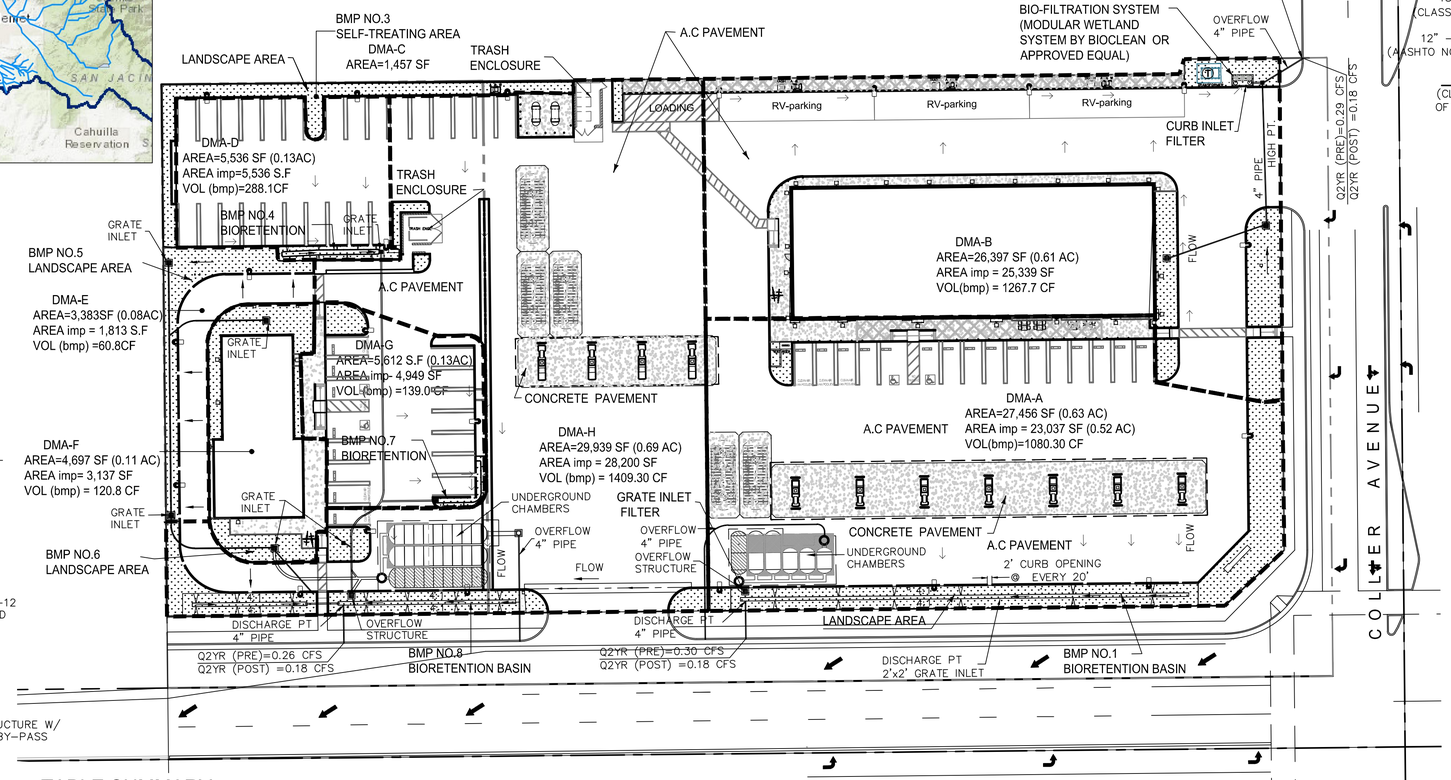
LOCATION MAP

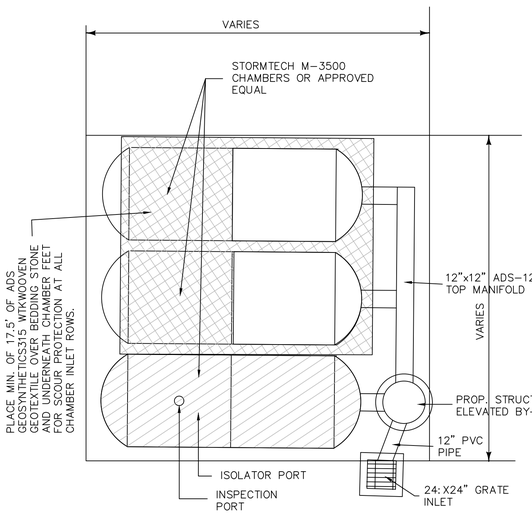
NTS

LEGEND OR KEY TO SYMBOLS

- PROPERTY LINE
- PROPOSED SLOPE
- 1950 — PROPOSED ELEV.
- (1940) — EXISTING ELEV.
- DRAINAGE FLOW
- DRAINAGE BOUNDARY

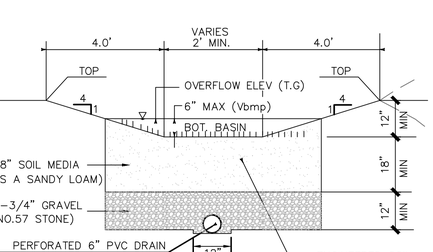
FULL TRASH CAPTURE DEVICES:
1. CURB INLET FILTER
2. FLO-GUARD GRATE INLET INSERTS





STORMTECH MC-□500 CHAMBERS OR APPEOVED E□UAL) UNDERGROUND CHAMBER DETAIL

NTS



TYPICAL BIORETENTION DETAIL

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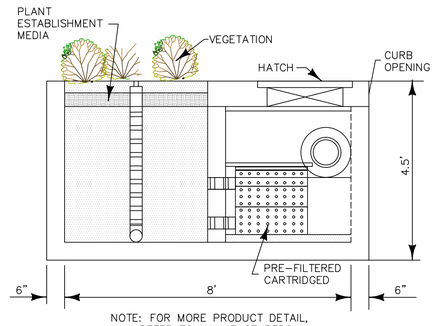


NOTE: FOR MORE PRODUCT DETAIL, REFER TO MANUFACTURERS STD, DETAILS

BIOCLEAN MODULAR WETLAND SYSTEM

NTS

TABLE SUMMARY:

DMA ID	AREA (S.F)	EFFECTIVE AREA (S.F)	IMPERVIOUS AREA (S.F)	PERVIOUS AREA (S.F)	VOL BMP (CF)	VOLUME PROVIDED (CF)
A	27,456	2,746	23,037	4,419	1,080.30	1,140
B	26,397	2,640	25,339	1,058	1,267.7	1,500
C	1,457	146	0	1,457		
D	5,536	554	5,536	0	288.10	312
E	3,383	338	1,813	1,570	60.80	186
F	4,697	470	3,137	1,560	120.80	121
G	5,612	561	4,949	663	139.00	176
H	29,939	2,994	28,200	1,739	1,409.30	1,410

FLOOR AREA RATIO (FAR) = GROSS FLOOR AREA OF BUILDING / GROSS LOT AREA
= 10,831SF / 104,523SF
= 0.10 < 1.0

TOTAL PROJECT AREA = 104,523 SF (2.40 AC)
TOTAL IMPERVIOUS AREA = 92,011 SF (2.11 AC)
TOTAL PERVIOUS AREA = 12,632 SF (0.29 AC)

NOTE:

ALL GRATE INLETS MUST HAVE FLO-GUARD INLET FILTERS OR APPROVED EQUAL FOR TRASH CAPTURE.

SOURCE CONTROL BMP'S

NON- STRUCTURAL SOURCE BMP
EDUCATION OF PROPERTY OWNERS, TENANTS, AND OCUPANYS ON STORMWATER BMP'S
SPILL CONTINGENCY PLAN
HAZARDOUS MATERIAL DISCLOSUE COMPIANCE
UNIFORM FIRE CODE IMPLEMENTATION
LITER/DEBRIS CONTROL PTOGRAM
EMPLOYEE TRAINING
VACUUM SWEEPING OF PRIVATE STREETS AND PARKIBG LOTS.
OTHER NON STRUCTURAL MEASURES FOR PUBLIC AGENCY PROJECTS.
COMPLY WITH ALL NPDES PERMITS.

STRUCTURAL SOURCE BMP
DESIGN AND CONSTRUCT TRASH AND AND WASTE STORAGE TO REDUCE POLLUTION INTRODUCTION.
USE EFFICIENT IRRIGATION SYSTEM AND LANDSCAPE DESIGN, WATER CONSERVATION.
FINISH GRADE OF LANDSCAPE AREAS IS 1" TO 2' BELOW TOP OF CURB, SIDEWALK OR PAVEMENT.
MAINTAIN LANDSCAPING USING MINIMUM OR NO PESTICIDES
SWEEP PARKING LOTS REGILARLY TO PREVENT ACCUMULATION OF TRASH AND DEBRIS
MARK INLETS "ONLY RAIN DOWN THE STORM DRAIN".

GRAPHIC SCALE
30 0 15 30 60 90
(IN FEET)
1 inch = 30 ft.

Underground Service Alert
Call: TOLL FREE
1-800 227-2600
TWO WORKING DAYS BEFORE YOU DIG

BENCHMARK
RIVERSIDE COUNTY FLOOD CONTROL DISTRICT BENCHMARK
DESIGNATION: Z 12924
ELEVATION: 1266.57
DESC: FOUND NAIL AND RCFC & WCD TAG FLUSH IN PAVEMENT ON LAKESHORE DRIVE .88 FEET ± EASTERLY OF K-RAILS ON LAKESHORE EASTERLY OF OUTLET

REVISIONS

SEAL: REGISTERED PROFESSIONAL ENGINEER — MOKSUDUR RAHMAN — No. C69263 — Exp. 6-30-20 — CIVIL — STATE OF CALIFORNIA

PLANS PREPARED BY:
RAHMAN ENGINEERING
6939 SCHAEFER AVE, SUITE # D-170,
CHINO, CA 91710
TEL: (213) 400 - 8078

PREPARED BY:
MOKSUDUR RAHMAN
R.C.E. NO. C69263 EXP. DATE :
ACCEPTED BY:
DATE:

SCALE
Horizontal
1" = 30'
Vertical
N/A

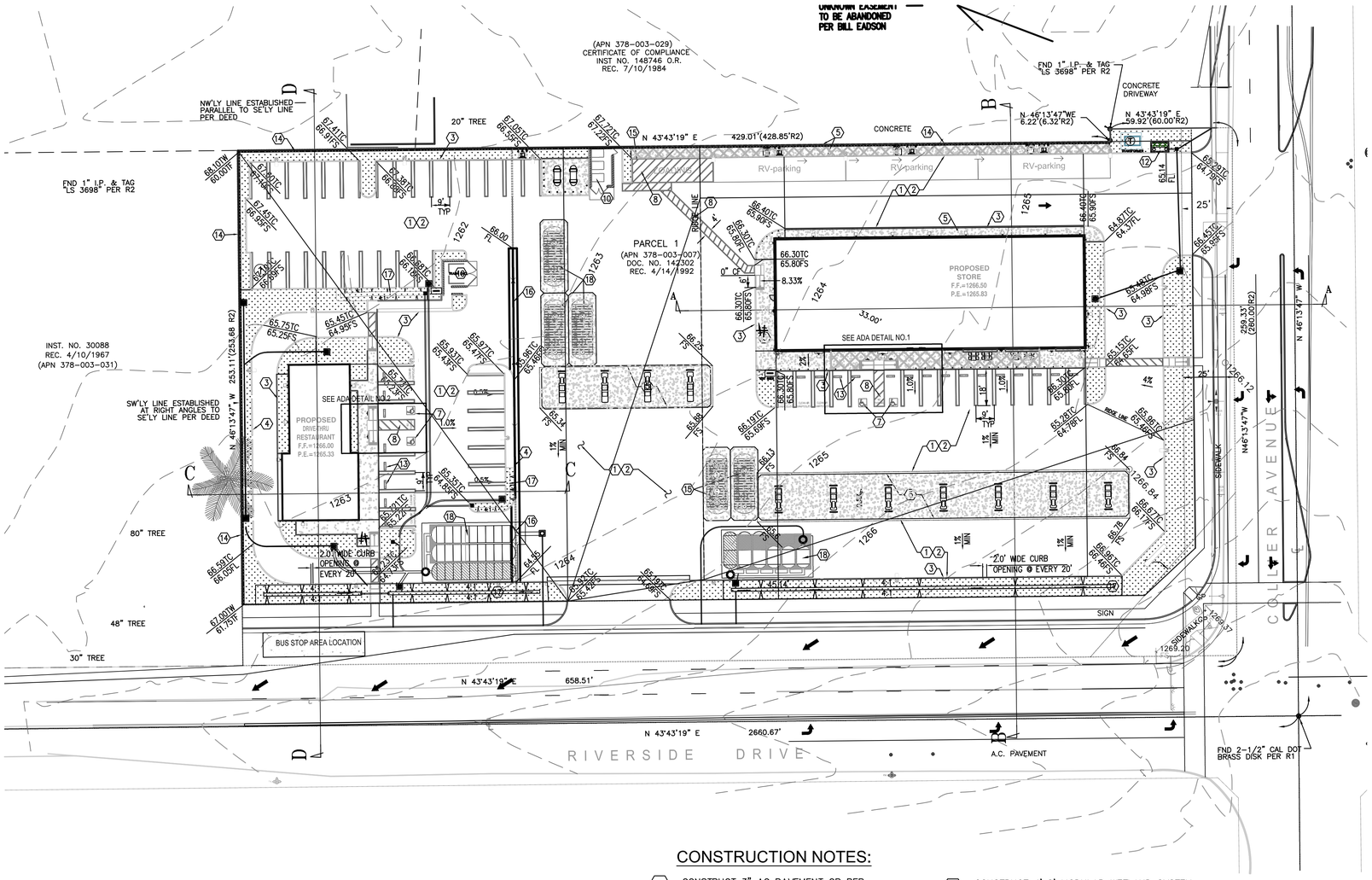
CITY OF LAKE ELSINORE
W.Q.M.P
THE KASSAB TRAVEL CENTER
29301 RIVERSIDE DRIVE
LAKE ELSINORE, CA 92530

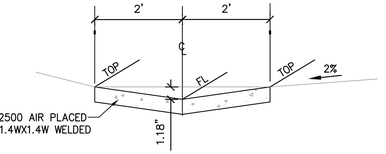
1 OF 1 SHEETS

C:\Land Projects 2018\RBR\2017-PROJECTS\RBR\MR ENGINEERING\KASSAB TRAVEL CENTER\RBR WQMP\K-WQMP SITE PLAN-V4.dwg 1-03-19 11:01:28 AM

Appendix 2: Construction Plans

Grading and Drainage Plans





RIBBON GUTTER DETAIL

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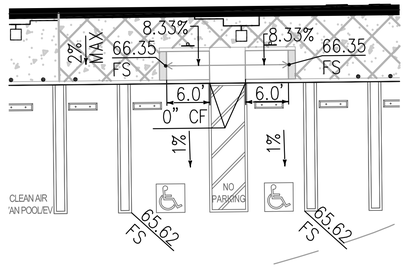

ADA DETAIL NO.1

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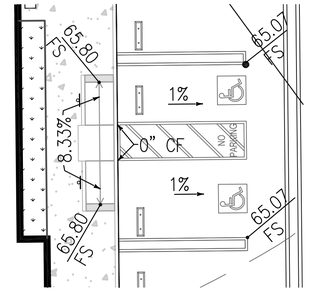

ADA DETAIL NO.2

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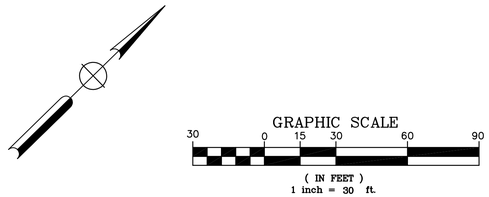


CONSTRUCTION NOTES:

1. CONSTRUCT 3" AC PAVEMENT OR PER SOILS ENGINEER RECOMMENDATIONS
2. CONSTRUCT 6" A.B OR PER SOILS ENGINEER RECOMMENDATIONS
3. CONSTRUCT TYPE 6A CURB PER CITY OF LAKE ELSINORE STD. DWG 202
4. CONSTRUCT TYPE 6 INTERGRAL CURB & GUTTER PER CITY OF LAKE ELSINORE STD. DWG 200
5. CONSTRUCT 4" CONCRETE SLAB/WALKWAY
6. PAINT 4" WHITE SOLID PARKING STRIPES
7. PAINT PAVEMENT ADA MARKING SYMBOL SIGNS
8. PAINT PAVEMENT ADA BLUE HATCH (VAN ACCESSIBLE)
9. INSTALL HANDICAPPED PARKING SIGN
10. CONSTRUCT TRASH ENCLOSURE PER ARCHITECTURAL PLANS.
11. REMOVE EXISTING TREES
12. CONSTRUCT 4'x8' MODULAR WETLAND SYSTEM (MWS-LINEAR) BY BIOCLEAN OR APPROVED EQUAL
13. CONSTRUCT 4' LONG CONCRETE WHEEL STOP
14. CONSTRUCT RETAINING WALL (UNDER SEPARATE PERMIT).
15. UNDERGROUND STORAGE TANKS (BY OYHERS)
16. CONSTRUCT RIBBON GUTTER PER DETAIL HEREON
17. CONSTRUCT BIORETENTION BASIN PER DETAIL PN SHEET 3
18. CONSTRUCT STORMTECH MC-3500 UNDERGROUND CHAMBERS OR APPROVED EQUAL PER DETAIL ON SHEET 3T 3
19. CONSTRUCT 24"x24" JENSEN GRATE INLET OR APPROVED EQUAL

NOTE:

1. NO WORK SHALL COMMENCE WITHIN THE ROAD RIGHT OF WAY WITHOUT ISSUANCE OF ENCROACHMENT PERMIT BY TRANSPORTATION DEPARTMENT.
2. SEE STREET IMPROVEMENT PLANS FOR IMPROVEMENTS ALONG RIVERSIDE DRIVE AMD COLLIER AVENUE.

Underground Service Alert

Call: TOLL FREE 1-800 227-2600

TWO WORKING DAYS BEFORE YOU DIG

BENCHMARK

RIVERSIDE COUNTY FLOOD CONTROL DISTRICT BENCHMARK
DESIGNATION: Z 12924
ELEVATION: 1266.57
DESC: FOUND NAIL AND RCFC & WCD TAG FLUSH IN PAVEMENT ON LAKESHORE DRIVE 88 FEET ± EASTERLY OF K-RAILS ON LAKESHORE EASTERLY OF OUTLET

REVISIONS

SEAL: REGISTERED PROFESSIONAL ENGINEER — MOKSUDUR RAHMAN — No. C69263 — Exp. 6-30-20 — CIVIL — STATE OF CALIFORNIA

PLANS PREPARED BY:

RAHMAN ENGINEERING
6939 SCHAEFER AVE, SUITE # D-170,
CHINO, CA 91710
TEL: (213) 400 - 8078

PREPARED BY:

MOKSUDUR RAHMAN
R.C.E. NO. 36117 EXP. DATE : 6-30-20

ACCEPTED BY:

DATE:

SCALE

Horizontal
1" = 40'
Vertical
N/A

CITY OF LAKE ELSINORE

CONCEPTUAL GRADING PLAN THE KASSAB TRAVEL CENTER 29301 RIVERSIDE DRIVE LAKE ELSINORE, CA 92530

2 OF 3 SHEETS

C:\Land Projects 2004\RRF\2017-PROJECTS\RRF\MR ENGINEERING\KASSAB TRAVEL CENTER RRF\GRADING\KASSAB-GP-V3.dwg 12-04-18 05:55:46 AM

Appendix 3: Soils Information

Geotechnical Study and Other Infiltration Testing Data

GEOBODEN, INC.
Geotechnical Consultants

December 30, 2017
Lake Elsinore-1-01

Attention: Mr. Ron Kassab

Subject: **Infiltration/Percolation Testing for Stormwater Retention**
Proposed Kassab Travel Center
29301 Riverside Drive
Lake Elsinore, California

As requested, we have performed percolation/infiltration testing on the subject site in order to determine the infiltration potential of the surface soils. The percolation rates determined should be useful in assessing stormwater retention needs. It is our understanding that on-site stormwater retention will be required. It is proposed to collect the stormwater runoff within subsurface percolation chambers. This report presents the results of our study, discussion of our findings, and provides percolation rates for the subject system.

PURPOSE AND SCOPE OF SERVICES

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

- Site exploration consisting of the excavation and logging of three test holes;
- Percolation testing in the test holes (P-1, P-2 and P-3);
- Compilation of this report, which presents the results of our study and provides percolation rates for the design of an onsite infiltration system.

SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The site is located at 29301 Riverside Drive in Lake Elsinore, California. The subject property is presently occupied by a vacant land. The project consists of construction of Gas Station, RV Fueling Station and associated improvements. Further information regarding proposed development and test hole locations is shown on Figure 1, Percolation Test Holes Location Map.

FIELD INVESTIGATION

Our field investigation consisted of excavating three shallow exploratory test holes, which were also used as percolation test holes. Hollow-stem drilled equipment was utilized to excavate the exploratory test holes. An engineer logged and observed the test holes excavations. Soil classification was based on visual observation. The approximate locations of the exploratory and

percolation test holes are shown on Figure 1 (Percolation Test Holes Location Map). Logs of the exploratory test holes are presented in Appendix A.

SUBSURFACE SOILS CONDITIONS

SOIL PROFILE

The soils encountered within our test holes consisted of native soil materials. Native soils encountered within the exploratory test holes consisted primarily of sandy clay and clay. A more detailed description of these materials is provided in the exploratory test holes logs included in the enclosed Appendix A. Soils encountered were classified according to the Unified Soil Classification System (USCS).

GROUNDWATER

Groundwater was not encountered within the exploratory test holes to the maximum explored depth of 5 feet below ground surface (bgs). Fluctuations of the groundwater table, localized zones of perched water, and rise in soil moisture content should be anticipated during the rainy season. Irrigation of landscaped areas can also lead to an increase in soil moisture content and fluctuations of intermittent shallow perched groundwater levels.

PERCOLATION TESTING AND PROCEDURE

Percolation testing was performed to assess the general percolation rates of the onsite soils for the design of an onsite infiltration system.

The continuous pre-soak (falling-head) test procedure was utilized for testing. Water was allowed to presoak in each test hole prior to obtaining test readings. Following the presoak period, the drop in water level in each hole was monitored every 10 to 30 minutes to determine the appropriate method for testing. Test holes were refilled following each reading or when the water depth was below 6 inches. Test times ranged from 120 to 150 minutes. The drop in water level was recorded to the nearest $1/10^{th}$ inch to produce conservative water level readings.

SUMMARY OF INFILTRATION TEST RESULTS

Tests results are summarized below:

Test Hole No.	Rate (Inch/Hour)
1	1.3
2	1.4
3	1.2

Based on the obtained field data, 1.2 inches per hour should be utilized in the design of the proposed onsite drain system. The base of the system should be founded into natural soils.

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

The Storm water Manager's Resource Center (SMRC) web site (http://www.stormwatercenter.net/) includes guidelines for disposal of storm water with respect to setback of structures. It is included in the criteria that infiltration facilities should be setback 10 feet down-gradient from structures. In order to avoid potential adversely impacting any existing structures, we recommend that any infiltration system be kept a horizontal distance of at least 10 feet from the edge of new building and the property line.

LIMITATIONS

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

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

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

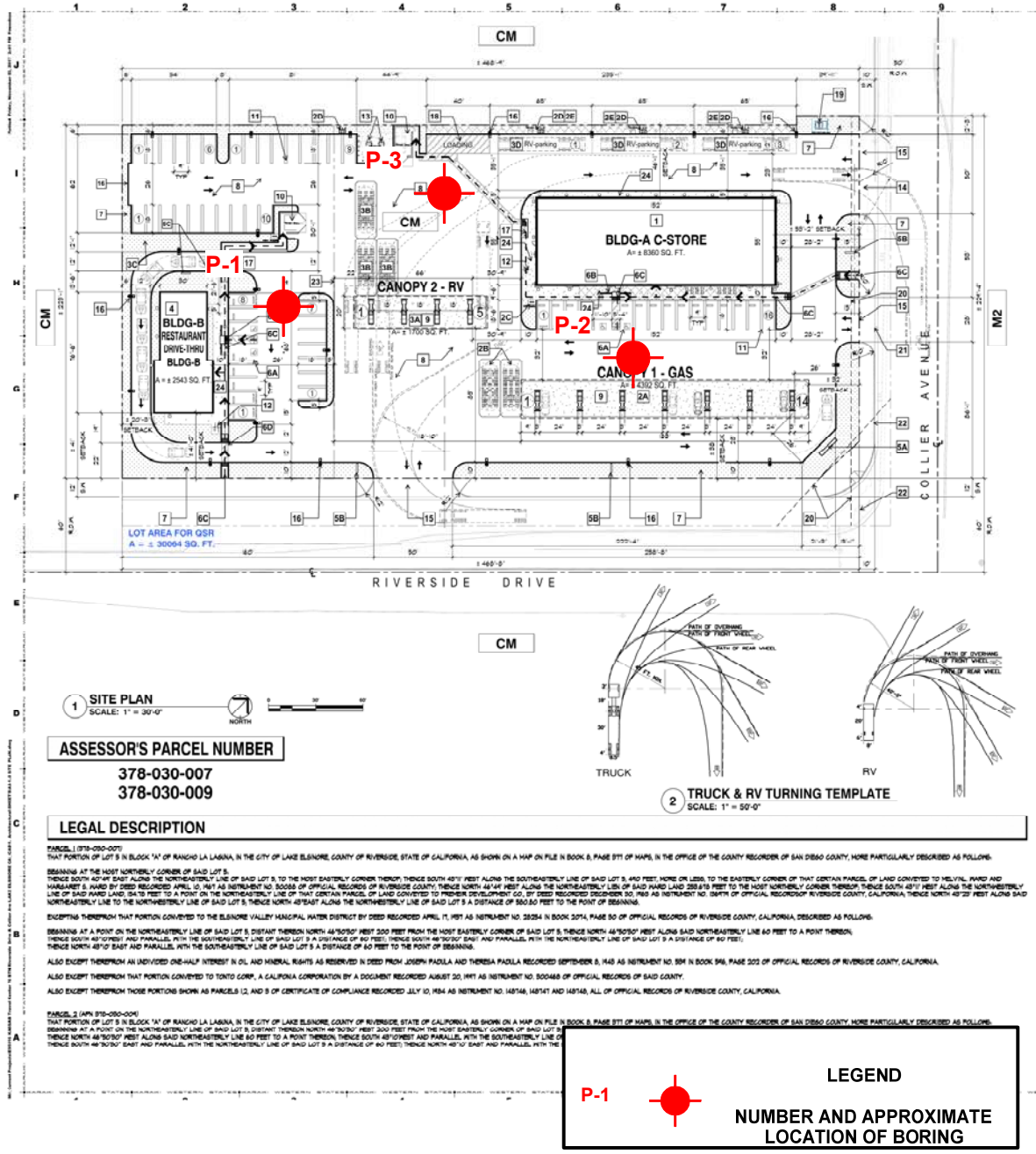
Sincerely,
GEOBODEN, INC.

Cyrus Radvar
Principal Engineer, G.E. 2742

Copies: 3/Addressee

Attachments:

Figure 1 – Percolation Test Holes Location Map
Appendix A – Test Holes Logs



ASSESSOR'S PARCEL NUMBER

378-030-007
378-030-009

LEGAL DESCRIPTION

PARCEL 1 (378-030-007)
THAT PORTION OF LOT 5 IN BLOCK "A" OF RANCHO LA LAGUNA, IN THE CITY OF LAKE ELSINORE, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA, AS SHOWN ON A MAP ON FILE IN BOOK 8, PAGE 871 OF MAPS, IN THE OFFICE OF THE COUNTY RECORDER OF SAN DIEGO COUNTY, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT THE MOST NORTHERLY CORNER OF SAID LOT 5;
THENCE SOUTH 40°49' EAST ALONG THE NORTHEASTERLY LINE OF SAID LOT 5, TO THE MOST EASTERLY CORNER THEREOF; THENCE SOUTH 49°11' WEST ALONG THE SOUTHEASTERLY LINE OF SAID LOT 5, 440 FEET, MORE OR LESS, TO THE EASTERLY CORNER OF THAT CERTAIN PARCEL OF LAND CONVEYED TO MELVIN L. WARD AND MARGARET S. WARD BY DEED RECORDED APRIL 10, 1961 AS INSTRUMENT NO. 30058 OF OFFICIAL RECORDS OF RIVERSIDE COUNTY; THENCE NORTH 40°49' WEST ALONG THE NORTHEASTERLY LINE OF SAID WARD LAND, 259.75 FEET TO A POINT ON THE NORTHEASTERLY LINE OF THAT CERTAIN PARCEL OF LAND CONVEYED TO PIONEER DEVELOPMENT CO., BY DEED RECORDED DECEMBER 30, 1960 AS INSTRUMENT NO. 138479 OF OFFICIAL RECORDSOF RIVERSIDE COUNTY, CALIFORNIA; THENCE NORTH 49°23' WEST ALONG SAID NORTHEASTERLY LINE TO THE NORTHWESTERLY LINE OF SAID LOT 5; THENCE NORTH 49°EAST ALONG THE NORTHWESTERLY LINE OF SAID LOT 5 A DISTANCE OF 550.50 FEET TO THE POINT OF BEGINNING.

EXCEPTING THEREFROM THAT PORTION CONVEYED TO THE ELSINORE VALLEY MUNICIPAL WATER DISTRICT BY DEED RECORDED APRIL 17, 1957 AS INSTRUMENT NO. 28254 IN BOOK 2074, PAGE 50 OF OFFICIAL RECORDS OF RIVERSIDE COUNTY, CALIFORNIA, DESCRIBED AS FOLLOWS:

BEGINNING AT A POINT ON THE NORTHEASTERLY LINE OF SAID LOT 5, DISTANT THEREON NORTH 40°50'50" WEST 300 FEET FROM THE MOST EASTERLY CORNER OF SAID LOT 5; THENCE NORTH 49°50'50" WEST ALONG SAID NORTHEASTERLY LINE 60 FEET TO A POINT THEREON;
THENCE SOUTH 40°10' WEST AND PARALLEL WITH THE SOUTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET; THENCE SOUTH 49°50'50" EAST AND PARALLEL WITH THE NORTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET;
THENCE NORTH 40°10' EAST AND PARALLEL WITH THE SOUTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET TO THE POINT OF BEGINNING.

ALSO EXCEPT THEREFROM AN UNDIVIDED ONE-HALF INTEREST IN OIL AND MINERAL RIGHTS AS RESERVED IN DEED FROM JOSEPH PADILLA AND THERESA PADILLA RECORDED SEPTEMBER 8, 1948 AS INSTRUMENT NO. 594 IN BOOK 596, PAGE 202 OF OFFICIAL RECORDS OF RIVERSIDE COUNTY, CALIFORNIA.

ALSO EXCEPT THEREFROM THAT PORTION CONVEYED TO TONTO CORP., A CALIFONIA CORPORATION BY A DOCUMENT RECORDED AUGUST 20, 1991 AS INSTRUMENT NO. 300468 OF OFFICIAL RECORDS OF SAID COUNTY.

ALSO EXCEPT THEREFROM THOSE PORTIONS SHOWN AS PARCELS 12, AND 9 OF CERTIFICATE OF COMPLIANCE RECORDED JULY 10, 1984 AS INSTRUMENT NO. 148746, 148747 AND 148748, ALL OF OFFICIAL RECORDS OF RIVERSIDE COUNTY, CALIFORNIA.

PARCEL 2 (APN 378-030-004)
THAT PORTION OF LOT 5 IN BLOCK "A" OF RANCHO LA LAGUNA, IN THE CITY OF LAKE ELSINORE, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA, AS SHOWN ON A MAP ON FILE IN BOOK 8, PAGE 871 OF MAPS, IN THE OFFICE OF THE COUNTY RECORDER OF SAN DIEGO COUNTY, MORE PARTICULARLY DESCRIBED AS FOLLOWS:
BEGINNING AT A POINT ON THE NORTHEASTERLY LINE OF SAID LOT 5, DISTANT THEREON NORTH 40°50'50" WEST 300 FEET FROM THE MOST EASTERLY CORNER OF SAID LOT 5;
THENCE NORTH 49°50'50" WEST ALONG SAID NORTHEASTERLY LINE 60 FEET TO A POINT THEREON; THENCE SOUTH 40°10' WEST AND PARALLEL WITH THE SOUTHEASTERLY LINE
THENCE SOUTH 49°50'50" EAST AND PARALLEL WITH THE NORTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET; THENCE NORTH 40°10' EAST AND PARALLEL WITH THE

P-1 — **LEGEND**

NUMBER AND APPROXIMATE LOCATION OF BORING

LEGEND

- NO. OF PARKING SPACES
- ACCESSIBLE PARKING
- PROPERTY LINE (BEFORE R.O.W. DEDICATION)
- PROPERTY LINE (AFTER R.O.W. DEDICATION)
- HANDICAP PATH OF TRAVEL
- CONCRETE PAVING AREA
- LANDSCAPED AREA
- DECORATIVE STAMPED CONCRETE
- WALL MOUNTED AREA LIGHTS
- DIRECTIONAL ARROW
- AREA LIGHTS
- (E) FIRE HYDRANT

SITE KEY NOTES

1 CONVENIENCE STORE
2A GAS STATION CANOPY AND FUEL DISPENSERS FOR AUTOS
2B UNDERGROUND STORAGE TANK
2C VENT RISER WITH CARBON CANISTER
2D AIR & WATER UNIT
2E TRASH BIN
3A GAS STATION CANOPY AND FUEL DISPENSERS OR R.V. & TRUCKS
3B UNDERGROUND STORAGE TANK
3C VENT RISER WITH CARBON CANISTER
3D RV PARKING W/ DUMP STATION
4 FASTFOOD WITH DRIVE-THRU
5A MONUMENT SIGN (UNDER SEPARATE PERMIT)
5B PRICE SIGN (UNDER SEPARATE PERMIT)
5C DRIVE THRU MENU BOARD SIGN
6A ACCESSIBLE PARKING (WITH WHEELCHAIR WHERE REQUIRED)
6B ACCESSIBLE PARKING SIGN
6C ADA ACCESSIBLE RAMP & TRUNCATED DOME PAVER
6D ADA ACCESSIBLE PATH STRIPING (2% MAX CROSS SLOPE)
7 LANDSCAPE WITH 6" CONCRETE CURB
8 ASPHALT PAVING - ALL WEATHER SURFACE TO SUPPORT 75,000 LBS PER FIRE DEPT REQUIREMENTS
9 CONCRETE PAVING - ALL WEATHER SURFACE TO SUPPORT 75,000 LBS PER FIRE DEPT REQUIREMENTS
10 TRASH ENCLOSURE PER CITY STANDARD WHERE APPLICABLE)
11 PARKING STRIPING AS PER CITY STANDARDS (WITH WHEELSTOP WHERE REQUIRED)
12 BIKE PARKING RACK
13 PROPANE TANK
14 (E) DRIVEWAY TO REMOVE, CONSTRUCT (N) SIDEWALK PER CITY STANDARDS
15 (N) DRIVEWAY PER CITY STANDARDS NO. 108A
16 AREA LIGHTS
17 SERVICE RAMP
18 SERVICE LOADING AREA
19 PROPOSED LOCATION OF TRANSFORMER
20 (E) WATER & TELEPHONE EASEMENT
21 (E) POWER POLE (TO BE RELOCATED PER CITY R.O.W. WIDENING)
22 (E) CURB, GUTTER & SIDEWALK (TO BE RELOCATED PER CITY R.O.W. WIDENING)
23 PROPOSED NEW PARCEL LINE FOR QSR WITH DRIVE-THRU
24 CONCRETE WALKWAY

VICINITY MAP

PROJECT DATA

ZONING	C-M (COMMERCIAL MANUFACTURING)	
LAND USE	COMMERCIAL	
AREA OF SITE	± 124,045 S.F. (± 2.85 ACRES) (BEFORE R.O.W. DEDICATION) ± 104,824 S.F. (± 2.34 ACRES) (AFTER R.O.W. DEDICATION)	
BLDG SETBACKS	REQUIRED	PROPOSED
FRONT	20'-0"	20'-0" / 41'-0"
REAR	0'-0" (5'-0" IF ADJACENT TO R-ZONE)	46'-1"
SIDE (YARD)	0'-0" (5'-0" IF ADJACENT TO R-ZONE)	20'-9"
SIDE (STREET)	15'-0"	52'-0" / 51'-0"
LANDSCAPE AREA	12%	16.45% (± 17,140 S.F.)
FLOOR AREA RATIO	-	0.152
LOT COVERAGE	-	18.2%
MAXIMUM HEIGHT	45'-0"	± 26'-0"
PARKING (SEE PARKING COMPUTATION BELOW)	64	75

BUILDING DATA

(N) BLDG-A CONVENIENCE STORE

AREA	± 8,360 SF
OCCUPANCY	M
TYPE OF CONST	V-B
NUMBER OF STORY	1
BLDG HEIGHT	± 26'-0"
FIRE SPRINKLER	YES

(N) BLDG CANOPY (FOR AUTOS)

AREA	± 4,312 SF
OCCUPANCY	M
TYPE OF CONST	II-B
NUMBER OF STORY	1
BLDG HEIGHT	± 18'-0"
(CANOPY CLEARANCE)	± 13'-0"
FIRE SPRINKLER	NONE

(N) BLDG CANOPY (FOR R.V.s)

AREA	± 1,700 SF
OCCUPANCY	M
TYPE OF CONST	II-B
NUMBER OF STORY	1
BLDG HEIGHT	± 14'-8"
(CANOPY CLEARANCE)	± 13'-0"
FIRE SPRINKLER	NONE

(N) BLDG-B FASTFOOD REATAURANT W/ DRIVE-THRU

AREA	± 2,543 SF
OCCUPANCY	A-2
TYPE OF CONST	V-B
NUMBER OF STORY	1
BLDG HEIGHT	± 22'-2"
FIRE SPRINKLER	NONE

PARKING ANALYSIS

PARKING STANDARDS

TYPE	SIZE
REGULAR	9'-0" X 18'-0"
PARALLEL	8'-0" X 23'-0"
HANDICAP	11'-0" X 18'-0" VAN ACCESSIBLE
LOADING	12'-0" X 40'-0" (TYPE-B)

PARKING REQUIREMENTS

USE	REQUIRED	PROPOSED
C-STORE (RETAIL AREA) (± 8,760 SF)	17	14 (6 CANOPIES)
FORMULA: 1 SP PER 400 SF (CM-DISTRICT)		
C-STORE (QSR AREA) (± 1,800 SF)	21	25
FORMULA: 1 SP PER 45 SF OF CUSTOMER AREA, PLUS 1 SP PER 200 SF OF NON-CUSTOMER AREA		
FASTFOOD RESTAURANT	21	31
FORMULA: 1 SP PER 45 SF OF CUSTOMER AREA, PLUS 1 SP PER 200 SF OF NON-CUSTOMER AREA		

HANDICAP PARKING REQUIREMENTS

FORMULA	REQUIRED	PROPOSED
51-75 PARKING SPACES (3)		(4)

CLEAN AIR VEHICLE PARKING

FORMULA	REQUIRED	PROPOSED
51-75 PARKING SPACES (6)		(6)

TOTAL PARKING SPACES	64	75

KARAKI WSe
WESTERN STATES ENGINEERING
A DESIGN-BUILD COMPANY
4667 E. LA PALMA STE. 707
TEL: (714)693-9300 FAX: (714)693-1002
CONSULTANT/ SEALS

SUBMITTAL
NO. DESCRIPTION BY DATE
1
2
3
4

REVISIONS
NO. DESCRIPTION BY DATE
△
△
△
△

OWNER NAME & ADDRESS
MR. RON KASSAB

PROJECT NAME & ADDRESS
THE KASSAB TRAVEL CENTER
Gas Station, RV Fueling Station
QSR w/ Drive-Thru
29301 RIVERSIDE DRIVE
LAKE ELSINORE CA 92530

NOTE TO CONTRACTOR

CONFIDENTIALITY STATEMENT

DESIGNED BY: WS
DRAWN BY: WS
CHECKED BY: JK
DATE DRAWN: 11.03.17
SCALE: 1" = 30'-0"
SHEET TITLE
SITE PLAN

BLDG SHEET NUMBER
AS-1.0
JOB No E95010
CUP No. CUP NO.

GEOBODEN INC. Geotechnical Consultants	PERCOLATION BORING LOCATION PLAN Proposed Kassab Travel Center 29301 Riverside Drive Lake Elsinore, California	Figure By S.R.	Project No. Lake Elsinore
		Map No. XX	Figure No. 2
		Date 12-30-17	

GEOBODEN, INC.

BORING NUMBER P-1

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		SANDY CLAY (CL): yellowish brown, moist, ~30% sand, ~70% fines										
2.5												
5.0		Bottom of borehole at 5 feet below ground surface. Ground water was not encountered. Boring was backfilled with cuttings. Bottom of borehole at 5.0 feet.										

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 12/30/17 12:06 - C:\PASSPORT\GBI\29301 RIVERSIDE DRIVE_LAKE ELSINORE-RAHMAN\PERCOLATION\LOGS.GPJ

GEOBODEN, INC.

BORING NUMBER P-2

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		SANDY CLAY (CL): brown, moist, fine sand										
2.5												
5.0		Bottom of borehole at 5 feet below ground surface. Ground water was not encountered. Boring was backfilled with cuttings. Bottom of borehole at 5.0 feet.										

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 12/30/17 12:06 - C:\PASSPORT\GBI\29301 RIVERSIDE DRIVE_LAKE ELSINORE-RAHMAN\PERCOLATION\LOGS.GPJ

GEOBODEN, INC.

BORING NUMBER P-3

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		SANDY CLAY (CL): strong brown, moist, fine sand										
2.5												
5.0		Bottom of borehole at 5 feet below ground surface. Ground water was not encountered. Boring was backfilled with cuttings. Bottom of borehole at 5.0 feet.										

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 12/30/17 12:06 - C:\PASSPORT\GBI\29301 RIVERSIDE DRIVE_LAKE ELSINORE-RAHMAN\PERCOLATION\LOGS.GPJ

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED KASSAB TRAVEL CENTER
29301 RIVERSIDE DRIVE

Lake Elsinore, California

Prepared for:
MR. RON KASSAB

Prepared by:
GEOBODEN INC.
Irvine, CA 92620

December 30, 2017

Project No. Lake Elsinore-1-01

GEOBODEN INC.

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED KASSAB TRAVEL CENTER
29301 RIVERSIDE DRIVE
LAKE ELSINORE, CALIFORNIA

MR. RON KASSAB

Prepared by:

GEOBODEN INC.
5 Hodgenville, Suite A.
Irvine, California 92620

December 30, 2017

JOB NO. Lake Elsinore-1-01

GEOBODEN, INC.
Geotechnical Consultants

December 30, 2017 Project No. Lake Elsinore-1-01

Attention: Mr. Ron Kassab

Subject: Geotechnical Investigation Report
Proposed Kassab Travel Center
29301 Riverside Drive
Lake Elsinore, California

GeoBoden, Inc. (GeoBoden) is pleased to submit herewith our geotechnical investigation report for the Proposed Kassab Travel Center to be constructed at 29301 Riverside Drive in the city of Lake Elsinore, California.

This report presents the results of our field investigation, laboratory testing and our engineering judgment, opinions, conclusions and recommendations pertaining to geotechnical design aspects of the proposed development.

It has been a pleasure to be of service to you on this project. Should you have any questions regarding the contents of this report, or should you require additional information, please do not hesitate to contact us.

Respectfully submitted,
GEOBODEN, INC.

Cyrus Radvar,
Principal Engineer, G.E. 2742

Copies: 4/Addressee

GEOTECHNICAL INVESTIGATION REPORT

PROPOSED KASSAB TRAVEL CENTER
29301 RIVERSIDE DRIVE
LAKE ELSINORE, CALIFORNIA

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FIGURES

APPENDIXES

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED KASSAB TRAVEL CENTER
29301 RIVERSIDE DRIVE
Lake Elsinore, California

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation performed by GeoBoden, Inc. (GeoBoden) for the Proposed Kassab Travel Center to be located at 29301 Riverside Drive in Lake Elsinore, California. The general location of the project is shown on Figure 1.

The purposes of this investigation were to determine the geotechnical properties of subsurface soil conditions, to evaluate their in-place characteristics, evaluate site seismicity, and to provide geotechnical recommendations with respect to site grading and for design and construction of proposed foundations and other site improvements.

The scope of the authorized investigation included performing a site reconnaissance, conducting field exploration and laboratory testing programs, performing engineering analyses, and preparing this Geotechnical Investigation Report. Evaluation of environmental issues or the potential presence of hazardous materials was not within the scope of services provided.

This report has been prepared for RON KASSAB and their other project team members, to be used solely in the development of facilities described herein. This report may not contain sufficient information for other uses or the purposes of other parties.

2.0 SITE LOCATION AND PROJECT DESCRIPTION

The site is located at 29301 Riverside Drive in Lake Elsinore, California. The site is bounded by Collier Avenue on the east, by an existing building on the north, by a vacant land on the west, and by Riverside Drive on the south. The subject property is presently occupied by a vacant land.

The maximum column load for the new building will be about 75 kips, and the line load will be about 3 kips per lineal feet. Currently, it is our understanding that the proposed building will consist of masonry construction with slab on-grade.

3.0 GEOTECHNICAL INVESTIGATION

Our geotechnical investigation included a field exploration program and a laboratory testing programs. These programs were performed in accordance with our scope of services. The field exploration and laboratory testing programs are briefly described below. A more detailed description of the field exploration and laboratory testing programs is provided in Appendix A and Appendix B, respectively.

3.1 FIELD EXPLORATION PROGRAM

The field exploration program was initiated on December 18, 2017 under the supervision of an engineer. Eight (8) exploratory borings were drilled using a truck-mounted drilling rig equipped with 8-inch diameter hollow stem augers. The borings were advanced to depths of ranging from 11.5 to 31.5 feet (below ground surface). The approximate locations of exploratory borings are shown on Figure 2.

Logs of subsurface conditions encountered in the borings were prepared in the field by a representative of our firm. Soil samples consisting of relatively undisturbed brass ring samples and Standard Penetration Tests (SPT) samples were collected at approximately 5-foot depth intervals and were returned to the laboratory for testing. The SPTs were performed in accordance with ASTM D 1586. Final boring logs were prepared from the field logs and are presented in Appendix A.

3.2 LABORATORY TESTING

Selected samples collected during drilling activities were tested in the laboratory to assist in evaluating controlling engineering properties of subsurface materials at the site. Physical tests performed included moisture and density determination, consolidation, expansion index, No. 200 Sieve, Atterberg limits, and corrosion. The results of laboratory are presented in Appendix B.

4.0 DISCUSSION OF FINDINGS

The following discussion of findings for the site is based on the results of the field exploration and laboratory testing programs.

4.1 SITE AND SUBSURFACE CONDITIONS

Observed subsurface native soils consisted of sandy clay, clay, clay with sand, sand and sand with silt to the maximum explored depth of 31.5 feet below ground surface (bgs).

Based on blow counts recorded during sampling, the clayey soils encountered within borings were found to be firm to stiff. The sandy soil was found to be medium dense. For a more detailed description of the subsurface materials refer to the boring logs included in Appendix A of this report.

4.2 GROUNDWATER CONDITIONS

Groundwater was encountered within our exploratory boring B-1 through B-5 at 15 feet bgs. Based on information from the nearby wells (http://www.water.ca.gov/waterdatalibrary/), the historic high ground water level in the site vicinity is at a depth of greater than 50 feet beneath the existing ground surface.

Fluctuations of the groundwater table, localized zones of perched water, and rise in soil moisture content should be anticipated during the rainy season. Irrigation of landscaped areas can also lead to an increase in soil moisture content and fluctuations of intermittent shallow perched groundwater levels.

4.3 SOIL ENGINEERING PROPERTIES

Physical tests were performed on the relatively undisturbed samples to characterize the engineering properties of the native soils. Moisture content determination was performed on the samples to evaluate the in-situ moisture content. Moisture content and dry unit weight results are included in Appendix B.

4.4 CONSOLIDATION CHARACTERISTICS

Consolidation tests were performed on samples of the existing fill and native overburden soils recovered from the boring. Results of the consolidation tests indicate that the overburden material will have moderate compressibility under the anticipated loads. These characteristics are compatible with the allowable bearing capacity values and corresponding settlement estimates presented in Foundations Section of our report.

4.5 COLLAPSE POTENTIALS

Results of consolidation tests on samples of native soil indicate that the native soils will have low collapse potential. Removal and recompaction of the surficial soils is expected to reduce the anticipated amount of total differential settlement within the site.

4.6 EXPANSIVE SOILS

Preliminary laboratory testing of representative sample of onsite soils indicate that these materials exhibit LOW expansion potential. We anticipate that the design and performance of the proposed new building will not be affected by expansion of onsite soils.

5.0 STRONG GROUND MOTION POTENTIAL

The project site is located in a seismically active area typical of Southern California and likely to be subjected to a strong ground shaking due to earthquakes on nearby faults.

The Elsinore (Glen Ivy) rev fault is the closest known active fault, located 1.91-km of the site with an anticipated maximum moment magnitude (M_w) of 7.7.

5.1 CBC DESIGN PARAMETERS

To accommodate effects of ground shaking produced by regional seismic events, seismic design can, at the discretion of the designing Structural Engineer, be performed in accordance with the 2016 edition of the California Building Code (CBC). Table below, 2016 CBC Seismic Parameters, lists (next) seismic design parameters based on the 2016 CBC methodology, which is based on ASCE/SEI 7-10:

2016 CBC Seismic Design Parameters	Value
Site Latitude (decimal degrees)	33.6947
Site Longitude (decimal degrees)	-117.3471
Site Class Definition (ASCE 7 Table 20.3-1)	D
Mapped Spectral Response Acceleration at 0.2s Period, S_s (Figure 1613.3.1(1))	2.293
Mapped Spectral Response Acceleration at 1s Period, S_1 (Figure 1613.3.1(2))	0.915
Short Period Site Coefficient at 0.2s Period, F_a (Table 1613.3.3(1))	1.0
Long Period Site Coefficient at 1s Period, F_v (Table 1613.3.3(2))	1.5
Adjusted Spectral Response Acceleration at 0.2s Period, S_{MS} (Eq. 16-37)	2.293
Adjusted Spectral Response Acceleration at 1s Period, S_{M1} (Eq. 16-38)	1.372
Design Spectral Response Acceleration at 0.2s Period, S_{DS} (Eq. 16-39)	1.528
Design Spectral Response Acceleration at 1s Period, S_{D1} (Eq. 16-40)	0.915

6.0 LIQUEFACTION POTENTIAL

For liquefaction to occur, all of three key ingredients are required: liquefaction-susceptible soils, groundwater within a depth of 50 feet or less, and strong earthquake shaking. Soils susceptible to liquefaction are generally saturated loose to medium dense sands and non-plastic silt deposits below the water table.

Groundwater was encountered within our borings B-1 through B-5 at 15 feet. Historic high groundwater at the site is as deep as 50 feet. Soil materials encountered within our borings are clayey soil. It is our opinion that potential for liquefaction at the site is low.

7.0 DESIGN RECOMMENDATIONS

Based upon the results of our investigation, the proposed development is considered geotechnically feasible provided the recommendations presented herein are incorporated into the design and construction. If changes in the design of the structure are made or variations or changed conditions are encountered during construction, GeoBoden should be contacted to evaluate their effects on these recommendations. The following geotechnical engineering recommendations for the proposed buildings are based on observations from the field investigation program and the physical test results.

7.1 EARTHWORK

All earthworks, including excavation, backfill and preparation of subgrade, should be performed in accordance with the geotechnical recommendations presented in this report and applicable portions of the grading code of local regulatory agencies. All earthwork should be performed under the observation and testing of a qualified geotechnical engineer.

7.2 SITE AND FOUNDATION PREPARATION

All site preparation should be observed by experienced personnel reporting to the project Geotechnical Engineer. Our field monitoring services are an essential continuation of our prior studies to confirm and correlate the findings and our prior recommendations with the actual subsurface conditions exposed during construction, and to confirm that suitable fill soils are placed and properly compacted.

Clearing operations should include the removal of all surface vegetation. Large shrubs, when removed, should be grubbed out to include their stumps and major root systems.

In general, all fill soils within the proposed building footprints should be overexcavated and replaced with engineered fill. As a minimum, removals should extend to competent native soils. At least 3 feet of compacted fill should be provided underneath all spread footings and floor slabs. The compacted fill should extend laterally a minimum of 5 feet beyond the foundation footprints, where possible. All existing low-density, near-surface soils will require removal to competent material from areas to receive newly compacted fill. The basis for establishing a competent exposed surface on which to place fill should consist of competent materials exhibiting an in-place relative compaction of at least 85 percent. Prior to placing structural fill, exposed bottom surfaces in each removal area approved for fill should first be scarified to a depth of at least 6 inches, water or air dried as necessary to achieve 3 percent above optimum moisture conditions, and then recompacted in place to a minimum relative compaction of 90 percent.

Based on the observations made in our borings and the results of pertinent laboratory tests, anticipated depths of removal of unsuitable soils will range from 4 to 5 feet. However, actual removal depths will have to be determined during grading on the basis of in-grading observations and testing performed by a representative of geotechnical consultants.

To provide support for foundations for minor structures and for at-grade concrete walks and slabs, all existing fill and disturbed natural soils should be excavated and replaced with properly compacted fill. Any required fill should be properly compacted as specified below.

At least the upper six (6) inches of all excavated surfaces should be scarified and moisture conditioned to 3 percent above optimum moisture, if necessary, and compacted to at least 90 percent relative compaction as per ASTM Standard D1557 test method, prior to placing any fill and/or structures.

7.3 FILL PLACEMENT AND COMPACTION REQUIREMENTS

Material for engineered fill should be select free of organic material, debris, and other deleterious substances, and should not contain fragments greater than 3 inches in maximum dimension. On-site excavated soils that meet these requirements may be used to backfill the excavated building pad area.

All fill should be placed in 6-inch-thick maximum lifts, watered or air dried as necessary to 3 percent above optimum moisture content, and then compacted in place to a maximum relative compaction of 90 percent. The laboratory maximum dry density and optimum moisture content for each change in soil type should be determined in accordance with Test Method ASTM D 1557. A representative of the project consultant should be present on-site during grading operations to verify proper placement and compaction of all fill, as well as to verify compliance with the other geotechnical recommendations presented herein.

Imported soils, if any, should consist of clean materials exhibiting a VERY LOW expansion potential (Expansion Index less than 20). Soils to be imported should be approved by the project geotechnical consultant prior to importation.

7.4 GEOTECHNICAL OBSERVATIONS

Exposed bottom surfaces in each removal area should be observed and approved by the project geotechnical consultant prior to placing fill. No fill should be placed without prior approval from the geotechnical consultant.

The project geotechnical consultant should be present on site during grading operations to verify proper placement and compaction of fill, as well as to verify compliance with the recommendations presented herein.

7.5 UTILITY TRENCH BACKFIL

All utility trench backfill should be compacted to a minimum relative compaction of 90 percent. Trench backfill materials should be placed in lifts no greater than approximately 6 inches in thickness, watered or air-dried as necessary to 3 percent above optimum moisture content, and then mechanically compacted in place to a minimum relative compaction of 90 percent. A representative of the project geotechnical consultant should probe and test the backfills to verify adequate compaction.

As an alternative for shallow trenches where pipe or utility lines may be damaged by mechanical compaction equipment, such as under floor slabs, imported clean sand exhibiting a sand equivalent (SE) value of 30 or greater may be utilized. The sand backfill materials should be watered to achieve 3 percent above optimum moisture conditions and then tamped into place. No specific relative compaction will be required; however, observation, probing, and if deemed necessary, testing should be performed by a representative of the project geotechnical consultant to verify an adequate degree of compaction and that the backfill will not be subject to settlement.

Where utility trenches enter the footprint of the floor slabs, they should be backfilled through their entire depths with on-site fill materials, sand-cement slurry, or concrete rather than with any sand or gravel shading. This "Plug" of less- or non-permeable materials will mitigate the potential for water to migrate through the backfilled trenches from outside to the areas beneath the foundations and floor slabs.

7.6 SHALLOW FOUNDATIONS

Following the site and foundation preparation recommended above, foundation for load bearing walls and interior columns may be designed as discussed below.

7.6.1 Bearing Capacity and Settlement

Load bearing walls and interior columns may be supported on continuous spread footings and isolated spread footings, respectively, and should bear entirely upon undisturbed native or properly engineered fill. Continuous and isolated footings should have a minimum width of 18 inches and 24 inches, respectively. All footings should be embedded a minimum depth of 24 inches measured from the lowest adjacent finish grade. Continuous and isolated footings placed on such materials may be designed using an allowable (net) bearing capacity of 1,800 pounds per square foot (psf) respectively. Allowable increases of 200 psf for each additional 1 foot in width and 200 psf for each additional 6 inches in depth may be utilized, if desired. The maximum allowable bearing pressure should be 2,500 psf. The maximum bearing value applies to combined dead and sustained live loads. The allowable bearing pressure may be increased by one-third when considering transient live loads, including seismic and wind forces.

Based on the allowable bearing value recommended above, total settlement of the shallow footings are anticipated to be less than one inch, provided foundation preparations conform to the recommendations described in this report. Differential settlement is anticipated to be approximately half the total settlement for similarly loaded footings spaced up to approximately 30 feet apart.

7.6.2 Lateral Load Resistance

Lateral load resistance for the spread footings will be developed by passive soil pressure against sides of footings below grade and by friction acting at the base of the concrete footings bearing on compacted fill. An allowable passive pressure of 200 psf per foot of depth may be used for design purposes. An allowable coefficient of friction 0.30 may be used for dead and sustained live load forces to compute the frictional resistance of the footings constructed directly on compacted fill. Safety factors of 2.0 and 1.5 have been incorporated in development of allowable passive and frictional resistance values, respectively. Under seismic and wind loading conditions, the passive pressure and frictional resistance may be increased by one-third.

7.6.3 Footing Reinforcement

Reinforcement for footings should be designed by the structural engineer based on the anticipated loading conditions. Footings for structures that are supported in low expansive soils should have No. 4 bars, two top and two bottom.

7.7 CONCRETE SLAB ON-GRADE

Concrete slabs will be placed on undisturbed natural soils or properly compacted fill as outlined in Section 7.2. Moisture content of subgrade soils should be maintained 3 percent above the optimum moisture content.

At the time of the concrete pour, subgrade soils should be firm and relatively unyielding. Any disturbed soils should be excavated and then replaced and compacted to a minimum of 90 percent relative compaction. Slabs should be designed to accommodate low expansive fill soils. The structural engineer should determine the minimum slab thickness and reinforcing depending upon the expansive soil condition intended use. Slabs placed on low expansive soils should be at least 4 inches thick and have minimum reinforcement of No. 3 bars placed at mid-height of the slabs and spaced 18 inches on centers, in both directions. The structural engineer may require thicker slabs with more reinforcement depending on the anticipated slab loading conditions.

If moisture-sensitive floor covering is planned, a layer of open-graded gravel, at least 4 inches thick, should be placed below the concrete slab to form a capillary break. Alternately, moisture-proof membrane (such as 10-mil) may be utilized. The vapor barrier should be placed between sand layers (2 inches above and below) to protect the membrane from damage during construction. Gravel for use under a concrete floor slab should be clean, crushed rock that meets the gradation requirements presented below.

Sieve Size	Percentage
1 inch	100
¾ inch	90-100

No. 4 0-10

7.8 PRELIMINARY PAVEMENT DESIGN

Pavement design should be confirmed at the completion of site grading when the subgrade soils are in-place. This should include sampling and R-Value testing of the actual subgrade soils and an analysis based upon the anticipated traffic loading.

For a preliminary pavement design, recommendations for pavement design section of asphalt parking areas are provided below. These values are based on an assumed R-value of 25.

For pavement design, Traffic indexes (TI) of 4.0 and 5.5 were used for the parking areas and auto driveways, respectively. The preliminary flexible pavement layer thickness is as follows:

RECOMMMENDED ASPHALT PAVEMENT SECTION LAYER THICKNESS

Pavement Material	Recommended Thickness	
	TI = 4.0	TI = 5.5
Asphalt Concrete Surface Course	3 inches	4 inches
Class II Aggregate Base Course	6 inches	8 inches
Compacted Subgrade Soils	12 inches	12 inches

Asphalt concrete should conform to Sections 203 and 302 of the latest edition of the Standard Specifications for Public Works Construction ("Greenbook").

Class II aggregate base should conform to Section 26 of the Caltrans Standard Specifications, latest edition. The aggregate base course should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Method D 1557.

Portland cement concrete paving sections were determined in accordance with procedures developed by the Portland Cement Association. Concrete paving sections for three Traffic Indices are presented below. We have assumed that the portland cement concrete will have a compressive strength of at least 3,000 pounds per square inch.

Assumed Traffic Index	PCC Paving (Inches)	Base Course (Inches)
4½ (Automobile Parking)	7	4
5½ (Driveways and Light Track Traffic)	7½	4
6½ (Roadways and Heavy Truck Traffic)	8	4

7.9 SOLUBLE SULFATES AND SOIL CORROSIVITY

Concrete subject to exposure to sulfates shall comply with the requirements set forth in ACI 318, Section 4.3. Based on the available water soluble sulfate results the corrosion potential to buried concrete should be considered "low", i.e., exposure Class S_0, per ACI 318, Table 4.2.1. Consequently, injurious sulfate attack is not a concern with a minimum 28-day compressive strength of 2,500 psi.

Per CBC 2016, Section 1904.4, concrete reinforcement should be protected from corrosion and exposure to chlorides in accordance with ACI 318, Section 4.4.

The corrosion potential of the on-site materials to buried steel was evaluated in accordance with Caltrans corrosive environment evaluation criteria. Caltrans considers a site corrosive, if at least one of the following conditions exists:

- Chloride content ≥ 500 ppm;
- Soluble sulphate content ≥ 2,000 ppm;
- pH ≤ 5.5.

Observations and laboratory tests indicate that based on the Caltrans' criteria the soils at the site are considered non-corrosive. If additional recommendations are desired, it is recommended that a corrosion specialist be consulted regarding suitable types of piping and necessary protection for underground metal conduits.

8.0 CONSTRUCTION CONSIDERATIONS

Based on our field exploration program, earthwork can be performed with conventional construction equipment.

8.1 TEMPORARY DEWATERING

Groundwater was encountered within our borings at 15 feet below ground surface. Based on the anticipated excavation depths, the need for temporary dewatering is considered low.

8.2 CONSTRUCTION SLOPES

Excavations during construction should be conducted so that slope failure and excessive ground movement will not occur. The short-term stability of excavation depends on many factors, including slope angle, engineering characteristics of the subsoils, height of the excavation and length of time the excavation remains unsupported and exposed to equipment vibrations, rainfall and desiccation.

Where space permits, and providing that adjacent facilities are adequately supported, open excavations may be considered. In general, unsupported slopes for temporary construction excavations should not be expected to stand at an inclination steeper than 1:1 (horizontal:vertical). The temporary excavation side walls may be cut vertically to a height of 3 feet and then laid back at a 1:1 slope ratio above a height of 3 feet.

Surcharge loads should be kept away from the top of temporary excavations a horizontal distance equal to at least one-half the depth of excavation. Surface drainage should be controlled along the top of temporary excavations to preclude wetting of the soils and erosion of the excavation faces. Even with the implementation of the above recommendations, sloughing of the surface of the temporary excavations may still occur, and workmen should be adequately protected from such sloughing.

If site conditions do not provide sufficient space for sloped excavations at the project site, slot cutting techniques in a repeating "ABC" sequence may be required. First, all the slots designated as "A" should be excavated, backfilled and recompacted. The procedure should continue with the "B" slots and end with the "C" slots. The width of each slot should not exceed 6 feet. If any evidence of potential instability is observed, revised recommendations such as narrower slot cuts may be necessary. All slot excavation and backfilling procedures should be performed under the observation and testing of a qualified geotechnical engineer.

9.0 POST INVESTIGATION SERVICES

Final project plans and specifications should be reviewed prior to construction to confirm that the full intent of the recommendations presented herein have been applied to design and construction. Following review of plans and specifications, observation should be performed by the geotechnical engineer during construction to document that foundation elements are founded on/or penetrate onto the recommended soils, and that suitable backfill soils are placed upon competent materials and properly compacted at the recommended moisture content.

10.0 CLOSURE

The conclusions, recommendations, and opinions presented herein are: (1) based upon our evaluation and interpretation of the limited data obtained from our field and laboratory programs; (2) based upon an interpolation of soil conditions between and beyond the borings; (3) are subject to confirmation of the actual conditions encountered during construction; and, (4) are based upon the assumption that sufficient observation and testing will be provided during construction.

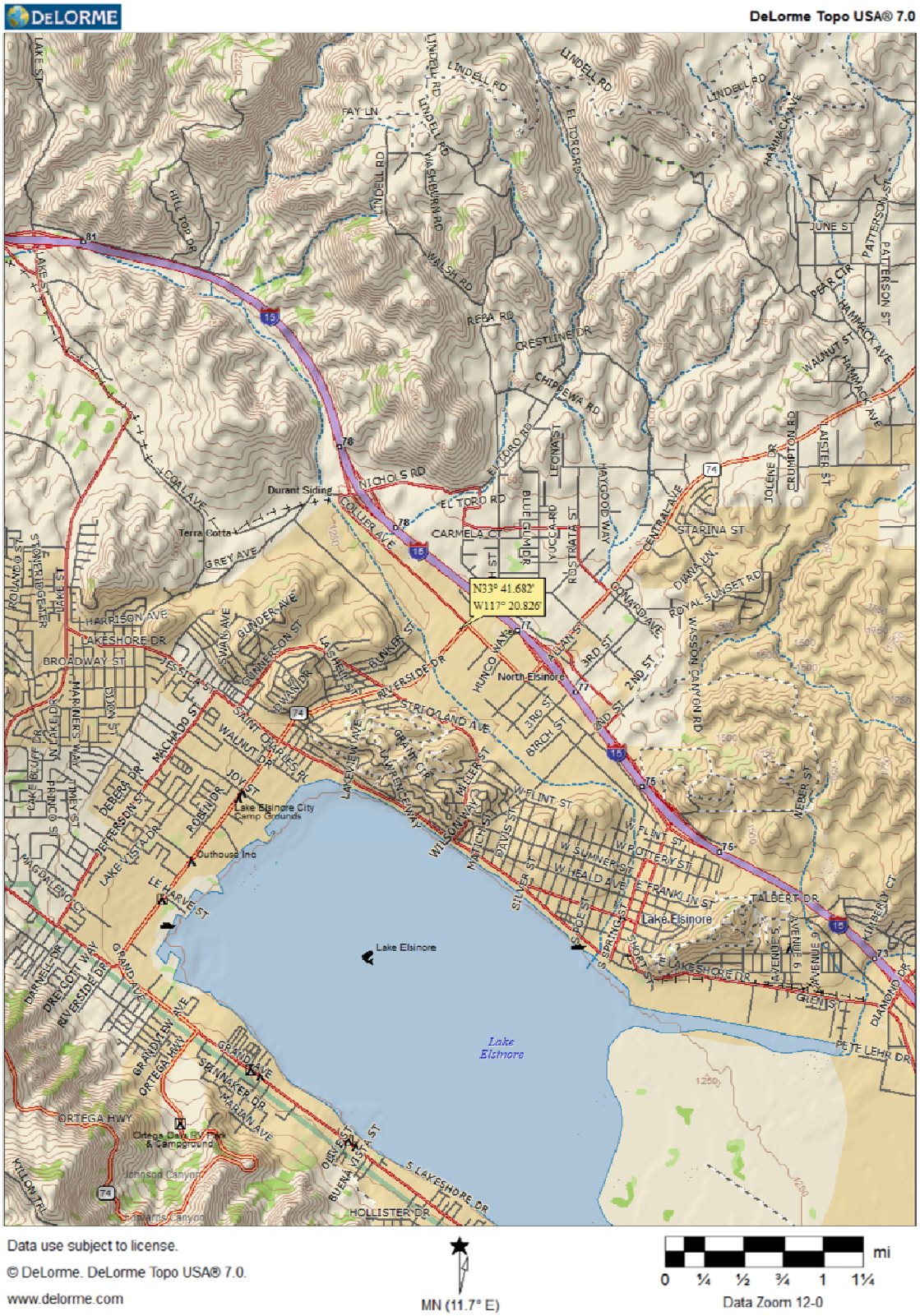
If parties other than GeoBoden are engaged to provide construction geotechnical services, they must be notified that they will be required to assume complete responsibility for the geotechnical phase of the project by concurring with the findings and recommendations in this report or providing alternate recommendations.

If pertinent changes are made in the project plans or conditions are encountered during construction that appear to be different than indicated by this report, please contact this office. Significant variations may necessitate a re-evaluation of the recommendations presented in this report.

11.0 REFERENCES

California Building Code, 2016 Volume 2.

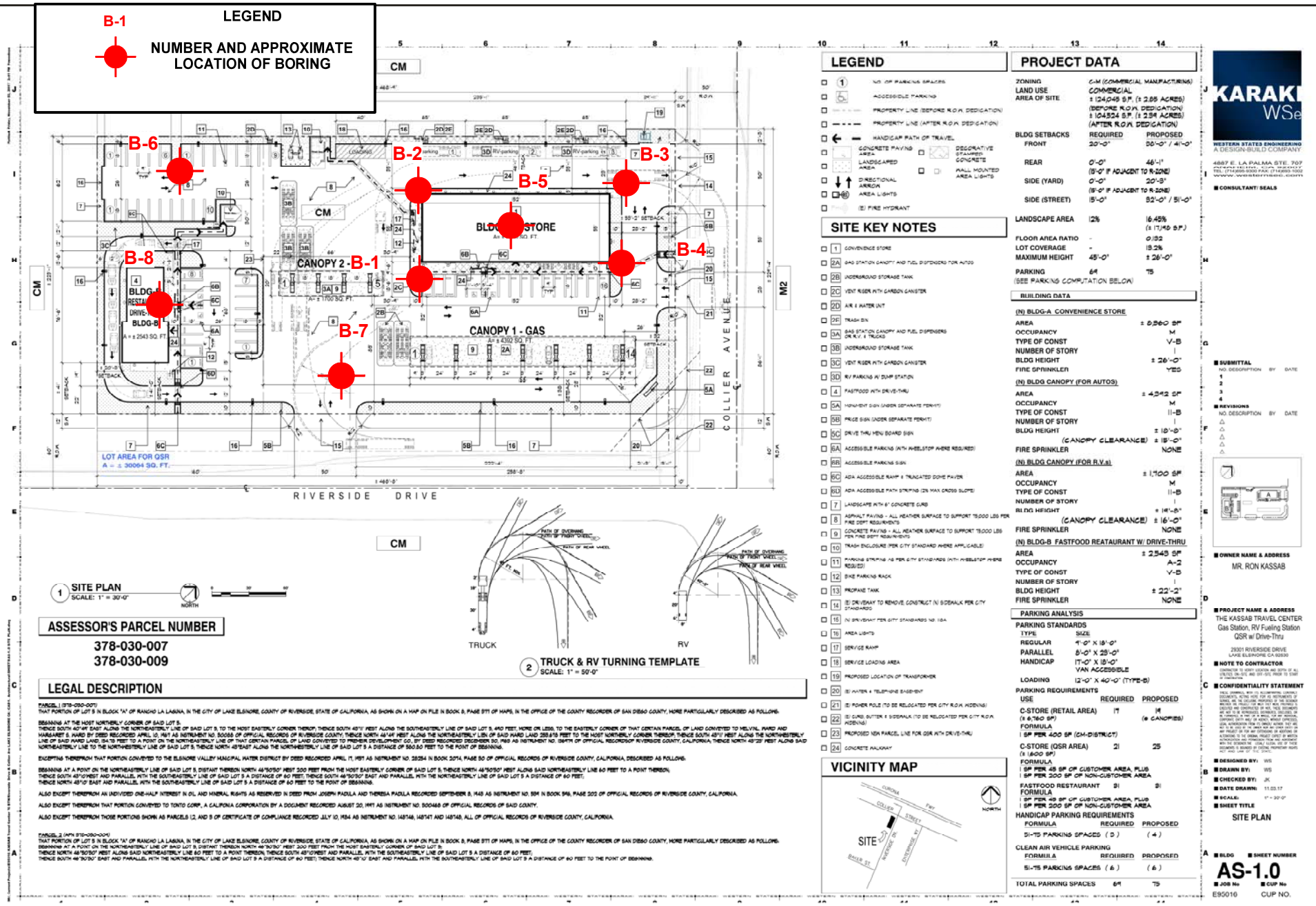
FIGURES



GEOBODEN INC.
Geotechnical Consultants

SITE VICINITY MAP
Proposed Kassab Travel Center
29301 Riverside Drive
Lake Elsinore, California

Figure By S.R.	Project No. Lake Elsinore
Map No. XX	Figure No. 1
Date 12-30-17	



ASSESSOR'S PARCEL NUMBER

378-030-007
378-030-009

LEGAL DESCRIPTION

PARCEL 1 (378-030-007)
THAT PORTION OF LOT 5 IN BLOCK "A" OF RANCHO LA LAGUNA, IN THE CITY OF LAKE ELSINORE, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA, AS SHOWN ON A MAP ON FILE IN BOOK 8, PAGE 571 OF MAPS, IN THE OFFICE OF THE COUNTY RECORDER OF SAN DIEGO COUNTY, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT THE MOST NORTHERLY CORNER OF SAID LOT 5;
THENCE SOUTH 40°48' EAST ALONG THE NORTHEASTERLY LINE OF SAID LOT 5, TO THE MOST EASTERLY CORNER THEREOF; THENCE SOUTH 49°11' WEST ALONG THE SOUTHEASTERLY LINE OF SAID LOT 5, 440 FEET, MORE OR LESS, TO THE EASTERLY CORNER OF THAT CERTAIN PARCEL OF LAND CONVEYED TO MELVIN L. WARD AND MARGARET S. WARD BY DEED RECORDED APRIL 10, 1961 AS INSTRUMENT NO. 50066 OF OFFICIAL RECORDS OF RIVERSIDE COUNTY; THENCE NORTH 46°48' WEST ALONG THE NORTHEASTERLY LINE OF SAID WARD LAND, 259.615 FEET TO THE MOST NORTHERLY CORNER THEREOF; THENCE SOUTH 49°11' WEST ALONG THE NORTHWESTERLY LINE OF SAID WARD LAND, 264.75 FEET TO A POINT ON THE NORTHEASTERLY LINE OF THAT CERTAIN PARCEL OF LAND CONVEYED TO PREMIER DEVELOPMENT CO., BY DEED RECORDED DECEMBER 30, 1960 AS INSTRUMENT NO. 138479 OF OFFICIAL RECORDS OF RIVERSIDE COUNTY, CALIFORNIA; THENCE NORTH 40°29' WEST ALONG SAID NORTHEASTERLY LINE TO THE NORTHWESTERLY LINE OF SAID LOT 5; THENCE NORTH 49°EAST ALONG THE NORTHWESTERLY LINE OF SAID LOT 5 A DISTANCE OF 560.50 FEET TO THE POINT OF BEGINNING.

EXCEPTING THEREFROM THAT PORTION CONVEYED TO THE ELSINORE VALLEY MUNICIPAL WATER DISTRICT BY DEED RECORDED APRIL 17, 1951 AS INSTRUMENT NO. 28294 IN BOOK 2074, PAGE 50 OF OFFICIAL RECORDS OF RIVERSIDE COUNTY, CALIFORNIA, DESCRIBED AS FOLLOWS:

BEGINNING AT A POINT ON THE NORTHEASTERLY LINE OF SAID LOT 5, DISTANT THEREON NORTH 46°50'50" WEST 300 FEET FROM THE MOST EASTERLY CORNER OF SAID LOT 5; THENCE NORTH 46°50'50" WEST ALONG SAID NORTHEASTERLY LINE 60 FEET TO A POINT THEREON;
THENCE SOUTH 43°10'WEST AND PARALLEL, WITH THE SOUTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET; THENCE SOUTH 46°50'50" EAST AND PARALLEL, WITH THE NORTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET;
THENCE NORTH 43°10' EAST AND PARALLEL, WITH THE SOUTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET TO THE POINT OF BEGINNING.

ALSO EXCEPT THEREFROM AN UNDIVIDED ONE-HALF INTEREST IN OIL AND MINERAL RIGHTS AS RESERVED IN DEED FROM JOSEPH PADILLA AND THERESA PADILLA RECORDED SEPTEMBER 8, 1948 AS INSTRUMENT NO. 504 IN BOOK 946, PAGE 202 OF OFFICIAL RECORDS OF RIVERSIDE COUNTY, CALIFORNIA.

ALSO EXCEPT THEREFROM THAT PORTION CONVEYED TO TONTO CORP., A CALIFONIA CORPORATION BY A DOCUMENT RECORDED AUGUST 20, 1991 AS INSTRUMENT NO. 300468 OF OFFICIAL RECORDS OF SAID COUNTY.

ALSO EXCEPT THEREFROM THOSE PORTIONS SHOWN AS PARCELS 1,2, AND 3 OF CERTIFICATE OF COMPLIANCE RECORDED JULY 10, 1984 AS INSTRUMENT NO. 148148, 148147 AND 148149, ALL OF OFFICIAL RECORDS OF RIVERSIDE COUNTY, CALIFORNIA.

PARCEL 2 (APN 378-030-004)
THAT PORTION OF LOT 5 IN BLOCK "A" OF RANCHO LA LAGUNA, IN THE CITY OF LAKE ELSINORE, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA, AS SHOWN ON A MAP ON FILE IN BOOK 8, PAGE 571 OF MAPS, IN THE OFFICE OF THE COUNTY RECORDER OF SAN DIEGO COUNTY, MORE PARTICULARLY DESCRIBED AS FOLLOWS:
BEGINNING AT A POINT ON THE NORTHEASTERLY LINE OF SAID LOT 5, DISTANT THEREON NORTH 46°50'50" WEST 300 FEET FROM THE MOST EASTERLY CORNER OF SAID LOT 5;
THENCE NORTH 46°50'50" WEST ALONG SAID NORTHEASTERLY LINE 60 FEET TO A POINT THEREON; THENCE SOUTH 43°10'WEST AND PARALLEL, WITH THE SOUTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET;
THENCE SOUTH 46°50'50" EAST AND PARALLEL, WITH THE NORTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET; THENCE NORTH 43°10' EAST AND PARALLEL, WITH THE SOUTHEASTERLY LINE OF SAID LOT 5 A DISTANCE OF 60 FEET TO THE POINT OF BEGINNING.

LEGEND

- NO. OF PARKING SPACES
- ACCESSIBLE PARKING
- PROPERTY LINE (BEFORE R.O.W. DEDICATION)
- PROPERTY LINE (AFTER R.O.W. DEDICATION)
- HANDICAP PATH OF TRAVEL
- CONCRETE PAVING AREA
- DECORATIVE STAMPED CONCRETE
- LANDSCAPED AREA
- WALL MOUNTED AREA LIGHTS
- DIRECTIONAL ARROW
- AREA LIGHTS
- (E) FIRE HYDRANT

SITE KEY NOTES

1 CONVENIENCE STORE
2A GAS STATION CANOPY AND FUEL DISPENSERS FOR AUTOS
2B UNDERGROUND STORAGE TANK
2C VENT RISER WITH CARBON CANISTER
2D AIR & WATER UNIT
2E TRASH BIN
3A GAS STATION CANOPY AND FUEL DISPENSERS OR R.V. & TRUCKS
3B UNDERGROUND STORAGE TANK
3C VENT RISER WITH CARBON CANISTER
3D RV PARKING W/ DUMP STATION
4 FASTFOOD WITH DRIVE-THRU
5A MONUMENT SIGN (UNDER SEPARATE PERMIT)
5B PRICE SIGN (UNDER SEPARATE PERMIT)
5C DRIVE THRU MENU BOARD SIGN
6A ACCESSIBLE PARKING (WITH WHEELSTOP WHERE REQUIRED)
6B ACCESSIBLE PARKING SIGN
6C ADA ACCESSIBLE RAMP & TRUNCATED DOME PAVER
6D ADA ACCESSIBLE PATH STRIPING (2% MAX CROSS SLOPE)
7 LANDSCAPE WITH 6" CONCRETE CURB
8 ASPHALT PAVING - ALL WEATHER SURFACE TO SUPPORT 75,000 LBS PER FIRE DEPT REQUIREMENTS
9 CONCRETE PAVING - ALL WEATHER SURFACE TO SUPPORT 75,000 LBS PER FIRE DEPT REQUIREMENTS
10 TRASH ENCLOSURE PER CITY STANDARD WHERE APPLICABLE)
11 PARKING STRIPING AS PER CITY STANDARDS (WITH WHEELSTOP WHERE REQUIRED)
12 BIKE PARKING RACK
13 PROPANE TANK
14 (E) DRIVEWAY TO REMOVE, CONSTRUCT (N) SIDEWALK PER CITY STANDARDS
15 (N) DRIVEWAY PER CITY STANDARDS NO. 108A
16 AREA LIGHTS
17 SERVICE RAMP
18 SERVICE LOADING AREA
19 PROPOSED LOCATION OF TRANSFORMER
20 (E) WATER & TELEPHONE EASEMENT
21 (E) POWER POLE (TO BE RELOCATED PER CITY R.O.W. WIDENING)
22 (E) CURB, GUTTER & SIDEWALK (TO BE RELOCATED PER CITY R.O.W. WIDENING)
23 PROPOSED NEW PARCEL LINE FOR QSR WITH DRIVE-THRU
24 CONCRETE WALKWAY

VICINITY MAP

PROJECT DATA

ZONING	C-M (COMMERCIAL MANUFACTURING)	
LAND USE	COMMERCIAL	
AREA OF SITE	± 124,045 S.F. (± 2.85 ACRES) (BEFORE R.O.W. DEDICATION) ± 104,824 S.F. (± 2.94 ACRES) (AFTER R.O.W. DEDICATION)	
BLDG SETBACKS	REQUIRED	PROPOSED
FRONT	20'-0"	20'-0" / 41'-0"
REAR	0'-0" (15'-0" IF ADJACENT TO R-ZONE)	46'-1"
SIDE (YARD)	0'-0" (15'-0" IF ADJACENT TO R-ZONE)	20'-3"
SIDE (STREET)	15'-0"	52'-0" / 51'-0"
LANDSCAPE AREA	12%	16.45% (± 17,140 S.F.)
FLOOR AREA RATIO	-	0.132
LOT COVERAGE	-	13.2%
MAXIMUM HEIGHT	45'-0"	± 26'-0"
PARKING (SEE PARKING COMPUTATION BELOW)	69	75

BUILDING DATA

(N) BLDG-A CONVENIENCE STORE

AREA	± 6,260 SF
OCCUPANCY	M
TYPE OF CONST	V-B
NUMBER OF STORY	I
BLDG HEIGHT	± 26'-0"
FIRE SPRINKLER	YES

(N) BLDG CANOPY (FOR AUTOS)

AREA	± 4,342 SF
OCCUPANCY	M
TYPE OF CONST	II-B
NUMBER OF STORY	I
BLDG HEIGHT	± 18'-0"
(CANOPY CLEARANCE)	± 13'-0"
FIRE SPRINKLER	NONE

(N) BLDG CANOPY (FOR R.V.s)

AREA	± 1,700 SF
OCCUPANCY	M
TYPE OF CONST	II-B
NUMBER OF STORY	I
BLDG HEIGHT	± 18'-0"
(CANOPY CLEARANCE)	± 16'-0"
FIRE SPRINKLER	NONE

(N) BLDG-B FASTFOOD REATAURANT W/ DRIVE-THRU

AREA	± 2,543 SF
OCCUPANCY	A-2
TYPE OF CONST	V-B
NUMBER OF STORY	I
BLDG HEIGHT	± 22'-2"
FIRE SPRINKLER	NONE

PARKING ANALYSIS

PARKING STANDARDS

TYPE	SIZE
REGULAR	9'-0" X 18'-0"
PARALLEL	8'-0" X 23'-0"
HANDICAP	17'-0" X 18'-0" VAN ACCESSIBLE
LOADING	12'-0" X 40'-0" (TYPE-B)

PARKING REQUIREMENTS

USE	REQUIRED	PROPOSED
C-STORE (RETAIL AREA) (± 6,760 SF)	17	14 (4 CANOPIES)
FORMULA	1 SP PER 400 SF (CM-DISTRICT)	
C-STORE (QSR AREA) (± 1,600 SF)	21	25
FORMULA	1 SP PER 45 SF OF CUSTOMER AREA, PLUS 1 SP PER 200 SF OF NON-CUSTOMER AREA	
FASTFOOD RESTAURANT	31	31
FORMULA	1 SP PER 45 SF OF CUSTOMER AREA, PLUS 1 SP PER 200 SF OF NON-CUSTOMER AREA	

HANDICAP PARKING REQUIREMENTS

FORMULA	REQUIRED	PROPOSED
51-75 PARKING SPACES (3)	(4)	

CLEAN AIR VEHICLE PARKING

FORMULA	REQUIRED	PROPOSED
51-75 PARKING SPACES (6)	(6)	

TOTAL PARKING SPACES	69	75

KARAKI WSE
WESTERN STATES ENGINEERING
A DESIGN-BUILD COMPANY
4667 E. LA PALMA STE. 707
ANAHEIM HILLS, CA 92807
TEL. (714)695-9000 FAX. (714)695-1002
www.westernstates.com
CONSULTANT/ SEALS

SUBMITTAL
NO. DESCRIPTION BY DATE
1
2
3
4

REVISIONS
NO. DESCRIPTION BY DATE
△
△
△
△

OWNER NAME & ADDRESS
MR. RON KASSAB

PROJECT NAME & ADDRESS
THE KASSAB TRAVEL CENTER
Gas Station, RV Fueling Station
QSR w/ Drive-Thru
29301 RIVERSIDE DRIVE
LAKE ELSINORE CA 92530

NOTE TO CONTRACTOR
CONFIDENTIALITY STATEMENT

DESIGNED BY: WS
DRAWN BY: WS
CHECKED BY: JK
DATE DRAWN: 11.03.17
SCALE: 1" = 30'-0"
SHEET TITLE
SITE PLAN

BLDG SHEET NUMBER
AS-1.0
JOB No E95016
CUP No. CUP NO.

GEOBODEN INC.
Geotechnical Consultants

BORING LOCATION PLAN
Proposed Kassab Travel Center
29301 Riverside Drive
Lake Elsinore, California

Figure By S.R.	Project No. Lake Elsinore
Map No. XX	Figure No. 2
Date 12-30-17	

APPENDIX A
BORING LOGS

APPENDIX A
SUBSURFACE EXPLORATION PROGRAM

PROPOSED KASSAB TRAVEL CENTER
29301 RIVERSIDE DRIVE
LAKE ELSINORE, CALIFORNIA

Prior to drilling, the proposed borings were located in the field by measuring from existing site features.

A total of 8 exploratory borings (B-1 through B-8) were drilled using a hollow-stem auger drill rig equipped with 8-inch outside diameter (O.D.) augers and hand-auger equipment. GeoBoden, Inc. of Irvine, California performed the drilling on December 18, 2017. The borings locations are shown on Figure 2.

Depth-discrete soil samples were collected at selected intervals from the exploratory borings using a 2 ½ -inch inside diameter (I.D.) modified California Split-barrel sampler fitted with 12 brass ring of 2 ½ inches in O.D. and 1-inch in height and one brass liner (2 ½ -inch O.D. by 6 inches long) above the brass rings. The sampler was lowered to the bottom of the boreholes and driven 18 inches into the soil with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler the lower 12 inches is shown on the blow count column of the boring logs.

After removing the sampler from the boreholes, the sampler was opened and the brass rings and liner containing the soil were removed and observed for soil classification. Brass rings containing the soil were sealed in plastic canisters to preserve the natural moisture content of the soil. Soil samples collected from exploratory borings were labeled, and were transported for physical testing.

Standard Penetration Tests (SPTs) were also performed. The SPT consists of driving a standard sampler, as described in the ASTM 1586 Standard Method, using a 140-pound hammer falling 30 inches. The number of blows required to drive the SPT sampler the lower 12 inches of the sampling interval is recorded on the blow count column of the boring logs.

The soil classifications and descriptions on field logs were performed using the Unified Soil Classification System as described by the American Society for Testing and Materials (ASTM) D 2488, "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)." The final boring logs were prepared from the field logs and are presented in this Appendix.

At the completion of the sampling and logging, the exploratory borings were backfilled with the drilled cuttings.

GEOBODEN, INC.

BORING NUMBER B-1

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
▽ **AT TIME OF DRILLING** 15.00 ft
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		SANDY CLAY (CL): yellowish brown, moist, ~30% sand, ~70% fines										
5			MC R-1		12		97	24	49	18	31	69
10		SANDY CLAY (CL): strong brown, moist, ~30% fine sand, ~70% fines	SS S-2		14			28				70
15		▽ light brown, wet	MC R-3		12							
20			SS S-4		14							
25		brown, wet	SS S-5		12							
30		SAND (SP): yellowish brown, wet, coarse sand	SS S-6		16							

Bottom of borehole at 31.5 feet below ground surface. Ground water was encountered at 15 feet. Boring was backfilled with cuttings. Bottom of borehole at 31.5 feet.

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GEOBODEN, INC.

BORING NUMBER B-2

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION ___ **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
▽ **AT TIME OF DRILLING** 15.00 ft
LOGGED BY C.R. **CHECKED BY** ___
AT END OF DRILLING ---
NOTES ___
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		SANDY CLAY (CL): brown, moist, fine sand										
5			MC R-1		16		99	25				
10			SS S-2		11							
15		SANDY CLAY (CL): yellowish brown, moist, ~30% fine sand, ~70% fines ▽	MC R-3		12							
20		SAND (SP): light yellowish brown, wet, coarse sand	SS S-4		15							
25		SANDY CLAY (CL): brown, moist, ~30% fine sand, ~70% fines	SS S-5		21							
30			SS S-6		26							

Bottom of borehole at 31.5 feet below ground surface. Ground water was encountered at 15 feet. Boring was backfilled with cuttings. Bottom of borehole at 31.5 feet.

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GEOBODEN, INC.

BORING NUMBER B-3

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
▽ **AT TIME OF DRILLING** 15.00 ft
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		SANDY CLAY (CL): brown, moist, ~30% sand, ~70% fines										
5			MC R-1		13		100	26				
10			SS S-2		16							
		SANDY CLAY (CL): brown, moist, ~30% fine sand, ~70% fines										
15		▽	MC R-3		19							
20			SS S-4		14							
25		wet	SS S-5		12							
		SAND w. SILT (SP-SM): yellowish brown, wet										
30			SS S-6		16							

Bottom of borehole at 31.5 feet below ground surface. Ground water was encountered at 15 feet. Boring was backfilled with cuttings. Bottom of borehole at 31.5 feet.

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GEOBODEN, INC.

BORING NUMBER B-4

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
▽ **AT TIME OF DRILLING** 15.00 ft
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		CLAY (CL): grayish brown, moist										
5			MC R-1		19		103	27				
		CLAY w. SAND (CL): yellowish brown, moist, ~20% fine sand, ~80% fines [NATIVE]										
10			SS S-2		26							
15		▽	MC R-3		36							
20			SS S-4		29							
		Bottom of borehole at 21.5 feet below ground surface. Ground water was encountered at 15 feet. Boring was backfilled with cuttings. Bottom of borehole at 21.5 feet.										

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GEOBODEN, INC.

BORING NUMBER B-5

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
▽ **AT TIME OF DRILLING** 15.00 ft
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		SANDY CLAY (CL): brown, moist, ~30% sand, ~70% fines										
5			MC R-1		14		104	27				
10		CLAY (CL): brown, moist, ~10% fine sand, ~90% fines	SS S-2		11							
15	▽		MC R-3		14							
20			SS S-4		18							

Bottom of borehole at 21.5 feet below ground surface. Ground water was encountered at 15 feet. Boring was backfilled with cuttings. Bottom of borehole at 21.5 feet.

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GEOBODEN, INC.

BORING NUMBER B-6

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		SANDY CLAY (CL): brown, moist, ~30% sand, ~70% fines										
5			MC R-1		11		103	26				
		SANDY CLAY (CL): light brown, moist, ~30% fine sand, ~70% fines										
10			MC R-2		14							
		Bottom of borehole at 11.5 feet below ground surface. Ground water was not encountered. Boring was backfilled with cuttings. Bottom of borehole at 11.5 feet.										

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GEOBODEN, INC.

BORING NUMBER B-7

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		SANDY CLAY (CL): brown, moist, ~30% sand, ~70% fines										
5			MC R-1		12							
		SANDY CLAY (CL): brown, moist, ~30% fine sand, ~70% fines										
10			MC R-2		16							
		Bottom of borehole at 11.5 feet below ground surface. Ground water was not encountered. Boring was backfilled with cuttings. Bottom of borehole at 11.5 feet.										

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GEOBODEN, INC.

BORING NUMBER B-8

CLIENT Mr. Ron Kassab
PROJECT NAME Proposed Kassab Travel Center
PROJECT NUMBER Lake Elsinore-1-01
PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA
DATE STARTED 12/18/17 **COMPLETED** 12/18/17
GROUND ELEVATION **HOLE SIZE** 8 inches
DRILLING CONTRACTOR GeoBoden Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY C.R. **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		SANDY CLAY (CL): brown, moist, ~30% sand, ~70% fines										
5			MC R-1		16							
		SANDY CLAY (CL): light brown, moist, ~30% fine sand, ~70% fines										
10			MC R-2		18							
		Bottom of borehole at 11.5 feet below ground surface. Ground water was not encountered. Boring was backfilled with cuttings. Bottom of borehole at 11.5 feet.										

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APPENDIX B
LABORATORY TESTING

APPENDIX B
LABORATORY TESTING
PROPOSED KASSAB TRAVEL CENTER
29301 RIVERSIDE DRIVE
LAKE ELSINORE, CALIFORNIA

Laboratory tests were performed on selected samples to assess the engineering properties and physical characteristics of soils at the site. The following tests were performed:

- moisture content and dry density
- No. 200 Wash sieve
- Atterberg limits
- consolidation
- expansion potential
- corrosion

Test results are summarized on laboratory data sheets or presented in tabular form in this appendix.

Moisture Density Tests

The field moisture contents, as a percentage of the dry weight of the soils, were determined by weighing samples before and after oven drying. The dry density, in pounds per cubic foot, was also determined fir all relatively undisturbed ring samples collected. These analyses were performed in accordance with ASTM D 2937. The results of these determinations are shown on the boring logs in Appendix A.

No. 200 Wash Sieve

A quantitative determination of the percentage of soil finer than 0.075 mm was performed on a selected soil sample by washing the soil through the No. 200 sieve. Test procedures were performed in accordance with ASTM Method D1140. The results of the tests are shown on the boring logs.

Atterberg Limits

Liquid limit, plastic limit, and plasticity index were determined for selected soil sample in accordance with ASTM D 4318. The soil sample was air-dried and passed through a No. 40 sieve and moisturized. The liquid and plastic limit tests were performed on the fraction passing the No. 40 sieve. Results of the Atterberg limits tests are shown graphically and presented in this Appendix.

Consolidation

The test was performed in accordance with ASTM Test method D 2345. The compression curve from the consolidation test is presented in this Appendix.

Expansion Potential

Expansion index test was performed on a representative sample of the on-site soils in accordance with ASTM D4829. The result of the expansion test is summarized in Table B-1.

TABLE B-1 (Expansion Index Test Data)

Boring Designation	**Depth (ft)**	Expansion Index (EI)
B-1	0-5	22

Corrosion Potential

A selected soil sample was tested to determine the corrosivity of the site soil to steel and concrete. The soil sample was tested for soluble sulfate (Caltrans 417), soluble chloride (Caltrans 422), and pH and minimum resistivity (Caltrans 643). The results of corrosion tests are summarized in Table B-2.

TABLE B-2 (Corrosion Test Results)

Boring No.	**Depth (ft)**	**Chloride Content (Calif. 422) ppm**	**Sulfate Content (Calif. 417) % by Weight**	**pH (Calif. 643)**	**Resistivity (Calif. 643) Ohm*cm**
B-1	0-5	89	0.0178	7.6	1,058

GEOBODEN, INC.

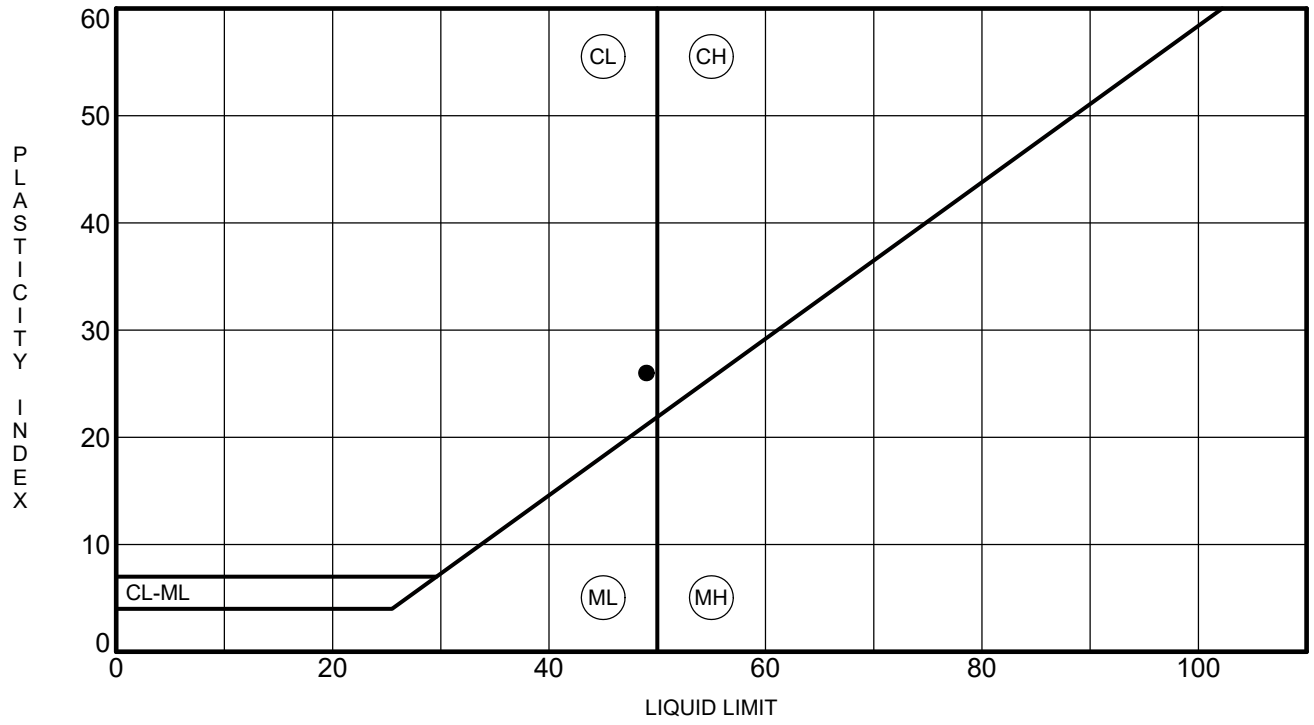
ATTERBERG LIMITS' RESULTS

CLIENT Mr. Ron Kassab

PROJECT NAME Proposed Kassab Travel Center

PROJECT NUMBER Lake Elsinore-1-01

PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-1**	**5.0**	**49**	**23**	**26**	**69**	**SANDY LEAN CLAY(CL)**

ATTERBERG LIMITS - GINT STD US LAB.GDT - 12/30/17 11:40 - C:\PASSPORT\GBI\29301 RIVERSIDE DRIVE_LAKE ELSINORE-RAHMAN\LOGS.GPJ

GEOBODEN, INC.

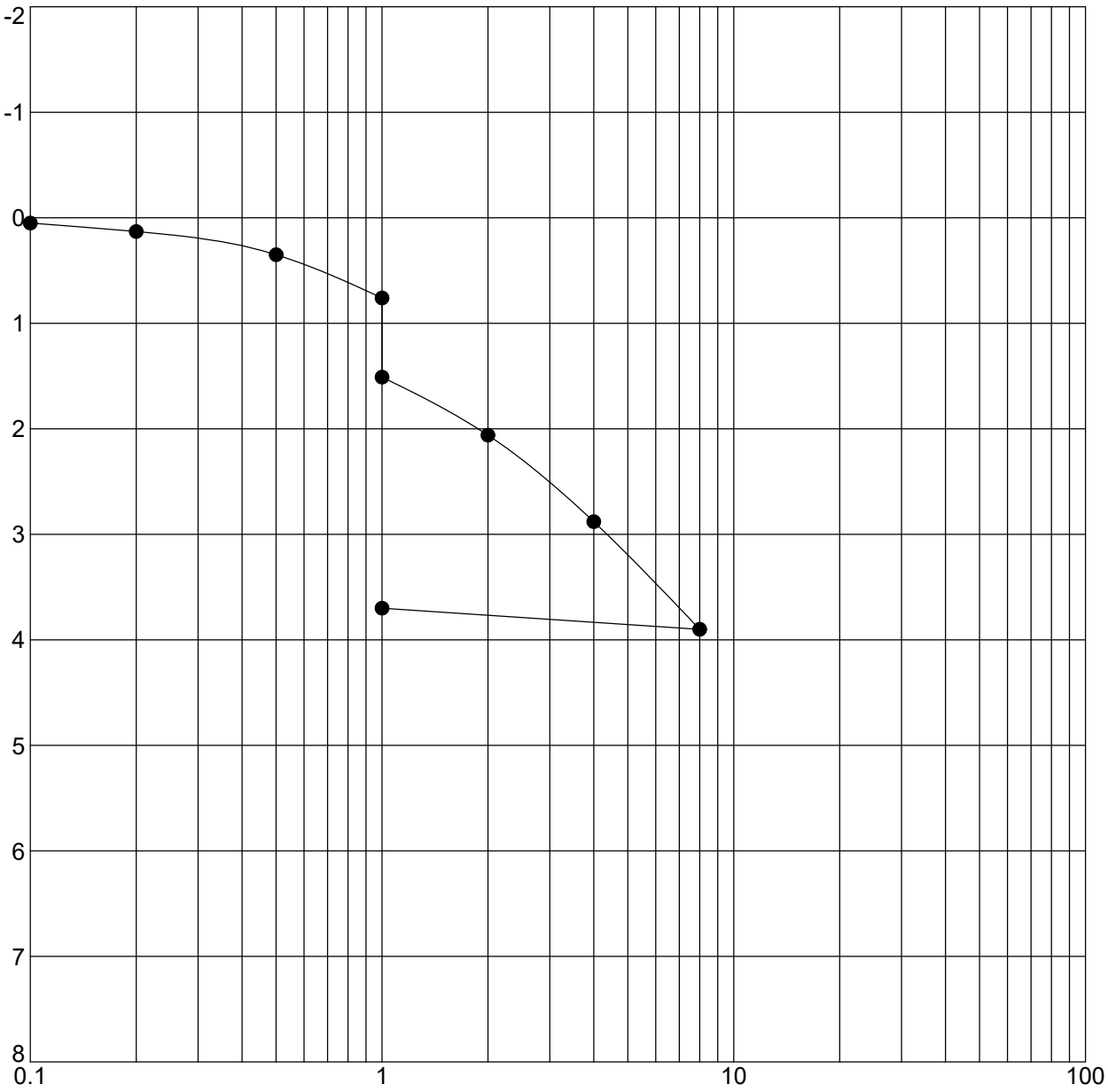
CONSOLIDATION TEST

CLIENT Mr. Ron Kassab

PROJECT NAME Proposed Kassab Travel Center

PROJECT NUMBER Lake Elsinore-1-01

PROJECT LOCATION 29301 Riverside Drive, Lake Elsinore, CA



Specimen Identification		Classification	γ_d	MC%
● B-1 5.0		**SANDY LEAN CLAY(CL)**	**97**	**24**

CONSOL STRAIN - GINT STD US LAB.GDT - 12/30/17 11:41 - C:\PASSPORT\GBI\29301 RIVERSIDE DRIVE_LAKE ELSINORE-RAHMAN\LOGS.GPJ

Appendix 4: Historical Site Conditions

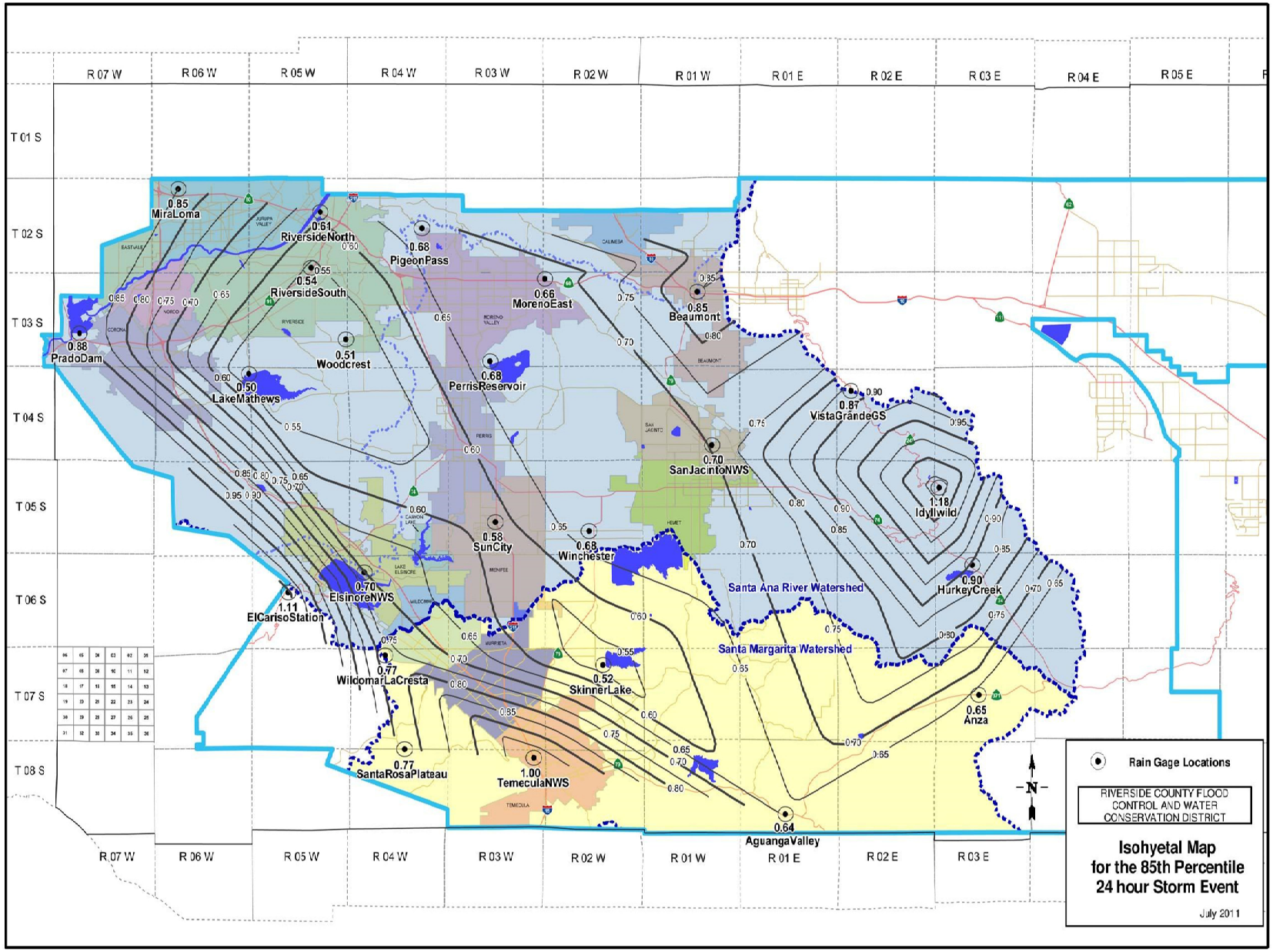
Phase I Environmental Site Assessment or Other Information on Past Site Use

Appendix 5: LID Infeasibility

LID Technical Infeasibility Analysis

Appendix 6: BMP Design Details

BMP Sizing, Design Details and other Supporting Documentation


R 07 W
R 06 W
R 05 W
R 04 W
R 03 W
R 02 W
R 01 W
R 01 E
R 02 E
R 03 E
R 04 E
R 05 E
T 01 S
T 02 S
T 03 S
T 04 S
T 05 S
T 06 S
T 07 S
T 08 S
0.85 MiraLoma
0.61 RiverSideNorth
0.68 PigeonPass
0.54 RiverSideSouth
0.66 MorenoEast
0.85 Beaumont
0.88 PradoDam
0.51 Woodcrest
0.68 PerrisReservoir
0.50 LakeMathews
0.87 VistaGrandeGS
0.70 SanJacintoNWS
1.18 Idyllwild
0.58 SunCity
0.68 Winchester
0.70 ElsinoreNWS
1.11 ElCarisoStation
0.90 HurkeyCreek
Santa Ana River Watershed
Santa Margarita Watershed
0.77 WildomarLaCresta
0.52 SkinnerLake
0.65 Anza
0.77 SantaRosaPlateau
1.00 TemeculaNWS
0.64 AguangaValley
Rain Gage Locations
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
Isohyetal Map for the 85th Percentile 24 hour Storm Event
July 2011

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: RAHMAN ENGINEERING — Date: 4/25/2018

Designed by: FR — Case No:

Company Project Number/Name:

BMP Identification

BMP NAME / ID: BIORETENTION

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}= 0.70 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 A	*27,456*	*Mixed Surface Types*	*0.86*	*0.67*	*18518.7*			
	27456	**Total**			**18518.7**	**0.70**	**1080.3**	**1,140**

Notes:

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: RAHMAN ENGINEERING — Date: 11/30/2018

Designed by: FR — Case No:

Company Project Number/Name:

BMP Identification

BMP NAME / ID: BMP-2/ BIOFILTRATION

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}= 0.70 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 B	*26,397*	*Mixed Surface Types*	*0.96*	*0.82*	*21732.5*			
	26397	**Total**			**21732.5**	**0.70**	**1267.7**	**1,500**

Notes:

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: RAHMAN ENGINEERING — Date: 11/26/2018

Designed by: FR — Case No:

Company Project Number/Name:

BMP Identification

BMP NAME / ID: BMP-4/ BIORETENTION

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}= 0.70 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-D	*5,536*	*Concrete or Asphalt*	*1*	*0.89*	*4938.1*			
	5536		***Total***		**4938.1**	**0.70**	***288.1***	***312***

Notes:

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: RAHMAN ENGINEERING — Date: 4/25/2018

Designed by: FR — Case No:

Company Project Number/Name:

BMP Identification

BMP NAME / ID: BMP-5/ LANDSCAPE AREAS

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}= 0.70 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)*
DM-E	*3,583*	*Mixed Surface Types*	*0.42*	*0.29*	*1042.9*			
	3583		***Total***		**1042.9**	**0.70**	***60.8***	***186***

Notes:

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	RAHMAN ENGINEERING	Date	4/25/2018
Designed by	FR	Case No	
Company Project Number/Name			

BMP Identification

BMP NAME / ID: BMP-6/ LANDSCAPE AREAS

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}= 0.70 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)*
DM-F	*4,697*	*Mixed Surface Types*	*0.64*	*0.44*	*2070.4*			
	4697	*Total*			*2070.4*	*0.70*	*120.8*	*121*

Notes:

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: RAHMAN ENGINEERING — Date: 4/25/2018

Designed by: FR — Case No:

Company Project Number/Name:

BMP Identification

BMP NAME / ID: BMP-7/BIORETENTION

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}= 0.70 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)*
DM-G	*5,612*	*Mixed Surface Types*	*0.62*	*0.42*	*2382.5*			
	5612	**Total**			**2382.5**	**0.70**	**139**	**176**

Notes:

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: RAHMAN ENGINEERING — Date: 4/25/2018

Designed by: FR — Case No:

Company Project Number/Name:

BMP Identification

BMP NAME / ID: BMP-8/LANDSCAPE AREA/BIORETENTION

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}= 0.70 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)*
DM-H	*29,939*	*Mixed Surface Types*	*0.95*	*0.81*	*24160.1*			
	29939		*Total*		*24160.1*	*0.70*	*1409.3*	*1,410*

Notes:

Bioretention Facility - Design Procedure	BMP ID 1	Legend:	Required Entries / Calculated Cells

Company Name: RAHMAN ENGINEERING Date: 4/25/2018

Designed by: FR County/City Case No.:

Design Volume

Enter the area tributary to this feature A_T= 0.63 acres

Enter V_{BMP} determined from Section 2.1 of this Handbook V_{BMP}= 1,080 ft^3

Type of Bioretention Facility Design

(●) Side slopes required (parallel to parking spaces or adjacent to walkways)

( ) No side slopes required (perpendicular to parking space or Planter Boxes)

Bioretention Facility Surface Area

Depth of Soil Filter Media Layer d_S = 1.5 ft

Top Width of Bioretention Facility, excluding curb w_T = 30.0 ft

Total Effective Depth, d_E

$d_E = (0.3) \times d_S + (0.4) \times 1 - (0.7/w_T) + 0.5$ d_E = 1.33 ft

Minimum Surface Area, A_m

$$A_M\ (ft^2) = \frac{V_{BMP}\ (ft^3)}{d_E\ (ft)}$$

A_M = 815 ft^2

Proposed Surface Area A= 857 ft^2

Bioretention Facility Properties

Side Slopes in Bioretention Facility z = 4 :1

Diameter of Underdrain 6 inches

Longitudinal Slope of Site (3% maximum) 2 %

6" Check Dam Spacing 25 feet

Describe Vegetation: Trees

Notes:

Bioretention Facility - Design Procedure	BMP ID 4	Legend:	Required Entries / Calculated Cells

Company Name: RAHMAN ENGINEERING Date: 11/26/2018

Designed by: FR County/City Case No.:

Design Volume

Enter the area tributary to this feature A_T= 0.13 acres

Enter V_{BMP} determined from Section 2.1 of this Handbook V_{BMP}= 288 ft^3

Type of Bioretention Facility Design

(●) Side slopes required (parallel to parking spaces or adjacent to walkways)

( ) No side slopes required (perpendicular to parking space or Planter Boxes)

Bioretention Facility Surface Area

Depth of Soil Filter Media Layer d_S = 1.5 ft

Top Width of Bioretention Facility, excluding curb w_T = 6.0 ft

Total Effective Depth, d_E

$d_E = (0.3) \times d_S + (0.4) \times 1 - (0.7/w_T) + 0.5$ d_E = 1.23 ft

Minimum Surface Area, A_m

$$A_M\ (ft^2) = \frac{V_{BMP}\ (ft^3)}{d_E\ (ft)}$$

A_M = 234 ft^2

Proposed Surface Area A= 254 ft^2

Bioretention Facility Properties

Side Slopes in Bioretention Facility z = 4 :1

Diameter of Underdrain 6 inches

Longitudinal Slope of Site (3% maximum) 2 %

6" Check Dam Spacing 25 feet

Describe Vegetation: Shrubs

Notes:

Bioretention Facility - Design Procedure	BMP ID 5	Legend:	Required Entries / Calculated Cells

Company Name: RAHMAN ENGINEERING — Date: 4/25/2018

Designed by: FR — County/City Case No.:

Design Volume

Enter the area tributary to this feature — A_T = 0.08 acres

Enter V_{BMP} determined from Section 2.1 of this Handbook — V_{BMP} = 61 ft^3

Type of Bioretention Facility Design

(●) Side slopes required (parallel to parking spaces or adjacent to walkways)

( ) No side slopes required (perpendicular to parking space or Planter Boxes)

Bioretention Facility Surface Area

Depth of Soil Filter Media Layer — d_S = 1.5 ft

Top Width of Bioretention Facility, excluding curb — w_T = 30.0 ft

Total Effective Depth, d_E

$d_E = (0.3) \times d_S + (0.4) \times 1 - (0.7/w_T) + 0.5$ — d_E = 1.33 ft

Minimum Surface Area, A_m

$$A_M\ (ft^2) = \frac{V_{BMP}\ (ft^3)}{d_E\ (ft)}$$

A_M = 46 ft^2

Proposed Surface Area — A= 140 ft^2

Bioretention Facility Properties

Side Slopes in Bioretention Facility — z = 4 :1

Diameter of Underdrain — 6 inches

Longitudinal Slope of Site (3% maximum) — 2 %

6" Check Dam Spacing — 25 feet

Describe Vegetation: Trees

Notes:

Bioretention Facility - Design Procedure	BMP ID 7	Legend:	Required Entries / Calculated Cells

Company Name: RAHMAN ENGINEERING Date: 11/26/2018

Designed by: FR County/City Case No.:

Design Volume

Enter the area tributary to this feature A_T= 0.13 acres

Enter V_{BMP} determined from Section 2.1 of this Handbook V_{BMP}= 139 ft^3

Type of Bioretention Facility Design

(●) Side slopes required (parallel to parking spaces or adjacent to walkways)

( ) No side slopes required (perpendicular to parking space or Planter Boxes)

Bioretention Facility Surface Area

Depth of Soil Filter Media Layer d_S = 1.5 ft

Top Width of Bioretention Facility, excluding curb w_T = 6.0 ft

Total Effective Depth, d_E

$d_E = (0.3) \times d_S + (0.4) \times 1 - (0.7/w_T) + 0.5$ d_E = 1.23 ft

Minimum Surface Area, A_m

$$A_M\ (ft^2) = \frac{V_{BMP}\ (ft^3)}{d_E\ (ft)}$$

A_M = 113 ft^2

Proposed Surface Area A= 143 ft^2

Bioretention Facility Properties

Side Slopes in Bioretention Facility z = 4 :1

Diameter of Underdrain 6 inches

Longitudinal Slope of Site (3% maximum) 2 %

6" Check Dam Spacing 25 feet

Describe Vegetation: Shrubs

Notes:

Bioretention Facility - Design Procedure	BMP ID 8	Legend:	Required Entries / Calculated Cells

Company Name: RAHMAN ENGINEERING Date: 4/25/2018

Designed by: FR County/City Case No.:

Design Volume

Enter the area tributary to this feature A_T= 0.69 acres

Enter V_{BMP} determined from Section 2.1 of this Handbook V_{BMP}= 1,409 ft^3

Type of Bioretention Facility Design

(●) Side slopes required (parallel to parking spaces or adjacent to walkways)

( ) No side slopes required (perpendicular to parking space or Planter Boxes)

Bioretention Facility Surface Area

Depth of Soil Filter Media Layer d_S = 1.5 ft

Top Width of Bioretention Facility, excluding curb w_T = 30.0 ft

Total Effective Depth, d_E

$d_E = (0.3) \times d_S + (0.4) \times 1 - (0.7/w_T) + 0.5$ d_E = 1.33 ft

Minimum Surface Area, A_m

$$A_M\ (ft^2) = \frac{V_{BMP}\ (ft^3)}{d_E\ (ft)}$$

A_M = 1,063 ft^2

Proposed Surface Area A= 1,172 ft^2

Bioretention Facility Properties

Side Slopes in Bioretention Facility z = 4 :1

Diameter of Underdrain 6 inches

Longitudinal Slope of Site (3% maximum) 2 %

6" Check Dam Spacing 25 feet

Describe Vegetation: Trees

Notes:

Appendix 7:Hydromodification

Supporting Detail Relating to Hydrologic Conditions of Concern

HCOC MITIGATION

Mimicking the pre-development hydrograph with the post-development hydrograph, for a 2-year return frequency storm. Generally, the hydrologic conditions of concern are not significant, if the post-development hydrograph is no more than 10% greater than pre-development hydrograph. In cases where excess volume cannot be infiltrated or captured and reused, discharge from the site must be limited to a flow rate no greater than 110% of the pre-development 2-year peak flow.

THIS CONDITION WAS MET BY SIZING THE OUTLET PIPE COMING OUT OF THE SITE TO CARRY A RUNOFF DISCHARGE OF NOT MORE THAN 10% OF THE 2 YR PRE DEVELOPESD HYDROGRAPH. THE RUNOFF DISCHARGE WAS CALCULATED USING THE MANNING'S FORMULA:

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

USING A 4" DIAMETER PIPE @ THE OUTLET;

$$A = (3.14)(0.33)^2/4$$

$$= 0.085 \text{ SF}$$

$$R^{2/3} = [(0.085/1.0362)]^{2/3}$$

$$= 0.187$$

$$S = .01$$

$$Q = (1.146)(0.085)(0.187)(0.1)$$

$$= 0.18 \text{ CFS} < \text{EXIST. PRE DISCHARGE @ 2 YR PEAK}$$

DMA	PRE DISCHARGE 2 YR-24 HR (CFS)	POST DISCHARGE 2 YR-24 HR (CFS)	REMARKS
A	0.30 CFS	0.18 CFS	@ OUTLET
B	0.29 CFS	0.18 CFS	@ OUTLET
H	0.26 CFS	0.18 CFS	@ OUTLET

IN CVASE OF HIGH WATER FLOWS, RUNOFF WILL FLOW INTO AN OVERFLOW GRATE INLET STRUTURE TOWARDS TO UNDERGROUND RETENTION CHAMBERS. IN AN OVERFLOW 4" PIPE WILL BE INSTALLED TO SERVE AS AN OVERFLOW DEVICE IN THE EVENT WATER RISES UP INSIDE THE CHAMBERS. THE OVERFLOW PIPE WAS SIZED TO CARRY A DISCHARGE LESS THAN THE DISCHARGE RATE ON THE PRE-DEVELOPED CONDITION.

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Kassab Travel Center
Pre-Developed

SUB-AREA:
DMA A Outlet .00098 69. .1

STREAM REACH:

STORM ANALYSIS:
2-Yr 2.39 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

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Pre-Developed

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STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DMA A	0.980E-03		0.128		12.02	0.30	304.11

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.842	0.05	0.06	0.07	0.09	0.10	0.11	0.13
11.886	0.14	0.16	0.17	0.19	0.20	0.22	0.23
11.930	0.24	0.25	0.26	0.26	0.27	0.27	0.28
11.975	0.28	0.28	0.28	0.29	0.29	0.29	0.30
12.019	0.30	0.30	0.29	0.28	0.27	0.25	0.24
12.063	0.22	0.20	0.18	0.17	0.15	0.14	0.13
12.107	0.12	0.11	0.11	0.10	0.10	0.09	0.09
12.151	0.09	0.08	0.08	0.08	0.08	0.08	0.07
12.196	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.240	0.07	0.07	0.07	0.07	0.06	0.06	0.06
12.284	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.328	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.372	0.06	0.06	0.06	0.05	0.05	0.05	0.05
12.417	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Area or Drainage Rain Gage Runoff Peak Flow

WinTR-20: Version 1.10 0 0 0.05
b Travel Center (continued)
Pre-Developed

STORM 2-Yr

SUB-AREA:
DMA A Outlet .00098 69. .1

STREAM REACH:

Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.980E-03		0.128		12.02	0.30	304.11

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.842	0.05	0.06	0.07	0.09	0.10	0.11	0.13
11.886	0.14	0.16	0.17	0.19	0.20	0.22	0.23
11.930	0.24	0.25	0.26	0.26	0.27	0.27	0.28
11.975	0.28	0.28	0.28	0.29	0.29	0.29	0.30
12.019	0.30	0.30	0.29	0.28	0.27	0.25	0.24
12.063	0.22	0.20	0.18	0.17	0.15	0.14	0.13
12.107	0.12	0.11	0.11	0.10	0.10	0.09	0.09
12.151	0.09	0.08	0.08	0.08	0.08	0.08	0.07
12.196	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.240	0.07	0.07	0.07	0.07	0.06	0.06	0.06
12.284	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.328	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.372	0.06	0.06	0.06	0.05	0.05	0.05	0.05
12.417	0.05	0.05	0.05	0.05	0.05	0.05	0.05

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Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)
DMA A	0.980E-03		0.30				
OUTLET	0.980E-03		0.30				

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b Travel Center (continued)
Pre-Developed

STORM 2-Yr

SUB-AREA:

	DMA A	Outlet	.00098	69.	.1

STREAM REACH:

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WinTR-20: Version 1.10 0 0 0.05
b Travel Center (continued)
Pre-Developed

STORM 2-Yr

SUB-AREA:

	DMA A	Outlet	.00098	69.	.1

STREAM REACH:

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WinTR-20 Printed Page File      Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10                  0         0         0.05
Kassab Travel Center
2yr Post-Developed

SUB-AREA:
          DMA A     Outlet              .00098    92.       .1

STREAM REACH:

STORM ANALYSIS:
          2-Yr                          2.39      Type II   2

STRUCTURE RATING:


GLOBAL OUTPUT:
          2         0.05                YYYYN     YYYYNN



WinTR-20 Printed Page File      End of Input Data List
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Kassab Travel Center
2yr Post-Developed

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TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DMA A	0.980E-03		1.096		11.93	1.52	1550.32

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
10.932	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.976	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.020	0.05	0.05	0.05	0.06	0.06	0.06	0.06
11.065	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.109	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.153	0.06	0.06	0.07	0.07	0.07	0.07	0.07
11.197	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.241	0.07	0.07	0.07	0.07	0.07	0.08	0.08
11.286	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.330	0.08	0.08	0.08	0.08	0.08	0.08	0.09
11.374	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.418	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.462	0.10	0.10	0.10	0.10	0.10	0.10	0.10
11.507	0.10	0.10	0.10	0.11	0.11	0.12	0.12
11.551	0.13	0.14	0.15	0.16	0.17	0.18	0.18
11.595	0.19	0.19	0.20	0.20	0.21	0.22	0.23
11.639	0.25	0.26	0.28	0.30	0.32	0.34	0.36
11.683	0.37	0.39	0.40	0.41	0.42	0.44	0.45
11.728	0.46	0.48	0.50	0.53	0.56	0.58	0.61
11.772	0.64	0.66	0.69	0.71	0.73	0.74	0.76
11.816	0.78	0.81	0.84	0.88	0.93	0.98	1.04
11.860	1.10	1.16	1.22	1.28	1.33	1.37	1.42
11.905	1.45	1.48	1.50	1.51	1.52	1.52	1.50
11.949	1.48	1.46	1.43	1.41	1.38	1.36	1.33
11.993	1.31	1.30	1.28	1.27	1.24	1.22	1.18
12.037	1.13	1.06	0.99	0.92	0.84	0.77	0.70
12.081	0.63	0.57	0.52	0.48	0.44	0.41	0.39
12.126	0.37	0.35	0.33	0.31	0.30	0.29	0.28
12.170	0.27	0.26	0.25	0.25	0.24	0.24	0.24
12.214	0.23	0.23	0.23	0.22	0.22	0.22	0.21
12.258	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.302	0.20	0.19	0.19	0.19	0.19	0.19	0.19
12.347	0.18	0.18	0.18	0.18	0.17	0.17	0.17
12.391	0.17	0.17	0.17	0.16	0.16	0.16	0.16
12.435	0.16	0.16	0.15	0.15	0.15	0.15	0.14

12.479	0.14	0.14	0.14	0.14	0.14	0.14	0.13
12.523	0.13	0.13	0.13	0.13	0.13	0.13	0.12
12.568	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.612	0.12	0.11	0.11	0.11	0.11	0.11	0.11
12.656	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Kassab Travel Center
2yr Post-Developed

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
12.700	0.11	0.11	0.11	0.11	0.11	0.11	0.10
12.745	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.789	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.833	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.877	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.921	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.966	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.010	0.09	0.09	0.09	0.09	0.08	0.08	0.08
13.054	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.098	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.142	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.187	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.231	0.08	0.08	0.08	0.08	0.07	0.07	0.07
13.275	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.319	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.363	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.408	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.452	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.496	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.540	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.585	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.629	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.673	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.717	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.761	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.806	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.850	0.06	0.06	0.06	0.06	0.06	0.06	0.05
13.894	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.938	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.982	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.027	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.071	0.05	0.05	0.05	0.05	0.05		

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.980E-03		1.096		11.93	1.52	1550.32

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
10.932	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.976	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.020	0.05	0.05	0.05	0.06	0.06	0.06	0.06
11.065	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.109	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.153	0.06	0.06	0.07	0.07	0.07	0.07	0.07
11.197	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.241	0.07	0.07	0.07	0.07	0.07	0.08	0.08

Kassab Travel Center
2yr Post-Developed

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.286	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.330	0.08	0.08	0.08	0.08	0.08	0.08	0.09
11.374	0.09	0.09	0.09	0.09	0.09	0.09	0.09

WinTR-20: Version 1.10 0 0 0.05
b Travel Center (continued)
2yr Post-Developed

STORM 2-Yr

SUB-AREA:
DMA A Outlet .00098 92. .1

STREAM REACH:

11.418	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.462	0.10	0.10	0.10	0.10	0.10	0.10	0.10
11.507	0.10	0.10	0.10	0.11	0.11	0.12	0.12
11.551	0.13	0.14	0.15	0.16	0.17	0.18	0.18
11.595	0.19	0.19	0.20	0.20	0.21	0.22	0.23
11.639	0.25	0.26	0.28	0.30	0.32	0.34	0.36
11.683	0.37	0.39	0.40	0.41	0.42	0.44	0.45
11.728	0.46	0.48	0.50	0.53	0.56	0.58	0.61
11.772	0.64	0.66	0.69	0.71	0.73	0.74	0.76
11.816	0.78	0.81	0.84	0.88	0.93	0.98	1.04
11.860	1.10	1.16	1.22	1.28	1.33	1.37	1.42
11.905	1.45	1.48	1.50	1.51	1.52	1.52	1.50
11.949	1.48	1.46	1.43	1.41	1.38	1.36	1.33
11.993	1.31	1.30	1.28	1.27	1.24	1.22	1.18
12.037	1.13	1.06	0.99	0.92	0.84	0.77	0.70
12.081	0.63	0.57	0.52	0.48	0.44	0.41	0.39
12.126	0.37	0.35	0.33	0.31	0.30	0.29	0.28
12.170	0.27	0.26	0.25	0.25	0.24	0.24	0.24
12.214	0.23	0.23	0.23	0.22	0.22	0.22	0.21
12.258	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.302	0.20	0.19	0.19	0.19	0.19	0.19	0.19
12.347	0.18	0.18	0.18	0.18	0.17	0.17	0.17
12.391	0.17	0.17	0.17	0.16	0.16	0.16	0.16
12.435	0.16	0.16	0.15	0.15	0.15	0.15	0.14
12.479	0.14	0.14	0.14	0.14	0.14	0.14	0.13
12.523	0.13	0.13	0.13	0.13	0.13	0.13	0.12
12.568	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.612	0.12	0.11	0.11	0.11	0.11	0.11	0.11
12.656	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.700	0.11	0.11	0.11	0.11	0.11	0.11	0.10
12.745	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.789	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.833	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.877	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.921	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.966	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.010	0.09	0.09	0.09	0.09	0.08	0.08	0.08
13.054	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.098	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.142	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.187	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.231	0.08	0.08	0.08	0.08	0.07	0.07	0.07
13.275	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.319	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.363	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.408	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.452	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.496	0.07	0.07	0.07	0.07	0.07	0.07	0.07

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
13.540	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.585	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
b Travel Center (continued)
2yr Post-Developed

STORM 2-Yr

SUB-AREA:
DMA A Outlet .00098 92. .1

STREAM REACH:

13.629	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.673	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.717	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.761	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.806	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.850	0.06	0.06	0.06	0.06	0.06	0.06	0.05
13.894	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.938	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.982	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.027	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.071	0.05	0.05	0.05	0.05	0.05		

Kassab Travel Center
2yr Post-Developed

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)
DMA A	0.980E-03		1.52				

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WinTR-20: Version 1.10                  0         0         0.05
b Travel Center                                                          (continued)
2yr Post-Developed
                                           STORM 2-Yr
SUB-AREA:
          DMA A     Outlet              .00098    92.       .1

STREAM REACH:
OUTLET    0.980E-03                1.52
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WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
KASSAB TRAVEL CENTER
PRE DEVELOPED

SUB-AREA:
DMA B Outlet .00095 69. .1

STREAM REACH:

STORM ANALYSIS:
2-Yr 2.39 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

KASSAB TRAVEL CENTER
PRE DEVELOPED

Name of printed page file:
TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DMA B	0.950E-03		0.126		12.02	0.29	304.11

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.848	0.06	0.07	0.08	0.10	0.11	0.12	0.14
11.892	0.15	0.17	0.18	0.20	0.21	0.22	0.23
11.937	0.24	0.25	0.26	0.26	0.26	0.27	0.27
11.981	0.27	0.28	0.28	0.28	0.29	0.29	0.29
12.025	0.29	0.28	0.27	0.26	0.25	0.23	0.21
12.069	0.19	0.18	0.16	0.15	0.14	0.13	0.12
12.114	0.11	0.10	0.10	0.09	0.09	0.09	0.08
12.158	0.08	0.08	0.08	0.08	0.07	0.07	0.07
12.202	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.246	0.07	0.06	0.06	0.06	0.06	0.06	0.06
12.290	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.335	0.06	0.06	0.06	0.06	0.06	0.06	0.05
12.379	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.423	0.05	0.05	0.05				

Area or	Drainage	Rain Gage	Runoff	Peak Flow

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CENTER (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:

DMA B	Outlet	.00095	69.	.1	

STREAM REACH:

Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.950E-03		0.126		12.02	0.29	304.11

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.848	0.06	0.07	0.08	0.10	0.11	0.12	0.14
11.892	0.15	0.17	0.18	0.20	0.21	0.22	0.23
11.937	0.24	0.25	0.26	0.26	0.26	0.27	0.27
11.981	0.27	0.28	0.28	0.28	0.29	0.29	0.29
12.025	0.29	0.28	0.27	0.26	0.25	0.23	0.21
12.069	0.19	0.18	0.16	0.15	0.14	0.13	0.12
12.114	0.11	0.10	0.10	0.09	0.09	0.09	0.08
12.158	0.08	0.08	0.08	0.08	0.07	0.07	0.07
12.202	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.246	0.07	0.06	0.06	0.06	0.06	0.06	0.06
12.290	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.335	0.06	0.06	0.06	0.06	0.06	0.06	0.05
12.379	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.423	0.05	0.05	0.05				

KASSAB TRAVEL CENTER
PRE DEVELOPED

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)				
DMA B	0.950E-03		0.29				
OUTLET	0.950E-03		0.29				

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CENTER (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA B Outlet .00095 69. .1

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CENTER (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA B Outlet .00095 69. .1

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
KASSAB TRAVEL CENTER
POST DEVELOPED

SUB-AREA:
DMA B Outlet .00095 92. .1

STREAM REACH:

STORM ANALYSIS:
2-Yr 2.39 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

KASSAB TRAVEL CENTER
POST DEVELOPED

Name of printed page file:
TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DMA B	0.950E-03		1.088		11.93	1.47	1550.32

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
10.963	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.008	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.052	0.05	0.05	0.06	0.06	0.06	0.06	0.06
11.096	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.140	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.185	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.229	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.273	0.07	0.07	0.07	0.08	0.08	0.08	0.08
11.317	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.361	0.08	0.08	0.08	0.08	0.08	0.09	0.09
11.406	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.450	0.09	0.09	0.09	0.09	0.09	0.09	0.10
11.494	0.10	0.10	0.10	0.10	0.10	0.10	0.11
11.538	0.11	0.12	0.13	0.14	0.15	0.15	0.16
11.582	0.17	0.18	0.18	0.19	0.19	0.20	0.21
11.627	0.21	0.23	0.24	0.26	0.27	0.29	0.31
11.671	0.33	0.35	0.36	0.38	0.39	0.40	0.41
11.715	0.42	0.44	0.45	0.47	0.49	0.51	0.54
11.759	0.57	0.59	0.62	0.64	0.67	0.69	0.71
11.803	0.72	0.74	0.76	0.78	0.81	0.85	0.90
11.848	0.95	1.01	1.07	1.13	1.18	1.24	1.29
11.892	1.33	1.37	1.41	1.43	1.45	1.47	1.47
11.936	1.47	1.46	1.44	1.42	1.39	1.36	1.34
11.980	1.31	1.29	1.27	1.26	1.24	1.23	1.21
12.025	1.18	1.14	1.09	1.03	0.96	0.89	0.82
12.069	0.74	0.68	0.61	0.56	0.51	0.46	0.43
12.113	0.40	0.38	0.35	0.34	0.32	0.30	0.29
12.157	0.28	0.27	0.26	0.25	0.25	0.24	0.24
12.201	0.23	0.23	0.23	0.22	0.22	0.22	0.21
12.246	0.21	0.21	0.21	0.20	0.20	0.20	0.19
12.290	0.19	0.19	0.19	0.19	0.19	0.19	0.18
12.334	0.18	0.18	0.18	0.18	0.17	0.17	0.17
12.378	0.17	0.17	0.16	0.16	0.16	0.16	0.16
12.422	0.16	0.16	0.15	0.15	0.15	0.15	0.15
12.467	0.14	0.14	0.14	0.14	0.13	0.13	0.13

12.511	0.13	0.13	0.13	0.13	0.13	0.13	0.12
12.555	0.12	0.12	0.12	0.12	0.12	0.11	0.11
12.599	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.643	0.11	0.11	0.11	0.11	0.11	0.11	0.10
12.688	0.10	0.10	0.10	0.10	0.10	0.10	0.10

KASSAB TRAVEL CENTER
POST DEVELOPED

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
12.732	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.776	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.820	0.10	0.10	0.10	0.09	0.09	0.09	0.09
12.865	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.909	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.953	0.09	0.09	0.09	0.09	0.09	0.08	0.08
12.997	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.041	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.086	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.130	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.174	0.08	0.08	0.07	0.07	0.07	0.07	0.07
13.218	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.262	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.307	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.351	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.395	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.439	0.07	0.07	0.07	0.07	0.07	0.06	0.06
13.483	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.528	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.572	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.616	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.660	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.705	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.749	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.793	0.06	0.06	0.06	0.06	0.06	0.06	0.05
13.837	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.881	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.926	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.970	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.014	0.05	0.05					

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.950E-03		1.088		11.93	1.47	1550.32

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
10.963	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.008	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.052	0.05	0.05	0.06	0.06	0.06	0.06	0.06
11.096	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.140	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.185	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.229	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.273	0.07	0.07	0.07	0.08	0.08	0.08	0.08
11.317	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.361	0.08	0.08	0.08	0.08	0.08	0.09	0.09

KASSAB TRAVEL CENTER
POST DEVELOPED

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.406	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.450	0.09	0.09	0.09	0.09	0.09	0.09	0.10
11.494	0.10	0.10	0.10	0.10	0.10	0.10	0.11

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CENTER (continued)
POST DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA B Outlet .00095 92. .1

STREAM REACH:

11.538	0.11	0.12	0.13	0.14	0.15	0.15	0.16
11.582	0.17	0.18	0.18	0.19	0.19	0.20	0.21
11.627	0.21	0.23	0.24	0.26	0.27	0.29	0.31
11.671	0.33	0.35	0.36	0.38	0.39	0.40	0.41
11.715	0.42	0.44	0.45	0.47	0.49	0.51	0.54
11.759	0.57	0.59	0.62	0.64	0.67	0.69	0.71
11.803	0.72	0.74	0.76	0.78	0.81	0.85	0.90
11.848	0.95	1.01	1.07	1.13	1.18	1.24	1.29
11.892	1.33	1.37	1.41	1.43	1.45	1.47	1.47
11.936	1.47	1.46	1.44	1.42	1.39	1.36	1.34
11.980	1.31	1.29	1.27	1.26	1.24	1.23	1.21
12.025	1.18	1.14	1.09	1.03	0.96	0.89	0.82
12.069	0.74	0.68	0.61	0.56	0.51	0.46	0.43
12.113	0.40	0.38	0.35	0.34	0.32	0.30	0.29
12.157	0.28	0.27	0.26	0.25	0.25	0.24	0.24
12.201	0.23	0.23	0.23	0.22	0.22	0.22	0.21
12.246	0.21	0.21	0.21	0.20	0.20	0.20	0.19
12.290	0.19	0.19	0.19	0.19	0.19	0.19	0.18
12.334	0.18	0.18	0.18	0.18	0.17	0.17	0.17
12.378	0.17	0.17	0.16	0.16	0.16	0.16	0.16
12.422	0.16	0.16	0.15	0.15	0.15	0.15	0.15
12.467	0.14	0.14	0.14	0.14	0.13	0.13	0.13
12.511	0.13	0.13	0.13	0.13	0.13	0.13	0.12
12.555	0.12	0.12	0.12	0.12	0.12	0.11	0.11
12.599	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.643	0.11	0.11	0.11	0.11	0.11	0.11	0.10
12.688	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.732	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.776	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.820	0.10	0.10	0.10	0.09	0.09	0.09	0.09
12.865	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.909	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.953	0.09	0.09	0.09	0.09	0.09	0.08	0.08
12.997	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.041	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.086	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.130	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.174	0.08	0.08	0.07	0.07	0.07	0.07	0.07
13.218	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.262	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.307	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.351	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.395	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.439	0.07	0.07	0.07	0.07	0.07	0.06	0.06
13.483	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.528	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.572	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.616	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Line Start Time (hr) — Flow Values @ time increment of 0.006 hr (cfs)

13.660	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.705	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CENTER (continued)
POST DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA B Outlet .00095 92. .1

STREAM REACH:

13.749	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.793	0.06	0.06	0.06	0.06	0.06	0.06	0.05
13.837	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.881	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.926	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.970	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.014	0.05	0.05					

KASSAB TRAVEL CENTER
POST DEVELOPED

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)
DMA B	0.950E-03		1.47				

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WinTR-20: Version 1.10                  0         0         0.05
B TRAVEL CENTER                                                                (continued)
POST DEVELOPED
                                           STORM 2-Yr
SUB-AREA:
          DMA B     Outlet              .00095    92.       .1

STREAM REACH:
OUTLET    0.950E-03                1.47
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WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
KASSAB TRAVEL CTR
PRE DEVELOPED

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:

STORM ANALYSIS:
2-Yr 2.39 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

KASSAB TRAVEL CTR
PRE DEVELOPED

Name of printed page file:
TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DMA G	0.002		0.173		12.02	0.55	304.11

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.829	0.06	0.08	0.09	0.11	0.13	0.16	0.18
11.874	0.21	0.24	0.26	0.29	0.32	0.35	0.38
11.918	0.40	0.43	0.45	0.46	0.48	0.49	0.50
11.962	0.50	0.51	0.51	0.52	0.52	0.53	0.54
12.006	0.54	0.55	0.55	0.55	0.54	0.52	0.50
12.050	0.47	0.44	0.40	0.37	0.34	0.31	0.28
12.095	0.26	0.24	0.22	0.21	0.20	0.19	0.18
12.139	0.17	0.17	0.16	0.16	0.15	0.15	0.14
12.183	0.14	0.14	0.14	0.13	0.13	0.13	0.13
12.227	0.13	0.13	0.13	0.12	0.12	0.12	0.12
12.271	0.12	0.12	0.12	0.12	0.11	0.11	0.11
12.316	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.360	0.11	0.11	0.10	0.10	0.10	0.10	0.10
12.404	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.448	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.492	0.09	0.08	0.08	0.08	0.08	0.08	0.08
12.537	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.581	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.625	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.669	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.714	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.758	0.07	0.07	0.07	0.07	0.06	0.06	0.06
12.802	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.846	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.890	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.935	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.979	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.023	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.067	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.111	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.156	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.200	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.244	0.05	0.05	0.05	0.05	0.05	0.05	

Area or	Drainage	Rain Gage	Runoff	Peak Flow

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:

Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.002		0.173		12.02	0.55	304.11

KASSAB TRAVEL CTR
PRE DEVELOPED

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:
Line
Start Time ---------- Flow Values @ time increment of 0.006 hr ----------

(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.829	0.06	0.08	0.09	0.11	0.13	0.16	0.18
11.874	0.21	0.24	0.26	0.29	0.32	0.35	0.38
11.918	0.40	0.43	0.45	0.46	0.48	0.49	0.50
11.962	0.50	0.51	0.51	0.52	0.52	0.53	0.54
12.006	0.54	0.55	0.55	0.55	0.54	0.52	0.50
12.050	0.47	0.44	0.40	0.37	0.34	0.31	0.28
12.095	0.26	0.24	0.22	0.21	0.20	0.19	0.18

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:

12.139	0.17	0.17	0.16	0.16	0.15	0.15	0.14
12.183	0.14	0.14	0.14	0.13	0.13	0.13	0.13
12.227	0.13	0.13	0.13	0.12	0.12	0.12	0.12
12.271	0.12	0.12	0.12	0.12	0.11	0.11	0.11
12.316	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.360	0.11	0.11	0.10	0.10	0.10	0.10	0.10
12.404	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.448	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.492	0.09	0.08	0.08	0.08	0.08	0.08	0.08
12.537	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.581	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:

12.625	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.669	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.714	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.758	0.07	0.07	0.07	0.07	0.06	0.06	0.06
12.802	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.846	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.890	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.935	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.979	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.023	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.067	0.05	0.05	0.05	0.05	0.05	0.05	0.05

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WinTR-20: Version 1.10                  0         0         0.05
B TRAVEL CTR                                                                (continued)
PRE DEVELOPED
                                          STORM 2-Yr
SUB-AREA:
          DMA G     Outlet              .00181    69.       .1

STREAM REACH:
    13.111      0.05      0.05      0.05      0.05      0.05      0.05      0.05
    13.156      0.05      0.05      0.05      0.05      0.05      0.05      0.05
    13.200      0.05      0.05      0.05      0.05      0.05      0.05      0.05
    13.244      0.05      0.05      0.05      0.05      0.05      0.05
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WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:

DMA G	Outlet	.00181	69.	.1

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:

KASSAB TRAVEL CTR
PRE DEVELOPED

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)
DMA G	0.002		0.55				

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:
OUTLET 0.002 0.55

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:

DMA G	Outlet	.00181	69.	.1

STREAM REACH:

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:

DMA G	Outlet	.00181	69.	.1

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
PRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 69. .1

STREAM REACH:

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WinTR-20 Printed Page File      Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10                  0         0         0.05
KASSAB TRAVEL CTR
POSTRE DEVELOPED

SUB-AREA:
          DMA G     Outlet              .00181    92.       .1

STREAM REACH:

STORM ANALYSIS:
          2-Yr                          2.39      Type II   2

STRUCTURE RATING:


GLOBAL OUTPUT:
          2         0.05                YYYYN     YYYYNN



WinTR-20 Printed Page File      End of Input Data List

                                KASSAB TRAVEL CTR
                                POSTRE DEVELOPED

                           Name of printed page file:
                                TR20.out

                                        STORM 2-Yr
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Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DMA G	0.002		1.326		11.93	2.81	1550.32

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
10.193	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.237	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.281	0.05	0.05	0.05	0.05	0.05	0.05	0.06
10.326	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.370	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.414	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.458	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.502	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.547	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.591	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.635	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.679	0.07	0.07	0.08	0.08	0.08	0.08	0.08
10.723	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.768	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.812	0.08	0.08	0.08	0.08	0.09	0.09	0.09
10.856	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.900	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.945	0.09	0.09	0.09	0.10	0.10	0.10	0.10
10.989	0.10	0.10	0.10	0.10	0.10	0.10	0.10
11.033	0.10	0.10	0.10	0.10	0.10	0.11	0.11
11.077	0.11	0.11	0.11	0.11	0.11	0.11	0.11
11.121	0.11	0.11	0.11	0.12	0.12	0.12	0.12
11.166	0.12	0.12	0.12	0.12	0.13	0.13	0.13
11.210	0.13	0.13	0.13	0.13	0.13	0.13	0.13
11.254	0.14	0.14	0.14	0.14	0.14	0.14	0.14
11.298	0.14	0.15	0.15	0.15	0.15	0.15	0.15
11.342	0.15	0.15	0.15	0.16	0.16	0.16	0.16
11.387	0.16	0.16	0.16	0.16	0.17	0.17	0.17
11.431	0.17	0.17	0.17	0.17	0.17	0.18	0.18
11.475	0.18	0.18	0.18	0.18	0.18	0.19	0.19
11.519	0.19	0.20	0.21	0.22	0.23	0.25	0.26
11.563	0.28	0.29	0.31	0.32	0.34	0.35	0.36
11.608	0.37	0.38	0.39	0.41	0.43	0.46	0.49
11.652	0.52	0.56	0.59	0.63	0.66	0.69	0.72
11.696	0.74	0.76	0.78	0.80	0.83	0.86	0.89

11.740	0.93	0.98	1.03	1.08	1.13	1.18	1.23
11.785	1.27	1.31	1.34	1.38	1.41	1.45	1.49
11.829	1.55	1.62	1.71	1.81	1.92	2.03	2.15
11.873	2.25	2.36	2.45	2.54	2.61	2.68	2.73
11.917	2.77	2.80	2.81	2.80	2.78	2.74	2.70

KASSAB TRAVEL CTR
POSTRE DEVELOPED

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.961	2.65	2.60	2.55	2.50	2.46	2.43	2.40
12.006	2.37	2.34	2.30	2.24	2.17	2.08	1.96
12.050	1.83	1.70	1.56	1.42	1.29	1.17	1.06
12.094	0.96	0.89	0.82	0.76	0.72	0.68	0.64
12.138	0.61	0.58	0.56	0.53	0.51	0.50	0.48
12.182	0.47	0.46	0.45	0.44	0.44	0.43	0.42
12.227	0.42	0.41	0.41	0.40	0.40	0.39	0.39
12.271	0.38	0.38	0.37	0.37	0.36	0.36	0.36
12.315	0.36	0.35	0.35	0.35	0.34	0.34	0.34
12.359	0.33	0.33	0.32	0.32	0.32	0.31	0.31
12.403	0.31	0.30	0.30	0.30	0.30	0.29	0.29
12.448	0.29	0.28	0.28	0.27	0.27	0.26	0.26
12.492	0.26	0.25	0.25	0.25	0.25	0.25	0.24
12.536	0.24	0.24	0.24	0.23	0.23	0.23	0.22
12.580	0.22	0.22	0.22	0.22	0.21	0.21	0.21
12.625	0.21	0.21	0.21	0.21	0.21	0.20	0.20
12.669	0.20	0.20	0.20	0.20	0.20	0.20	0.20
12.713	0.20	0.20	0.20	0.19	0.19	0.19	0.19
12.757	0.19	0.19	0.19	0.19	0.19	0.19	0.19
12.801	0.18	0.18	0.18	0.18	0.18	0.18	0.18
12.846	0.18	0.18	0.18	0.18	0.18	0.17	0.17
12.890	0.17	0.17	0.17	0.17	0.17	0.17	0.17
12.934	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.978	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.022	0.16	0.16	0.16	0.16	0.16	0.15	0.15
13.067	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.111	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.155	0.15	0.14	0.14	0.14	0.14	0.14	0.14
13.199	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.243	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.288	0.14	0.14	0.14	0.13	0.13	0.13	0.13
13.332	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.376	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.420	0.13	0.13	0.13	0.13	0.13	0.13	0.12
13.465	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.509	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.553	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.597	0.12	0.12	0.12	0.12	0.11	0.11	0.11
13.641	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.686	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.730	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.774	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.818	0.11	0.10	0.10	0.10	0.10	0.10	0.10
13.862	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.907	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.951	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.995	0.10	0.10	0.10	0.10	0.10	0.10	0.09
14.039	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.083	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.128	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.172	0.09	0.09	0.09	0.09	0.09	0.09	0.09

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

KASSAB TRAVEL CTR
POSTRE DEVELOPED

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
14.216	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.260	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.305	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.349	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.393	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.437	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.481	0.09	0.09	0.09	0.09	0.09	0.09	0.08
14.526	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.570	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.614	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.658	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.702	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.747	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.791	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.835	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.879	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.923	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.968	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.012	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.056	0.08	0.08	0.08	0.08	0.08	0.08	0.07
15.100	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.145	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.189	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.233	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.277	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.321	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.366	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.410	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.454	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.498	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

15.542	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.587	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.631	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.675	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.719	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.763	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.808	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.852	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.896	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.940	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.985	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.029	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.073	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.117	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.161	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.206	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.250	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.294	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.338	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.382	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.427	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
16.471	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.515	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.559	0.06	0.06	0.05	0.05	0.05	0.05	0.05
16.603	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.648	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.692	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.736	0.05	0.05	0.05	0.05	0.05	0.05	0.05

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

16.780	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.825	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.869	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.913	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.957	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.001	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.046	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.090	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.134	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.178	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.222	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.267	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.311	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.355	0.05	0.05	0.05	0.05			

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
OUTLET	0.002		1.326		11.93	2.81	1550.32

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
10.193	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.237	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.281	0.05	0.05	0.05	0.05	0.05	0.05	0.06
10.326	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.370	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.414	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.458	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.502	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.547	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.591	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.635	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.679	0.07	0.07	0.08	0.08	0.08	0.08	0.08
10.723	0.08	0.08	0.08	0.08	0.08	0.08	0.08

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

10.768	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.812	0.08	0.08	0.08	0.08	0.09	0.09	0.09
10.856	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.900	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.945	0.09	0.09	0.09	0.10	0.10	0.10	0.10
10.989	0.10	0.10	0.10	0.10	0.10	0.10	0.10

KASSAB TRAVEL CTR
POSTRE DEVELOPED

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.033	0.10	0.10	0.10	0.10	0.10	0.11	0.11
11.077	0.11	0.11	0.11	0.11	0.11	0.11	0.11
11.121	0.11	0.11	0.11	0.12	0.12	0.12	0.12
11.166	0.12	0.12	0.12	0.12	0.13	0.13	0.13
11.210	0.13	0.13	0.13	0.13	0.13	0.13	0.13
11.254	0.14	0.14	0.14	0.14	0.14	0.14	0.14
11.298	0.14	0.15	0.15	0.15	0.15	0.15	0.15
11.342	0.15	0.15	0.15	0.16	0.16	0.16	0.16
11.387	0.16	0.16	0.16	0.16	0.17	0.17	0.17
11.431	0.17	0.17	0.17	0.17	0.17	0.18	0.18
11.475	0.18	0.18	0.18	0.18	0.18	0.19	0.19
11.519	0.19	0.20	0.21	0.22	0.23	0.25	0.26
11.563	0.28	0.29	0.31	0.32	0.34	0.35	0.36
11.608	0.37	0.38	0.39	0.41	0.43	0.46	0.49
11.652	0.52	0.56	0.59	0.63	0.66	0.69	0.72
11.696	0.74	0.76	0.78	0.80	0.83	0.86	0.89
11.740	0.93	0.98	1.03	1.08	1.13	1.18	1.23
11.785	1.27	1.31	1.34	1.38	1.41	1.45	1.49
11.829	1.55	1.62	1.71	1.81	1.92	2.03	2.15
11.873	2.25	2.36	2.45	2.54	2.61	2.68	2.73
11.917	2.77	2.80	2.81	2.80	2.78	2.74	2.70
11.961	2.65	2.60	2.55	2.50	2.46	2.43	2.40

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

12.006	2.37	2.34	2.30	2.24	2.17	2.08	1.96
12.050	1.83	1.70	1.56	1.42	1.29	1.17	1.06
12.094	0.96	0.89	0.82	0.76	0.72	0.68	0.64
12.138	0.61	0.58	0.56	0.53	0.51	0.50	0.48
12.182	0.47	0.46	0.45	0.44	0.44	0.43	0.42
12.227	0.42	0.41	0.41	0.40	0.40	0.39	0.39
12.271	0.38	0.38	0.37	0.37	0.36	0.36	0.36
12.315	0.36	0.35	0.35	0.35	0.34	0.34	0.34
12.359	0.33	0.33	0.32	0.32	0.32	0.31	0.31
12.403	0.31	0.30	0.30	0.30	0.30	0.29	0.29
12.448	0.29	0.28	0.28	0.27	0.27	0.26	0.26
12.492	0.26	0.25	0.25	0.25	0.25	0.25	0.24
12.536	0.24	0.24	0.24	0.23	0.23	0.23	0.22
12.580	0.22	0.22	0.22	0.22	0.21	0.21	0.21
12.625	0.21	0.21	0.21	0.21	0.21	0.20	0.20
12.669	0.20	0.20	0.20	0.20	0.20	0.20	0.20
12.713	0.20	0.20	0.20	0.19	0.19	0.19	0.19
12.757	0.19	0.19	0.19	0.19	0.19	0.19	0.19
12.801	0.18	0.18	0.18	0.18	0.18	0.18	0.18
12.846	0.18	0.18	0.18	0.18	0.18	0.17	0.17
12.890	0.17	0.17	0.17	0.17	0.17	0.17	0.17
12.934	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.978	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.022	0.16	0.16	0.16	0.16	0.16	0.15	0.15
13.067	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.111	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.155	0.15	0.14	0.14	0.14	0.14	0.14	0.14
13.199	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.243	0.14	0.14	0.14	0.14	0.14	0.14	0.14

KASSAB TRAVEL CTR
POSTRE DEVELOPED

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

13.288	0.14	0.14	0.14	0.13	0.13	0.13	0.13
13.332	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.376	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.420	0.13	0.13	0.13	0.13	0.13	0.13	0.12
13.465	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.509	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.553	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.597	0.12	0.12	0.12	0.12	0.11	0.11	0.11
13.641	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.686	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.730	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.774	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.818	0.11	0.10	0.10	0.10	0.10	0.10	0.10
13.862	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.907	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.951	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.995	0.10	0.10	0.10	0.10	0.10	0.10	0.09
14.039	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.083	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.128	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.172	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.216	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.260	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.305	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.349	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.393	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.437	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.481	0.09	0.09	0.09	0.09	0.09	0.09	0.08
14.526	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.570	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.614	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.658	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.702	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.747	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.791	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.835	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.879	0.08	0.08	0.08	0.08	0.08	0.08	0.08

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

14.923	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.968	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.012	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.056	0.08	0.08	0.08	0.08	0.08	0.08	0.07
15.100	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.145	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.189	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.233	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.277	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.321	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.366	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.410	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.454	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.498	0.07	0.07	0.07	0.07	0.07	0.07	0.07

KASSAB TRAVEL CTR
POSTRE DEVELOPED

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
15.542	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.587	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.631	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.675	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.719	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.763	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.808	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.852	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.896	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.940	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.985	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.029	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.073	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.117	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

16.161	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.206	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.250	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.294	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.338	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.382	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.427	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.471	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.515	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.559	0.06	0.06	0.05	0.05	0.05	0.05	0.05
16.603	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.648	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.692	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.736	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.780	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.825	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.869	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.913	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.957	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.001	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.046	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.090	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.134	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.178	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.222	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.267	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.311	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.355	0.05	0.05	0.05	0.05			

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

KASSAB TRAVEL CTR
POSTRE DEVELOPED

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)
DMA G	0.002		2.81				
OUTLET	0.002		2.81				

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
B TRAVEL CTR (continued)
POSTRE DEVELOPED

STORM 2-Yr

SUB-AREA:
DMA G Outlet .00181 92. .1

STREAM REACH:

User Inputs

Chamber Model	MC-3500
Outlet Control Structure	Yes (Outlet)
Project Name	KASSAB -DMA A
Project Location	RIVERSIDE DR, RIVERSIDE
Project Date	11/07/2018
Engineer	RRF
Measurement Type	Imperial
Required Storage Volume	2600 cubic ft.
Stone Porosity	40%
Stone Above Chambers	12 in.
Stone Foundation Depth	9 in.
Average Cover Over Chambers	24 in.
Design Constraint	Length
Design Constraint Dimension	50 ft.

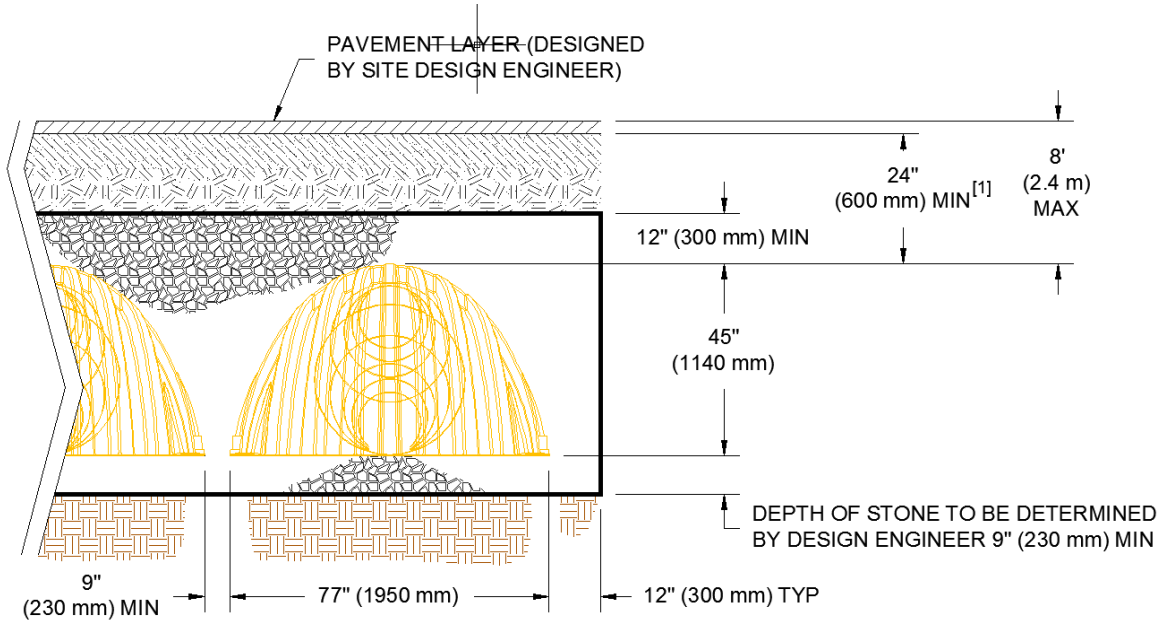
Results

System Volume and Bed Size

Installed Storage Volume	2675 cubic ft.
Storage Volume Per Chamber	178.9 cubic ft.
Storage Volume Per End Cap	46.9 cubic ft.
Number Of Chambers Required	11 each
Number Of End Caps Required	6 each
Rows/Chambers	2 row(s) of 5 chamber(s)
Leftover Rows/Chambers	1 row(s) of 1 chamber(s)
Maximum Length	45.14 ft.
Maximum Width	23.35 ft.
Approx. Bed Size Required	861 square ft.

System Components

Amount Of Stone Required	127 cubic yards
Volume Of Excavation (Not Including Fill)	175 cubic yards
Non-woven Filter Fabric Required	269 square yards
Length Of Isolator Row	39.53 ft.
Woven Isolator Row Fabric	74 square yards



[1] - TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

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FOR STORMTECH INSTRUCTIONS, DOWNLOAD THE INSTALLATION APP

KASSAB -DMA A

RIVERSIDE DR, RIVERSIDE

STORMTECH CHAMBER SPECIFICATIONS

1. CHAMBERS SHALL BE STORMTECH MC-3500 OR APPROVED EQUAL.
2. CHAMBERS SHALL BE MADE FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE COPOLYMERS.
3. CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORT PANELS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
4. THE STRUCTURAL DESIGN OF THE CHAMBERS, THE STRUCTURAL BACKFILL, AND THE INSTALLATION REQUIREMENTS SHALL ENSURE THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET FOR: 1) LONG-DURATION DEAD LOADS AND 2) SHORT-DURATION LIVE LOADS, BASED ON THE AASHTO DESIGN TRUCK WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.
5. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
6. CHAMBERS SHALL BE DESIGNED AND ALLOWABLE LOADS DETERMINED IN ACCORDANCE WITH ASTM F2787, "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
7. ONLY CHAMBERS THAT ARE APPROVED BY THE SITE DESIGN ENGINEER WILL BE ALLOWED. THE CHAMBER MANUFACTURER SHALL SUBMIT THE FOLLOWING UPON REQUEST TO THE SITE DESIGN ENGINEER FOR APPROVAL BEFORE DELIVERING CHAMBERS TO THE PROJECT SITE:
   a. A STRUCTURAL EVALUATION SEALED BY A REGISTERED PROFESSIONAL ENGINEER THAT DEMONSTRATES THAT THE SAFETY FACTORS ARE GREATER THAN OR EQUAL TO 1.95 FOR DEAD LOAD AND 1.75 FOR LIVE LOAD, THE MINIMUM REQUIRED BY ASTM F2787 AND BY AASHTO FOR THERMOPLASTIC PIPE.
   b. A STRUCTURAL EVALUATION SEALED BY A REGISTERED PROFESSIONAL ENGINEER THAT DEMONSTRATES THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET. THE 50 YEAR CREEP MODULUS DATA SPECIFIED IN ASTM F2418 MUST BE USED AS PART OF THE AASHTO STRUCTURAL EVALUATION TO VERIFY LONG-TERM PERFORMANCE.
   c. STRUCTURAL CROSS SECTION DETAIL ON WHICH THE STRUCTURAL EVALUATION IS BASED.
8. CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF MC-3500 CHAMBER SYSTEM

1. STORMTECH MC-3500 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTATIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
2. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR AN EXCAVATOR SITUATED OVER THE CHAMBERS.

   STORMTECH RECOMMENDS 3 BACKFILL METHODS:
   - STONESHOOTER LOCATED OFF THE CHAMBER BED.
   - BACKFILL AS ROWS ARE BUILT USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
   - BACKFILL FROM OUTSIDE THE EXCAVATION USING A LONG BOOM HOE OR EXCAVATOR.
4. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
5. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
6. MAINTAIN MINIMUM - 9" (230 mm) SPACING BETWEEN THE CHAMBER ROWS.
7. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM OF 12" (300 mm) INTO CHAMBER END CAPS.
8. EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE 3/4-2" (20-50 mm) MEETING THE AASHTO M43 DESIGNATION OF #3 OR #4.
9. STONE MUST BE PLACED ON THE TOP CENTER OF THE CHAMBER TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING..
10. ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

NOTES FOR CONSTRUCTION EQUIPMENT

1. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
2. THE USE OF EQUIPMENT OVER MC-3500 CHAMBERS IS LIMITED:
   - NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS.
   - NO RUBBER TIRED LOADER, DUMP TRUCK, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
   - WEIGHT LIMITS FOR CONSRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. FULL 36" (900 mm) OF STABILIZED COVER MATERIALS OVER THE CHAMBERS IS REQUIRED FOR DUMP TRUCK TRAVEL OR DUMPING.

USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

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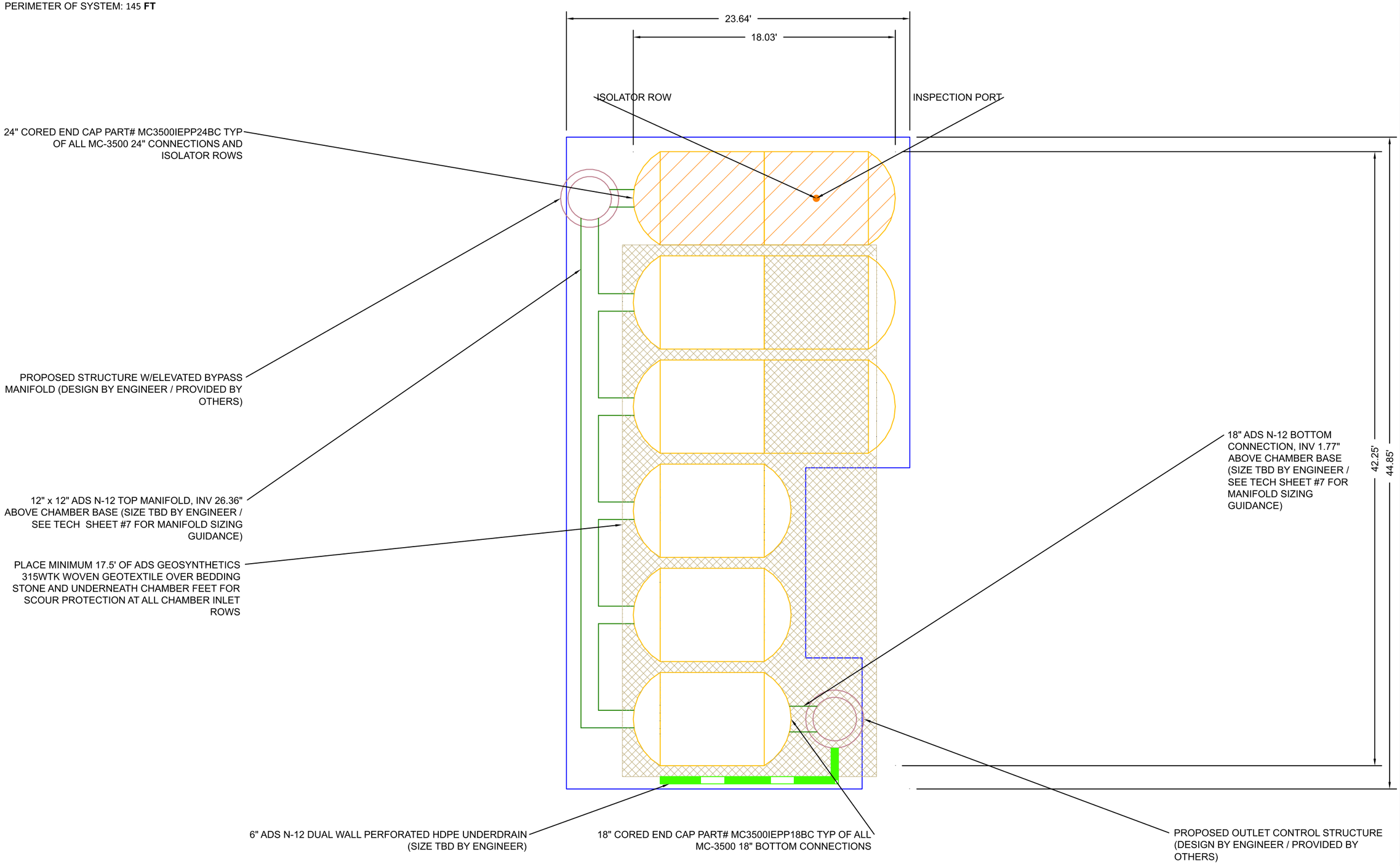
CONCEPTUAL LAYOUT

(9) STORMTECH MC-3500 CHAMBERS
(12) STORMTECH MC-3500 END CAPS
INSTALLED WITH 12 " COVER STONE, 9 " BASE STONE, 40% STONE VOID
INSTALLED SYSTEM VOLUME: 2762 CF
AREA OF SYSTEM: 937 **FT²**
PERIMETER OF SYSTEM: 145 **FT**

COMPUTER GENERATED CONCEPTUAL LAYOUT - NOT FOR CONSTRUCTION



KASSAB -DMA A
RIVERSIDE DR, RIVERSIDE

DATE: 11/07/2018 | DRAWN: RF | CHECKED: ---
PROJECT #: Tool

REV	DRW	CHK	DESCRIPTION

StormTech®
Detention• Retention• Water Quality
70 INWOOD ROAD, SUITE 3 | ROCKY HILL | CT | 06067
860-529-8188 |888-892-2694 | WWW.STORMTECH.COM

ADS®
ADVANCED DRAINAGE SYSTEMS, INC.
4640 TRUEMAN BLVD
HILLIARD, OH 43026
1-800-733-7473

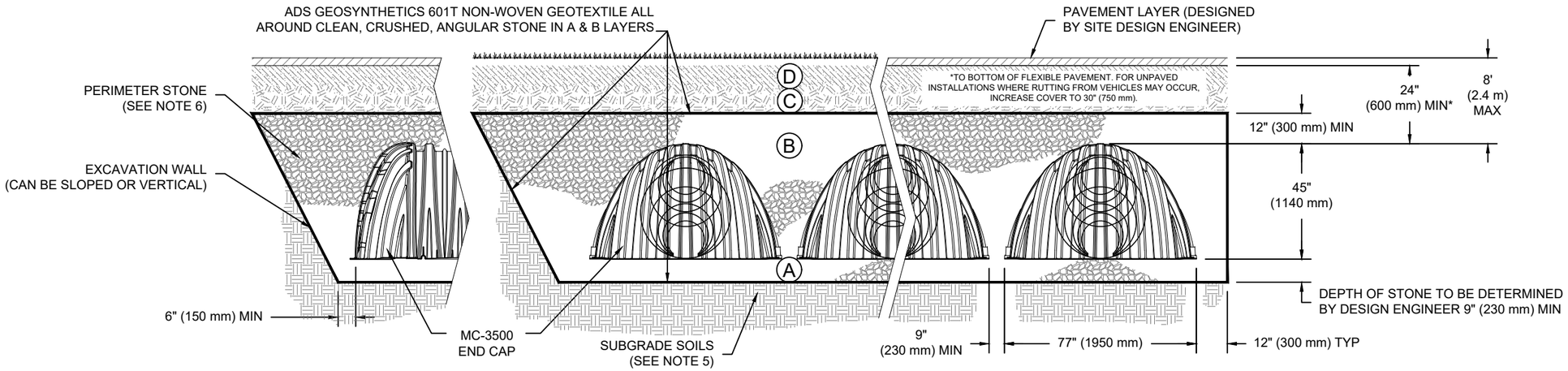
NOT TO SCALE

THIS DRAWING HAS BEEN PREPARED BASED ON INFORMATION PROVIDED TO ADS UNDER THE DIRECTION OF THE SITE DESIGN ENGINEER OR OTHER PROJECT REPRESENTATIVE. THE SITE DESIGN ENGINEER SHALL REVIEW THIS DRAWING PRIOR TO CONSTRUCTION. IT IS THE ULTIMATE RESPONSIBILITY OF THE SITE DESIGN ENGINEER TO ENSURE THAT THE PRODUCT(S) DEPICTED AND ALL ASSOCIATED DETAILS MEET ALL APPLICABLE LAWS, REGULATIONS, AND PROJECT REQUIREMENTS.

ACCEPTABLE FILL MATERIALS: STORMTECH MC-□500 CHAMBER SYSTEMS

MATERIAL LOCATION		DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1, A-2-4, A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE, NOMINAL SIZE DISTRIBUTION BETWEEN 3/4-2 INCH (20-50 mm)	AASHTO M43[1] 3, 4	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE, NOMINAL SIZE DISTRIBUTION BETWEEN 3/4-2 INCH (20-50 mm)	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE. [2] [3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.



NOTES:

1. MC-3500 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. MC-3500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
4. THE "SITE DESIGN ENGINEER" REFERS TO THE ENGINEER RESPONSIBLE FOR THE DESIGN AND LAYOUT OF THE STORMTECH CHAMBERS FOR THIS PROJECT.
5. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
6. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
7. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.

KASSAB -DMA A
RIVERSIDE DR, RIVERSIDE

DATE: 11/07/2018 | DRAWN: RF | PROJECT #: Tool | CHECKED: ---

REV	DRW	CHK	DESCRIPTION

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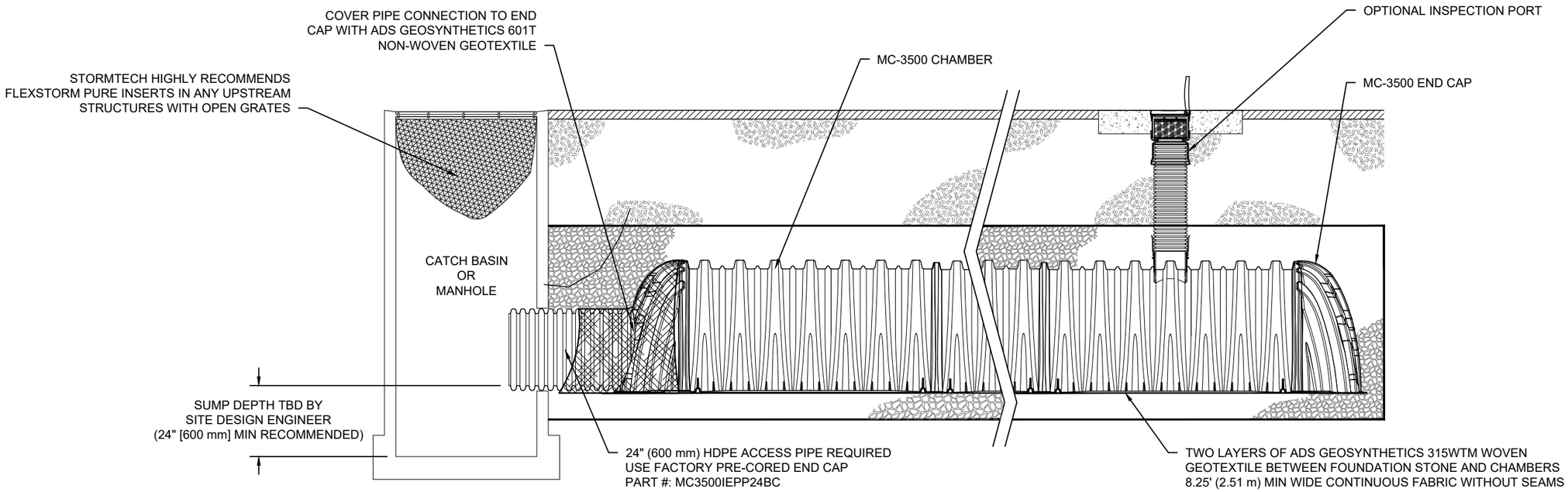


MC-□500 ISOLATOR ROW DETAIL
NTS

INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

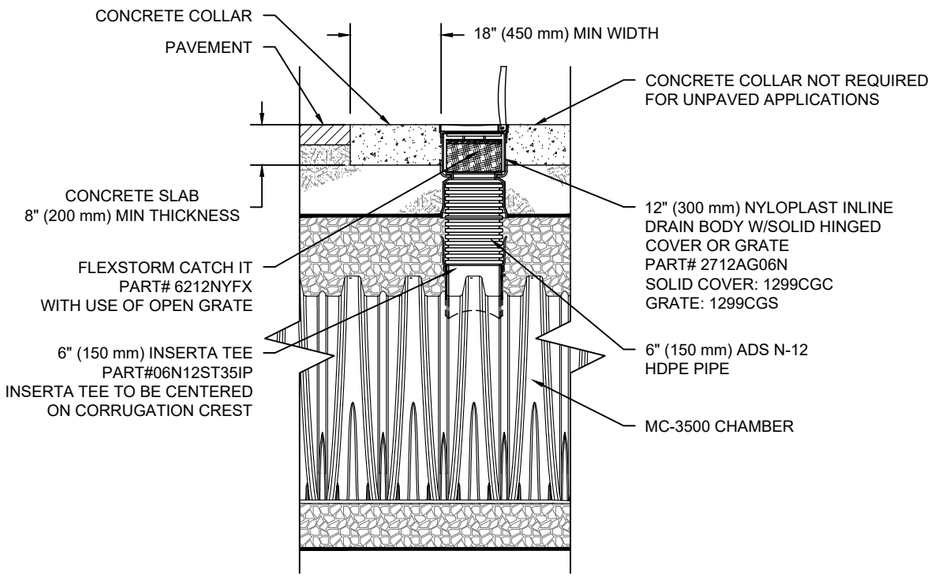
STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.

2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.



MC-□500 6" INSPECTION PORT DETAIL
NTS

KASSAB -DMA A
RIVERSIDE DR, RIVERSIDE

DATE: 11/07/2018 | DRAWN: RF | CHECKED: ---
PROJECT #: Tool

REV	DRW	CHK	DESCRIPTION

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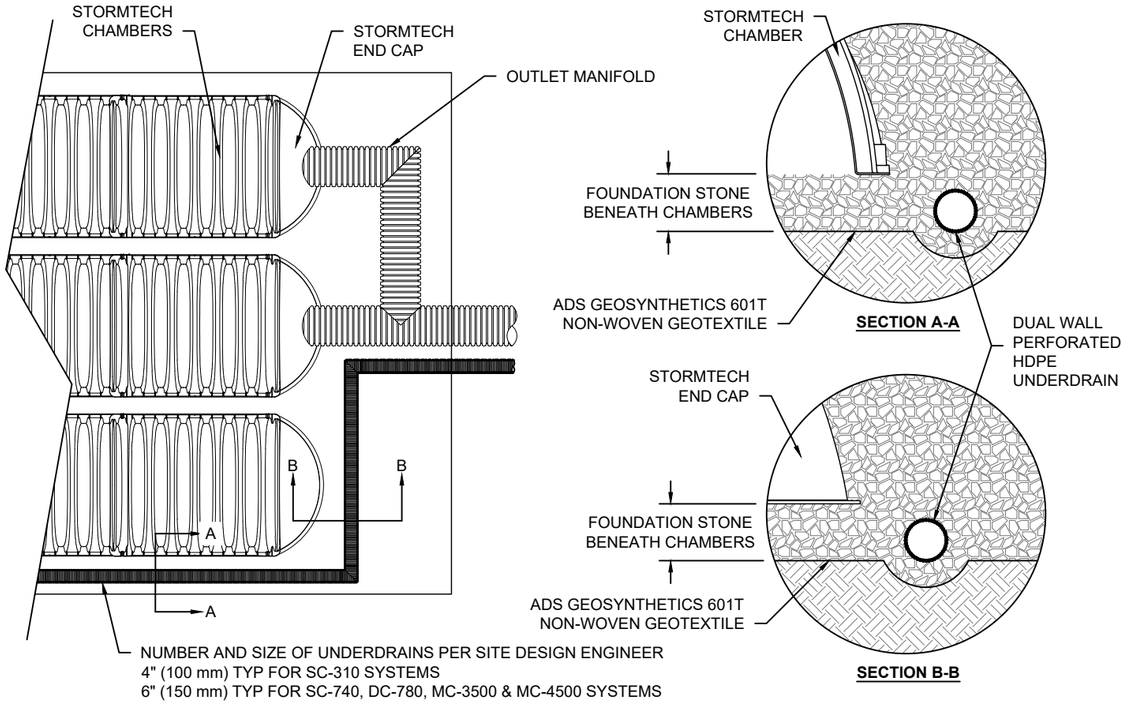
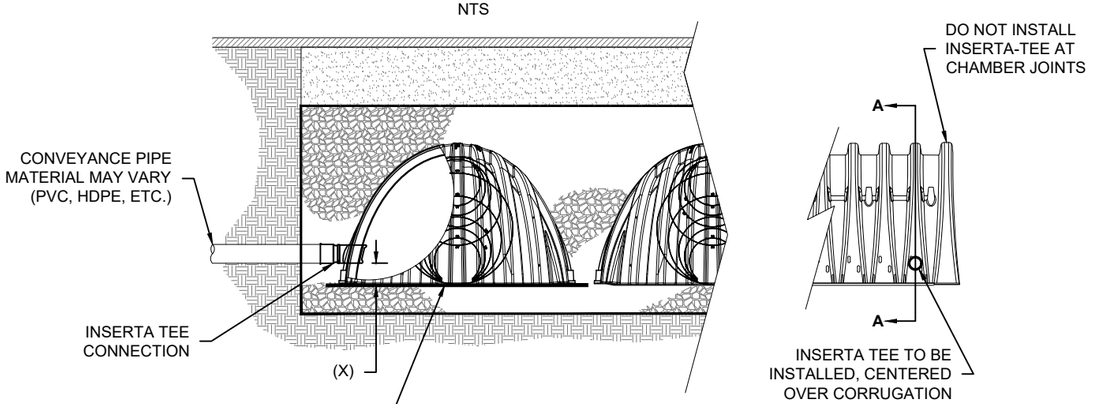
UNDERDRAIN DETAIL

NTS



INSERTA TEE DETAIL

NTS

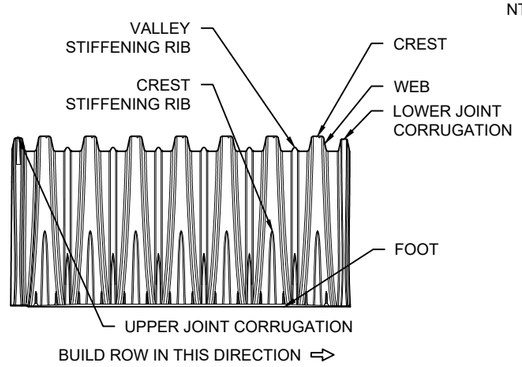


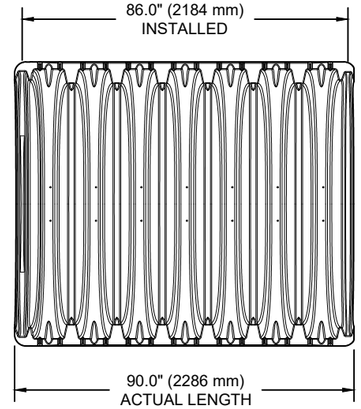
NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS.
CONTACT STORMTECH FOR MORE INFORMATION.

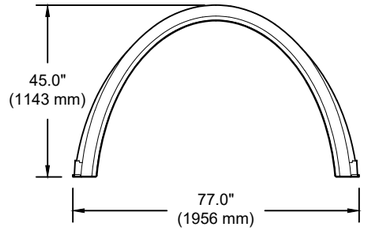
CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
SC-310	6" (150 mm)	4" (100 mm)
SC-740	10" (250 mm)	4" (100 mm)
DC-780	10" (250 mm)	4" (100 mm)
MC-3500	12" (300 mm)	6" (150 mm)
MC-4500	12" (300 mm)	8" (200 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 35, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON		

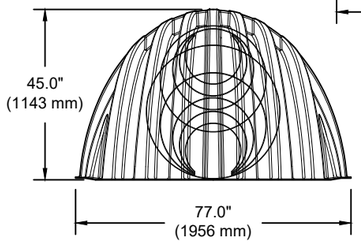
MC-□500 TECHNICAL SPECIFICATION

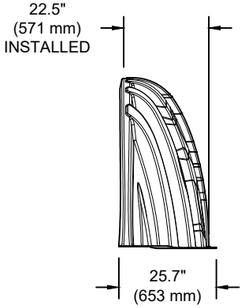
NTS











NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	77.0" X 45.0" X 86.0"	(1956 mm X 1143 mm X 2184 mm)
CHAMBER STORAGE	109.9 CUBIC FEET	(3.11 m³)
MINIMUM INSTALLED STORAGE*	178.9 CUBIC FEET	(5.06 m³)
WEIGHT	135.0 lbs.	(61.2 kg)

NOMINAL END CAP SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	77.0" X 45.0" X 22.5"	(1956 mm X 1143 mm X 571 mm)
END CAP STORAGE	14.9 CUBIC FEET	(0.42 m³)
MINIMUM INSTALLED STORAGE*	46.0 CUBIC FEET	(1.30 m³)
WEIGHT	50.0 lbs.	(22.7 kg)

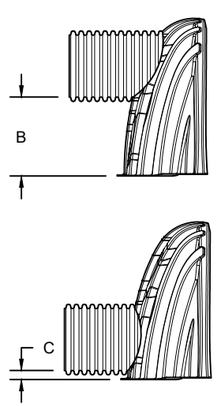
*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION AND BETWEEN CHAMBERS,
12" (305 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY

STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"

PART #	STUB	B	C
MC3500IEPP06T	6" (150 mm)	33.21" (844 mm)	---
MC3500IEPP06B		---	0.66" (17 mm)
MC3500IEPP08T	8" (200 mm)	31.16" (791 mm)	---
MC3500IEPP08B		---	0.81" (21 mm)
MC3500IEPP10T	10" (250 mm)	29.04" (738 mm)	---
MC3500IEPP10B		---	0.93" (24 mm)
MC3500IEPP12T	12" (300 mm)	26.36" (670 mm)	---
MC3500IEPP12B		---	1.35" (34 mm)
MC3500IEPP15T	15" (375 mm)	23.39" (594 mm)	---
MC3500IEPP15B		---	1.50" (38 mm)
MC3500IEPP18TC	18" (450 mm)	20.03" (509 mm)	---
MC3500IEPP18BC		---	1.77" (45 mm)
MC3500IEPP24TC	24" (600 mm)	14.48" (368 mm)	---
MC3500IEPP24BC		---	2.06" (52 mm)
MC3500IEPP30BC	30" (750 mm)	---	

NOTE: ALL DIMENSIONS ARE NOMINAL

CUSTOM PRECORED INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS.
CUSTOM INVERT LOCATIONS ON THE MC-3500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm)
THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHTEST POSSIBLE FOR THE PIPE SIZE.



KASSAB -DMA A
RIVERSIDE DR, RIVERSIDE

DATE: 11/07/2018 | DRAWN: RF | CHECKED: ---
PROJECT #: Tool

REV	DRW	CHK	DESCRIPTION

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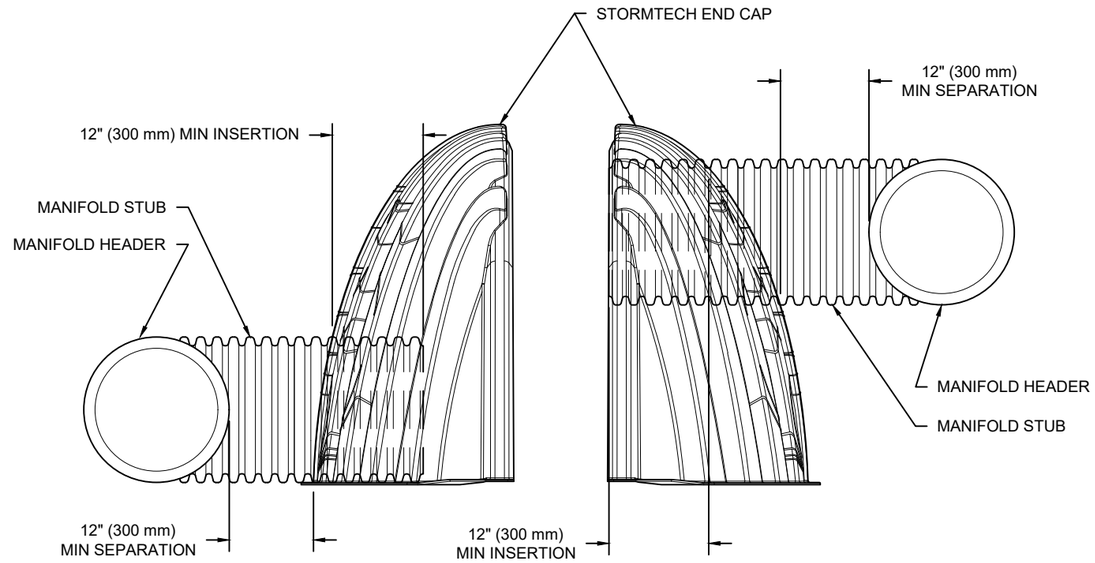
MC-SERIES END CAP INSERTION DETAIL

NTS



NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL
FOR A PROPER FIT IN END CAP OPENING.

KASSAB -DMA A
RIVERSIDE DR, RIVERSIDE

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User Inputs

Chamber Model	MC-3500
Outlet Control Structure	Yes (Outlet)
Project Name	KASSAB -DMA D TO H
Project Location	RIVERSIDE DR, RIVERSIDE
Project Date	11/07/2018
Engineer	RRF
Measurement Type	Imperial
Required Storage Volume	5600 cubic ft.
Stone Porosity	40%
Stone Above Chambers	12 in.
Stone Foundation Depth	9 in.
Average Cover Over Chambers	24 in.
Design Constraint	Length
Design Constraint Dimension	50 ft.

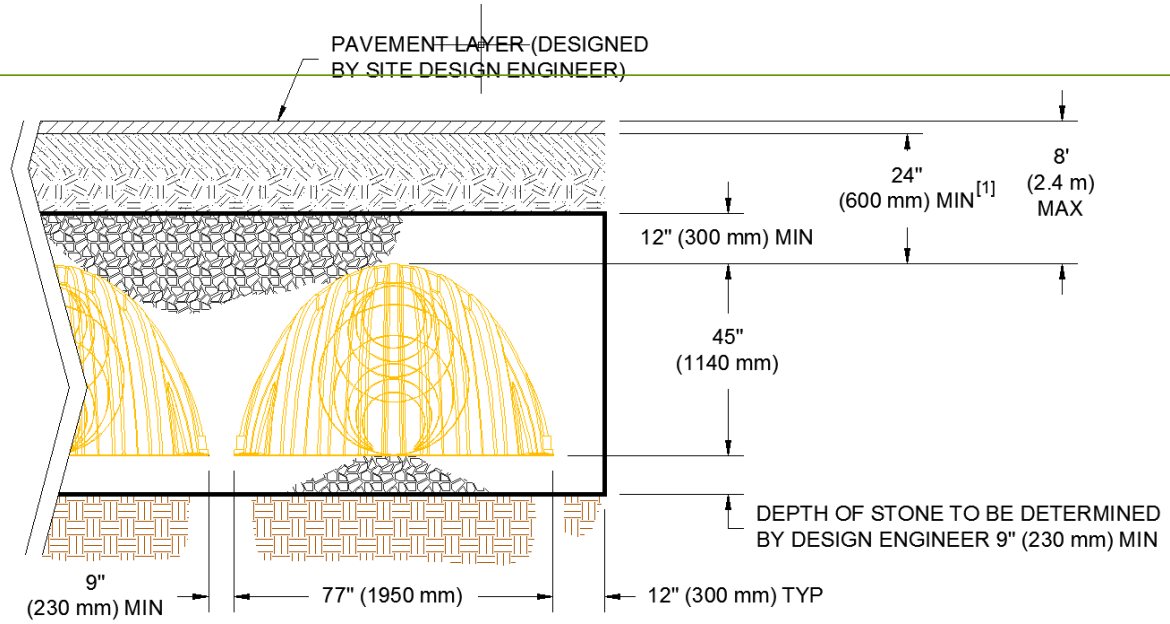
Results

System Volume and Bed Size

Installed Storage Volume	5853 cubic ft.
Storage Volume Per Chamber	178.9 cubic ft.
Storage Volume Per End Cap	46.9 cubic ft.
Number Of Chambers Required	26 each
Number Of End Caps Required	12 each
Rows/Chambers	5 row(s) of 5 chamber(s)
Leftover Rows/Chambers	1 row(s) of 1 chamber(s)
Maximum Length	45.14 ft.
Maximum Width	44.85 ft.
Approx. Bed Size Required	1832 square ft.

System Components

Amount Of Stone Required	261 cubic yards
Volume Of Excavation (Not Including Fill)	373 cubic yards
Non-woven Filter Fabric Required	511 square yards
Length Of Isolator Row	39.53 ft.
Woven Isolator Row Fabric	74 square yards



[1] - TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

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KASSAB -DMA DTO H

RIVERSIDE DR, RIVERSIDE

STORMTECH CHAMBER SPECIFICATIONS

1. CHAMBERS SHALL BE STORMTECH MC-4500 OR APPROVED EQUAL.
2. CHAMBERS SHALL BE MANUFACTURED FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE COPOLYMERS.
3. CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORT PANELS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
4. THE STRUCTURAL DESIGN OF THE CHAMBERS, THE STRUCTURAL BACKFILL, AND THE INSTALLATION REQUIREMENTS SHALL ENSURE THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET FOR: 1) LONG-DURATION DEAD LOADS AND 2) SHORT-DURATION LIVE LOADS, BASED ON THE AASHTO DESIGN TRUCK WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.
5. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
6. CHAMBERS SHALL BE DESIGNED AND ALLOWABLE LOADS DETERMINED IN ACCORDANCE WITH ASTM F2787, "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
7. ONLY CHAMBERS THAT ARE APPROVED BY THE SITE DESIGN ENGINEER WILL BE ALLOWED. THE CHAMBER MANUFACTURER SHALL SUBMIT THE FOLLOWING UPON REQUEST TO THE SITE DESIGN ENGINEER FOR APPROVAL BEFORE DELIVERING CHAMBERS TO THE PROJECT SITE:
   a. A STRUCTURAL EVALUATION SEALED BY A REGISTERED PROFESSIONAL ENGINEER THAT DEMONSTRATES THAT THE SAFETY FACTORS ARE GREATER THAN OR EQUAL TO 1.95 FOR DEAD LOAD AND 1.75 FOR LIVE LOAD, THE MINIMUM REQUIRED BY ASTM F2787 AND BY AASHTO FOR THERMOPLASTIC PIPE.
   b. A STRUCTURAL EVALUATION SEALED BY A REGISTERED PROFESSIONAL ENGINEER THAT DEMONSTRATES THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET. THE 50 YEAR CREEP MODULUS DATA SPECIFIED IN ASTM F2418 MUST BE USED AS PART OF THE AASHTO STRUCTURAL EVALUATION TO VERIFY LONG-TERM PERFORMANCE.
   c. STRUCTURAL CROSS SECTION DETAIL ON WHICH THE STRUCTURAL EVALUATION IS BASED.
8. CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

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IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF MC-4500 CHAMBER SYSTEM

1. STORMTECH MC-4500 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTITIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
2. STORMTECH MC-4500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR EXCAVATOR SITUATED OVER THE CHAMBERS.

   STORMTECH RECOMMENDS 3 BACKFILL METHODS:
   - STONESHOOTER LOCATED OFF THE CHAMBER BED.
   - BACKFILL AS ROWS ARE BUILT USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
   - BACKFILL FROM OUTSIDE THE EXCAVATION USING A LONG BOOM HOE OR EXCAVATOR.
4. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
5. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
6. MAINTAIN MINIMUM - 9" (230 mm) SPACING BETWEEN THE CHAMBER ROWS.
7. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM OF 12" (300 mm) INTO CHAMBER END CAPS.
8. EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE 3/4-2" (20-50 mm) MEETING THE AASHTO M43 DESIGNATION OF #3 OR #4.
9. STONE SHALL BE BROUGHT UP EVENLY AROUND CHAMBERS SO AS NOT TO DISTORT THE CHAMBER SHAPE. STONE DEPTHS SHOULD NEVER DIFFER BY MORE THAN 12" (300 mm) BETWEEN ADJACENT CHAMBER ROWS.
10. STONE MUST BE PLACED ON THE TOP CENTER OF THE CHAMBER TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING.
11. ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

NOTES FOR CONSTRUCTION EQUIPMENT

1. STORMTECH MC-4500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
2. THE USE OF EQUIPMENT OVER MC-4500 CHAMBERS IS LIMITED:
   - NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS.
   - NO RUBBER TIRED LOADER, DUMP TRUCK, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
   - WEIGHT LIMITS FOR CONSRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. FULL 36" (900 mm) OF STABILIZED COVER MATERIALS OVER THE CHAMBERS IS REQUIRED FOR DUMP TRUCK TRAVEL OR DUMPING.

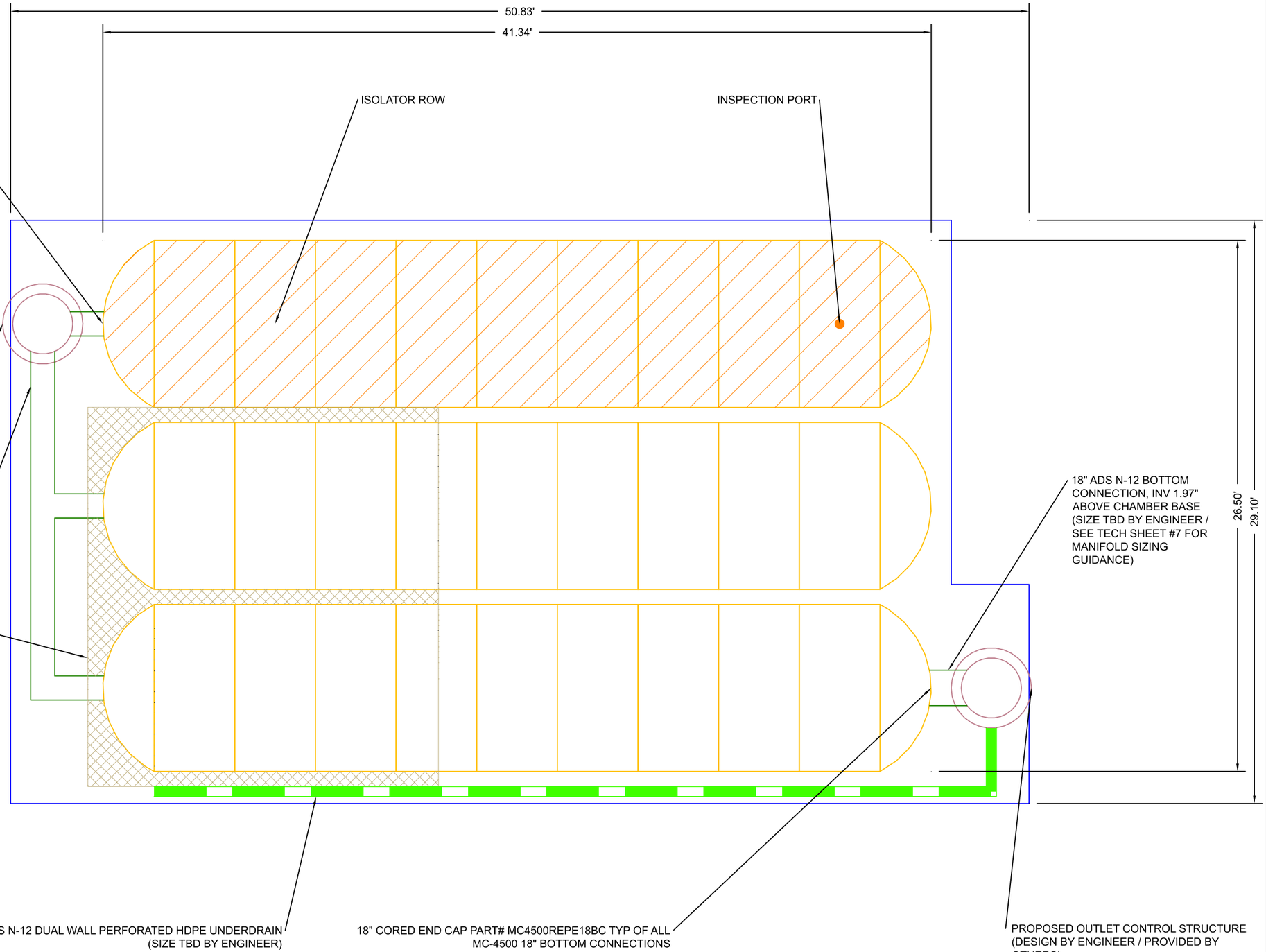
USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

CONCEPTUAL LAYOUT

(27) STORMTECH MC-4500 CHAMBERS
(6) STORMTECH MC-4500 END CAPS
INSTALLED WITH 12 " COVER STONE, 9 " BASE STONE, 40% STONE VOID
INSTALLED SYSTEM VOLUME: 5657 CF
AREA OF SYSTEM: 1409 **FT²**
PERIMETER OF SYSTEM: 160 **FT**

COMPUTER GENERATED CONCEPTUAL LAYOUT - NOT FOR CONSTRUCTION



KASSAB -DMA DTO H
RIVERSIDE DR, RIVERSIDE

DATE: 11/07/2018 | DRAWN: RF | CHECKED: ---
PROJECT #: Tool

REV	DRW	CHK	DESCRIPTION

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NOT TO SCALE

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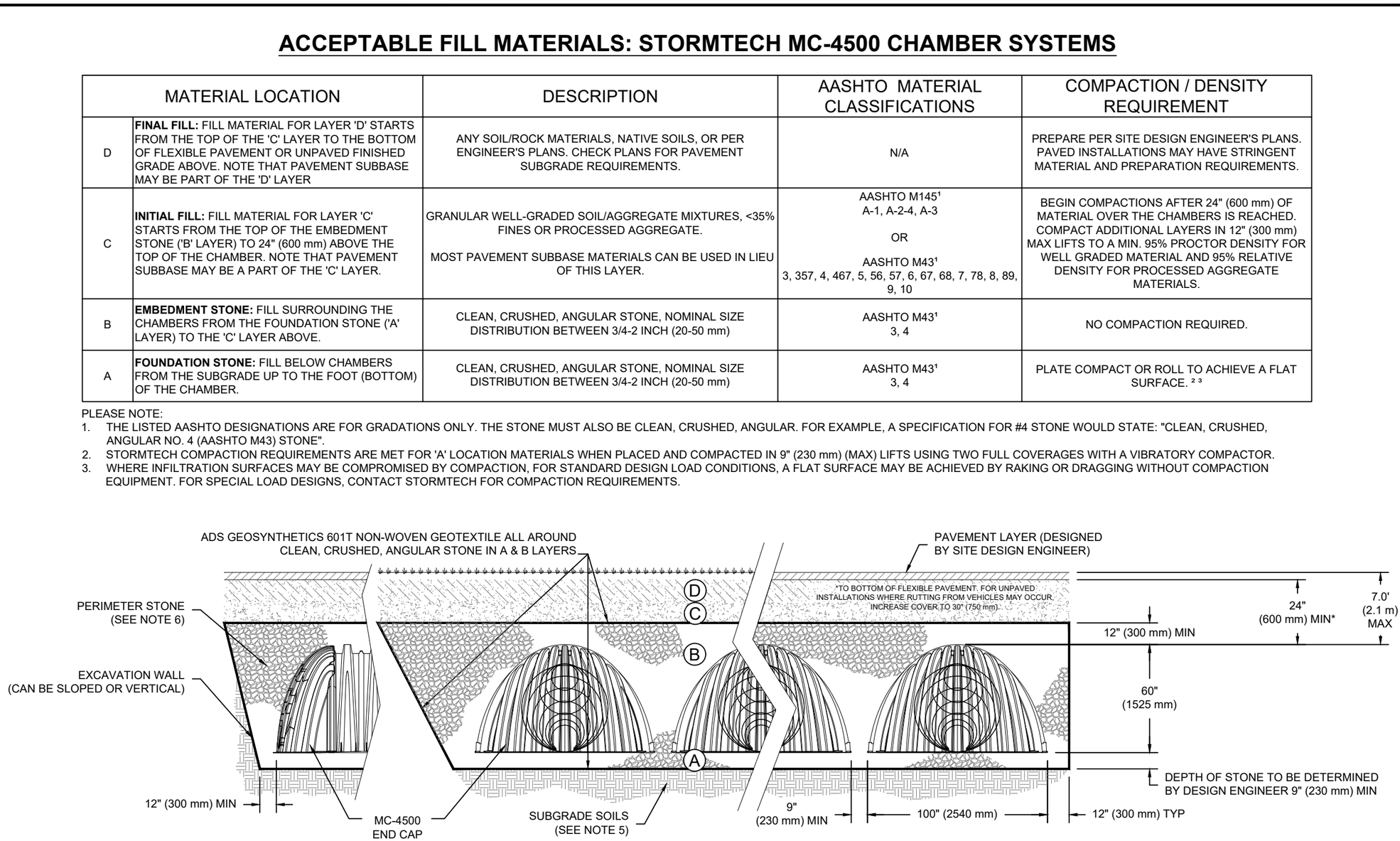
ACCEPTABLE FILL MATERIALS: STORMTECH MC-4500 CHAMBER SYSTEMS

MATERIAL LOCATION		DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1, A-2-4, A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE, NOMINAL SIZE DISTRIBUTION BETWEEN 3/4-2 INCH (20-50 mm)	AASHTO M43[1] 3, 4	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE, NOMINAL SIZE DISTRIBUTION BETWEEN 3/4-2 INCH (20-50 mm)	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE. [2] [3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.



NOTES:

1. MC-4500 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. MC-4500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
4. THE "SITE DESIGN ENGINEER" REFERS TO THE ENGINEER RESPONSIBLE FOR THE DESIGN AND LAYOUT OF THE STORMTECH CHAMBERS FOR THIS PROJECT.
5. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
6. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
7. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.

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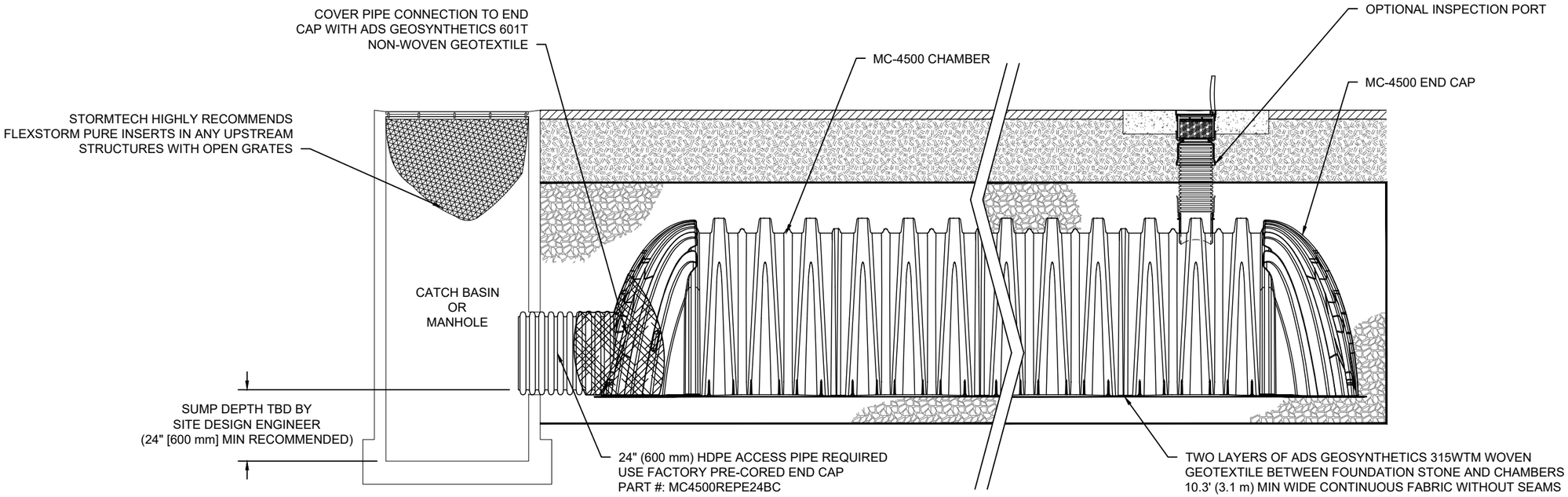


MC-4500 ISOLATOR ROW DETAIL
NTS

INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

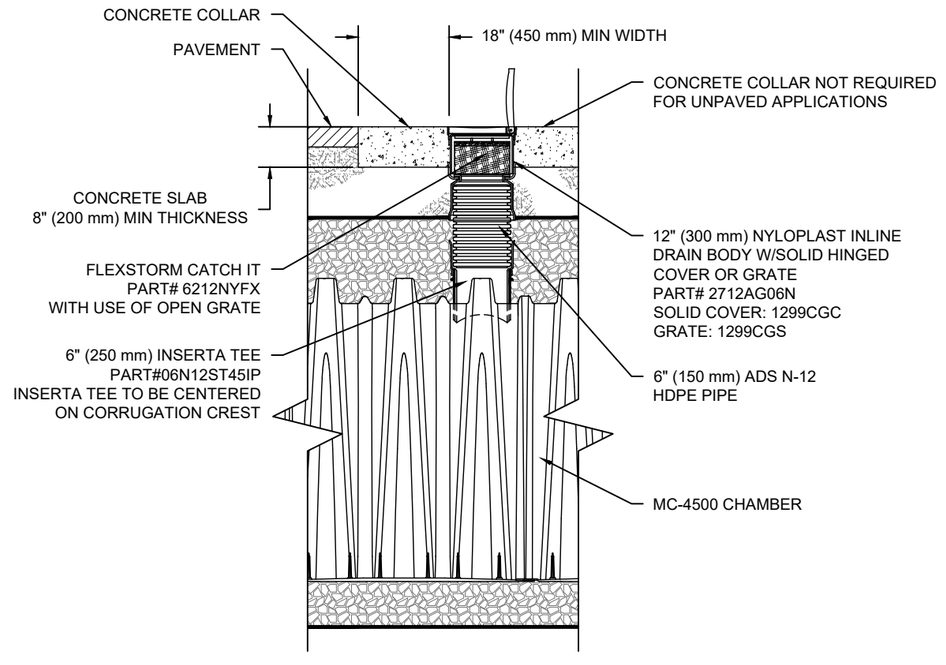
STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.

2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.



MC-4500 6" INSPECTION PORT DETAIL
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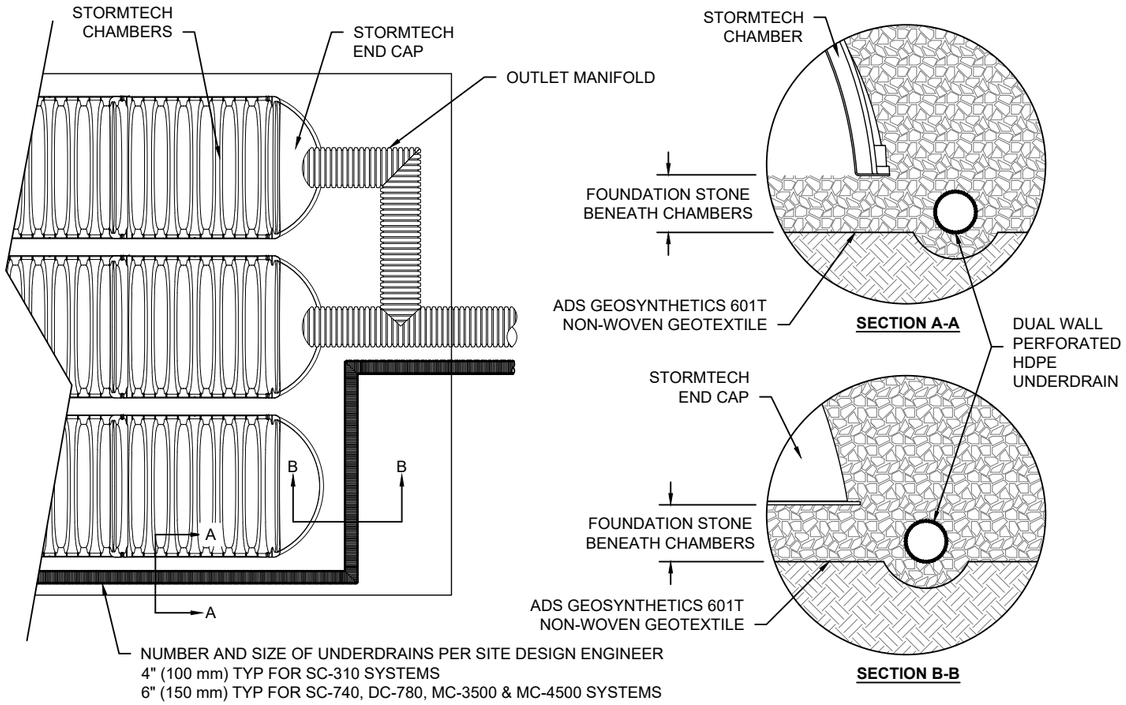
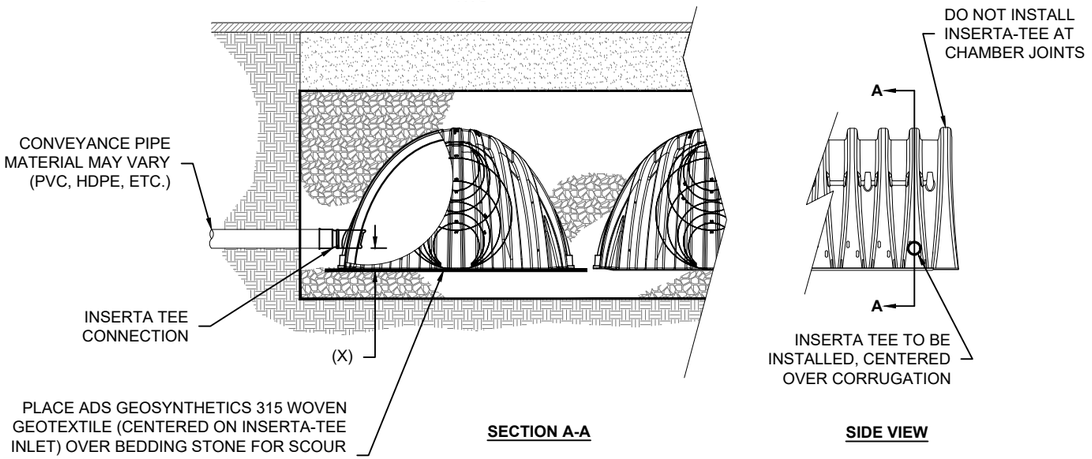
UNDERDRAIN DETAIL

NTS



INSERTA TEE DETAIL

NTS

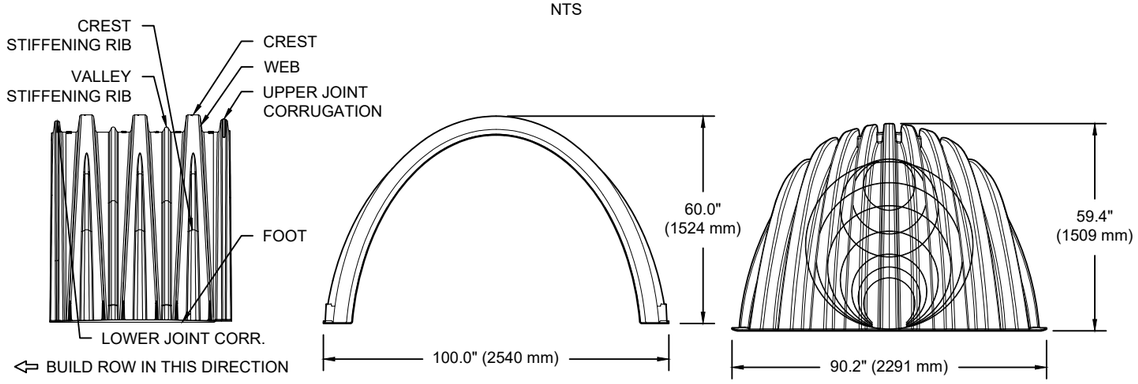


NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS.
CONTACT STORMTECH FOR MORE INFORMATION.

CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
SC-310	6" (150 mm)	4" (100 mm)
SC-740	10" (250 mm)	4" (100 mm)
DC-780	10" (250 mm)	4" (100 mm)
MC-3500	12" (300 mm)	6" (150 mm)
MC-4500	12" (300 mm)	8" (200 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 35, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON		

MC-4500 TECHNICAL SPECIFICATION

NTS



NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	100.0" X 60.0" X 48.3"	(2540 mm X 1524 mm X 1227 mm)
CHAMBER STORAGE	106.5 CUBIC FEET	(3.01 m³)
MINIMUM INSTALLED STORAGE*	162.6 CUBIC FEET	(4.60 m³)
WEIGHT	130.0 lbs.	(59.0 kg)

NOMINAL END CAP SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	90.2" X 59.4" X 30.7"	(2291 mm X 1509 mm X 781 mm)
END CAP STORAGE	35.7 CUBIC FEET	(1.01 m³)
MINIMUM INSTALLED STORAGE*	108.7 CUBIC FEET	(3.08 m³)
WEIGHT	135.0 lbs.	(61.2 kg)

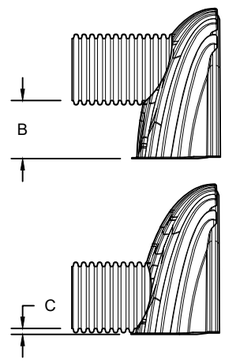
*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION AND BETWEEN CHAMBERS, 12" (305 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY.

STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"

PART #	STUB	B	C
MC4500REPE06T	6" (150 mm)	42.54" (1.081 m)	---
MC4500REPE06B		---	0.86" (22 mm)
MC4500REPE08T	8" (200 mm)	40.50" (1.029 m)	---
MC4500REPE08B		---	1.01" (26 mm)
MC4500REPE10T	10" (250 mm)	38.37" (975 mm)	---
MC4500REPE10B		---	1.33" (34 mm)
MC4500REPE12T	12" (300 mm)	35.69" (907 mm)	---
MC4500REPE12B		---	1.55" (39 mm)
MC4500REPE15T	15" (375 mm)	32.72" (831 mm)	---
MC4500REPE15B		---	1.70" (43 mm)
MC4500REPE18TC	18" (450 mm)	29.36" (746 mm)	---
MC4500REPE18BC		---	1.97" (50 mm)
MC4500REPE24TC	24" (600 mm)	23.05" (585 mm)	---
MC4500REPE24BC		---	2.26" (57 mm)
MC4500REPE30BC	30" (750 mm)	---	2.95" (75 mm)
MC4500REPE36BC	36" (900 mm)	---	3.25" (83 mm)
MC4500REPE42BC	42" (1050 mm)	---	3.55" (90 mm)

NOTE: ALL DIMENSIONS ARE NOMINAL

CUSTOM PRECORED INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS.
CUSTOM INVERT LOCATIONS ON THE MC-4500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm)
THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHTEST POSSIBLE FOR THE PIPE SIZE.



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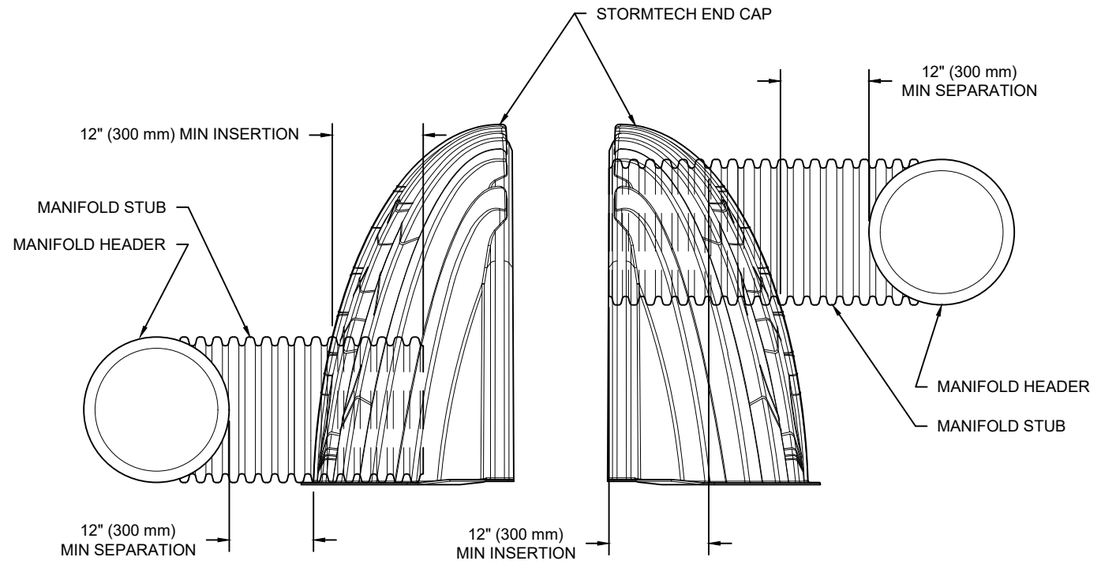
MC-SERIES END CAP INSERTION DETAIL

NTS



NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL
FOR A PROPER FIT IN END CAP OPENING.

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Appendix 8 Source Control

Pollutant Sources/Source Control Checklist

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

How to use this worksheet (also see instructions in Section G of the WQMP Template):

1. Review Column 1 and identify which of these potential sources of stormwater pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your WQMP Exhibit.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in your WQMP. Use the format shown in Table G.1on page 23 of this WQMP Template. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternative BMPs for those shown here.

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	**... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE**		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include 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

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on WQMP Drawings**	3 **Permanent Controls—List in WQMP Table and Narrative**	4 **Operational BMPs—Include 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/Error! Hyperlink reference not valid. ☐ Provide IPM information to new owners, lessees and operators.

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on WQMP Drawings**	3 **Permanent Controls—List in WQMP Table and Narrative**	4 **Operational BMPs—Include 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

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on WQMP Drawings**	3 **Permanent Controls—List in WQMP Table and Narrative**	4 **Operational BMPs—Include 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

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on WQMP Drawings**	3 **Permanent Controls—List in WQMP Table and Narrative**	4 **Operational BMPs—Include 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

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on WQMP Drawings**	3 **Permanent Controls—List in WQMP Table and Narrative**	4 **Operational BMPs—Include 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.**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on WQMP Drawings**	3 **Permanent Controls—List in WQMP Table and Narrative**	4 **Operational BMPs—Include 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/

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☐ 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.

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☐ 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

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☑ **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 containment. ☐ Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water. ☑ Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff. Include controls for other sources as specified by local reviewer.	

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☑ 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

APPPENDIX 10 Educational Materials

BMP Fact Sheets, Maintenance Guidelines and Other End-User BMP Information

Vegetated Swale TC-30

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

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

Targeted Constituents

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

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

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

Advantages

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

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

Limitations

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

Design and Sizing Guidelines

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

Construction/Inspection Considerations

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

Performance

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

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

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

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

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

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

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

Siting Criteria

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

Selection Criteria (NCTCOG, 1993)

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

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

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

Additional Design Guidelines

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

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

Summary of Design Recommendations

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

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

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

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

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

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

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

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

Maintenance

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

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

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

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.

- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.

- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.

- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.

- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

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

Table 2 Swale Cost Estimate (SEWRPC, 1991)

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

Source: (SEWRPC, 1991)

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

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

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

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

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

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

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Table 3 Estimated Maintenance Costs (SEWRPC, 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	$0.85 / 1,000 ft^2/ mowing	$0.14 / linear foot	$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	$9.00 / 1,000 ft^2/ year	$0.18 / linear foot	$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	$0.10 / linear foot / year	$0.10 / linear foot	$0.10 / linear foot	–
Grass Reseeding with Mulch and Fertilizer	$0.30 / yd^2	$0.01 / linear foot	$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	$0.15 / linear foot / year, plus $25 / inspection	$0.15 / linear foot	$0.15 / linear foot	Inspect four times per year
Total	--	**$0.58 / linear foot**	**$ 0.75 / linear foot**	--

Maintenance Cost

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

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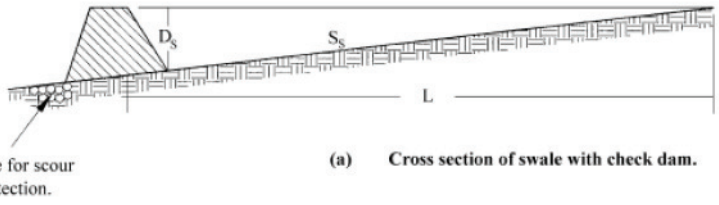
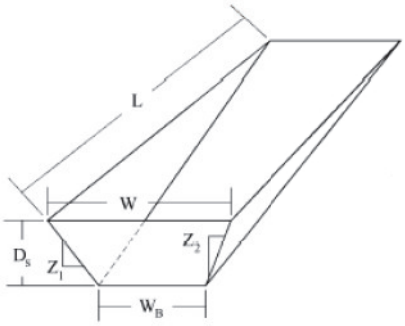


(a) Cross section of swale with check dam.



(b) Dimensional view of swale impoundment area.

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

Bioretention TC-32

Design Considerations

- Soil for Infiltration
- Tributary Area
- Slope
- Aesthetics
- Environmental Side-effects

Description

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

Targeted Constituents

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

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

None documented. Bioretention has been used as a stormwater BMP since 1992. In addition to Prince George's County, MD and Alexandria, VA, bioretention has been used successfully at urban and suburban areas in Montgomery County, MD; Baltimore County, MD; Chesterfield County, VA; Prince William County, VA; Smith Mountain Lake State Park, VA; and Cary, NC.

Advantages

- Bioretention provides stormwater treatment that enhances the quality of downstream water bodies by temporarily storing runoff in the BMP and releasing it over a period of four days to the receiving water (EPA, 1999).
- The vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

Limitations

- The bioretention BMP is not recommended for areas with slopes greater than 20% or where mature tree removal would

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be required since clogging may result, particularly if the BMP receives runoff with high sediment loads (EPA, 1999).

- Bioretention is not a suitable BMP at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
- By design, bioretention BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water.
- In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

Design and Sizing Guidelines

- The bioretention area should be sized to capture the design storm runoff.
- In areas where the native soil permeability is less than 0.5 in/hr an underdrain should be provided.
- Recommended minimum dimensions are 15 feet by 40 feet, although the preferred width is 25 feet. Excavated depth should be 4 feet.
- Area should drain completely within 72 hours.
- Approximately 1 tree or shrub per 50 ft^2 of bioretention area should be included.
- Cover area with about 3 inches of mulch.

Construction/Inspection Considerations

Bioretention area should not be established until contributing watershed is stabilized.

Performance

Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization (EPA, 1999). Adsorption is the process whereby particulate pollutants attach to soil (e.g., clay) or vegetation surfaces. Adequate contact time between the surface and pollutant must be provided for in the design of the system for this removal process to occur. Thus, the infiltration rate of the soils must not exceed those specified in the design criteria or pollutant removal may decrease. Pollutants removed by adsorption include metals, phosphorus, and hydrocarbons. Filtration occurs as runoff passes through the bioretention area media, such as the sand bed, ground cover, and planting soil.

Common particulates removed from stormwater include particulate organic matter, phosphorus, and suspended solids. Biological processes that occur in wetlands result in pollutant uptake by plants and microorganisms in the soil. Plant growth is sustained by the uptake of nutrients from the soils, with woody plants locking up these nutrients through the seasons. Microbial activity within the soil also contributes to the removal of nitrogen and organic matter. Nitrogen is removed by nitrifying and denitrifying bacteria, while aerobic bacteria are responsible for the decomposition of the organic matter. Microbial processes require oxygen and can result in depleted oxygen levels if the bioretention area is not adequately

aerated. Sedimentation occurs in the swale or ponding area as the velocity slows and solids fall out of suspension.

The removal effectiveness of bioretention has been studied during field and laboratory studies conducted by the University of Maryland (Davis et al, 1998). During these experiments, synthetic stormwater runoff was pumped through several laboratory and field bioretention areas to simulate typical storm events in Prince George's County, MD. Removal rates for heavy metals and nutrients are shown in Table 1.

Table 1 Laboratory and Estimated Bioretention Davis et al. (1998); PGDER (1993)

Pollutant	Removal Rate
Total Phosphorus	70-83%
Metals (Cu, Zn, Pb)	93-98%
TKN	68-80%
Total Suspended Solids	90%
Organics	90%
Bacteria	90%

Results for both the laboratory and field experiments were similar for each of the pollutants analyzed. Doubling or halving the influent pollutant levels had little effect on the effluent pollutants concentrations (Davis et al, 1998).

The microbial activity and plant uptake occurring in the bioretention area will likely result in higher removal rates than those determined for infiltration BMPs.

Siting Criteria

Bioretention BMPs are generally used to treat stormwater from impervious surfaces at commercial, residential, and industrial areas (EPA, 1999). Implementation of bioretention for stormwater management is ideal for median strips, parking lot islands, and swales. Moreover, the runoff in these areas can be designed to either divert directly into the bioretention area or convey into the bioretention area by a curb and gutter collection system.

The best location for bioretention areas is upland from inlets that receive sheet flow from graded areas and at areas that will be excavated (EPA, 1999). In order to maximize treatment effectiveness, the site must be graded in such a way that minimizes erosive conditions as sheet flow is conveyed to the treatment area. Locations where a bioretention area can be readily incorporated into the site plan without further environmental damage are preferred. Furthermore, to effectively minimize sediment loading in the treatment area, bioretention only should be used in stabilized drainage areas.

Additional Design Guidelines

The layout of the bioretention area is determined after site constraints such as location of utilities, underlying soils, existing vegetation, and drainage are considered (EPA, 1999). Sites with loamy sand soils are especially appropriate for bioretention because the excavated soil can be backfilled and used as the planting soil, thus eliminating the cost of importing planting soil.

The use of bioretention may not be feasible given an unstable surrounding soil stratum, soils with clay content greater than 25 percent, a site with slopes greater than 20 percent, and/or a site with mature trees that would be removed during construction of the BMP.

Bioretention can be designed to be off-line or on-line of the existing drainage system (EPA, 1999). The drainage area for a bioretention area should be between 0.1 and 0.4 hectares (0.25 and 1.0 acres). Larger drainage areas may require multiple bioretention areas. Furthermore, the maximum drainage area for a bioretention area is determined by the expected rainfall intensity and runoff rate. Stabilized areas may erode when velocities are greater than 5 feet per second (1.5 meter per second). The designer should determine the potential for erosive conditions at the site.

The size of the bioretention area, which is a function of the drainage area and the runoff generated from the area is sized to capture the water quality volume.

The recommended minimum dimensions of the bioretention area are 15 feet (4.6 meters) wide by 40 feet (12.2 meters) long, where the minimum width allows enough space for a dense, randomly-distributed area of trees and shrubs to become established. Thus replicating a natural forest and creating a microclimate, thereby enabling the bioretention area to tolerate the effects of heat stress, acid rain, runoff pollutants, and insect and disease infestations which landscaped areas in urban settings typically are unable to tolerate. The preferred width is 25 feet (7.6 meters), with a length of twice the width. Essentially, any facilities wider than 20 feet (6.1 meters) should be twice as long as they are wide, which promotes the distribution of flow and decreases the chances of concentrated flow.

In order to provide adequate storage and prevent water from standing for excessive periods of time the ponding depth of the bioretention area should not exceed 6 inches (15 centimeters). Water should not be left to stand for more than 72 hours. A restriction on the type of plants that can be used may be necessary due to some plants' water intolerance. Furthermore, if water is left standing for longer than 72 hours mosquitoes and other insects may start to breed.

The appropriate planting soil should be backfilled into the excavated bioretention area. Planting soils should be sandy loam, loamy sand, or loam texture with a clay content ranging from 10 to 25 percent.

Generally the soil should have infiltration rates greater than 0.5 inches (1.25 centimeters) per hour, which is typical of sandy loams, loamy sands, or loams. The pH of the soil should range between 5.5 and 6.5, where pollutants such as organic nitrogen and phosphorus can be adsorbed by the soil and microbial activity can flourish. Additional requirements for the planting soil include a 1.5 to 3 percent organic content and a maximum 500 ppm concentration of soluble salts.

Soil tests should be performed for every 500 cubic yards (382 cubic meters) of planting soil, with the exception of pH and organic content tests, which are required only once per bioretention area (EPA, 1999). Planting soil should be 4 inches (10.1 centimeters) deeper than the bottom of the largest root ball and 4 feet (1.2 meters) altogether. This depth will provide adequate soil for the plants' root systems to become established, prevent plant damage due to severe wind, and provide adequate moisture capacity. Most sites will require excavation in order to obtain the recommended depth.

Planting soil depths of greater than 4 feet (1.2 meters) may require additional construction practices such as shoring measures (EPA, 1999). Planting soil should be placed in 18 inches or greater lifts and lightly compacted until the desired depth is reached. Since high canopy trees may be destroyed during maintenance the bioretention area should be vegetated to resemble a terrestrial forest community ecosystem that is dominated by understory trees. Three species each of both trees and shrubs are recommended to be planted at a rate of 2500 trees and shrubs per hectare (1000 per acre). For instance, a 15 foot (4.6 meter) by 40 foot (12.2 meter) bioretention area (600 square feet or 55.75 square meters) would require 14 trees and shrubs. The shrub-to-tree ratio should be 2:1 to 3:1.

Trees and shrubs should be planted when conditions are favorable. Vegetation should be watered at the end of each day for fourteen days following its planting. Plant species tolerant of pollutant loads and varying wet and dry conditions should be used in the bioretention area.

The designer should assess aesthetics, site layout, and maintenance requirements when selecting plant species. Adjacent non-native invasive species should be identified and the designer should take measures, such as providing a soil breach to eliminate the threat of these species invading the bioretention area. Regional landscaping manuals should be consulted to ensure that the planting of the bioretention area meets the landscaping requirements established by the local authorities. The designers should evaluate the best placement of vegetation within the bioretention area. Plants should be placed at irregular intervals to replicate a natural forest. Trees should be placed on the perimeter of the area to provide shade and shelter from the wind. Trees and shrubs can be sheltered from damaging flows if they are placed away from the path of the incoming runoff. In cold climates, species that are more tolerant to cold winds, such as evergreens, should be placed in windier areas of the site.

Following placement of the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses or legumes can be planted at the beginning of the growing season. Mulch should be placed immediately after trees and shrubs are planted. Two to 3 inches (5 to 7.6 cm) of commercially-available fine shredded hardwood mulch or shredded hardwood chips should be applied to the bioretention area to protect from erosion.

Maintenance

The primary maintenance requirement for bioretention areas is that of inspection and repair or replacement of the treatment area's components. Generally, this involves nothing more than the routine periodic maintenance that is required of any landscaped area. Plants that are appropriate for the site, climatic, and watering conditions should be selected for use in the bioretention cell. Appropriately selected plants will aide in reducing fertilizer, pesticide, water, and overall maintenance requirements. Bioretention system components should blend over time through plant and root growth, organic decomposition, and the development of a natural

soil horizon. These biologic and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Routine maintenance should include a biannual health evaluation of the trees and shrubs and subsequent removal of any dead or diseased vegetation (EPA, 1999). Diseased vegetation should be treated as needed using preventative and low-toxic measures to the extent possible. BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water. Routine inspections for areas of standing water within the BMP and corrective measures to restore proper infiltration rates are necessary to prevent creating mosquito and other vector habitat. In addition, bioretention BMPs are susceptible to invasion by aggressive plant species such as cattails, which increase the chances of water standing and subsequent vector production if not routinely maintained.

In order to maintain the treatment area's appearance it may be necessary to prune and weed. Furthermore, mulch replacement is suggested when erosion is evident or when the site begins to look unattractive. Specifically, the entire area may require mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas. Mulch replacement should be done prior to the start of the wet season.

New Jersey's Department of Environmental Protection states in their bioretention systems standards that accumulated sediment and debris removal (especially at the inflow point) will normally be the primary maintenance function. Other potential tasks include replacement of dead vegetation, soil pH regulation, erosion repair at inflow points, mulch replenishment, unclogging the underdrain, and repairing overflow structures. There is also the possibility that the cation exchange capacity of the soils in the cell will be significantly reduced over time. Depending on pollutant loads, soils may need to be replaced within 5-10 years of construction (LID, 2000).

Cost

Construction Cost

Construction cost estimates for a bioretention area are slightly greater than those for the required landscaping for a new development (EPA, 1999). A general rule of thumb (Coffman, 1999) is that residential bioretention areas average about $3 to $4 per square foot, depending on soil conditions and the density and types of plants used. Commercial, industrial and institutional site costs can range between $10 to $40 per square foot, based on the need for control structures, curbing, storm drains and underdrains.

Retrofitting a site typically costs more, averaging $6,500 per bioretention area. The higher costs are attributed to the demolition of existing concrete, asphalt, and existing structures and the replacement of fill material with planting soil. The costs of retrofitting a commercial site in Maryland, Kettering Development, with 15 bioretention areas were estimated at $111,600.

In any bioretention area design, the cost of plants varies substantially and can account for a significant portion of the expenditures. While these cost estimates are slightly greater than those of typical landscaping treatment (due to the increased number of plantings, additional soil excavation, backfill material, use of underdrains etc.), those landscaping expenses that would be required regardless of the bioretention installation should be subtracted when determining the net cost.

Perhaps of most importance, however, the cost savings compared to the use of traditional structural stormwater conveyance systems makes bioretention areas quite attractive financially. For example, the use of bioretention can decrease the cost required for constructing stormwater conveyance systems at a site. A medical office building in Maryland was able to reduce the amount of storm drain pipe that was needed from 800 to 230 feet - a cost savings of $24,000 (PGDER, 1993). And a new residential development spent a total of approximately $100,000 using bioretention cells on each lot instead of nearly $400,000 for the traditional stormwater ponds that were originally planned (Rappahanock,). Also, in residential areas, stormwater management controls become a part of each property owner's landscape, reducing the public burden to maintain large centralized facilities.

Maintenance Cost

The operation and maintenance costs for a bioretention facility will be comparable to those of typical landscaping required for a site. Costs beyond the normal landscaping fees will include the cost for testing the soils and may include costs for a sand bed and planting soil.

References and Sources of Additional Information

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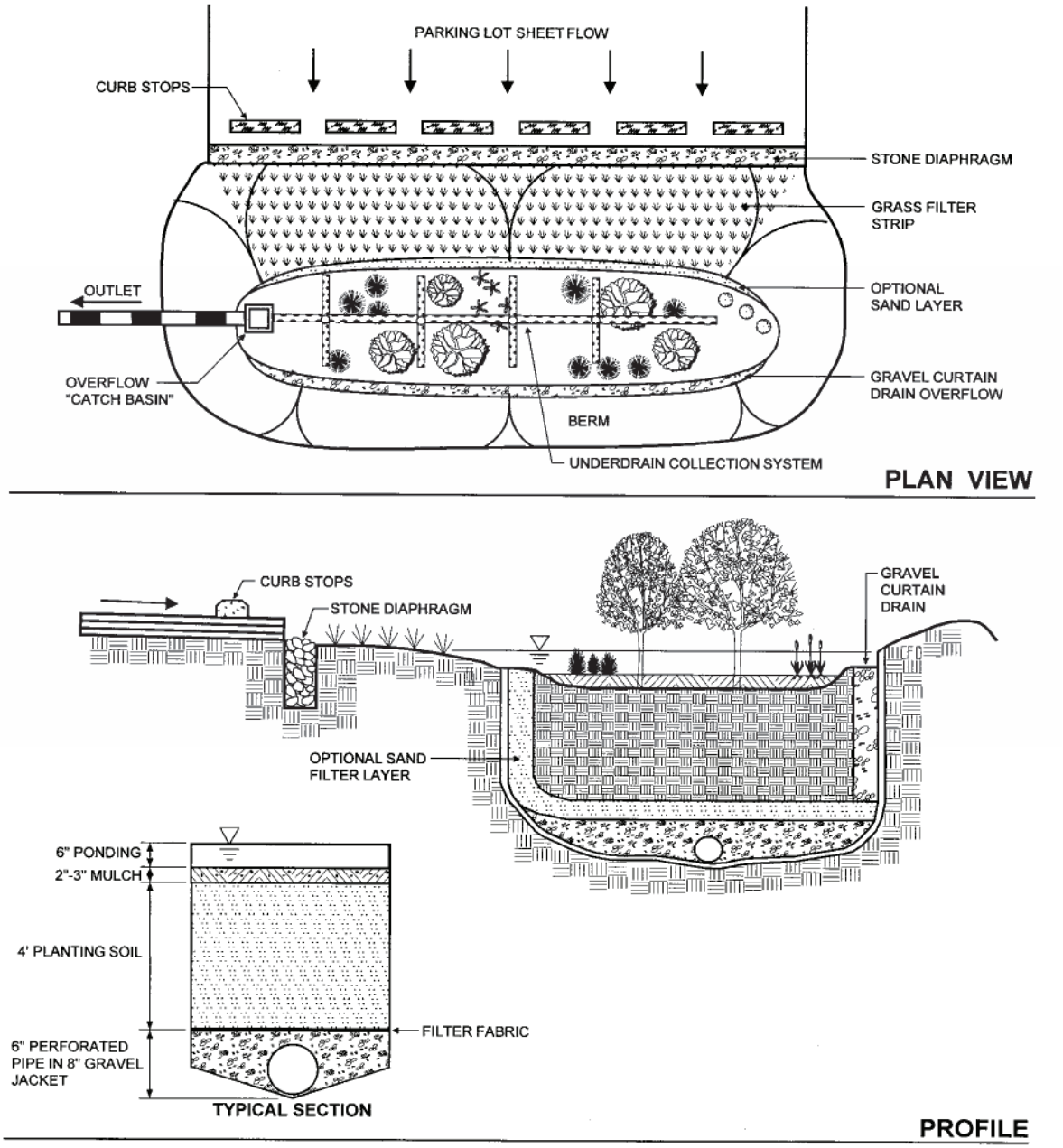

Schematic of a Bioretention Facility (MDE, 2000)

3.3 Permeable Pavement

Type of BMP	LID - Infiltration
Treatment Mechanisms	Infiltration, Evaporation
Maximum Drainage Area	10 acres
Other Names	porous pavement, pervious concrete, pervious asphalt, pervious gravel pavement, cobblestone block, modular block, modular pavement

Description

Permeable pavements can be either pervious asphalt and concrete surfaces, or permeable modular block. Unlike traditional pavements that are impermeable, permeable pavements reduce the volume and peak of stormwater runoff as well as mitigate pollutants from stormwater runoff, provided that the underlying soils can accept infiltration. Permeable pavement surfaces work best when they are designed to be flat or with gentle slopes. This factsheet discusses criteria that apply to infiltration designs.

The permeable surface is placed on top of a reservoir layer that holds the water quality stormwater volume, $V_{BMP.}$ The water infiltrates from the reservoir layer into the native subsoil. Tests must be performed according to the Infiltration Testing Section in Appendix A to be able to use this design procedure.

In some circumstances, permeable pavement may be implemented on a project as a source control feature. Where implemented as a source control feature (sometimes referred to as a 'self-retaining' area), the pavement is not considered a 'BMP' that would be required to be designed and sized per this manual. Where permeable pavement receives runoff from adjacent tributary areas, the permeable pavement *may* be considered a BMP that must be sized according to this manual. Consult the Engineering Authority and the WQMP for any applicable requirements for designing and sizing permeable pavement installations.

Siting Considerations

The WQMP applicable to the project location should be consulted, as it may include criteria for determining the applicability of this and other Infiltration-based BMPs to the project.

Permeable pavements can be used in the same manner as concrete or asphalt in low traffic parking lots, playgrounds, walkways, bike trails, and sports courts. Most types of permeable pavement can be designed to meet Americans with Disabilities Act (ADA) requirements. Permeable pavements **should not** be used in the following conditions:

- Downstream of erodible areas
- Downstream of areas with a high likelihood of pollutant spills
- Industrial or high vehicular traffic areas (25,000 or greater average daily traffic)
- Areas where geotechnical concerns, such as soils with low infiltration rates, would preclude the use of this BMP.

Sites with Impermeable Fire Lanes

Oftentimes, Fire Departments do not allow alternative pavement types including permeable pavement. They require traditional impermeable surfaces for fire lanes. In this situation, it is acceptable to use an impermeable surface for the fire lane drive aisles and permeable pavement for the remainder of the parking lot.

Where impermeable fire lanes are used in the design, the impermeable surface must slope towards the permeable pavement, and the base layers shall remain continuous underneath the two pavement types, as shown in Figure 1. This continuous reservoir layer helps to maintain infiltration throughout the pervious pavement site, and can still be considered as part of the total required storage area.

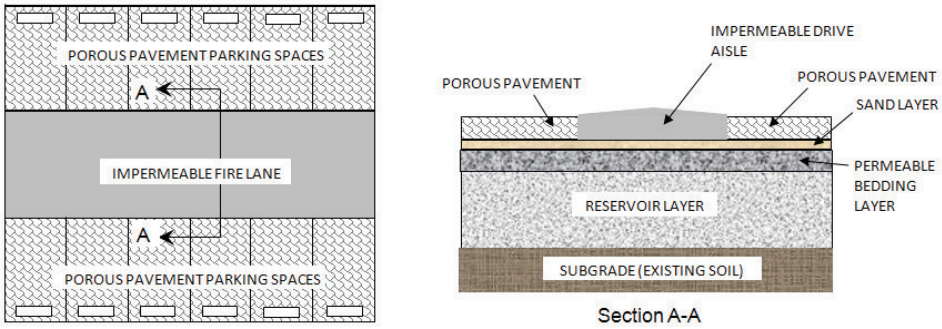

Figure 1: Impermeable Fire Lanes

Also, while a seal coat treatment may be used on the impermeable fire land, traditional seal coat treatments **shall not** be used on permeable pavement.

Setbacks

Always consult your geotechnical engineer for site specific recommendations regarding setbacks for permeable pavement. Recommended setbacks are needed to protect buildings, walls, onsite wells, streams and tanks.

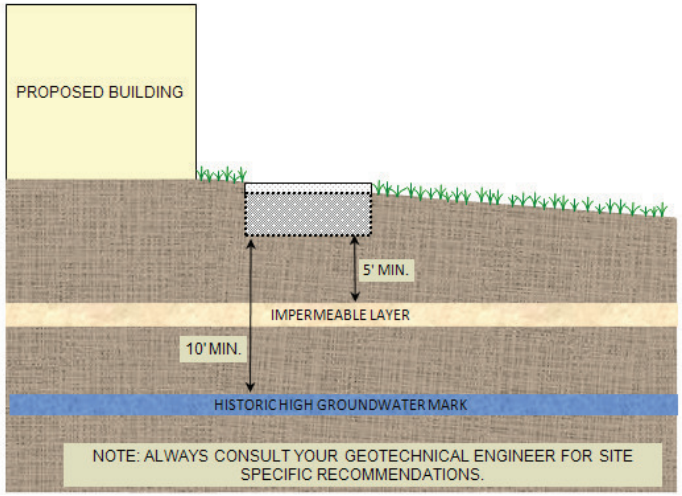

Figure 2: Permeable Pavement Setback Requirements

A minimum vertical separation of 10 feet is required from the bottom of the reservoir layer to the historic high groundwater mark, see Figure 2. A minimum vertical separation of 5 feet is required from the bottom of the reservoir layer to any impermeable layer in the soil. If the historic high groundwater mark is less than 10 feet below the reservoir layer section, or less than 5 feet from an impermeable layer, the infiltration design is not feasible.

Design and Sizing Criteria

To ensure that the pavement structural section is not compromised, a 24-hour drawdown time is utilized for this BMP instead of the longer drawdown time used for most volume based BMPs.

Reservoir Layer Considerations

Even with proper maintenance, sediment will begin to clog the soil below the permeable pavement. Since the soil cannot be scarified or replaced, this will result in slower infiltration rates over the life of the permeable pavement. Therefore, the reservoir layer is limited to a maximum of 12 inches in depth to ensure that over the life of the BMP, the reservoir layer will drain in an adequate time.

***Note**: All permeable pavement BMP installations (not including Permeable Pavement as a source control BMP i.e. a self-retaining area) must be tested by the geotechnical engineer to ensure that the soils drain at a minimum allowable rate to ensure drainage.. See the Infiltration Testing Section of this manual for specific details for the required testing and applied factors of safety.*

Sloping Permeable Pavement

Ideally permeable pavement would be level, however most sites will have a mild slope. If the tributary drainage area is too steep, the water may be flowing too fast when it approaches the permeable pavement, which may cause water to pass over the pavement instead of percolating and entering the reservoir layer. If the maximum slopes shown in Table 1 are complied with, it should address these concerns.

Table 1: Design Parameters for Permeable Pavement

Design Parameter	Permeable Pavement
Maximum slope of permeable pavement	3%
Maximum contributing area slope	5%

Regardless of the slope of the pavement surface design, the bottom of the reservoir layers **shall be flat and level** as shown in Figure 3. The design shown ensures that the water quality volume will be contained in the reservoir layer. A terraced design utilizing non-permeable check dams may be a useful option when the depth of gravel becomes too great as shown in Figure 3.

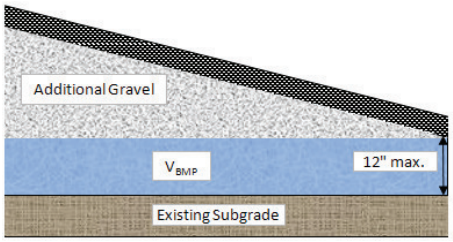

Figure 3: Sloped Cross Sections for Permeable Pavement

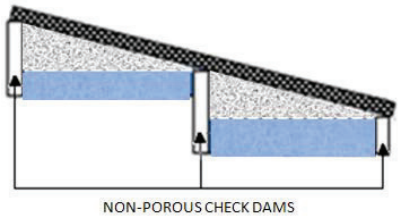

Figure 4: Permeable Pavement with Non-permeable Check Dams

In Figure 4, the bottom of the gravel reservoir layer is incorrectly sloped parallel to the pavement surface. Water would only be allowed to pond up to the lowest point of the BMP. Additional flows would simply discharge from the pavement. Since only a portion of the gravel layer can store water, this design would result in insufficient capacity. This is not acceptable.

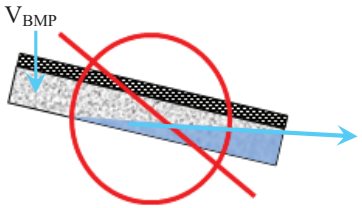

Figure 5: Incorrect Sloping of Permeable Pavement

To assure that the subgrade will empty within the 24 hour drawdown time, it is important that the maximum depth of 12 inches for the reservoir layer discussed in the design procedure is not exceeded. The value should be measured from the lowest elevation of the slope (Figure 4).

Minimum Surface Area

The minimum surface area required, A_S, is calculated by dividing the water quality volume, V_{BMP}, by the depth of water stored in the reservoir layer. The depth of water is found by multiplying the void ratio of the reservoir aggregate by the depth of the layer, b_{TH}. The void ratio of the reservoir aggregate is typically 40%; the maximum reservoir layer depth is 12".

Sediment Control

A pretreatment BMP should be used for sediment control. This pretreatment BMP will reduce the amount of sediment that enters the system and reduce clogging. The pretreatment BMP will also help to spread runoff flows, which allows the system to infiltrate more evenly. The pretreatment BMP must discharge to the surface of the pavement and not the subgrade. Grass swales may also be used as part of a treatment train with permeable pavements.

Liners and Filter Fabric

Always consult your geotechnical engineer for site specific recommendations regarding liners and filter fabrics. Filter fabric may be used around the edges of the permeable pavement; this will help keep fine sediments from entering the system. Unless recommended for the site, impermeable liners are not to be used below the subdrain gravel layer.

Overflow

An overflow route is needed in the permeable pavement design to bypass storm flows larger than the V_{BMP} or in the event of clogging. Overflow systems must connect to an acceptable discharge point such as a downstream conveyance system.

Roof Runoff

Permeable pavement can be used to treat roof runoff. However, the runoff cannot be discharged beneath the surface of the pavement directly into the subgrade, as shown in Figure 6. Instead the pipe should empty on the surface of the permeable pavement as shown in Figure 7. A filter on the drainpipe should be used to help reduce the amount of sediment that enters the permeable pavement.

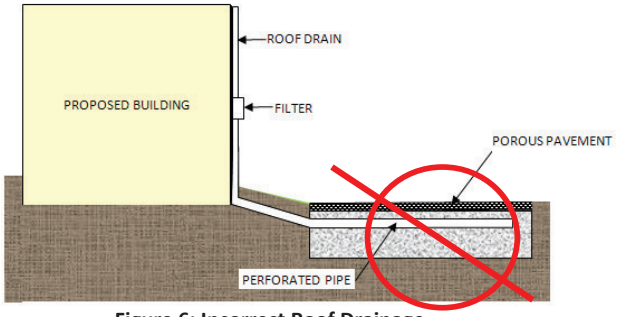

Figure 6: Incorrect Roof Drainage

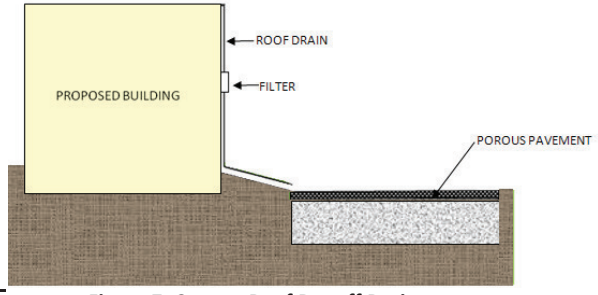

Figure 7: Correct Roof Runoff Drainage

Infiltration

Refer to the Infiltration Testing Section (Appendix A) in this manual for recommendations on testing for this BMP.

Pavement Section

The cross section necessary for infiltration design of permeable pavement includes:

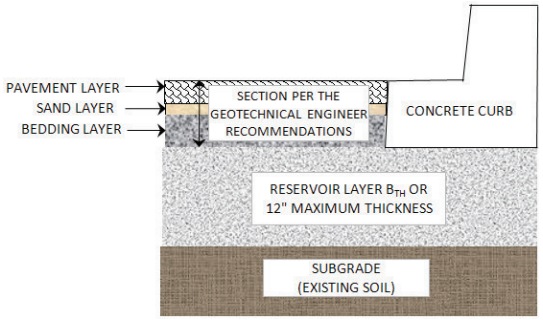

Figure 8: Infiltration Cross Section

- The thickness of the layers of permeable pavement, sand and bedding layers depends on whether it is permeable modular block or pervious pavement. A licensed geotechnical or civil engineer is required to determine the thickness of these upper layers appropriate for the pavement type and expected traffic loads.
- A 12" maximum reservoir layer consisting of AASHTO #57 gravel vibrated in place or equivalent with a minimum of 40% void ratio.

Inspection and Maintenance Schedule –Modular Block

Schedule	Activity
Ongoing	• Keep adjacent landscape areas maintained. Remove clippings from landscape maintenance activities. • Remove trash and debris
Utility Trenching and other pavement repairs	• Remove and reset modular blocks, structural section and reservoir layer as needed. Replace damaged blocks in-kind. • Do not pave repaired areas with impermeable surfaces.
After storm events	• Inspect areas for ponding
2-3 times per year	• Sweep to reduce the chance of clogging
As needed	• Sand between pavers may need to be replaced if infiltration capacity is lost

Inspection and Maintenance Schedule –Pervious Concrete/Asphalt

Schedule	Activity
Ongoing	• Keep adjacent landscape areas maintained. Remove clippings from landscape maintenance activities. • Remove trash and debris
Utility Trenching other pavement repairs	• Replace structural section and reservoir layer in kind. • Re-pave using pervious concrete/asphalt. Do not pave repaired areas with impermeable surfaces.
After storm events	• Inspect areas for ponding
2-3 times per year	• Vacuum the permeable pavement to reduce the chance of clogging
As needed	• Remove and replace damaged or destroyed permeable pavement

Design Procedure Permeable Pavement

1. Enter the Tributary Area, A_T.

2. Enter the Design Volume, $V_{BMP,}$ determined from Section 2.1 of this Handbook.

3. Enter the reservoir layer depth, b_{TH} for the proposed permeable pavement. The reservoir layer maximum depth is 12 inches.

4. Calculate the Minimum Surface Area, A_S, required.

$$A_S(\text{ft}) = \frac{V_{BMP}\ (\text{ft}^3)}{(0.4 \times b_{TH}\ (\text{in}))/12(\text{in/ft})}$$

   Where, the porosity of the gravel in the reservoir layer is assumed to be 40%.

5. Enter the proposed surface area and ensure that this is equal to or greater than the minimum surface area required.

6. Enter the dimensions, per the geotechnical engineer's recommendations, for the pavement cross section. The cross section includes a pavement layer, usually a sand layer and a permeable bedding layer. Then add this to the maximum thickness of the reservoir layer to find the total thickness of the BMP.

7. Enter the slope of the top of the permeable pavement. The maximum slope is 3%.

8. Enter whether sediment control was provided.

9. Enter whether the geotechnical approach is attached.

10. Describe the surfaces surrounding the permeable pavement. It is preferred that a vegetation buffer is used around the permeable pavement.
11. Check to ensure that vertical setbacks are met. There should be a minimum of 10 feet between the bottom of the BMP and the top of the high groundwater table, and a minimum of 5 feet between the reservoir layer the top of the impermeable layer.

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