Appendix A

Best Management Practice Manual
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City of El Centro

Best Management Practice Manual

November 2015

Approved:

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Ruben Duran
City Manager

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Date

Implementation delegated to the Public Works Director in accordance with Article VII, Division 1, Sec. 22-702 and Sec. 22-707(a) of the City Ordinance.
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## Attachment

Attachment 1  City of El Centro Post-Construction Storm Water Best Management Practice Standards Manual for Development Projects  
Attachment 1-A Approved Infiltration Rate Assessment Methods
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1 Introduction

1.1 BMP Manual
This Best Management Practice (BMP) Manual (hereafter, “Manual”) supports the City of El Centro (City) City Code Chapter 22, Article VII, “Storm Water Regulations, Use and Storm Sewer Construction” (Storm Water Ordinance). The Manual also supports as the water quality protection provisions of the City’s Grading Ordinance. The Manual is not a stand-alone document but must be read with applicable parts of the aforementioned chapters of the City Code (collectively, “Ordinances”). In general, this Manual categorically and explicitly establishes what dischargers must do to comply with the Ordinances and to receive permits for projects and activities that are subject to them. “Dischargers” are any responsible parties or site owners or operators within the City’s jurisdiction whose site discharges storm water runoff, or a non-storm water discharge (i.e., any discharge that is not comprised entirely of storm water).

The Manual and the Ordinances have been prepared to provide the City with the legal authority necessary to comply with the requirements of State Water Resources Control Board (SWRCB) Order No. 2013-0001-DWQ, National Pollutant Discharge Elimination System General Permit No. CAS000004 (MS4 Permit).

1.2 Purposes and Use
The Manual establishes minimum storm water management requirements and controls to prevent pollutant discharges to the City’s municipal separate storm sewer system (MS4) from municipal, industrial, commercial, construction, and post-construction development sources. Best management practices are schedules of activities, prohibitions of practices, general good housekeeping practices, pollution prevention and educational practices, maintenance procedures, and other management practices to prevent or reduce to the maximum extent practicable the discharge of pollutants directly or indirectly to receiving waters. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw materials storage.

The purpose of this Manual is to restore and maintain the water quality of receiving waters and further ensure the health, safety and general welfare of the citizens of the City of El Centro by effectively prohibiting non-storm water discharges, including spills, dumping, and disposal of materials other than storm water, to the MS4, and by reducing pollutants in discharges from the MS4 to receiving waters to the maximum extent practicable.

The Manual supports the City’s legal authority to following require operators of construction sites, new or redeveloped land; and industrial and commercial facilities to minimize the discharge of pollutants to receiving waters through the installation, implementation, or maintenance of BMPs consistent with the California Storm Water Quality Association (CASQA)
Best Management Practice Handbooks or equivalent, in accordance with MS4 Permit Section E.6.a.(ii).

The requirements described in the Manual are primarily in the form of BMPs to be used to reduce the amount of pollutants discharged to the City’s MS4. The Manual is intended to provide direction to residents, businesses, contractors, developers, and City staff about what is necessary to meet the City’s storm water requirements. All terms used in the Manual have the same meaning as defined in the City Code, unless otherwise noted.

2 Other Potentially Applicable Regulations

The Manual describes storm water BMPs required by the City of El Centro. Some actions and activities associated with storm water BMP requirements may be subject to additional requirements or approvals, such as other City departments or non-municipal agencies. Other agencies, such as the Regional Water Quality Control Board (RWQCB), the US Army Corps of Engineers, and the Imperial County, may also have applicable requirements. Complying with the BMPs described in the Manual does not ensure compliance with all other regulatory requirements, including requirements of other agencies. Dischargers are responsible for determining what other requirements may apply, if any, and taking actions as necessary to comply with them.

Discharges to the sanitary sewer system require approval from the City’s Public Works Department. Call (760) 337-4505 for more information. Structural improvements to properties, such as building an overhead canopy, may require City permits. Contact the City’s Building and Safety Division at (760) 337-4508 for more information.

The RWQCB and SWRCB issue permits for a number of activities that have potential to impact storm water discharges. Consideration may be given to the following permits and waivers:

- State of California Industrial General Permit, SWRCB Order No. 2014-0057-DWQ
- State of California Construction General Permit, SWRCB Order No. 2009-0009-DWQ
- Utility Vault Dewatering Permit, SWRCB Order No. 2014-0174-DWQ

Information on the most current requirements for RWQCB permitting and waivers can be obtained from the following website: http://www.waterboards.ca.gov/coloradoriver/

3 Minimum Requirements for All Dischargers

Table 1 presents the minimum required BMPs for all dischargers, as defined in Section 1.1. Dischargers include but are not limited to industrial, commercial, and construction site owners or operators, municipal staff, and residents. The City maintains the legal authority to require BMP implementation at any site in order to prevent or minimize pollutant discharges to receiving waters. Wherever BMP requirements reference “where applicable,” “where feasible,”
or similar terms that involve discretion, the final determination shall be made by the Enforcement Official, as defined in City Code Section 22-701. Enforcement Staff also have the authority to require additional BMPs beyond the minimum BMPs listed in this Manual if necessary to comply with City Code Chapter 22 or the MS4 Permit.

Although Table 1 discusses requirements for more common types of non-storm water discharges, City Code Sections 22-703 through 22-705 discusses other types of non-storm water discharges that may require additional BMPs or permits.

These BMPs have been developed, and are supported by, the City’s Storm Water Ordinance and factsheets adopted by CASQA. Where any conflict may exist between CASQA factsheets and requirements in the Manual or the City Code, the requirements of the Manual and the City Code shall prevail. Complying with the BMPs described in the Manual does not ensure compliance with all other regulatory requirements, including requirements of other agencies. See Section 2 for more information about other potentially applicable requirements.
<table>
<thead>
<tr>
<th>No.</th>
<th>BMP Title</th>
<th>BMP Description</th>
<th>El Centro City Code Section Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Eliminate illicit non-storm water discharges.</td>
<td>Illicit discharges include all non-storm water discharges not otherwise authorized in the State Water Resources Control Board (SWRCB) Order No. 2013-0001-DWQ (MS4 Permit), except discharges allowed under a National Pollutant Discharge Elimination System (NPDES) permit and discharges conditionally allowed under the MS4 Permit, as set forth in El Centro City Code Section 22-704.</td>
<td>22-703 through 22-705</td>
</tr>
<tr>
<td>A-2</td>
<td>Eliminate illicit connections to the MS4.</td>
<td>Illicit connections are manmade physical connections to the municipal separate storm sewer system (MS4) that convey an illicit discharge. For example, a sink plumbed to drain to the MS4 instead of the sanitary sewer system is an illicit connection. Find and abate all illicit connections to the MS4 through approved procedures, permits, and protocols.</td>
<td>22-706</td>
</tr>
<tr>
<td>A-3</td>
<td>Control the discharge of vehicle wash water.</td>
<td><strong>Non-Residential Implementation</strong>&lt;br&gt;Discharge of vehicle, boat, and equipment wash water shall be contained, captured, and reused, or properly disposed of to the sanitary sewer (City permit required), an appropriate waste hauler, or to landscaping or other pervious surfaces. No drains within wash areas shall be connected to the storm drain system. Storm drain inlets located down gradient of wash areas and activities shall be covered or otherwise protected to prevent the entry of wash water or rinse water. Wash water containing oil, paint, or other hazardous waste shall be disposed of properly in accordance with applicable regulations.&lt;br&gt;&lt;br&gt;<strong>Residential Implementation</strong>&lt;br&gt;Wash water from individual residential vehicle washing should be directed to landscaped areas or other unpaved surfaces, where feasible. Minimizing water use (e.g., through use of a nozzle) and use of detergents and other vehicle wash products are encouraged. Non-commercial car washes, such as fundraisers and other similar activities, are not considered individual residential vehicle washing, and are therefore subject to the requirements listed above for non-residential dischargers. Per City Code 23-6, the washing of vehicles or other equipment in City streets, sidewalks, or alleys is prohibited.</td>
<td>22-704</td>
</tr>
</tbody>
</table>
### Table 1. Minimum Best Management Practices (BMPs) for All Dischargers (continued)

<table>
<thead>
<tr>
<th>No.</th>
<th>BMP Title</th>
<th>BMP Description</th>
<th>El Centro City Code Section Reference</th>
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</table>
| A-4 | Minimize irrigation runoff. | Irrigation runoff in excess of an amount deemed to be incidental runoff shall be controlled by the responsible party. Incidental runoff is defined as unintended amounts of runoff, such as unintended, minimal over-spray from sprinklers that escapes the area of intended use. Water leaving an intended use area is not considered incidental if it is part of the facility design or if it is due to excessive application, intentional overflow or application, or to negligence. All irrigation water and associated pollutants from nurseries, garden centers, and similar facilities shall be prevented from reaching City storm drains, curb gutters along City streets, or any other part of the City’s storm drain system. Parties responsible for controlling runoff in excess of incidental runoff shall:  
  - Detect leaks and correct leak within 72 hours of learning of the leak.  
  - Properly design and aim sprinkler heads.  
  - Not irrigate during precipitation events.  
  - Manage ponds containing recycled water such that no discharge occurs unless the discharge is a result of a 25-year, 24-hour storm event or greater, and the RWQCB is notified by email no later than 24 hours after the discharge. The notification shall include City contact information and permit identification number. Currently, recycled water is not used in the City of El Centro. | 22-703, 22-704 |
<p>| A-5 | Properly dispose of discharges from swimming pools and spas. | Water from swimming pools or spas may be discharged to the MS4 after obtaining a no cost City permit. To obtain a permit, call the City’s Compliance Specialist at (760) 337-4538, or complete the form located on the City’s website (<a href="http://www.cityofelcentro.org">www.cityofelcentro.org</a>). The water to be discharged must be dechlorinated, have no algae or suspended solids, and not be from a salt water pool or spa. Spa water must also be allowed to cool to ambient temperature before discharge. To prevent the transport of pollutants, the use of a hose to transport the water directly to a storm drain should be used, or the path from the point of the discharge to the storm drain inlet should be swept prior to the discharge. Note that filter backwash water and filtered solids may not be discharged to the MS4. | 22-705 |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>BMP Title</th>
<th>BMP Description</th>
<th>El Centro City Code Section Reference</th>
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<tr>
<td>A-6</td>
<td>Control discharges from air conditioning condensation.</td>
<td>Direct air conditioning condensation discharges to onsite landscaped or pervious area to infiltrate or evaporate, without resulting in erosion or runoff to the MS4 or any adjacent property, where feasible. Directing discharges to landscaping close to a building foundation is not recommended. Directing air conditioning condensation to the sanitary sewer if allowed. Contact the Public Works Department at (760) 337-4505 for information on allowable discharges to the sanitary sewer system. If these discharge methods are not feasible, air conditioning condensation may be discharged to the MS4 provided it does not contain or transport significant pollutants.</td>
<td>22-704</td>
</tr>
<tr>
<td>A-7</td>
<td>Control discharges from potable water sources.</td>
<td>Direct discharges of potable water to onsite landscaped or pervious area to infiltrate or evaporate, without resulting in erosion or runoff to the MS4 or any adjacent property, where feasible. Where not feasible, potable water may be discharged to the MS4 provided it does not contain or transport significant pollutants. In order to prevent the transport of pollutants, the use of a hose to transport the water directly to a storm drain should be used, or the path from the point of the discharge to the storm drain inlet should be swept prior to the discharge. Dischargers must obtain a no cost City permit prior to discharging potable water to the MS4. To obtain a permit, call the City’s Compliance Specialist at (760) 337-4538, or complete the form located on the City’s website (<a href="http://www.cityofelcentro.org">www.cityofelcentro.org</a>). Additionally, if the discharge is the result of water line flushing, the discharger must obtain the NPDES Permit No. CAG1400001 (State Water Resources Control Board Order WQ 2014-0194-DWQ, or subsequent order), prior to discharging. This permit applies primarily to water utilities.</td>
<td>22-704, 22-705</td>
</tr>
<tr>
<td>No.</td>
<td>BMP Title</td>
<td>BMP Description</td>
<td>El Centro City Code Section Reference</td>
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<tr>
<td>A-8</td>
<td>Control discharges from uncontaminated pumped ground water.</td>
<td>Direct discharges of uncontaminated pumped ground water to onsite landscaped or pervious area to infiltrate or evaporate, without resulting in erosion or runoff to the MS4 or any adjacent property, where feasible. Where not feasible, uncontaminated pumped ground water may be discharged to the MS4 provided it does not contain or transport significant pollutants. In order to prevent the transport of pollutants, the use of a hose to transport the water directly to a storm drain should be used, or the path from the point of the discharge to the storm drain inlet should be swept prior to the discharge. Dischargers must obtain a no cost City permit prior to discharging potable water to the MS4. To obtain a permit, call the City’s Compliance Specialist at (760) 337-4538, or complete the form located on the City’s website (<a href="http://www.cityofelcentro.org">www.cityofelcentro.org</a>).</td>
<td>22-705</td>
</tr>
<tr>
<td>A-9</td>
<td>Prevent the transport of pollutants in storm water runoff.</td>
<td>Any person engaged in activities which may result in discharges to the MS4 shall, to the maximum extent practicable, undertake all measures to reduce the risk of pollutant discharges in storm water. Pollution prevention measures may include providing coverage of pollutant sources and/or secondary containment to contain liquid pollutants (e.g., hazardous materials).</td>
<td>22-707</td>
</tr>
<tr>
<td>A-10</td>
<td>Properly manage pesticides and fertilizers.</td>
<td>Pesticides and fertilizers shall be applied in accordance with manufacturer’s label, as authorized by U.S. Environmental Protection Agency. Chemicals shall be stored safely in covered and contained areas. Waste products shall be disposed of in accordance with the manufacturer's label and applicable hazardous waste regulations. The use of integrated pest management (IPM) principles is encouraged to reduce or eliminate use of chemicals. For more information about integrated pest management, see the University of California Statewide IPM Program at <a href="http://www.ipm.ucdavis.edu">http://www.ipm.ucdavis.edu</a>.</td>
<td>22-707</td>
</tr>
<tr>
<td>No.</td>
<td>BMP Title</td>
<td>BMP Description</td>
<td>El Centro City Code Section Reference</td>
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<tr>
<td>A-11</td>
<td>Maintain structural BMPs.</td>
<td>All structural BMPs installed pursuant to City or State storm water requirements shall be maintained as necessary to maintain the design functionality of the BMP(s). The owner of the property on which the BMP is located is responsible for BMP maintenance unless otherwise established via legal agreement. Spills shall be cleaned up promptly and prevented from entering the MS4. Dry cleaning methods such as the use of rags and absorbents are preferred cleaning methods. Materials and equipment appropriate for the type and quantity of potential spills shall be kept onsite as a spill cleanup kit. Keep cleanup materials in close proximity to locations where spills may occur, with instructions for use clearly displayed. Spill kits should also be kept on vehicles where appropriate based on the type of work completed in the field. If a spill results in an illegal discharge, the discharger shall notify the City within 24 hours of the discharge occurrence at (760) 337-4505 or to (760) 352-2113 after business hours.</td>
<td>22-709</td>
</tr>
<tr>
<td>A-12</td>
<td>Clean up spills.</td>
<td></td>
<td>22-708</td>
</tr>
<tr>
<td>A-13</td>
<td>Keep storm drains free of sediment, trash, and debris.</td>
<td>Keep and maintain storm drains on the premises reasonably free of trash, debris and other obstacles which would pollute, contaminate, or impede the flow of water through the MS4. Maintain existing structures within or adjacent to the MS4 so that those structures will not become a hazard to the use, function, or physical integrity of the MS4.</td>
<td>22-709</td>
</tr>
</tbody>
</table>
4 Minimum BMP Requirements for Municipal Facilities and Operations

Minimum BMP requirements for municipal sites and activities are provided in Table 2. These BMPs have been developed, and are supported by, factsheets adopted by CASQA.¹ City exceptions to the procedures described in the municipal CASQA factsheets are identified in footnotes. Where any conflict may exist between CASQA factsheets and requirements in the Manual or the City Code, the requirements of the Manual and the City Code shall prevail. Complying with the BMPs described in the Manual does not ensure compliance with all other regulatory requirements, including requirements of other agencies. See Section 2 for more information about other potentially applicable requirements.

These are the minimum BMP requirements that must be implemented for applicable activities. However, additional consideration should be given to the following:

1. Due to site-specific conditions, some BMP requirements reference terms such as “where applicable” or “where feasible.” These terms require that BMPs be implemented at the discretion and with the final determination made by City personnel or their designees (i.e., contract staff). City staff or their designees also have the authority to require additional BMPs, if necessary, to comply with the Storm Water Ordinance and/or the MS4 Permit.

2. References to “CASQA Factsheets” refer to factsheets in manuals prepared by the California Stormwater Quality Association (CASQA). CASQA materials can be accessed at www.casqa.org. Some materials may not be viewable without a paid subscription.

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### Table 2. Minimum Best Management Practices (BMPs) for Municipal Sites/Sources

<table>
<thead>
<tr>
<th>No.</th>
<th>BMP Title</th>
<th>BMP Description</th>
<th>CASQA BMP Factsheet Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-1</td>
<td>Eliminate illicit non-storm water discharges and illicit connections.</td>
<td>Implement practices as required by BMPs A-1 through A-5 in Table 1 and as required by El Centro City Code Chapter 22, Article VII. Illicit discharges include all non-storm water discharges not otherwise authorized in the State Water Resources Control Board (SWRCB) Order No. 2013-0001-DWQ (MS4 Permit), except discharges allowed under a National Pollutant Discharge Elimination System (NPDES) permit and discharges conditionally allowed under the MS4 Permit, as set forth in El Centro City Code Section 22-704. Non-storm water discharged to the MS4 as a result of emergency or non-emergency firefighting activities is considered an illicit discharge if the City or a Regional Water Quality Control Board (RWQCB) Executive Officer identifies the discharge as a significant source of pollutants to receiving waters. Paved parking lots, roads, and driveways shall be cleaned as needed to prevent pollutants from entering the City’s MS4, including the curb and gutter. Sweeping is the preferred method of cleaning. Wet cleaning methods, such as mopping or power washing, may be substituted for sweeping if all wash water is contained, captured, and disposed of appropriately.</td>
<td>SC-10, SC-21, SC-41, SC-72, SC-73</td>
</tr>
<tr>
<td>M-2</td>
<td>Regularly clean parking areas and roads.</td>
<td></td>
<td>SC-41, SC-43, SC-60, SC-70</td>
</tr>
</tbody>
</table>

2 Factsheet SC-41 - Building & Grounds Maintenance, states (in regards to pressure washing), "If soaps, detergents, or other harsh chemicals are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff." Non-storm water discharges of this nature, even if filtered, are not allowed to enter the MS4. Wash water must be contained, collected, and disposed of properly.
<table>
<thead>
<tr>
<th>No.</th>
<th>BMP Title</th>
<th>BMP Description</th>
<th>CASQA BMP Factsheet Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-3</td>
<td>Keep storm drains free of sediment, trash, and debris.</td>
<td>Inspect storm drain systems regularly to determine the level of required maintenance or cleaning. At a minimum, all high priority catch basins (i.e., storm drain inlets) and systems are inspected annually. Non-priority catch basins and systems are inspected as needed. Removal of trash and debris from high priority catch basins and system shall occur annually prior to the rainy season (October 1 – April 30) and shall be disposed of appropriately.</td>
<td>SC-74</td>
</tr>
<tr>
<td>M-4</td>
<td>Provide pollution prevention signage for storm drains.</td>
<td>Pollution prevention signage shall be provided on catch basins in high foot traffic areas. Examples of storm drain prohibitive signage include concrete stamping, paint stenciling, signage posting, and the installation of ceramic or plastic tiles. Storm drain signage should include a message similar to “Only Rain in the Drain.”</td>
<td>SC-74</td>
</tr>
<tr>
<td>M-5</td>
<td>Properly manage pesticides and fertilizers.</td>
<td>Pesticides and fertilizers shall be applied in strict accordance with manufacturer’s label, as authorized by U.S. Environmental Protection Agency. Chemicals shall be stored safely in covered and contained areas. Waste products shall be disposed of in accordance with the manufacturer’s label and applicable hazardous waste regulations. The use of integrated pest management (IPM) principles is encouraged to reduce or eliminate use of chemicals. For more information about integrated pest management, see the University of California Statewide IPM Program at <a href="http://www.ipm.ucdavis.edu">http://www.ipm.ucdavis.edu</a>.</td>
<td>SC-35, SC-41, SC-73</td>
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<tr>
<td>No.</td>
<td>BMP Title</td>
<td>BMP Description</td>
<td>CASQA BMP Factsheet Reference</td>
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<tr>
<td>M-6</td>
<td>Implement controls to minimize pollution from exposed outdoor work areas.</td>
<td>Activities that may generate pollutants shall be conducted in covered, contained areas, or equivalent measures taken to prevent the discharge of associated pollutants, where feasible. To avoid contaminating storm water runoff, one or more of the following precautions may be taken as appropriate: (1) move activities indoors; (2) cover areas where outdoor activities are performed; (3) protect areas where outdoor activities are performed from runoff from upstream areas; (4) prevent spills or by-products from escaping contained areas; (5) do not conduct outdoor activities that may generate pollutants when it is raining; (6) protect storm drain inlets and ensure adequate spill response materials are readily available; and (7) regularly clean outdoor work areas to remove accumulated sediment, debris, oil and grease, particulate matter, and other pollutants.</td>
<td>SC-22, SC-30, SC-32, SC-34, SC-41, SC-70</td>
</tr>
<tr>
<td>M-7</td>
<td>Clean up spills.</td>
<td>Spills shall be cleaned up promptly and prevented from entering the MS4. Dry cleaning methods such as the use of rags and absorbents are preferred cleaning methods. Materials and equipment appropriate for the type and quantity of potential spills shall be kept onsite as a spill cleanup kit. Keep cleanup materials in close proximity to locations where spills may occur, with instructions for use clearly displayed. Spill kits should also be kept on vehicles where appropriate based on the type of work completed in the field. If a spill results in an illegal discharge, the discharger shall notify the appropriate City department/division or staff member within 24 hours of the discharge occurrence.</td>
<td>SC-11</td>
</tr>
<tr>
<td>No.</td>
<td>BMP Title</td>
<td>BMP Description</td>
<td>CASQA BMP Factsheet Reference</td>
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<tr>
<td>M-8</td>
<td>Temporarily protect storm drains from non-storm water discharges while conducting activities that have the potential to result in a discharge.</td>
<td>If activities conducted cannot be fully contained or minor failures in containment would potentially result in discharges of non-storm water to the MS4, temporary measures shall be used to protect storm drains. Any activity-related materials that enter the MS4 shall be removed promptly and disposed of appropriately (in accordance with other minimum BMPs).</td>
<td>SC-10, SC-11</td>
</tr>
<tr>
<td>M-9</td>
<td>Keep trash/waste storage areas free of exposed trash, sediment, and debris.</td>
<td>Stored waste shall be protected from contact with storm water and non-storm water. Disposal areas for trash and other wastes shall be cleaned as frequently as necessary to keep these areas free of loose trash, litter, debris, liquids, powders, and sediment. Liquid waste, hazardous waste, medical waste, universal waste, and other items prohibited that require special disposal per current regulations shall not be placed in solid waste dumpsters. Dry cleaning methods such as sweeping are preferred. If wet cleaning methods are used, all wash water must be contained, captured, and disposed of appropriately. See BMP #M-2 for information on appropriate wet cleaning practices.</td>
<td>SC-34, SC-41, SC-75</td>
</tr>
<tr>
<td>M-10</td>
<td>Properly store and dispose of green waste.</td>
<td>Green waste shall be properly stored and disposed of such that it will not be transported to the MS4 by storm water or non-storm water runoff.</td>
<td>SC-34, SC-73, SC-75</td>
</tr>
</tbody>
</table>
5 Construction

The BMPs in Table 1, which apply to all dischargers, are required for construction sites. Additional minimum BMPs required for construction sites are presented in Table 3. The City’s BMP standards are based on the CASQA BMP factsheets. Where any conflict may exist between CASQA factsheets and requirements in the Manual or the City Code, the requirements of the Manual and the City Code shall prevail. Complying with the BMPs described in the Manual does not ensure compliance with all other regulatory requirements, including requirements of other agencies. See Section 2 for more information about other potentially applicable requirements.

Construction site BMPs are required to be implemented in an effective combination of BMPs that are site specific, construction phase appropriate, and seasonally appropriate. Dry season (May 1 through September 30) BMP implementation must plan for and address rain events that may occur in the dry season. City staff have the authority to require additional BMPs to prevent discharges of pollutants and to prevent non-storm water discharges to the City’s MS4 from construction sites year round. Construction sites also must adhere to the requirements of the State Construction General Permit where applicable (see Section 2). Typically, projects that are one (1) acre or larger are subject to the State Construction General Permit.
Table 3. Minimum Best Management Practices (BMPs) for Construction Sites

<table>
<thead>
<tr>
<th>BMP Categories</th>
<th>Required, Where Applicable</th>
<th>CASQA BMP Factsheet No.</th>
<th>CASQA BMP Factsheet Name</th>
<th>CASQA BMP Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EC-1</td>
<td>Scheduling</td>
<td>Erosion Control</td>
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<tr>
<td></td>
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<td>EC-2</td>
<td>Preservation of Existing Vegetation</td>
<td>Sediment Control</td>
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<td>EC-3</td>
<td>Hydraulic Mulch</td>
<td>Tracking Control</td>
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<td>EC-4</td>
<td>Hydroseeding</td>
<td>Wind Erosion</td>
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<td>EC-5</td>
<td>Soil Binders</td>
<td>Non-Storm Water</td>
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<td>EC-6</td>
<td>Straw Mulch</td>
<td>Management</td>
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### Table 3. Minimum Best Management Practices (BMPs) for Construction Sites (continued)

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<td>Spill Prevention &amp; Control</td>
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Table 3. Minimum Best Management Practices (BMPs) for Construction Sites (continued)

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<th>BMP Categories</th>
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<td>Yes</td>
<td>WM-7</td>
<td>Contaminated Soil Management</td>
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<td>WM-9</td>
<td>Sanitary/ Septic Waste Management</td>
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<td></td>
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<td>Liquid Waste Management</td>
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</table>

Notes:
CASQA BMP Objectives P – Primary, S - Secondary

1. BMPs marked as required do not need to be included in plans or implemented if demonstrated not to be applicable satisfactory to City staff.
2. A combination of the BMPs within these categories that will be effective, as determined by City staff, shall be proposed. Typically not all BMPs within the category will be necessary to provide an effective combination. In some cases only one BMP from the category may be necessary to be effective.
3. Erosion control BMPs are required to be implemented when there is at least as 50% chance of rain within the next 48 hours, as determined by the NOAA National Weather Service forecast. Projects subject to the Construction General Permit are also required to implement erosion control BMPs in areas that have been inactive for at least 14 days.
4. These BMPs may be included as part of the overall effective combination of erosion control BMPs if approved by City staff.
5. An effective combination of sediment control BMPs includes both full perimeter protection and sediment control within the boundaries of the site.
6. Silt fence and fiber rolls shall be staked into the ground as shown in the CASQA factsheet to be effective. Therefore, they may not be used in paved areas or other areas where staking is not possible; gravel bags (SE-6) or compost socks (SE-13) shall be used instead.
7. Sediment basins and traps shall be sized per CASQA and City standards. Sediment basins and traps shall be maintained after storms in accordance with the CASQA factsheets unless otherwise directed by City staff. Due to site drainage patterns, sediment basins and traps are often located where permanent post-construction BMPs will eventually be installed. All accumulated sediment from the construction phase shall be removed prior to final installation of permanent post-construction BMPs to maintain the as-designed percolation rate.
8. These BMPs are not required to be included in plans or implemented unless specifically directed to be included by City staff to meet the maximum extent practicable standard.
9. These BMPs may be included as part of the overall effective combination of sediment control BMPs if approved by City staff.
10. Active treatment systems may be required for Construction General Permit Risk Level 3 sites, as necessary to meet Construction General Permit standards. They may also be required for other sites at the discretion of City staff.
11. Irrigation runoff discharges are subject to BMP No. A-4 in Table 1.
6 BMP Requirements for Development Projects
The City’s BMP requirements for new and redevelopment projects are presented in Attachment 1 of this Manual. These requirements specify permanent water quality improvement measures to be installed at development projects.
Attachment 1

City of El Centro Post-Construction Storm Water Best Management Practice Standards Manual for Development Projects
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City of El Centro
Post-Construction Storm Water Best Management Practice Standards Manual for Development Projects
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Attachment

1-A  Approved Infiltration Rate Assessment Methods for Selection and Design of Storm Water BMPs
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1 Introduction
Post-construction best management practices (BMPs) are permanent features of a project that reduce runoff and/or pollutants discharged from a development project after it has been built. Post-construction BMPs are intended to operate continuously over the life of the completed project. These BMPs are different than the practices used to control discharges of sediment and other pollutants during project construction. Those practices are typically referred to as construction BMPs.

To meet the requirements of Provision E.12 of the Phase II Storm Water Permit (Permit) issued by the State Water Resources Control Board, the City of El Centro requires certain projects to implement post-construction BMPs. This City of El Centro Post-Construction Storm Water Best Management Practice Standards Manual for Development Projects (Post-Construction Storm Water Standards Manual) identifies requirements applicable to projects in the City of El Centro.

2 Requirements Applicability
Different requirements apply depending on the size and type of the project, as discussed below. There are three basic classes of projects:

- Exempt
- Standard
- Regulated

More detailed descriptions of project classes are provided below. Following the descriptions of project classes, Figures 1 and 2 present flow charts that can be used to determine project class and applicable requirements. Table 1 summarizes the requirements for each class of project.

In addition to post-construction BMPs, other requirements may also apply. For example, projects may be subject to the State Construction General Permit. See Section 2 of the City of El Centro BMP Manual for additional information about other potentially applicable requirements.

2.1 Exempt Projects
The following types of projects are exempt from post-construction BMP requirements:

- Interior remodels
- Routine maintenance or repair such as exterior wall surface replacement, pavement grinding and resurfacing of existing roadways or other pavement resurfacing within the existing footprint, applying slurry seal or seal coat to existing pavement, and routine replacement of damaged pavement, including full depth replacement, such as pothole repair or replacement of short, non-contiguous sections of roadway
- Projects that create or replace less than 2,500 square feet of impervious area
- Certain types of work associated with linear underground/overhead projects (LUP) or road or trail projects:
o Sidewalks built as part of new streets or roads and built to direct storm water runoff to adjacent vegetated areas.

o Bicycle lanes that are built as part of new streets or roads that direct storm water runoff to adjacent vegetated areas.

o Impervious trails built to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas, preferably away Imperial Irrigation District drains.

o Sidewalks, bicycle lanes, or trails constructed with permeable surfaces.

o Trenching, excavation and resurfacing associated with LUPs; pavement grinding and resurfacing of existing roadways and parking lots; construction of new sidewalks, pedestrian ramps, or bike lanes on existing roadways; or routine replacement of damaged pavement such as pothole repair or replacement of short, non-contiguous sections of roadway.

2.2 Standard Projects
Standard projects are defined as projects that create or replace between 2,500 and 5,000 square feet of impervious area. In addition to the exceptions listed in Section 2.1, note that LUPs are never standard projects—they are either Regulated Projects (Section 2.3) or are not subject to any post-construction BMP requirements. Also note that single family residences that are not a part of a larger plan of development and create or replace 2,500 or more square feet of impervious area are still considered standard projects. Such single family residential projects are not considered Regulated Projects, even if they create or replace more than 5,000 square feet of impervious area. Standard projects are required to implement what are known as site design BMPs, which are a set of measures designed to reduce runoff from development projects. Site design BMPs required are described in Section 3.

2.3 Regulated Projects
Regulated Projects are projects that create or replace at least 5,000 square feet of impervious area, except for the exempted project categories listed in Section 2.1. Regulated projects may be new development or redevelopment projects. Redevelopment projects involve work on a site on which some past development has occurred. See Section 4.3.2.1 for more details.

As noted in Section 1.2, a single family residence project that creates or replaces 5,000 or more square feet of impervious area and is not part of a larger plan of development is considered a Standard Project, not a Regulated Project.

Replacement of impervious area is not counted toward the 5,000 foot threshold for road projects and LUPs. Road projects and LUPs that create 5,000 square feet or more of newly constructed contiguous impervious surface and that are public road projects and/or fall under the City’s building and planning authority are considered Regulated Projects. Section 4 describes the requirements applicable to Regulated Projects.

2.3.1 Additional Requirements for Hydromodification Management
Baseline hydromodification management, as defined in the Permit, is provided by meeting the Low Impact Development (LID) treatment control requirements (see Section 4). Additional
hydromodification management requirements apply to certain projects, referred to as “hydromodification Projects.” Hydromodification Projects are Regulated Projects that create and/or replace one acre or more of impervious surface. A project that does not increase impervious surface area over the pre-project condition is not a Hydromodification Project. See Figure 2 for summary of what are and are not Hydromodification Projects.

2.3.2 Effective Date for Requirements
By June 30, 2015, the City will require the post-construction BMP standards described in this Post-Construction Storm Water Standards Manual, both private development requiring municipal permits and public projects, to the extent allowable by applicable law. These include discretionary permit projects that have not been deemed complete for processing and discretionary permit projects without vesting tentative maps that have not requested and received an extension of previously granted approvals. Discretionary projects that have been deemed complete prior to June 30, 2015 are not subject to the Post-Construction Standards herein. For City projects, the effective date shall be the date their governing body or designee approves initiation of the project design.
Figure 1. Post-Construction BMP Requirements Applicable to Different Types and Sizes of Projects

Notes
* See Section 2.1 for a detailed description of exempted project types.
** Different numeric sizing and BMP design standards may apply to road projects and LUPs; see sections 4.3.2.2 and 4.3.4.2 for details.
*** Different numeric sizing requirements may apply to redevelopment projects. See Section 4.3.2.1 for details.

sf: square feet
Figure 2. Applicability of Additional Hydromodification Requirements

Note
* See Section 4.4 for additional detail on requirements for Hydromodification Projects.

2.4 Summary of Requirements by Project Classification

Table 1 below summarizes the types of post-construction BMPs required for each project class. Site design BMPs apply to both Standard Projects and to Regulated Projects and are discussed in Section 3. The other BMPs apply only to Regulated Projects. Those BMPs are discussed in Section 4. The section in which more information about a type of BMP can be located is also provided in parentheses in the header row of Table 1. Answers to common questions about requirements applicability are provided in Section 6.

Table 1. Summary of BMP Requirements for Projects, by Project Class

<table>
<thead>
<tr>
<th>Project Class</th>
<th>Site Design BMPs (Section 3)</th>
<th>Source Control BMPs (Section 4)</th>
<th>Low Impact Development Treatment BMPs (Section 4)</th>
<th>Hydromodification Management Measures (Section 4)</th>
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<tr>
<td>Regulated</td>
<td>X</td>
<td>X</td>
<td>X*</td>
<td>Potentially. See Figure 2.</td>
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</table>

Note
* Different numeric sizing requirements may apply for redevelopment projects and for roads and LUPs. See Section 4 for details. Site Assessment, as defined in the Permit, is included as part of the overall Low Impact Development Treatment BMP selection and design process.
3 Site Design BMPs

Projects subject to Site Design BMP requirements shall implement one or more of the following measures to reduce project site runoff:

- Soil Quality Improvement and Maintenance - improvement and maintenance soil through soil amendments, adding topsoil, and similar actions
- Tree Planting and Preservation - planting and preservation of healthy, established trees that include both evergreens and deciduous, as applicable
- Downspout Disconnection - rerouting of rooftop drainage pipes to drain rainwater to rain barrels, cisterns, or permeable areas instead of the storm sewer
- Rooftop Impervious Area Disconnection - rerouting of rooftop drainage pipes to direct runoff to landscaping or other permeable areas
- Impervious Area Disconnection – draining runoff from parking lots, driveways, roads, sidewalks, and other impervious areas to drain to landscaping or other permeable areas
- Porous Pavement System- pavement that allows runoff to pass through it, thereby reducing the runoff from a site and surrounding areas and filtering pollutants. Because the native soil in El Centro typically has a low infiltration rate, such systems must be underlain by a permeable material (typically gravel) to obtain credit.
- Vegetated Swales - a vegetated, open-channel management practice designed specifically to treat and attenuate storm water runoff, in accordance with California Storm Water Quality Association (CASQA) standards.

Note that the above list includes the site design measures that are believed to be most applicable to conditions in the City of El Centro. Project proponents may also incorporate other site design measures allowed by the Phase II Permit into the project design if appropriate to the specific circumstances of a particular project.

Project proponents shall use an approved method of calculating runoff reduction resulting from implementation of site design measures. To receive credit, proposed site design BMPs must be designed in accordance with the standards in the calculator files specified below.

- Projects that are not subject to the State Construction General Permit (typically this is projects that have less than 1 acre of land disturbance): use the Excel file provided at the City’s website: http://www.cityofelcentro.org/engineering.¹
- Projects that are subject to the State Construction General Permit (typically this is projects that have at least 1 acre of land disturbance): use the post-construction calculator integrated into the SMARTS system at https://smarts.waterboards.ca.gov/smarts/faces/SwSmartsLogin.jsp.

This calculator can be accessed as part of the process of submitting permit required documents

¹ The calculator spreadsheet on the City’s website is an adapted version of the calculator spreadsheet prepared by the State Water Resources Control Board. The City’s version has been pre-filled with El Centro specific inputs, but all the calculation formulas are the same as the State’s version. The original version from the State is available at http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml.
and filing a Notice of Intent for the Construction General Permit. If projects subject to the Construction General Permit have difficulty accessing the online calculator or obtaining the necessary outputs from it, they may use the Excel file provided on the City’s website instead.

Note that Regulated Projects should implement Site Design BMPs to the extent feasible, as the calculated runoff reduction from Site Design BMPs reduces the amount of water that needs to be treated using bioretention or other LID treatment measures. Typically site design measures are less costly than bioretention or other LID treatment measures. Section 4.3 and Figure 3 provide more details about how runoff reduction from Site Design BMPs is incorporated into numeric sizing calculations for LID treatment measures.

4 Requirements for Regulated Projects

Regulated Projects shall implement measures for site design BMPs (Section 3), source control BMPs (Section 4.2), and Low Impact Development (Section 4.3), subject to numeric sizing requirements (Section 4.3.2). Note that special numeric sizing considerations apply to redevelopment projects (Section 4.3.2.1) and road projects and LUPs (Section 4.3.2.2). Additional requirements for hydromodification also apply to some, but not all, Regulated Projects, as detailed in Section 4.4.

4.1 Site Assessment

At the earliest planning stages, Regulated Projects shall assess and evaluate how site conditions, such as soils, vegetation, and flow paths, will influence the placement of buildings and paved surfaces. The evaluation will be used to meet the goals of capturing and treating runoff and assuring these goals are incorporated into the project design. Regulated Projects are required to consider optimizing the site layout through the following methods:

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas to be left undisturbed.
- Concentrate development on portions of the site with less permeable soils and preserve areas that can promote infiltration.
- Limit overall impervious coverage of the site with paving and roofs.
- Set back development from creeks, wetlands, and riparian habitats.
  - This method is expected not to be applicable to most developments in the City.
- Preserve significant trees.
- Conform the site layout along natural landforms.
- Avoid excessive grading and disturbance of vegetation and soils.
- Replicate the site's natural drainage patterns.
- Detain and retain runoff throughout the site.

For additional resources on how to conduct this type of assessment, see the California Stormwater Quality Association LID Port. The Watershed Management Group's Green Infrastructure for Southwestern Neighborhoods also has useful examples of measures that are tailored toward use in more arid environments and can be considered in initial site layout.
4.2 Source Control Measures
Regulated Projects shall implement source control BMPs for the activities and sources listed below, as applicable. Where any of the activities and sources below is not applicable to a Regulated Project, the project’s submittal shall clearly state the reason why (e.g., the activity or source is not present). Measures for each of the listed pollutant generating activities and sources at Regulated Projects shall be designed consistent with the standards presented in Table 2. These standards incorporate the standards in the current California Stormwater Quality Association (CASQA) Stormwater BMP Handbook for New Development and Redevelopment or equivalent manual where applicable.
Table 2. Summary of Source Control BMP Requirements (continued)

<table>
<thead>
<tr>
<th>Source Control BMP</th>
<th>Description</th>
<th>CASQA Reference¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental spills or leaks</td>
<td>Keep a spill kit or other means of responding to spills onsite. Liquid storage containers kept outdoors must be equipped with secondary containment unless the liquid stored contains no pollutants (e.g., purified water). Secondary containment design and spill response materials available onsite may also need to meet the requirements of other standards (e.g., hazardous materials, fire department).</td>
<td>--</td>
</tr>
<tr>
<td>Interior floor drains</td>
<td>Plumb indoor floor drains to the sanitary sewer system. Pretreatment is required where necessary to comply with City wastewater regulations.</td>
<td>--</td>
</tr>
<tr>
<td>Parking/storage areas and maintenance</td>
<td>Design parking areas to drain to landscaping or LID features where feasible. Complete regular sweeping or other cleaning of parking areas as necessary to remove accumulated trash, sediment, and other pollutants.</td>
<td>--</td>
</tr>
<tr>
<td>Indoor and structural pest control</td>
<td>Use integrated pest management to avoid or minimize pesticide use where feasible, and use pesticides only in accordance with manufacturer’s instructions. See BMP A-10 in Table 1 of the El Centro BMP Manual.</td>
<td>--</td>
</tr>
<tr>
<td>Landscape/outdoor pesticide use</td>
<td>Use integrated pest management to avoid or minimize pesticide use where feasible, and use pesticides only in accordance with manufacturer’s instructions. See BMP A-10 in Table 1 of the El Centro BMP Manual. Also use native plants or other plants that require minimal pesticide use as feasible.</td>
<td>--</td>
</tr>
<tr>
<td>Pools, spas, ponds, decorative fountains, and other water features</td>
<td>Discharges from water features to the municipal separate storm sewer system (MS4) are only allowed in certain cases. See BMP A-5 in Table 1 of the El Centro BMP Manual for pool and spa discharge regulations. Discharges from ponds, decorative fountains, and other water features to the MS4 are typically not allowed.</td>
<td>--</td>
</tr>
<tr>
<td>Source Control BMP</td>
<td>Description</td>
<td>CASQA Reference¹</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Restaurants, grocery stores, and other food service operations</td>
<td>Provide a covered, contained storage area for used cooking oil. This requirement may be satisfied by storing used cooking oil inside a building (ensure health regulations and fire department regulations are met) or in a “refuse area” designed to meet the requirements described below.</td>
<td>--</td>
</tr>
<tr>
<td>Refuse areas</td>
<td>Equip each new trash enclosure with a structural overhead canopy and a four-sided enclosure. Dumpsters and other trash receptacles in existing trash enclosures being protected in place at redevelopments must be provided with functional lids to prevent contact of stored wastes with precipitation. Site drainage should be directed away from the refuse area to prevent run-on. No storm drains are allowed within refuse areas.</td>
<td></td>
</tr>
<tr>
<td>Industrial processes</td>
<td>Design facilities such that industrial processes are located indoors or in covered areas protected from run-on to the extent feasible. Where applicable, industrial processes must be designed to comply with State of California Industrial General Permit requirements.</td>
<td>SD-31, SD-35</td>
</tr>
<tr>
<td>Outdoor storage of equipment</td>
<td>Regularly maintain equipment or vehicles to eliminate leaks. Store equipment or vehicles in covered areas where feasible. Unless vehicles are expected to accumulate significant amounts of pollutants on their exteriors, outdoor storage (e.g., in a parking lot) is acceptable.</td>
<td>--</td>
</tr>
<tr>
<td>Outdoor storage of materials</td>
<td>Design facilities such that material storage is located indoors or in covered areas protected from run-on to the extent feasible. Liquid storage shall comply with the standards listed in “Accidental spills and leaks” above. Outdoor material storage must also comply with all applicable planning and zoning requirements.</td>
<td>SD-34</td>
</tr>
<tr>
<td>Vehicle and equipment cleaning</td>
<td>Designated wash areas should be designed to drain to the sanitary sewer and covered and bermed or graded to prevent rain water from entering the sanitary sewer drain. See El Centro BMP Manual BMP A-3 for additional information.</td>
<td>SD-33</td>
</tr>
<tr>
<td>Source Control BMP</td>
<td>Description</td>
<td>CASQA Reference¹</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Vehicle and equipment repair and maintenance</td>
<td>Design facilities such that vehicle and equipment repair and maintenance are located indoors or in covered areas protected from run-on to the extent feasible. Pave maintenance areas with Portland cement concrete or equivalent to facilitate spill cleanup and prevent soil contamination. No storm drains shall be located within maintenance areas. Comply with all applicable planning and zoning requirements.</td>
<td>SD-31</td>
</tr>
<tr>
<td>Fuel dispensing areas</td>
<td>Cover fueling areas with a structural canopy and design site drainage such that run-on is not directed to fueling areas (e.g., a drainage swale directs runoff around the fueling area rather than through it). Appropriate spill prevention and response measures must also be incorporated in the site’s design; see the SD-30 fact sheet for more information. Each fueling area shall be equipped with a dead sump or equivalent to capture fuel in the event of a spill. The dead sump shall be located under the canopy to avoid receiving storm water runoff. Sizing of the sump shall be as directed by the City Engineer.</td>
<td>SD-30</td>
</tr>
<tr>
<td>Loading docks</td>
<td>Design loading docks to prevent run-on. Cover loading docks where feasible. Drains in uncovered loading docks, including depressed loading docks, must drain to an appropriate LID treatment BMP or to a dead sump. Pretreatment may also be required. Drains in covered loading docks must drain to a dead sump.</td>
<td>SD-31</td>
</tr>
<tr>
<td>Fire sprinkler test water</td>
<td>Fire sprinkler systems shall be designed to direct test water to the sanitary sewer system where approved by the City. Where discharge to the sanitary sewer system is not feasible, a paved pathway to the MS4 (to prevent erosion) shall be provided. Discharge to the MS4 is only allowed when no additives are present in the fire sprinkler test water.</td>
<td>--</td>
</tr>
<tr>
<td>Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources</td>
<td>Air conditioning condensate shall be managed in accordance with BMP A-6 in Table 1 of the El Centro BMP Manual. Discharges from other sources in this category are generally not allowed. See El Centro BMP Manual Section 3 and El Centro City Code sections 22-703 through 22-705.</td>
<td>--</td>
</tr>
</tbody>
</table>
Table 2. Summary of Source Control BMP Requirements (continued)

<table>
<thead>
<tr>
<th>Source Control BMP</th>
<th>Description</th>
<th>CASQA Reference¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unauthorized non-storm water discharges</td>
<td>Unauthorized non-storm water discharges are prohibited and should not be included in the site design. See El Centro BMP Manual Section 3 for additional details about non-storm water discharges.</td>
<td>--</td>
</tr>
<tr>
<td>Building and grounds maintenance</td>
<td>Water from indoor cleaning activities (mop water) shall not be discharged to the storm drain system. Mop sinks should be included in food service establishments. Water from power washing shall not be discharged to the MS4.</td>
<td>--</td>
</tr>
</tbody>
</table>

Note:
4.3 Low Impact Development (LID) Design Standards

All Regulated Projects are required to implement low impact development (LID) standards designed to reduce runoff, treat storm water, and provide baseline hydromodification management to the extent feasible, to meet the Numeric Sizing Criteria for Storm Water Retention and Treatment under Section 4.3.2.

4.3.1 Drainage Management Area Determination

Each Regulated Project shall provide a map or diagram dividing the developed portions of the project site into discrete Drainage Management Areas (DMAs). A drainage management area is a portion of the site that all drains to a single discharge point. Depending on the size of the site and the site’s drainage patterns, a site may have only one DMA, or it may have several. Runoff from each DMA shall be managed as follows:

- Implement all applicable source control BMPs (Section 4.2)
- Implement a combination of Site Design BMPs (Section 3) and Low Impact Development measures (Section 4.3) such that numeric sizing standards (Section 4.3.2) are satisfied
  - Additional hydromodification management measures may be needed if required by Section 4.4.

4.3.2 Numeric Sizing Criteria for Storm Water Retention and Treatment

Regulated Projects shall design facilities to evapotranspire, infiltrate, harvest/use, and biotreat runoff to meet at least one of the following hydraulic sizing design criteria. Calculations must be prepared per DMA.

1) **Volumetric Criteria**: The maximized capture storm water volume for the tributary area, on the basis of historical rainfall records, determined using the formula and volume capture coefficients in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87 (1998) pages 175-178 (that is, approximately the 85th percentile 24-hour storm runoff event, which is 0.41 inch in the City of El Centro\(^3\)). This calculation approach is described below.

   a) Calculate the runoff coefficient \(C\) to be used for storm water design volume (SDV) calculations using the formula below. Note that this \(C\) value is intended for use in calculating the SDV only and should not be used for flood control calculations.

   \[
   C = 0.858 \times i^3 - 0.78 \times i^2 + 0.774 \times i + 0.04
   \]

   \(i\) = impervious fraction of drainage area, calculated as (impervious area within DMA)/(total DMA area)

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\(^3\) Based on information provided in the post-construction calculator file available at [http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml](http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml). Alternative hydrologic analysis that determines a different value for the 85th percentile, 24-hour storm based on validated local rainfall data may be used if approved by the City Engineer.
b) Calculate the DMA-specific unit storm water volume ($P_0$) using the formula below:

$$P_0 = (a \times C) \times P_6$$

- $a =$ regression constant (1.963)
- $C =$ runoff coefficient, as determined in part (a) above
- $P_6 =$ mean annual runoff-producing rainfall depth, which is set at 0.41 inch for El Centro

c) Calculate the SDV as follows:

$$SDV = A \times \frac{P_0}{12}$$

- $SDV =$ storm water design volume (cubic feet)
- $A =$ DMA area (square feet)
- $P_0 =$ unit storm water volume (inches)

2) **Flow-Based Criteria:** The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity. This is determined using the rational method, where $Q = CIA$. “$A$” is the tributary area, “$I$” is the intensity (0.2 in/hr), and “$C$” is the runoff coefficient. For flow-based sizing, the same “$C$” value used for flood control calculations is used to calculate the storm water design flow rate.

a) Alternatively, if bioretention areas are designed using a flow-based criteria, a sizing factor of 4\% of the tributary impervious area may be used, as described in a footnote in Section 4.3.4.

Volumetric sizing criteria is typically used for bioretention, infiltration, retention basins, and detention basins. Flow-based sizing criteria is typically used for media filters and vegetated swales, where such BMPs are allowed. Flow-based criteria may also be instead of volumetric criteria for bioretention areas if desired, as described in a footnote in Section 4.3.4. However, flow-based sizing for bioretention may result in an oversized (larger) bioretention area when compared to volumetric sizing.

Other numeric sizing criteria allowed by the Phase II Permit may also be used where applicable. Applicants should discuss alternative approaches with Engineering staff before proposing them in a submittal.

Note that the City of El Centro requires projects to provide what are typically referred to as “retention basins” sized for the 100-year storm. These basins are typically designed such that during smaller storms little to no runoff is directed to the basin. A common design is that, to meet LID standards, a larger storm drain pipe is connected downstream to a smaller pipe. When the capacity of the smaller pipe is exceeded, water backs up in the system and flows into the basin. When the capacity of the smaller pipe is not exceeded though, runoff does not flow into the basin. Basins designed in that way do not provide a significant water quality benefit for the smaller storms to which the water quality numeric
sizing standards described above apply. Basins that capture water for all sizes of storms and allow it to infiltrate or evaporate can be used to meet the water quality numeric sizing standards described above. However, the proposed design must demonstrate that water will be drawn down within 72 hours to meet vector control requirements.

4.3.2.1 Special Sizing Standards for Redevelopment Projects
Redevelopment is any land-disturbing activity that results in the creation, addition, or replacement of exterior impervious surface area on a site on which some past development has occurred. Redevelopment does not include trenching, excavation and resurfacing associated with LUPs; pavement grinding and resurfacing of existing roadways; construction of new sidewalks, pedestrian ramps, or bike lanes on existing roadways; or routine replacement of damaged pavement such as pothole repair or replacement of short, non-contiguous sections of roadway.

- Where a redevelopment project results in an increase of more than 50 percent of the impervious surface of a previously existing development, runoff from the entire project, consisting of all existing, new, and/or replaced impervious surfaces, must be included to the extent feasible.
- Where a redevelopment project results in an increase of less than 50 percent of the impervious surface of a previously existing development, only runoff from the new and/or replaced impervious surface of the project must be included.

4.3.2.2 Special Sizing Standards for LUPs and Road Projects
Specific Regulated Project requirements for road projects and LUPs are discussed below. Note that certain types of road projects and LUPs are exempt from post-construction BMP requirements and are not considered Regulated Projects—see Section 2.1 for details.

Any of the following types of road projects and LUPs that create 5,000 square feet or more of newly constructed contiguous impervious surface and that are public road projects and/or fall under the City’s building and planning authority shall implement site design BMPs, source control BMPs, and LID BMPs, except that treatment of runoff of the SDV that cannot be infiltrated onsite shall follow U.S. EPA guidance regarding green infrastructure to the extent feasible. Types of projects include the following:

- Construction of new streets or roads, including sidewalks and bicycle lanes built as part of the new streets or roads, except as exempted in Section 2.1.
- Widening of existing streets or roads with additional traffic lanes.
  - Where the addition of traffic lanes results in an alteration of more than 50 percent of the impervious surface of an existing street or road, runoff from the entire project, consisting of all existing, new, and/or replaced impervious surfaces, must be included in the treatment system design.
  - Where the addition of traffic lanes results in an alteration of less than 50 percent (but 5,000 square feet or more) of the impervious surface of an existing street or road, only

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the runoff from new and/or replaced impervious surface of the project must be included in the treatment system design.

- Construction of LUPs that have one or more discrete locations that each individually has 5,000 square feet or more of new contiguous impervious surface.
  - When the LUP has one or more discrete locations with 5,000 square feet or more of new contiguous impervious surface, only the specific discrete locations with 5,000 square feet or more of new contiguous impervious surface are subject to the requirements for Regulated Projects.

The EPA guidance focuses primarily on three types of BMPs: minimizing street widths, implementing bioretention areas along street corridors, and implementing permeable pavement. The guidance manual itself provides more detail on these measures, how they may be implemented for road projects, and their limitations.\(^5\) The process for designing projects according to the EPA guidance involves first assessing whether numeric sizing standards (see Section 4.3.2) can be met using the BMPs discussed in the EPA guidance. Where it is not feasible to meet numeric sizing standards, e.g., due to site constraints, the reason why it is not feasible must be documented, and BMPs must be implemented to the maximum extent practicable. The County of Orange has developed a useful process for making this assessment.\(^6\)

**4.3.3 Site Design BMPs**

Each Regulated Project shall implement Site Design BMPs as defined in Section 3, and in consideration of the site assessment completed per Section 4.1, based on the objective of achieving infiltration, evapotranspiration and/or harvesting/reuse of the SDV. Site design BMPs shall be used to reduce the amount of runoff, to the extent technically feasible, for which retention and runoff is required. The amount of runoff reduced by site design BMPs shall be calculated per the method described in Section 3. Any remaining runoff from impervious DMAs may then be directed to one or more BMPs as specified in Section 4.3.4.

**4.3.4 Storm Water Treatment BMPs and Baseline Hydromodification Management BMPs**

Site Design BMPs provide a credit that is used to reduce the amount of the SDV to be treated with LID or treatment BMPs, as shown in Figure 3. Any remaining runoff from DMAs that include impervious area\(^7\) that is not treated by site design BMPs shall be directed to one or more facilities designed to infiltrate, evapotranspire, and/or bioretain runoff. The facilities must be demonstrated to be at least as effective as a bioretention system with the following design parameters:

- Minimum surface reservoir volume equal to surface area times a depth of 6 inches

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\(^5\) Ibid.

\(^6\) See the Santa Ana Region Technical Guidance Document (TGD), available at http://ocwatersheds.com/documents/wqmp. As of this writing, the discussion on applying EPA green infrastructure guidance is included in Section 2.7 of the TGD.

\(^7\) DMAs that are solely pervious area and that drain directly offsite without their runoff comingling with runoff from DMAs with impervious area must implement site design BMPs to the maximum extent practicable, but are not required to implement LID or treatment BMPs to treat any remaining runoff after implementing site design BMPs.
• Minimum planting medium depth of 18 inches. The planting medium must sustain a minimum infiltration rate of 5 inches per hour throughout the life of the project and must maximize runoff retention and pollutant removal. A mixture of sand (60%-70%) meeting the specifications of American Society for Testing and Materials (ASTM) C33 and compost (30%-40%) may be used.

• Subsurface drainage/storage (gravel) layer with an area equal to the surface area and having a minimum depth of 12 inches.

• Volume that equals or exceeds $V_{bd}$, as calculated per the process in Figure 3.\(^8\) The bioretention volume is calculated as the sum of the following component volumes:
  
  - Surface storage = (Average surface ponding depth) x (plan view surface area)
  - Planting medium storage = (planting medium depth) x (plan view surface area) x 0.3
    - Planting medium is assumed to be 30% voids
  - Gravel layer storage = (gravel layer depth) x (plan view surface area) x 0.4
    - Gravel layer is assumed to be 40% voids

• Underdrain with discharge elevation at top of gravel layer.
  
  - Note that the underdrain pipe must be perforated only with the perforations facing downward. Perforations must not face up toward the ground surface.

• No compaction of soils beneath the facility, or ripping/loosening of soils if compacted.

• No liners or other barriers interfering with infiltration.

• Appropriate plant palette for the specified soil mix and maximum available water use.

Note that bioretention area designs are allowed to vary from the specifications provided above under certain circumstances, as described in Section 4.3.4.3 below. Figure 4 presents a flow chart that provides directions about when alternative bioretention designs, as described in Section 4.3.4.3, should be used based on site-specific factors.

BMPs that retain or store water that may be exposed to vectors must be designed to draw down within 72 hours for vector control purposes. Subsurface storage not exposed to vectors should also be drawn down within 72 hours where feasible. Note that if longer periods of subsurface retention are anticipated, the landscape designer must ensure that selected plants are can tolerate extended periods of saturated soil conditions. Also note that BMPs that store water (including, but not limited to infiltration and bioretention) may pose geotechnical risks when located close to a structure or other infrastructure. Project proponents are responsible for evaluating and appropriately mitigating geotechnical risks associated with BMPs.

Example cross sections and additional design tips for bioretention and other BMPs can be found in other publicly available manuals, such as the following:

\[^8\] Alternatively, a maximum surface loading rate of 5 inches per hour, based on the flow rates calculated, may be used in a flow-based sizing approach. A sizing factor of 4% of tributary impervious area may be used in this scenario. For example, a bioretention area with 5,000 square feet of tributary impervious area would need to be (5,000 square feet of impervious area) x 4% = 200 square feet.

Note that while other manuals may be helpful references, they are generally developed for different requirements than those that apply to the City of El Centro. **All submittals to the City of El Centro must be prepared to meet the numeric sizing standards in Section 4.3.2, the BMP performance standards in this section, and the other requirements as provided in this Post-Construction Storm Water Standards Manual.** Submittals that do not meet City of El Centro standards, even if they meet standards of other manuals, will not be approved.

### 4.3.4.1 Alternative Designs

Facilities, or a combination of facilities, of a different design than in Section 4.3.4 may be permitted if all of the following measures of equivalent effectiveness are demonstrated:

• Equal or greater amount of runoff infiltrated or evapotranspired  
• Equal or lower pollutant concentrations in runoff that is discharged after biotreatment  
• Equal or greater protection against shock loadings and spills  
• Equal or greater accessibility and ease of inspection and maintenance

In some cases, bioretention areas may not be feasible due to a combination of lack of hydraulic head and low soil infiltration rate. Bioretention facilities in these areas would require an underdrain due to the low soil infiltration rate, but cannot be equipped with an underdrain due to insufficient hydraulic head (e.g., there is no nearby underground storm drain system, and the bioretention area underdrain invert would be below the flow line elevation of the curb and gutter along streets adjacent to the property). In these situations, the design should first verify that it is not possible to implement additional site design BMPs that would treat the SDV. If site design BMPs have been implemented to the extent practicable, and the SDV has still not been fully treated, a rock retention/storage area may be used, as described below. These BMPs are considered to be as effective as bioretention would be if bioretention was implemented in this limited set of circumstances.

Retention/storage BMPs are typically designed as rock filled trenches. Water is stored in the voids and eventually infiltrates or evaporates. The volume credit for a retention/storage BMP is determined by calculating the volume of the rock filled area and multiplying it by a void percentage of 40%.
These retention/storage BMPs are not the same as flood control "retention" basins. A retention BMP stores captured water until it infiltrates or evaporates. The water is not released back into the storm drain system after high flow rates subside. Also, water from all storm sizes, not just large storms, must be directed to the retention BMP for credit to be given. Finally, for vector control purposes, retention BMPs must be designed such that there is no above ground water 72 hours after a storm. If any initial surface storage is proposed for a retention BMP, the designer must show how all water initially stored above ground will be infiltrated or evaporated within 72 hours based on saturated soil infiltration rates and on winter evapotranspiration values. Site specific infiltration test information must also be submitted as part of this explanation; see Section 4.3.4.5 for additional details. Retention/storage systems are also subject to the same adjustments as bioretention areas for special site circumstances described in Section 4.3.4.3, except for underdrains, since retention/storage systems do not have underdrains.

BMPs that store water, including, but not limited to infiltration and retention BMPs, may pose geotechnical risks when located close to a structure or other infrastructure. Project proponents are responsible for evaluating and appropriately mitigating geotechnical risks associated with BMPs.

4.3.4.2 Alternative Designs for Road Projects and LUPs
Road projects and LUPs may implement BMPs per the EPA green infrastructure guidance, as described in Section 4.3.2.2.

4.3.4.3 Allowed Variations for Special Site Conditions
The bioretention system design parameters in Section 4.3.4 may be adjusted for the following special site conditions:

- Facilities located within 10 feet of structures or other potential geotechnical hazards established by the geotechnical expert for the project may incorporate an impervious cutoff wall between the bioretention facility and the structure or other geotechnical hazard.
- Facilities with documented high concentrations of pollutants in underlying soil or groundwater, facilities located where infiltration could contribute to a geotechnical hazard, and facilities located on elevated plazas or other structures may incorporate an impervious liner and may locate the underdrain discharge at the bottom of the subsurface drainage/storage layer (this configuration is commonly known as a “flow-through planter”).
- Facilities located in areas of high groundwater (less than 6 feet depth to groundwater\(^9\)), highly infiltrative soils (greater than 0.5 inch/hour\(^10\)), or where connection of underdrain to a surface drain or to a subsurface storm drain are infeasible, may omit the underdrain.
- Facilities serving high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites may be required to provide additional treatment to address pollutants of concern unless these high-risk areas are isolated from storm water runoff or bioretention areas with little chance of spill migration. Additional treatment is typically provided via a sand filter or

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\(^{10}\) Ibid. Note that this infiltration rate is the rate after applying the safety factor, as described in Section 4.3.4.5.
other media filter, such as a proprietary cartridge filter. The pretreatment device selected must be demonstrated to be effective for the anticipated pollutants associated with activities or material storage in the high-risk area.

Figure 4 presents a flow chart summarizing the scenarios in which bioretention designs may be adjusted based on site conditions.

4.3.4.4 Exceptions to Requirements for Bioretention Facilities
Contingent on a demonstration that use of bioretention or a facility of equivalent effectiveness is infeasible, other types of biotreatment or media filters may be used for the following categories of Regulated Projects:

- Projects creating or replacing an acre or less of impervious area, and located in a designated pedestrian-oriented commercial district (i.e., smart growth projects), and having at least 85% of the entire project site covered by permanent structures. Downtown El Centro, in the area bounded by State, Broadway, 4th, and 8th, is considered a pedestrian-oriented commercial district. Contact Engineering staff for more information on this potential exemption if your project is located in this area and at least 85% of the proposed project site will be covered by permanent structures.
- Facilities receiving runoff solely from existing (pre-project) impervious areas
- Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity

BMPs that may be considered acceptable when bioretention or other equally effective BMPs are infeasible include tree-box-type biofilters, modular wetlands, in-vault media filters, or sand filters, or other BMPs that can be demonstrated to be as effective as these methods to the satisfaction of the City Engineer. To demonstrate equal effectiveness, the factors included in Section 4.3.4.1 must be considered, but the standard of comparison is tree-box-type biofilters, modular wetlands, in-vault media filters, or sand filters rather than bioretention. Alternative BMPs shall be sized to treat the flow rate or volume of runoff as provided in Section 4.3.2. Sizing of these BMPs shall follow guidance provided by the manufacturer or CASQA, as applicable.

4.3.4.5 Infiltration BMPs
Infiltration BMPs can be used in place of bioretention or biofiltration BMPs when feasible. To be feasible, the BMP must meet all of the following criteria at a minimum:

- The infiltration rate, after safety factor adjustment (see below), must be at least 0.5 inch/hour.
- The depth to groundwater, as measured from the bottom elevation of the proposed BMP, must be at least 6 feet.
- A geotechnical professional must certify that the proposed placement of the BMP will not result in negative geotechnical impacts (impacts to building foundations, liquefaction, slope stability, etc.). Project proponents are responsible for evaluating and appropriately mitigating geotechnical risks associated with BMPs.
• No contaminated soils or groundwater are present in the immediate vicinity, and infiltration in the proposed location will not result in mobilizing pollutants in contaminated soils or groundwater.
• Infiltration BMPs must not be used for areas of industrial or light industrial activity, and other high threat to water quality land uses and activities as designated by the City, unless source control BMPs to prevent exposure of high threat activities are implemented, or runoff from such activities is first treated or filtered to remove pollutants prior to infiltration.
• Infiltration BMPs must be located a minimum of 100 feet horizontally from any water supply well.

Note that because most soils in El Centro have low infiltration rates, using infiltration may be difficult. A site-specific infiltration test completed by an appropriately licensed professional will be required whenever an infiltration BMP is proposed, and an appropriate safety factor must be used. Infiltration tests shall meet the following standards:

• In situ infiltration/ percolation testing shall be conducted at a minimum of two locations within 50-feet of each proposed storm water infiltration/ percolation BMP.
• In situ infiltration/percolation testing shall be conducted using an approved method listed in Table D.3-1 in Attachment 1-A.
• Testing shall be conducted at approximately the same depth and in the same material as the base of the proposed storm water BMP.

The measured infiltration rate or percolation rate based on test results is divided by the safety factor to give the infiltration rate used for design purposes. For example, if the measured infiltration rate is 1.0 inch/hour, and the safety factor is 4.0, then the design infiltration rate is 0.25 inch/hour. Infiltration rates and safety factors are determined using the procedures in Appendix D of the San Diego Region Model BMP Design Manual,\(^\text{11}\) which is included as Attachment 1-A to this document.

4.4 Hydromodification Management

Hydromodification management projects are Regulated Projects that create and/or replace one acre or more of impervious surface. A project that does not increase impervious surface area over the pre-project condition is not a hydromodification management project. The pre-project condition is defined as the condition of the site proposed for development at the time of the permit application submittal. Post-project runoff for Hydromodification Projects shall not exceed estimated pre-project peak flow rate for the 10-year, 24-hour storm. For the El Centro area, the 10-year, 24-hour storm is approximately 1.93 inch.\(^\text{12}\)


\(^{12}\) NOAA Atlas 14, Volume 6, Version 2. El Centro data was obtained from the following: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_printpage.html?lat=32.7893&lon=-115.5671&data=depth&units=english&series=pds
Hydromodification Projects shall submit hydrologic analyses that show the 10-year, 24-hour flow rate for the pre-project (existing) condition and for the post-project (proposed) condition. The calculations shall demonstrate that the combination of BMPs implemented for the project is sufficient to meet the performance standard described above. Projects connecting to IID drains must also meet all IID standards for flow control and all City of El Centro standards for flood control.

5 Required Submittals

5.1 Submittals for Standard Projects
Standard projects are required to submit the following:

1. Plan sheets that specifically identify where at least one of the site design BMPs listed in Section 3 will be implemented for the proposed project.
2. Complete the City’s standard project worksheet to estimate runoff volume reduction credit for the proposed site design BMPs. The worksheet, which is available from the Building and Safety Division, is a simplified tool based on the spreadsheet calculator tool described in Section 3.

5.2 Submittals for Regulated Projects
Regulated projects are required to submit the following:

1. Plan sheets that
   a. Show the location and size, as applicable, of all site design BMPs, source control BMPs, LID measures, and if applicable, additional controls for hydromodification (as specified in Section 4.4).
   b. Include cross sections and details as necessary to demonstrate compliance with BMP sizing standards.
2. A Water Quality Management Plan (WQMP) demonstrating compliance with the requirements of the Post-Construction Storm Water Standards Manual. A WQMP template is available on the City’s website at http://www.cityofelcentro.org/engineering/. The WQMP must include an operation and maintenance plan (O&M Plan) for proposed BMPs, as described below.
   a. At a minimum, the O&M Plan must describe operation and maintenance procedures for each of the following BMPs, if proposed for the project: retention/storage, bioretention, and any other LID or treatment BMP; any hydromodification flow control BMP, such as detention basins; vegetated swales; porous pavement. The O&M Plan must include the following components:
      i. Specific maintenance indicators and actions for proposed BMP(s). Example descriptions of operation and maintenance actions that can be used are provided in the the Whitewater River Region Stormwater Quality Best Management Practice Design Handbook for Low Impact Development (http://rcflood.org/NPDES/WhitewaterWS.aspx) prepared by Riverside County Flood Control District and the CASQA California Stormwater BMP Handbook,

ii. How to access the BMP(s) to inspect and maintain them
iii. Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
iv. Recommended equipment to perform maintenance
v. When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

3. The project owner is also required to record a maintenance agreement that runs with the land prior to project completion. The maintenance agreement shall be submitted for City review along with the WQMP before it is recorded.

Figures 3 and 4 provide additional guidance for Regulated Projects on calculations to demonstrate compliance with BMP sizing and on justifying the type of bioretention design used, respectively. These figures are expected to be applicable to most Regulated Projects, but different requirements may apply to some Regulated Projects, as detailed in Section 4.
Figure 3. Site Design and Storm Water Treatment Sizing Guidance Summary

1. Calculate Storm Water Design Volume (SDV)
2. Propose site design measures, and then calculate the volume of runoff reduced by the site design measures ($V_{SDM}$).
3. Calculate remaining runoff volume, $V_R$ ($V_R = SDV - V_{SDM}$).
   - If $V_R \leq 0$, done (no more BMPs necessary).
   - If $V_R > 0$:
     - DMA is 100% pervious area and drains offsite without comingling with runoff from DMAs containing impervious area.
       - Yes: Self-treating, no further BMPs necessary.
       - No: Additional treatment required (select one of options below)
         - Use bioretention to treat $V_R$
         - Use other, equally effective treatment method (See Section 4.3.4.1)
         - Use alternative BMPs, where allowed (See Section 4.3.4.4)

Notes
- This flow chart assumes a volumetric sizing approach. A flow-based sizing approach is also allowed per Section 4.3.2, but this flow chart is not directly applicable to that method.
- This flow chart is a summary of relevant requirements that should apply to most projects. Different sizing and BMP design standards may apply to some projects—see Section 4.3 for details.
- See Section 3 for more detail on calculating $V_{SDM}$. 
Figure 4. Bioretention Design Guidance

**Underdrain**
- Shallow groundwater, high infiltration rate soil, or connection to outlet drain is infeasible → True → No underdrain
  - False → Underdrain included at top of subsurface gravel layer

**Impervious Liner**
- Documented underlying contaminated soil or groundwater, locations where infiltration could contribute to geotechnical hazard, or facilities located on elevated plazas or other structures → True → Underdrain placed at bottom of subsurface gravel layer
  - False →Located within 10 feet of structures or other geotechnical hazards established by the project’s geotechnical expert → True → Impervious cutoff wall (e.g., impermeable liner) between bioretention facility and hazard
  - False → No liner

**Pretreatment**
- High risk area (exposed fueling station, truck stop, auto repair, heavy industrial, etc.) drains to BMP → True → Pretreatment required**
  - False → No pretreatment

**Notes:**
*Also mark as false if the high risk area(s) are all isolated from storm water runoff, with minimal spill risk (e.g., a covered fueling area graded to prevent run-on)*
**See Section 4.3.4.3 for additional information about pretreatment.*
6 Common Questions and Answers about Applicability

What counts as “impervious surface”?
The most common examples of impervious surfaces are rooftops and concrete or asphalt pavement. Impervious surfaces are any surface covering or pavement of a developed parcel of land that prevents the land’s natural ability to absorb and infiltrate rainfall/storm water. Impervious surfaces include, but are not limited to, rooftops, walkways, patios, driveways, parking lots, storage areas, impervious concrete and asphalt, and any other continuous watertight pavement or covering. Landscaped soil and pervious pavement, including pavers with pervious openings and seams, underlain with pervious soil or pervious storage material, such as a gravel layer, are not impervious surfaces.

Does pervious pavement count toward the total impervious area?
No, pervious asphalt, pervious concrete, pavers with pervious openings, and other types of pervious pavement do not count as impervious area as long as the pavement is underlain with pervious soil, gravel, or other pervious material. For example, a site with 1,000 square feet of rooftop and 2,000 square feet of standard concrete paving would have 3,000 square feet of impervious area. If the same site kept the 1,000 square feet of rooftop but used 1,000 square feet of standard concrete paving and 1,000 square feet of pervious pavement, it would only have 2,000 square feet of impervious area.

How is the amount of impervious area calculated for a redevelopment project?
The requirements ask for the amount of impervious area created or replaced, not only the amount newly created. If existing impervious area is removed and replaced with new impervious area, that new impervious area counts toward the total project impervious area, even though the area was already pervious in the existing condition. If a redevelopment leaves existing area undisturbed, that impervious area is not counted toward the total project impervious area.

Example 1: an existing 20,000 square foot developed property that is being redeveloped currently has 12,000 square feet of impervious area. All existing impervious area is demolished. The project then constructs a 7,000 square foot parking lot and 3,000 square foot building. This project would have a total project impervious area of 10,000 square feet and would be a Regulated Project. Because the development results in an increase of less than 50 percent of the pre-project impervious area (since pre-project impervious is 12,000 square feet and post-project impervious is 7,000 + 3,000 = 10,000 square feet, it actually is a slight decrease), only runoff from the new and/or replaced impervious surface must be treated. See section 4.3.2.1 for details.

Example 2: the same property in Example 1 is redeveloped. This time, instead of completely demolishing all impervious area, the existing 7,000 square foot parking lot is retained, and the remaining 5,000 square feet of building and other impervious areas is demolished. The project does some minor resurfacing to the 7,000 square foot parking lot but does not completely remove the pavement and replace it. A new 3,000 square foot building is constructed, as in the example above. Since the parking lot was not completely removed and replaced, it does not count toward the total project impervious
area. For Example 2, the total project impervious area is 3,000 square feet. The project is required to do Site Design BMPs but is not a Regulated Project.

**Example 3:** A 20,000 square foot property with 5,000 square feet of existing impervious area is redeveloped. The existing impervious area is retained as is. A new building and parking lot totaling 8,000 square feet of impervious area is built. Because more than 5,000 square feet of impervious area is created or replaced, this is a Regulated Project. The increase in impervious area is more than 50 percent (8,000/5,000 = 160%), so the project must treat runoff the runoff from both the addition (8,000 square feet) and the existing impervious area (5,000 square feet) to the extent feasible. See Section 4.3.2.1 for details.

**What is a linear underground/overhead project (LUP)?**
Most LUPs are public projects associated with utilities. LUPs include, but are not limited to, any conveyance, pipe, or pipeline for the transportation of any gaseous, liquid (including water and wastewater for domestic municipal services), liquefied, or slurry substance; any cable line or wire for the transmission of electrical energy; any cable line or wire for communications (e.g., telephone, telegraph, radio, or television messages); and associated ancillary facilities. Construction activities associated with LUPs include, but are not limited to, (a) those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment, and associated ancillary facilities); and include, but are not limited to, (b) underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/or pavement repair or replacement, and stockpile/borrow locations.
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Attachment 1-A

Approved Infiltration Rate Assessment Methods for Selection and Design of Storm Water BMPs

(Appendix D of the San Diego Region Model BMP Design Manual)
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Appendix D Approved Infiltration Rate Assessment Methods for Selection and Design of Storm Water BMPs

D.1 Introduction

Characterization of potential infiltration rates is a critical step in evaluating the degree to which infiltration can be used to reduce storm water runoff volume. This appendix is intended to provide guidance to help answer the following questions:

1. How and where does infiltration testing fit into the project development process?
   Section D.2 discusses the role of infiltration testing in different stages of project development and how to plan a phased investigation approach.

2. What infiltration rate assessment methods are acceptable?
   Section D.3 describes the infiltration rate assessment methods that are acceptable.

3. What factors should be considered in selecting the most appropriate testing method for a project?
   Section D.4 provides guidance on site-specific considerations that influence which assessment methods are most appropriate.

4. How should factors of safety be selected and applied to, for BMP selection and design?
   Section D.5 provides guidance for selecting a safety factor.

Note, that this appendix does not consider other feasibility criteria that may make infiltration infeasible, such as groundwater contamination and geotechnical considerations (these are covered in Appendix C). In general, infiltration testing should only be conducted after other feasibility criteria specified in this manual have been evaluated and cleared.

D.2 Role of Infiltration Testing in Different Stages of Project Development

In the process of planning and designing infiltration facilities, there are a number of ways that infiltration testing or estimation factors into project development, as summarized in Table D.2-1. As part of selecting infiltration testing methods, the geotechnical engineer shall select methods that are applicable to the phase of the project and the associated burden of proof.
Appendix D: Approved Infiltration Rate Assessment Methods

Table D.2-1: Role of Infiltration Testing

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Key Questions/Burden of Proof</th>
<th>General Assessment Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Planning</td>
<td>• Where within the project area is infiltration potentially feasible?</td>
<td>• Use existing data and maps to the extent possible</td>
</tr>
<tr>
<td>Phase</td>
<td>• What volume reduction approaches are potentially suitable for my project?</td>
<td>• Use less expensive methods to allow a broader area to be investigated more rapidly</td>
</tr>
<tr>
<td></td>
<td>• Use existing data and maps to the extent possible.</td>
<td>• Reach tentative conclusions that are subject to confirmation/refinement at the design phase</td>
</tr>
<tr>
<td>BMP Design</td>
<td>• What infiltration rates should be used to design infiltration and biofiltration facilities?</td>
<td>• Use more rigorous testing methods at specific BMP locations</td>
</tr>
<tr>
<td>Phase</td>
<td>• What factor of safety should be applied?</td>
<td>• Support or modify preliminary feasibility findings</td>
</tr>
<tr>
<td></td>
<td>• Reach tentative conclusions that are subject to confirmation/refinement at the design phase</td>
<td>• Estimate design infiltration rates with appropriate factors of safety</td>
</tr>
</tbody>
</table>

D.3 Guidance for Selecting Infiltration Testing Methods

The geotechnical engineer shall select appropriate testing methods for the site conditions, subject to the engineer’s discretion and approval of the [City Engineer], that are adequate to meet the burden of proof that is applicable at each phase of the project design (See Table D.3-1):

- At the planning phase, testing/evaluation method must be selected to provide a reliable estimate of the locations where infiltration is feasible and allow a reasonably confident determination of infiltration feasibility to support the selection between full infiltration, partial infiltration, and no infiltration BMPs.

- At the design phase, the testing method must be selected to provide a reliable infiltration rate to be used in design. The degree of certainty provided by the selected test should be considered.

Table D.3-1 provides a matrix comparison of these methods. Sections D.3.1 to D.3.3 provide a summary of each method. This appendix is not intended to be an exhaustive reference on infiltration testing at this time. It does not attempt to discuss every method for testing, nor is it intended to provide step-by-step procedures for each method. The user is directed to supplemental resources (referenced in this appendix) or other appropriate references for more specific information. Alternative testing methods are allowed with appropriate rationales, subject to
Appendix D: Approved Infiltration Rate Assessment Methods

the discretion of the [City Engineer].

In order to select an infiltration testing method, it is important to understand how each test is applied and what specific physical properties the test is designed to measure. Infiltration testing methods vary considerably in these regards. For example, a borehole percolation test is conducted by drilling a borehole, filling a portion of the hole with water, and monitoring the rate of fall of the water. This test directly measures the three dimensional flux of water into the walls and bottom of the borehole. An approximate correction is applied to indirectly estimate the vertical hydraulic conductivity from the results of the borehole test. In contrast, a double-ring infiltrometer test is conducted from the ground surface and is intended to provide a direct estimate of vertical (one-dimensional) infiltration rate at this point. Both of these methods are applicable under different conditions.

Table D.3-1: Comparision of Infiltration Rate Estimation and Testing Methods

<table>
<thead>
<tr>
<th>Test</th>
<th>Suitability at Planning Level Screening Phase</th>
<th>Suitability at BMP Design Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRCS Soil Survey Maps</td>
<td>Yes, but mapped soil types must be confirmed with site observations. Regional soil maps are known to contain inaccuracies at the scale of typical development sites.</td>
<td>No, unless a strong correlation is developed between soil types and infiltration rates in the direct vicinity of the site and an elevated factor of safety is used.</td>
</tr>
<tr>
<td>Grain Size Analysis</td>
<td>Not preferred. Should only be used if a strong correlation has been developed between grain size analysis and measured infiltration rates testing results of site soils.</td>
<td>No</td>
</tr>
<tr>
<td>Cone Penetrometer Testing</td>
<td>Not preferred. Should only be used if a strong correlation has been developed between CPT results and measured infiltration rates testing results of site soils.</td>
<td>No</td>
</tr>
<tr>
<td>Simple Open Pit Test</td>
<td>Yes</td>
<td>Yes, with appropriate correction for infiltration into side walls and elevated factor of safety.</td>
</tr>
<tr>
<td>Open Pit Falling Head Test</td>
<td>Yes</td>
<td>Yes, with appropriate correction for infiltration into side walls and elevated factor of safety.</td>
</tr>
<tr>
<td>Double Ring Infiltrometer Test (ASTM 3385)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Single Ring Infiltrometer Test</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Test</th>
<th>Suitability at Planning Level Screening Phase</th>
<th>Suitability at BMP Design Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-scale Pilot Infiltration Test</td>
<td>Yes, but generally cost prohibitive and too water-intensive for preliminary screening of a large area.</td>
<td>Yes, but should consider relatively large water demand associated with this test.</td>
</tr>
<tr>
<td>Smaller-scale Pilot Infiltration Test</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Well Permeameter Method (USBR 7300-89)</td>
<td>Yes; reliability of this test can be improved by obtaining a continuous core where tests are conducted.</td>
<td>Yes in areas of proposed cut where other tests are not possible; a continuous boring log should be recorded and used to interpret test; should be confirmed with a more direct measurement following excavation.</td>
</tr>
<tr>
<td>Borehole Percolation Tests (various methods)</td>
<td>Yes; reliability of this test can be improved by obtaining a continuous core where tests are conducted.</td>
<td>Yes in areas of proposed cut where other tests are not possible; a continuous boring log should be recorded and used to interpret test; should be confirmed with a more direct measurement following excavation.</td>
</tr>
<tr>
<td>Laboratory Permeability Tests (e.g., ASTM D2434)</td>
<td>Yes, only suitable for evaluating potential infiltration rates in proposed fill areas. For sites with proposed cut, it is preferred to do a borehole percolation test at the proposed grade instead of analyzing samples in the lab. A combination of both tests may improve reliability.</td>
<td>No. However, may be part of a line of evidence for estimating the design infiltration of partial infiltration BMPs constructed in future compacted fill.</td>
</tr>
</tbody>
</table>

D.3.1 Desktop Approaches and Data Correlation Methods

This section reviews common methods used to evaluate infiltration characteristics based on desktop-available information, such as GIS data. This section also introduces methods for estimating infiltration properties via correlations with other measurements.

D.3.1.1 NRCS Soil Survey Maps

NRCS Soil Survey maps (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) can be used to estimate preliminary feasibility conditions, specifically by mapping hydrologic soil groups, soil texture classes, and presence of hydric soils relative to the site layout. For feasibility determinations, mapped conditions must be supplemented with available data from the site (e.g., soil borings, observed soil textures, biological indicators). The presence of D soils, if confirmed by available data, provides a reasonable basis to determine that full infiltration is not feasible for a given DMA.

D.3.1.2 Grain Size Analysis Testing and Correlations to Infiltration Rate

Hydraulic conductivity can be estimated indirectly from correlations with soil grain-size
Appendix D: Approved Infiltration Rate Assessment Methods

distributions. While this method is approximate, correlations have been relatively well established for
some soil conditions. One of the most commonly used correlations between grain size parameters
and hydraulic conductivity is the Hazen (1892, 1911) empirical formula (Philips and Kitch, 2011),
but a variety of others have been developed. Correlations must be developed based on testing of
site-specific soils.

D.3.1.3 Cone Penetrometer Testing and Correlations to Infiltration Rate

Hydraulic conductivity can also be estimated indirectly from cone penetrometer testing (CPT). A
cone penetrometer test involves advancing a small probe into the soil and measuring the relative
resistance encountered by the probe as it is advanced. The signal returned from this test can be
interpreted to yield estimated soil types and the location of key transitions between soil layers. If this
method is used, correlations must be developed based on testing of site-specific soils.

D.3.2 Surface and Shallow Excavation Methods

This section describes tests that are conducted at the ground surface or within shallow excavations
close to the ground surface. These tests are generally applicable for cases where the bottom of the
infiltration system will be near the existing ground surface. They can also be conducted to confirm
the results of borehole methods after excavation/site grading has been completed.

D.3.2.1 Simple Open Pit Test

The Simple Open Pit Test is most appropriate for planning level screening of infiltration feasibility.
Although it is similar to Open Pit Falling Head tests used for establishing a design infiltration rate
(see below), the Simple Open Pit Test is less rigorous and is generally conducted to a lower standard
of care. This test can be conducted by a nonprofessional as part of planning level screening phase.

The Simple Open Pit Test is a falling head test in which a hole at least two feet in diameter is filled
with water to a level of 6” above the bottom. Water level is checked and recorded regularly until
either an hour has passed or the entire volume has infiltrated. The test is repeated two more times in
succession and the rate at which the water level falls in the third test is used as the infiltration rate.

This test has the advantage of being inexpensive to conduct. Yet it is believed to be fairly reliable for
screening as the dimensions of the test are similar, proportionally, to the dimensions of a typical
BMP. The key limitations of this test are that it measures a relatively small area, does not necessarily
result in a precise measurement, and may not be uniformly implemented.

D.3.2.2 Open Pit Falling Head Test

This test is similar to the Simple Open Pit Test, but covers a larger footprint, includes more specific instructions, returns more precise measurements, and generally should be overseen by a geotechnical professional. Nonetheless, it remains a relatively simple test.

To perform this test, a hole is excavated at least 2 feet wide by 4 feet long (larger is preferred) and to a depth of at least 12 inches. The bottom of the hole should be approximately at the depth of the proposed infiltrating surface of the BMP. The hole is pre-soaked by filling it with water at least a foot above the soil to be tested and leaving it at least 4 hours (or overnight if clays are present). After pre-soaking, the hole is refilled to a depth of 12 inches and allow it to drain for one hour (2 hours for slower soils), measuring the rate at which the water level drops. The test is then repeated until successive trials yield a result with less than 10 percent change.

In comparison to a double-ring infiltrometer, this test has the advantage of measuring infiltration over a larger area and better resembles the dimensionality of a typical small scale BMP. Because it includes both vertical and lateral infiltration, it should be adjusted to estimate design rates for larger scale BMPs.

D.3.2.3 Double Ring Infiltrometer Test (ASTM 3385)

The Double Ring Infiltrometer was originally developed to estimate the saturated hydraulic conductivity of low permeability materials, such as clay liners for ponds, but has seen significant use in storm water applications. The most recent revision of this method from 2009 is known as ASTM 3385-09. The testing apparatus is designed with concentric rings that form an inner ring and an annulus between the inner and outer rings. Infiltration from the annulus between the two rings is intended to saturate the soil outside of the inner ring such that infiltration from the inner ring is restricted primarily to the vertical direction.

To conduct this test, both the center ring and annulus between the rings are filled with water. There is no pre-wetting of the soil in this test. However, a constant head of 1 to 6 inches is maintained for 6 hours, or until a constant flow rate is established. Both the inner flow rate and annular flow rate are recorded, but if they are different, the inner flow rate should be used. There are a variety of approaches that are used to maintain a constant head on the system, including use of a Mariotte tube, constant level float valves, or manual observation and filling. This test must be conducted at the elevation of the proposed infiltrating surface; therefore application of this test is limited in cases where the infiltration surface is a significant distance below existing grade at the time of testing.

This test is generally considered to provide a direct estimate of vertical infiltration rate for the specific point tested and is highly replicable. However, given the small diameter of the inner ring (standard diameter is 12 inches, but it can be larger), this test only measures infiltration rate in a small area. Additionally, given the small quantity of water used in this test compared to larger scale
Appendix D: Approved Infiltration Rate Assessment Methods

tests, this test may be biased high in cases where the long term infiltration rate is governed by groundwater mounding and the rate at which mounding dissipates (i.e., the capacity of the infiltration receptor). Finally, the added effort and cost of isolating vertical infiltration rate may not necessarily be warranted considering that BMPs typically have a lateral component of infiltration as well. Therefore, while this method has the advantages of being technical rigorous and well standardized, it should not necessarily be assumed to be the most representative test for estimating full-scale infiltration rates. Source: American Society for Testing and Materials (ASTM) International (2009)

D.3.2.4 Single Ring Infiltrometer Test

The single ring infiltrometer test is not a standardized ASTM test, however it is a relatively well-controlled test and shares many similarities with the ASTM standard double ring infiltrometer test (ASTM 3385-09). This test is a constant head test using a large ring (preferably greater than 40 inches in diameter) usually driven 12 inches into the soil. Water is ponded above the surface. The rate of water addition is recorded and infiltration rate is determined after the flow rate has stabilized. Water can be added either manually or automatically.

The single ring used in this test tends to be larger than the inner ring used in the double ring test. Driving the ring into the ground limits lateral infiltration; however some lateral infiltration is generally considered to occur. Experience in Riverside County (CA) has shown that this test gives results that are close to full-scale infiltration facilities. The primary advantages of this test are that it is relatively simple to conduct and has a larger footprint (compared to the double-ring method) and restricts horizontal infiltration and is more standardized (compared to open pit methods). However, it is still a relatively small scale test and can only be reasonably conducted near the existing ground surface.

D.3.2.5 Large-scale Pilot Infiltration Test

As its name implies, this test is closer in scale to a full-scale infiltration facility. This test was developed by Washington State Department of Ecology specifically for storm water applications.

To perform this test, a test pit is excavated with a horizontal surface area of roughly 100 square feet to a depth that allows 3 to 4 feet of ponding above the expected bottom of the infiltration facility. Water is continually pumped into the system to maintain a constant water level (between 3 and 4 feet about the bottom of the pit, but not more than the estimated water depth in the proposed facility) and the flow rate is recorded. The test is continued until the flow rate stabilizes. Infiltration rate is calculated by dividing the flow rate by the surface area of the pit. Similar to other open pit test, this test is known to result in a slight bias high because infiltration also moves laterally through the walls of the pit during the test. Washington State Department of Ecology requires a correction factor of 0.75 (factor of safety of 1.33) be applied to results.
Appendix D: Approved Infiltration Rate Assessment Methods

This test has the advantage of being more resistant to bias from localized soil variability and being more similar to the dimensionality and scale of full scale BMPs. It is also more likely to detect long term decline in infiltration rates associated with groundwater mounding. As such, it remains the preferred test for establishing design infiltration rates in Western Washington (Washington State Department of Ecology, 2012). In a comparative evaluation of test methods, this method was found to provide a more reliable estimate of full-scale infiltration rate than double ring infiltrometer and borehole percolation tests (Philips and Kitch 2011).

The difficulty encountered in this method is that it requires a larger area be excavated than the other methods, and this in turn requires larger equipment for excavation and a greater supply of water. However, this method should be strongly considered when less information is known about spatial variability of soils and/or a higher degree of certainty in estimated infiltration rates is desired.


D.3.2.6 Smaller-scale Pilot Infiltration Test

The smaller-scale PIT is conducted similarly to the large-scale PIT but involves a smaller excavation, ranging from 20 to 32 square feet instead of 100 square feet for the large-scale PIT, with similar depths. The primary advantage of this test compared to the full-scale PIT is that it requires less excavation volume and less water. It may be more suitable for small-scale distributed infiltration controls where the need to conduct a greater number of tests outweighs the accuracy that must be obtained in each test, and where groundwater mounding is not as likely to be an issue. Washington State Department of Ecology establishes a correction factor of 0.5 (factor of safety of 2.0) for this test in comparison to 0.75 (factor of safety of 1.33) for the large-scale PIT to account for a greater fraction of water infiltrating through the walls of the excavation and lower degree of certainty related to spatial variability of soils.

D.3.3 Deeper Subsurface Tests

D.3.3.1 Well Permeameter Method (USBR 7300-89)

Well permeameter methods were originally developed for purposes of assessing aquifer permeability and associated yield of drinking water wells. This family of tests is most applicable in situations in which infiltration facilities will be placed substantially below existing grade, which limits the use of surface testing methods.

In general, this test involves drilling a 6 inch to 8 inch test well to the depth of interest and maintaining a constant head until a constant flow rate has been achieved. Water level is maintained with down-hole floats. The Porchet method or the nomographs provided in the USBR Drainage Manual (United States Department of the Interior, Bureau of Reclamation, 1993) are used to convert
the measured rate of percolation to an estimate of vertical hydraulic conductivity. A smaller diameter boring may be adequate, however this then requires a different correction factor to account for the increased variability expected.

While these tests have applicability in screening level analysis, considerable uncertainty is introduced in the step of converting direct percolation measurements to estimates of vertical infiltration. Additionally, this testing method is prone to yielding erroneous results cases where the vertical horizon of the test intersects with minor lenses of sandy soils that allow water to dissipate laterally at a much greater rate than would be expected in a full-scale facility. To improve the interpretation of this test method, a continuous bore log should be inspected to determine whether thin lenses of material may be biasing results at the strata where testing is conducted. Consult USBR procedure 7300-89 for more details.

Source: (United States Department of the Interior, Bureau of Reclamation, 1990, 1993)

**D.3.3.2 Borehole Percolation Tests (various methods)**

Borehole percolation tests were originally developed as empirical tests to estimate the capacity of onsite sewage disposal systems (septic system leach fields), but have more recently been adopted into use for evaluating storm water infiltration. Similar to the well permeameter method, borehole percolation methods primarily measure lateral infiltration into the walls of the boring and are designed for situations in which infiltration facilities will be placed well below current grade. The percolation rate obtained in this test should be converted to an infiltration rate using a technique such as the Porchet method.

This test is generally implemented similarly to the USBR Well Permeameter Method. Per the Riverside County Borehole Percolation method, a hole is bored to a depth at least 5 times the borehole radius. The hole is presoaked for 24 hours (or at least 2 hours if sandy soils with no clay). The hole is filled to approximately the anticipated top of the proposed infiltration basin. Rates of fall are measured for six hours, refilling each half hour (or 10 minutes for sand). Tests are generally repeated until consistent results are obtained.

The same limitations described for the well permeameter method apply to borehole percolation tests, and their applicability is generally limited to initial screening. To improve the interpretation of this test method, a continuous soil core can be extracted from the hole and below the test depth, following testing, to determine whether thin lenses of material may be biasing results at the strata where testing is conducted.

Sources: Riverside County Percolation Test (2011), California Test 750 (Caltrans, 1986), San Bernardino County Percolation Test (1992); USEPA Falling Head Test (USEPA, 1980).
Appendix D: Approved Infiltration Rate Assessment Methods

D.4 Specific Considerations for Infiltration Testing

The following subsections are intended to address specific topics that commonly arise in characterizing infiltration rates.

D.4.1 Hydraulic Conductivity versus Infiltration Rate versus Percolation Rate

A common misunderstanding is that the “percolation rate” obtained from a percolation test is equivalent to the “infiltration rate” obtained from tests such as a single or double ring infiltrometer test which is equivalent to the “saturated hydraulic conductivity”. In fact, these terms have different meanings. Saturated hydraulic conductivity is an intrinsic property of a specific soil sample under a given degree of compaction. It is a coefficient in Darcy’s equation (Darcy 1856) that characterizes the flux of water that will occur under a given gradient. The measurement of saturated hydraulic conductivity in a laboratory test is typically referred to as “permeability”, which is a function of the density, structure, stratification, fines, and discontinuities of a given sample under given controlled conditions. In contrast, infiltration rate is an empirical observation of the rate of flux of water into a given soil structure under long term ponding conditions. Similarly to permeability, infiltration rate can be limited by a number of factors including the layering of soil, density, discontinuities, and initial moisture content. These factors control how quickly water can move through a soil. However, infiltration rate can also be influenced by mounding of groundwater, and the rate at which water dissipates horizontally below a BMP – both of which describe the “capacity” of the “infiltration receptor” to accept this water over an extended period. For this reason, an infiltration test should ideally be conducted for a relatively long duration resembling a series of storm events so that the capacity of the infiltration receptor is evaluated as well as the rate at which water can enter the system. Infiltration rates are generally tested with larger diameter holes, pits, or apparatuses intended to enforce a primarily vertical direction of flux.

In contrast, percolation is tested with small diameter holes, and it is mostly a lateral phenomenon. The direct measurement yielded by a percolation test tends to overestimate the infiltration rate, except perhaps in cases in which a BMP has similar dimensionality to the borehole, such as a dry well. Adjustment of percolation rates may be made to an infiltration rate using a technique such as the Porchet Method.

D.4.2 Cut and Fill Conditions

**Cut Conditions:** Where the proposed infiltration BMP is to be located in a cut condition, the infiltration surface level at the bottom of the BMP might be far below the existing grade. For example, if the infiltration surface of a proposed BMP is to be located at an elevation that is currently beneath 15 feet of planned cut, *how can the proposed infiltration surface be tested to establish a design
Appendix D: Approved Infiltration Rate Assessment Methods

Infiltration rate prior to beginning excavation? The question can be addressed in two ways: First, one of the deeper subsurface tests described above can be used to provide a planning level screening of potential rates at the elevation of the proposed infiltrating surface. These tests can be conducted at depths exceeding 100 feet, therefore are applicable in most cut conditions. Second, the project can commit to further testing using more reliable methods following bulk excavation to refine or adjust infiltration rates, and/or apply higher factors of safety to borehole methods to account for the inherent uncertainty in these measurements and conversions.

Fill Conditions: There are two types of fills – those that are engineered or documented, and those that are undocumented. Undocumented fills are fills placed without engineering controls or construction quality assurance and are subject to great uncertainty. Engineered fills are generally placed using construction quality assurance procedures and may have criteria for grain-size and fines content, and the properties can be very well understood. However, for engineered fills, infiltration rates may still be quite uncertain due to layering and heterogeneities introduced as part of construction that cannot be precisely controlled.

If the bottom of a BMP (infiltration surface) is proposed to be located in a fill location, the infiltration surface may not exist prior to grading. How then can the infiltration rate be determined? For example, if a proposed infiltration BMP is to be located with its bottom elevation in 10 feet of fill, how could one reasonably establish an infiltration rate prior to the fill being placed?

Where possible, infiltration BMPs on fill material should be designed such that their infiltrating surface extends into native soils. Additionally, for shallow fill depths, fill material can be selectively graded (i.e., high permeability granular material placed below proposed BMPs) to provide reliable infiltration properties until the infiltrating water reaches native soils. In some cases, due to considerable fill depth, the extension of the BMP down to natural soil and/or selective grading of fill material may prove infeasible. In additional, fill material will result in some compaction of now buried native soils potentially reducing their ability to infiltrate. In these cases, because of the uncertainty of fill parameters as described above as well as potential compaction of the native soils, an infiltration BMP may not be feasible.

If the source of fill material is defined and this material is known to be of a granular nature and that the native soils below is permeable and will not be highly compacted, infiltration through compacted fill materials may still be feasible. In this case, a project phasing approach could be used including the following general steps, (1) collect samples from areas expected to be used as borrow sites for fill activities, (2) remold samples to approximately the proposed degree of compaction and measure the saturated hydraulic conductivity of remolded samples using laboratory methods, (3) if infiltration rates appear adequate for infiltration, then apply an appropriate factor of safety and use the initial rates for preliminary design, (4) following placement of fill, conduct in-situ testing to refine design infiltration rates and adjust the design as needed; the infiltration rate of native soil below the fill should also be tested at this time to determine if compaction as a result of fill placement has
significantly reduced its infiltration rate. The project geotechnical engineer should be involved in decision making whenever infiltration is proposed in the vicinity of engineered fill structures so that potential impacts of infiltration on the strength and stability of fills and pavement structures can be evaluated.

**D.4.3 Effects of Direct and Incidental Compaction**

It is widely recognized that compaction of soil has a major influence on infiltration rates (Pitt et al. 2008). However, direct (intentional) compaction is an essential aspect of project construction and indirect compaction (such as by movement of machinery, placement of fill, stockpiling of materials, and foot traffic) can be difficult to avoid in some parts of the project site. Infiltration testing strategies should attempt to measure soils at a degree of compaction that resembles anticipated post-construction conditions.

Ideally, infiltration systems should be located outside of areas where direct compaction will be required and should be staked off to minimize incidental compaction from vehicles and stockpiling. For these conditions, no adjustment of test results is needed.

However, in some cases, infiltration BMPs will be constructed in areas to be compacted. For these areas, it may be appropriate to include field compaction tests or prepare laboratory samples and conducting infiltration testing to approximate the degree of compaction that will occur in post-construction conditions. Alternatively, testing could be conducted on undisturbed soil, and an additional factor of safety could be applied to account for anticipated infiltration after compaction. To develop a factor of safety associated with incidental compaction, samples could compacted to various degrees of compaction, their hydraulic conductivity measured, and a “response curve” developed to relate the degree of compaction to the hydraulic conductivity of the material.

**D.4.4 Temperature Effects on Infiltration Rate**

The rate of infiltration through soil is affected by the viscosity of water, which in turn is affected by the temperature of water. As such, infiltration rate is strongly dependent on the temperature of the infiltrating water (Cedergren, 1997). For example, Emerson (2008) found that wintertime infiltration rates below a BMP in Pennsylvania were approximately half their peak summertime rates. As such, it is important to consider the effects of temperature when planning tests and interpreting results.

If possible, testing should be conducted at a temperature that approximates the typical runoff temperatures for the site during the times when rainfall occurs. If this is not possible, then the results of infiltration tests should be adjusted to account for the difference between the temperature at the time of testing and the typical temperature of runoff when rainfall occurs. The measured infiltration can be adjusted by the ratio of the viscosity at the test temperature versus the typical temperature when rainfall occurs (Cedergren, 1997), per the following formula:
Appendix D: Approved Infiltration Rate Assessment Methods

\[ K_{\text{Typical}} = K_{\text{Test}} \times \left( \frac{\mu_{\text{Test}}}{\mu_{\text{Typical}}} \right) \]

Where:
- \( K_{\text{Typical}} \) = the typical infiltration rate expected at typical temperatures when rainfall occurs
- \( K_{\text{Test}} \) = the infiltration rate measured or estimated under the conditions of the test
- \( \mu_{\text{Typical}} \) = the viscosity of water at the typical temperature expected when rainfall occurs
- \( \mu_{\text{Test}} \) = the viscosity of water at the temperature at which the test was conducted

D.4.5 Number of Infiltration Tests Needed

The heterogeneity inherent in soils implies that all but the smallest proposed infiltration facilities would benefit from infiltration tests in multiple locations. The following requirements apply for in situ infiltration/percolation testing:

- In situ infiltration/percolation testing shall be conducted at a minimum of two locations within 50-feet of each proposed storm water infiltration/percolation BMP.
- In situ infiltration/percolation testing shall be conducted using an approved method listed in Table D.3-1.
- Testing shall be conducted at approximately the same depth and in the same material as the base of the proposed storm water BMP.

D.5 Selecting a Safety Factor

Monitoring of actual facility performance has shown that the full-scale infiltration rate can be much lower than the rate measured by small-scale testing (King County Department of Natural Resources and Parks, 2009). Factors such as soil variability and groundwater mounding may be responsible for much of this difference. Additionally, the infiltration rate of BMPs naturally declines between maintenance cycles as the BMP surface becomes occluded and particulates accumulate in the infiltrative layer.

In the past, infiltration structures have been shown to have a relatively short lifespan. Over 50 percent of infiltration systems either partially or completely failed within the first 5 years of operation (United States EPA, 1999). In a Maryland study on infiltration trenches (Lindsey et al. 1991), 53 percent were not operating as designed, 36 percent were clogged, and 22 percent showed reduced filtration. In a study of 12 infiltration basins (Galli 1992), none of which had built-in pretreatment systems, all had failed within the first two years of operation.

Given the known potential for infiltration BMPs to degrade or fail over time, an appropriate factor of safety applied to infiltration testing results is strongly recommended. This section presents a recommended thought process for selecting a safety factor. This method considers factor of safety...

Should I use a factor of safety for design infiltration rate?
to be a function of:

- Site suitability considerations, and
- Design-related considerations.

These factors and the method for using them to compute a safety factor are discussed below. Importantly, this method encourages rigorous site investigation, good pretreatment, and commitments to routine maintenance to provide technically-sound justification for using a lower factor of safety.

### D.5.1 Determining Factor of Safety

Worksheet D.5-1, at the end of this section can be used in conjunction with Tables D.5-1 and D.5-2 to determine an appropriate safety factor. Tables D.5-1 and D.5-2 assign point values to design considerations; the values are entered into Worksheet D.5-1, which assign a weighting factor for each design consideration.

The following procedure can be used to estimate an appropriate factor of safety to be applied to the infiltration testing results. When assigning a factor of safety, care should be taken to understand what other factors of safety are implicit in other aspects of the design to avoid incorporating compounding factors of safety that may result in significant over-design.

1. For each consideration shown above, determine whether the consideration is a high, medium, or low concern.

2. For all high concerns in Table D.5-1, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.

3. Multiply each of the factors in Table D.5-1 by 0.25 and then add them together. This should yield a number between 1 and 3.

4. For all high concerns in Table D.5-2, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.

5. Multiply each of the factors in Table D.5-2 by 0.5 and then add them together. This should yield a number between 1 and 3.

6. Multiply the two safety factors together to get the final combined safety factor. If the combined safety factor is less than 2, then 2 should be used as the safety factor.

7. Divide the tested infiltration rate by the combined safety factor to obtain the adjusted design infiltration rate for use in sizing the infiltration facility.

**Note:** The minimum combined adjustment factor should not be less than 2.0 and the maximum combined adjustment factor should not exceed 9.0.
Appendix D: Approved Infiltration Rate Assessment Methods

D.5.2 Site Suitability Considerations for Selection of an Infiltration Factor of Safety

Considerations related to site suitability include:

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

These considerations are summarized in Table D.5-1 below, in addition to presenting classification of concern.
Table D.5-1: Suitability Assessment Related Considerations for Infiltration Facility Safety Factors

<table>
<thead>
<tr>
<th>Consideration</th>
<th>High Concern – 3 points</th>
<th>Medium Concern – 2 points</th>
<th>Low Concern – 1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment methods (see explanation below)</td>
<td>Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates. Use of well permeameter or borehole methods without accompanying continuous boring log. Relatively sparse testing with direct infiltration methods.</td>
<td>Use of well permeameter or borehole methods with accompanying continuous boring log. Direct measurement of infiltration area with localized infiltration measurement methods (e.g., infiltrometer). Moderate spatial resolution.</td>
<td>Direct measurement with localized (i.e., small-scale) infiltration testing methods at relatively high resolution(^1) or Use of extensive test pit infiltration measurement methods(^2).</td>
</tr>
<tr>
<td>Texture Class</td>
<td>Silty and clayey soils with significant fines.</td>
<td>Loamy soils.</td>
<td>Granular to slightly loamy soils.</td>
</tr>
<tr>
<td>Site soil variability</td>
<td>Highly variable soils indicated from site assessment, or Unknown variability.</td>
<td>Soil borings/test pits indicate moderately homogeneous soils.</td>
<td>Soil borings/test pits indicate relatively homogeneous soils.</td>
</tr>
<tr>
<td>Depth to groundwater/impervious layer</td>
<td>&lt;5 ft below facility bottom</td>
<td>5-15 ft below facility bottom</td>
<td>&gt;15 ft below facility bottom</td>
</tr>
</tbody>
</table>

1 - Localized (i.e., small scale) testing refers to methods such as the double-ring infiltrometer and borehole tests.

2 - Extensive infiltration testing refers to methods that include excavating a significant portion of the proposed infiltration area, filling the excavation with water, and monitoring drawdown. The excavation should be to the depth of the proposed infiltration surface and ideally be at least 30 to 100 square feet.

**D.5.3 Design Related Considerations for Selection of an Infiltration Factor of Safety**

Design related considerations include:

- Level of pretreatment and expected influent sediment loads – credit should be given for good pretreatment to account for the reduced probability of clogging from high sediment loading. Appendix B.6 describes performance criteria for “flow-thru treatment” based on 80 percent capture of total suspended solids, which provides excellent levels of pretreatment. Additionally, the Washington State Technology Acceptance Protocol-Ecology provides a certification for “pre-treatment” based on 50 percent removal of TSS, which provides moderate levels of treatment. Current approved technologies are listed at: [http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html](http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html). Use of certified...
technologies can allow a lower factor of safety. Also, facilities designed to capture runoff from relatively clean surfaces such as rooftops are likely to see low sediment loads and therefore may be designed with lower safety factors. Finally, the amount of landscaped area and its vegetation coverage characteristics should be considered. For example in arid areas with more soils exposed, open areas draining to infiltration systems may contribute excessive sediments.

- Compaction during construction – proper construction oversight is needed during construction to ensure that the bottoms of infiltration facility are not impacted by significant incidental compaction. Facilities that use proper construction practices and oversight need less restrictive safety factors.

Table D.5-2: Design Related Considerations for Infiltration Facility Safety Factors

<table>
<thead>
<tr>
<th>Consideration</th>
<th>High Concern – 3 points</th>
<th>Medium Concern – 2 points</th>
<th>Low Concern – 1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of pretreatment/ expected influent sediment loads</td>
<td>Limited pretreatment using gross solids removal devices only, such as hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, road sanding, or any other areas expected to produce high sediment, trash, or debris loads.</td>
<td>Good pretreatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be moderate (e.g., low traffic, mild slopes, stabilized pervious areas, etc.). Performance of pretreatment consistent with “pretreatment BMP performance criteria” (50% TSS removal) in Appendix B.6</td>
<td>Excellent pretreatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops/non-sanded road surfaces. Performance of pretreatment consistent with “flow-thru treatment control BMP performance criteria” (i.e., 80% TSS removal) in Appendix B.6</td>
</tr>
<tr>
<td>Redundancy/ resiliency</td>
<td>No “backup” system is provided; the system design does not allow infiltration rates to be restored relatively easily with maintenance</td>
<td>The system has a backup pathway for treated water to discharge if clogging occurs or infiltration rates can be restored via maintenance.</td>
<td>The system has a backup pathway for treated water to discharge if clogging occurs and infiltration rates can be relatively easily restored via maintenance.</td>
</tr>
<tr>
<td>Compaction during construction</td>
<td>Construction of facility on a compacted site or increased probability of unintended/ indirect compaction.</td>
<td>Medium probability of unintended/ indirect compaction.</td>
<td>Equipment traffic is effectively restricted from infiltration areas during construction and there is low probability of unintended/ indirect compaction.</td>
</tr>
</tbody>
</table>
D.5.4 Implications of a Factor of Safety in BMP Feasibility and Design

The above method will provide safety factors in the range of 2 to 9. From a simplified practical perspective, this means that the size of the facility will need to increase in area from 2 to 9 times relative to that which might be used without a safety factor. Clearly, numbers toward the upper end of this range will make all but the best locations prohibitive in land area and cost.

In order to make BMPs more feasible and cost effective, steps should be taken to plan and execute the implementation of infiltration BMPs in a way that will reduce the safety factors needed for those projects. A commitment to effective site design and source control thorough site investigation, use of effective pretreatment controls, good construction practices, and restoration of the infiltration rates of soils that are damaged by prior compaction should lower the safety factor that should be applied, to help improve the long term reliability of the system and reduce BMP construction cost. While these practices decrease the recommended safety factor, they do not totally mitigate the need to apply a factor of safety. The minimum recommended safety factor of 2.0 is intended to account for the remaining uncertainty and long-term deterioration that cannot be technically mitigated.

Because there is potential for an applicant to “exaggerate” factor of safety to artificially prove infeasibility, an upper cap on the factor of safety is proposed for feasibility screening. A maximum factor of safety of 2.0 is recommended for infiltration feasibility screening such that an artificially high factor of safety cannot be used to inappropriately rule out infiltration, unless justified. If the site passes the feasibility analysis at a factor of safety of 2.0, then infiltration must investigated, but a higher factor of safety may be selected at the discretion of the design engineer.
### Appendix D: Approved Infiltration Rate Assessment Methods

#### Worksheet D.5-1: Factor of Safety and Design Infiltration Rate Worksheet

<table>
<thead>
<tr>
<th>Factor Category</th>
<th>Factor Description</th>
<th>Assigned Weight (w)</th>
<th>Factor Value (v)</th>
<th>Product (p) p = w x v</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Soil assessment methods</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Predominant soil texture</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site soil variability</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depth to groundwater / impervious layer</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Suitability Assessment Safety Factor, S_A = Σp</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Level of pretreatment/ expected sediment loads</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Redundancy/resiliency</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compaction during construction</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Design Safety Factor, S_B = Σp</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Combined Safety Factor, S_total = S_A x S_B</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Observed Infiltration Rate, inch/hr, K_{observed}**
(corrected for test-specific bias)

**Design Infiltration Rate, in/hr, K_{design} = K_{observed} / S_{total}**

**Supporting Data**

Briefly describe infiltration test and provide reference to test forms: