STORMWATER POLLUTION PREVENTION PLAN

Phase I Site Reclamation
Former Route 44 Sand & Gravel Operation
Carver, Massachusetts
Amendment One - Revised – July 2017

Langdon Environmental LLC
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SECTION 1 - SITE DESCRIPTION AND RESPONSIBLE PARTIES

1.1 SITE INFORMATION
This document presents the Storm Water Pollution Prevention Plan (SWPPP) for the second and final phase (Phase II) of reclamation activities at the former Route 44 Sand & Gravel Site (Site) located off Park Avenue and Montello Street in Carver, Massachusetts.

The current site owners, Route 44 Development LLC, has received approval from the Town of Carver Planning Board for a Special Permit Application to conduct this phase of work as outlined below. Charter Contracting Company, LLC (Charter) is implementing these site reclamation tasks. Langdon Environmental LLC (Langdon) is the Massachusetts Professional Engineer under agreement to oversee the construction activities at the Site.

This SWPPP summarizes the stormwater related controls and procedures that will be implemented during Phase II of reclamation activities. It also fulfills the requirements for a Detailed Stormwater Management Plan as required by the “Interim Policy on the Re-Use of Soil for Large Reclamation Projects (COMM-15-01)” issued by the Massachusetts Department of Environmental Protection (MassDEP); Part 7 of the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) required for construction projects with disturbance greater than 5 acres; and the Massachusetts Stormwater Standard No. 8 concerning erosion and sedimentation controls.

This SWPPP is intended for use by Charter and any other site operations contractors to provide consistent and effective management of storm water runoff and erosion mitigation.

The Site is not located on Indian country lands, nor located on a property of religious or cultural significance to an Indian tribe. Several residential properties border the Site to the east and north, Route 44 to the south and active cranberry bogs to the east. A locus plan is provided as Figure 1.

1.2 PROJECT SITE AND CONTACT INFORMATION

1.2.1 Project Site Information

Project Name and Address
Project/Site Name: Former Route 44 Sand & Gravel Site
Project Street/Location: Off Park Avenue and Montello Street
City: Carver
State: Massachusetts
ZIP Code: 02330
County or Similar Subdivision: Plymouth County
Section 1 - Site Description and Responsible Parties

Project Latitude/Longitude
Latitude: 41° 55' 32.3" N
Longitude: 70° 49' 17.2" W
Method for determining latitude/longitude: Google Earth
USGS topographic map (scale: 1:25,000): See Figure 1

1.2.2 Owner, Operator and Subcontractor Information
The following list of individuals are those who will be engaged in construction activities at the site. All subcontractors will be notified of the stormwater requirements applicable to their work.

Owner
Route 44 Development, LLC
c/o Charter Contracting Company, LLC
500 Harrison Avenue
Boston, Massachusetts 02118

Operator
Charter Contracting Company, LLC
Chris Ryan, Project Manager
500 Harrison Avenue
Boston, Massachusetts 02118
(857) 246-6800

Engineer
Langdon Environmental LLC
Bruce W. Haskell, P.E.
2 Summer Street, Suite 300
Natick, Massachusetts 01760
(508) 545-0333

Emergency 24-Hour Contact
Contact Name: To be determined
Contact Phone Number: To be determined

1.2.3 Stormwater Team
The individuals listed above comprise the project’s stormwater team. These are individuals responsible for overseeing the development of the SWPPP, any later modifications to it, and for compliance with the requirements in it.

1.3 Discharge Information
Surface water bodies at the Site include a pond associated stream located near the southern edge of the Site. In general, surface water from portions of the Site discharges to these two features but most precipitation infiltrates due to the highly disturbed condition of the Site. Groundwater flow is to the northeast away from the wetlands and ponds.
1.4 **NATURE OF THE CONSTRUCTION ACTIVITY**

The proposed reclamation activities will be conducted in two phases. At this time, Phase I is in progress and near completion. Phase I activities included installation of a weigh scale, wheel wash, site trailer, Stormwater controls, site cleanup and preliminary grading.

Plans for the Phase II construction activities have been developed by Langdon on behalf of the site owners. These plans have been submitted to the Carver Planning Board as part of the Special Permit Application. Reduced size copies of these plans are included in Appendix A to the SWPPP. A full size set of plans shall be maintained at the Site.

The work described during Phase II is subject to the Massachusetts Wetlands Protection Act (WPA). The Carver Conservation Commission issued an Order of Resource Area Delineation in January 2016 that approved the wetland delineation. All activities during Phase II will occur outside of the delineated wetland resource areas, but some site cleanup and grading will occur within the buffer zones to the resource areas. A copy of the Order issued by the Commission is included in Appendix B to this SWPPP.

1.5 **SEQUENCE AND ESTIMATED DATES OF CONSTRUCTION ACTIVITIES**

The proposed schedule includes acceptance of Phase II reclamation soils starting on August 1, 2017, following receipt of an Order of Conditions and Special Permit from the Town and continuing until the approved quantity of materials has been received and placed. The final schedule will be determined based on the availability of adequate reclamation soils.

1.6 **ALLOWABLE NON-STORMWATER DISCHARGES**

Anticipated non-storm water discharges associated with the former Route 44 Sand and Gravel site include:

- Water to control dust

These discharges will be handled within the proposed stormwater system described herein or infiltrate into the ground locally.

1.7 **SITE MAPS AND PLANS**

The design plans for Phase II activities are provided in Appendix A to this SWPPP.
SECTION 2 – COMPLIANCE WITH OTHER FEDERAL REQUIREMENTS AND POTENTIAL SOURCE IDENTIFICATION

2.1 COMPLIANCE WITH OTHER FEDERAL REGULATORY REQUIREMENTS

2.1.1 Endangered Species Protection
There are no mapped areas within the Site that are mapped as either Mapped or Potential Habitats for Rare or State-Protected Species by the Natural Heritage and Endangered Species Program (NHESP). There are no vernal pools within mapped by NHESP within the Site.

2.1.2 Historic Preservation
Although ground-disturbing stormwater controls are proposed at the Site, there are no known registered historic properties that will be impacted by these construction activities. The Site was previously utilized for historic sand and gravel operation as well as other material processing and disposal operations. Based on a search of the Massachusetts Cultural Resource Information System database there are no properties, structures, and areas of historical significance in the vicinity of the Site.

2.1.3 Federal Emergency Management Agency (FEMA)
The Federal Emergency Management Agency (FEMA) updated their mapping of the floodplain at the Site as shown on a map dated July 17, 2012 (Map Number 25023C0337J). There are no mapped floodplains within the proposed Phase II active areas.

2.2 POTENTIAL SOURCE IDENTIFICATION
This section identifies existing and proposed activities at the Site which have the potential to adversely impact the quality of the surrounding surface water bodies. These activities are used as the basis for the SWPPP mitigation procedures discussed elsewhere in this document. The potential for Total Suspended Solids (TSS) being discharged into the wetlands from this phase of reclamation activities prior to it being stabilization is a specific focus of this SWPPP.

2.2.1 Current Site Activities
Prior to the initial phase of site reclamation activities, the Site was an inactive sand and gravel pit with an exposed bottom surface of the historic sand and gravel removal operations and numerous debris piles including an inactive woodwaste landfill. There were no stormwater collection and treatment systems at the Site as drainage largely infiltrated into several depressions located throughout the Site. Groundwater flows to the northeast through the Site.

Current site activities include the completion of the Phase I site preparation work. Phase I activities included access road improvements; construction of interim stormwater controls; installation of erosion and sedimentation controls; installation of a wheel wash, truck scale and office trailer; and preliminary grading with imported soils.
Section 2 - Compliance with Other Federal Requirements and Potential Source Identification

2.2.2 Proposed Operations
Phase II of Site reclamation activities covered by the SWPPP includes the following work items:

- Additional Stormwater controls. Perimeter drainage swales and three stormwater basins are proposed to contain stormwater at the site during Phase II site activities. These will be installed in phases as site grading activities require.

- Woodwaste Landfill Corrective Actions. The woodwaste Landfill will be excavated processed on site for organics. These corrective actions will be conducted in accordance with the Massachusetts Solid Waste Regulations (310 CMR 19.000) and as approved by MassDEP as part of Phase II.

- Site Regrading and Stabilization. The Site is currently poorly graded and largely covered with sandy soils and scrubby vegetation. Route 44 Development proposes to conduct grading with imported soils to restore the Site with either appropriately tested soils or asphalt, brick and concrete (ABC) materials from off-Site sources. The Site owners propose to perform the soil filling operations in accordance with a Fill Management Plan approved by MassDEP and the Town of Carver via Special Permit. The site grading will reclaim the site and prepare it for future development.

- Wood and Debris Piles. Various debris piles remaining at the Site from previous Sand and Gravel operations will be removed and processed.

- ABC Processing. On-site and imported ABC material to be crushed on periodic basis.

2.2.3 Summary of Potential Source Identification
Potential sources of impacts to the surrounding wetland resources around the Site are particulates running off the placed soils and processed ABC materials.

During construction, potential sources also include trucking and construction machinery including lubricants and fuel. Every reasonable precaution to prevent contamination by leaking of these materials will be employed during work activities.

2.2.4 General Mitigation Requirements
Based on the anticipated construction activities, stormwater related mitigation activities have been formulated to control sediment and erosion. The particulate sizes associated with the imported soils will vary widely based on their source. Coarser particles will easily be mitigated using conventional stormwater and erosion control measures such as silt fence and straw bales/wattles. The finer particles will not be easily settled by typical control measures and will require treatment within the proposed stormwater detention basins.

Erosion control measures as shown on the attached plans will be established and maintained for both for the short- and long-term conditions, especially before final vegetation is established.

Management controls for the mitigation requirements are discussed in Section 3.
SECTION 3 – STORMWATER MANAGEMENT, EROSION AND SEDIMENT CONTROLS

3.1 INTRODUCTION
A stormwater Best Management Practice (BMP) is defined as any program, technology, process, siting criteria, operating method, measure, or device that controls, removes, or reduces pollution. Appropriate BMPs are selected based on an assessment of the operations and potential storm water impacts. Areas of actual or potential pollutant contact are evaluated and applicable BMPs are implemented to eliminate or minimize the release and transport of pollutants.

3.2 NATURAL BUFFERS OR EQUIVALENT SEDIMENT CONTROLS
The previous sand and gravel operations disturbed the natural buffer surrounding the resource areas on site. The Phase II activities will require some regrading of previous stockpiles and berms within the buffer zones to the resource areas, however no disturbance will occur in the resource area. Erosion control barriers, consisting of silt fence and straw bales or wattles will be installed at the limit of work upgradient of the resource areas to contain any sediments.

All stormwater run-off will be directed to the stormwater basins as shown on the design plans in Appendix B via perimeter swales. The basins shown on the plans will be constructed in phases as construction progresses.

3.3 BEST MANAGEMENT PRACTICES IMPLEMENTATION PROGRAM
To minimize the effects of the activities on the surrounding wetlands and surface water, site work will include the implementation of several BMPs. A portion of the BMPs indicated below will be implemented during various stages of material stockpiling and placement. A discussion of the specific BMPs to be used at this site is provided in the sections below. Information on general BMPs that may be applicable to Site operations is provided in Appendix D.

3.3.1 Sedimentation and Stabilization Control BMPs
The anticipated Sedimentation and Stabilization Control BMPs to be implemented during stockpiling of shaping and grading materials will include, but are not necessarily limited to, the following:

- Dust Controls;
- Stormwater Basins;
- Construction Road Stabilization;
- Check dams;
- Drainage Swales; and
- Installation of Erosion Controls.

Sediment controls will be established prior to disturbance or placement of soils in that given area. These controls will be augmented and improved as discussed below for the Site reclamation project. The following is a summary of the Site mitigation measures:
Section 3 – Stormwater Management, Erosion and Sediment Controls

- New stormwater basins will be constructed to receive the stormwater from the operational portions of the Site as shown on the plans. These basins have been designed to handle the run-off from the operating areas in accordance with the Massachusetts Stormwater Standards. The basins contain the 2-and 10-year, 24-hour storm events as required, as well as the 25-year and 100-year storm events. Copies of the stormwater calculations are provided in Appendix E.

- Stormwater drainage diversion swales will be constructed as required to direct flow to the basins and will contain check dams to remove sediments.

- Sediment controls must be cleaned on a regular basis. At a minimum, control devices, such as temporary sedimentation basins, will be cleaned when their design capacity has been reduced by 50 percent.

- Disturbance of soils will be minimized by limiting activity within the operations area and where stormwater controls are established, and will proceed in a manner to reduce erosion and sedimentation. All work will be conducted in a manner that reduces the unlikely potential for sedimentation to be discharged into the adjacent wetlands. All temporarily inactive areas will be temporarily stabilized using methods suitable for protecting against erosion.

- The site will be inspected daily when active and monthly by a third party for any actual or potential erosion causing situations and will be corrected. Charter will be responsible for adequately protecting the work to minimize or eliminate potential harm to on-site resource areas. Monthly reports will be submitted to MassDEP and the Town of Carver Planning and Development Director.

- The ongoing work will be protected from erosion and may use temporary stabilization measures in that effort. Surface roughening may be used, in concert with other temporary erosion control measures if necessary, as a velocity dissipation measure to temporary control erosion. Surface roughening reduces speed of runoff, increases infiltration, and traps sediment before discharge to the sedimentation basin or straw bale barrier.

- Existing ground cover will be maintained to the maximum extent practicable during construction.

- General controls will be installed at the edge of the operating area(s) and downgradient of the stormwater basins to ensure minimal disturbance to downgradient resources. These erosion controls will be appropriately anchored into the ground and placed in a continuous row. The erosion control barriers will be inspected regularly and those showing signs of deterioration will be replaced immediately. Material collected behind the barriers will be removed as needed.

- Surface drainage from operating areas will be intercepted and diverted towards the stormwater basins. Repair of drainage swales will be performed in order to maintain stormwater within the Site and the active operating areas. Active areas will be drained by diversion of runoff to the basins as shown on the Phase II plans.
Section 3 – Stormwater Management, Erosion and Sediment Controls

- Suspended particles will be removed from the surface water towards runoff stream using the basins. Check dams that lead to open drainage channels and natural swales will be installed as necessary to diffuse overland flows and prevent erosion. All swales and sedimentation basins shall be checked regularly and repaired and cleaned as necessary to ensure that they operate as intended.

- In no case will construction equipment, delivery vehicles, or construction personnel vehicles approach the site by routes through wetland resources.

- All earthwork, grading, movement of equipment, and other operations likely to cause siltation and tracking of sediments, shall be planned and performed in a sequence as to avoid or minimize the potential for pollution to discharge into the adjacent wetlands.

- Stabilization measures will be initiated in areas where soil has been disturbed as follows:
  
  1. Contractor will ultimately be responsible for the protection of the work and the protection of on-site resource areas.
  2. An on-site monitor will inspect the work and ensure that adequate erosion controls are being implemented.
  3. Contractor will repair any and all damage to the on-site resource areas that is caused by, related to, or in any way pertaining to the work.

  Procedures will be put in-place to remove any excess mud, dirt or rock originating from the Site. Water spray equipment shall be used to reduce dust.

3.4 STORMWATER MANAGEMENT

For Phase II, Contractor will construct the drainage basins as sequencing of work requires. The existing Phase I infiltration basin will be removed only after Phase II stormwater controls (perimeter swales and basins) are installed. These structures are designed for TSS removal and stormwater retention in accordance with MassDEP policies and regulations.

During the project covered by this SWPPP, stormwater control devices and basins will be utilized to control stormwater and TSS leaving the Site. The size of the basin has been designed so that the combined peak flow from the basin during the 100-year frequency design storm does not exceed the peak discharge rate for the Site under existing conditions. In addition, the discharge rate allows for adequate detention time for sediment removal.

The proposed detention basin system will entirely detain stormwater flows during the 2- and 10-year, 24-hour frequency storm events, thereby achieving the 80 percent TSS removal requirement, as no stormwater will be discharged. The stormwater design report including supporting calculations is included in Appendix E.
3.5 OTHER CONTROLS

Portable sanitary units will be provided for use by all workers during the project at the office trailer/scale house location. A licensed sanitary waste management contractor will regularly collect all sanitary waste from the portable units.

Any trash and construction debris generated from the Site will be disposed of off-site in accordance with MassDEP’s Solid Waste Management Regulations (310 CMR 19.000). Employee waste and other loose materials will be collected so as to prevent the release of floatables during runoff events.
SECTION 4 - POLLUTION PREVENTION STANDARDS

4.1 POTENTIAL SOURCES OF POLLUTION
During the work, potential sources of pollution include trucking and grading machinery lubricants and fuel. Every reasonable precaution to prevent contamination by leaking of these materials will be employed during the work activities.

The long access road to the Site will minimize off-Site tracking of soils. Potentially generated pollutants include: detergents, oil and fuel, suspended solids, grease, and antifreeze. These materials, and other materials used during construction with the potential to impact stormwater, will be stored, managed, used, and disposed of in a manner that minimizes the potential for releases to the environment and especially into stormwater.

A water source will be available as needed to wash construction trucks and minimize off-Site tracking of soils and dust generation.

BMPs will be implemented in accordance with EPA's Vehicle Maintenance and Washing Areas BMP Fact Sheet when possible.

4.2 SPILL PREVENTION AND RESPONSE
Potential pollutants will be stored and used in a manner consistent with the manufacturer's instructions in a secure location. Materials disposal will be in accordance with the manufacturer's instructions and applicable local, state, and federal regulations. Materials no longer required for construction will be removed from the Site as soon as practicable.

Garbage, construction waste, and sanitary waste handling and disposal facilities will be provided to the extent necessary to keep the Site clear of obstruction and BMPs clear and functional.

The following agencies should be contacted in the event of a spill:

- Carver Fire Department: (508) 866-3440
- Carver Health Department: (508) 866-3420
- Carver Police Department: (508) 866-2000
- MassDEP Southeast Regional Office: (508) 946-2700

4.3 TRAINING
On-Site training to personnel responsible for compliance with the SWPPP will be provided. Training shall include the location of all stormwater controls on-Site and how they are to be maintained; procedures to follow with respect to pollution prevention; and how and when to conduct inspections, record applicable findings and take corrective actions. Charter's superintendent and project manager will be familiarized with the major elements of the plan. Others working on-Site will be given appropriate training information at the conclusion of Site safety meetings or on an as-needed basis.
SECTION 5 - INSPECTION AND CORRECTIVE ACTION

5.1 INSPECTIONS
Langdon will assist Charter to monitor the activities at the Site with respect to sedimentation, erosion, and storm water controls. Langdon personnel will be responsible for performing a Site inspection on a monthly basis concurrent with the inspection required as part of the Carver Special Permit. In addition, Langdon personnel will inspect all controls after all significant storm events experienced at the Site. A significant storm event will be defined as greater than 0.5-inches of rain falling within a 24-hour period. A locally available weather station for the Carver area (available through a web site services such as weatherunderground.com) will be used to monitor measurable local rain events. Finally, reports will be prepared during all inspection activities and submitted to the Town of Carver. The reports will include summaries of sedimentation, erosion and stormwater control effectiveness as well as noting other conditions, activities or modifications.

Inspections will be performed of the following items and locations:

- Erosion control barriers for evidence of breaching or deterioration;
- Sedimentation barriers for excess siltation or clogging of stone dikes;
- Structural control measures for damage or clogging; and
- Access and egress points from the Site.

Disturbed areas in the vicinity of the initial phase of operations that are exposed to precipitation shall be inspected for evidence of, or the potential for, excess sediments entering the drainage system. Sediment and erosion control measures identified in this SWPPP shall be observed to ensure proper operations. Where discharge locations or points are accessible, inspection shall be conducted to ascertain whether effective erosion control is being maintained. Where discharge locations are inaccessible, nearby downstream locations shall be inspected. Locations where vehicles exit the Site shall be inspected for evidence of offsite sediment tracking.

Based on the results of these inspections, the SWPPP may be modified as necessary to include specific BMPs designed to correct any problems identified. If existing BMPs need to be modified or additional BMPs are necessary, implementation shall be completed as soon as is practicable. Revisions to the SWPPP shall be completed within seven calendar days following the inspection.

5.2 CORRECTIVE ACTIONS
Upon identification of BMPs in need of corrective action, Langdon will communicate with Charter the nature and extent of corrective action necessary. Charter will implement additional BMPs, as necessary until the previously identified deficiency has been remedied.
SWPPP
Appendix A
Design Plans – Phase II
SWPPP
Appendix B
Order of Resource Area Delineation Issued by Carver Conservation Commission
January 21, 2016

Robert Delhome
Route 44 Development, LLC
560 Harrison Avenue
Boston, MA 02118

RE: Order of Resource Area Delineation – DEP# SE126-527
3-4 Park Avenue

Dear Mr. Delhome:

Enclosed please find a copy of the Order of Resource Area Delineation (ORAD) for the address listed above. Please see Section B. 1. (a) and (b) for the resource areas confirmed on the site. The original ORAD will be kept on file in our office. Please keep this copy for your records.

If you have any questions or concerns, please do not hesitate to contact me.

Yours truly,

Brooke Monroe, Environmental Scientist
Agent, Carver Conservation Commission

Enc.

CC: DEP
Laura Simkins, VHB
Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 4B – Order of Resource Area Delineation

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

A. General Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

From:
1. Conservation Commission

2. This Issuance is for (check one):
   a. ☑ Order of Resource Area Delineation
   b. ☐ Amended Order of Resource Area Delineation

3. Applicant:
   Robert Delhome
   Route 44 Development LLC
   560 Harrison Avenue
   Boston
   MA 02118
   a. First Name
   b. Last Name
   c. Organization
   d. Mailing Address
   e. City/Town

4. Property Owner (if different from applicant):
   Same as Applicant
   a. First Name
   b. Last Name
   c. Organization
   d. Mailing Address
   e. City/Town
   f. State
   g. Zip Code

5. Project Location:
   3-4 Park Avenue
   Carver
   Map 20
   Lot 2
   a. Street Address
   b. City/Town
   c. Zip Code
   d. Assessors Map/Plat Number
   e. Parcel/Lot Number
   f. Latitude
   g. Longitude
   (in degrees, minutes, seconds):
   1113116
   1113t16

6. Dates:
   December 2015
   a. Date ANRAD filed
   b. Date Public Hearing Closed
   c. Date of Issuance
   1/13/16
   1/13/16

7. Title and Date (or Revised Date if applicable) of Final Plans and Other Documents:
   "Existing Conditions, ANRAD Plan, Stone Cranberry, Carver, MA"
   a. Title
   b. Date
   c. Title
   d. Date
B. Order of Delineation

1. The Conservation Commission has determined the following (check whichever is applicable):

   a. ☒ Accurate: The boundaries described on the referenced plan(s) above and in the Abbreviated Notice of Resource Area Delineation are accurately drawn for the following resource area(s):

      1. ☒ Bordering Vegetated Wetlands
      2. ☒ Other resource area(s), specifically:

         a. Wetland series #3 and #13 are defined as resource area bordering vegetated wetland; series #1, #2, #10, #11, #15 are isolated (By-law only). See b. below.

   b. ☒ Modified: The boundaries described on the plan(s) referenced above, as modified by the Conservation Commission from the plans contained in the Abbreviated Notice of Resource Area Delineation, are accurately drawn from the following resource area(s):

      1. ☐ Bordering Vegetated Wetlands
      2. ☒ Other resource area(s), specifically:

         a. Based on the conditions observed in the field (i.e. vegetation, hydrology, soils) wetland series #1, #2, #10, #11 and #15 as shown on the Plan do not qualify as wetland resource areas under the By-law; and, therefore are non-jurisdictional. Wetland series #3 and #13 are wetland resource areas (BVW); and therefore, are jurisdictional (See "Attachment A").

   c. ☐ Inaccurate: The boundaries described on the referenced plan(s) and in the Abbreviated Notice of Resource Area Delineation were found to be inaccurate and cannot be confirmed for the following resource area(s):

      1. ☐ Bordering Vegetated Wetlands
      2. ☐ Other resource area(s), specifically:

      3. ☐ The boundaries were determined to be inaccurate because:
ATTACHMENT "A"
Special Conditions for Order of Resource Area Delineation
Route 4 Development LLC
3-4 Park Avenue, Carver, Map 20, Lot 2

1. This ORAD confirms the presence of wetland resource area bordering vegetated wetland (BVW) shown as Wetland Series # 3 and #13 on the approved Plan. Any work/activities proposed within 100 feet of this resource area shall require a permit from the Carver Conservation Commission (see Section B (b) relative to the modifications made to the other resource area boundaries shown on the Plan).

2. This ORAD is valid for 3 years from the date of issuance and does not relieve the Applicant from complying with all other local regulations.
C. Findings

This Order of Resource Area Delineation determines that the boundaries of those resource areas noted above, have been delineated and approved by the Commission and are binding as to all decisions rendered pursuant to the Massachusetts Wetlands Protection Act (M.G.L. c. 131, § 40) and its regulations (310 CMR 10.00). This Order does not, however, determine the boundaries of any resource area or Buffer Zone to any resource area not specifically noted above, regardless of whether such boundaries are contained on the plans attached to this Order or to the Abbreviated Notice of Resource Area Delineation.

This Order must be signed by a majority of the Conservation Commission. The Order must be sent by certified mail (return receipt requested) or hand delivered to the applicant. A copy also must be mailed or hand delivered at the same time to the appropriate DEP Regional Office (see http://www.mass.gov/eea/agencies/massdep/about/contacts/find-the-massdep-regional-office-for-your-city-or-town.html).

D. Appeals

The applicant, the owner, any person aggrieved by this Order, any owner of land abutting the land subject to this Order, or any ten residents of the city or town in which such land is located, are hereby notified of their right to request the appropriate DEP Regional Office to issue a Superseding Order of Resource Area Delineation. When requested to issue a Superseding Order of Resource Area Delineation, the Department’s review is limited to the objections to the resource area delineation(s) stated in the appeal request. The request must be made by certified mail or hand delivery to the Department, with the appropriate filing fee and a completed Request for Departmental Action Fee Transmittal Form, as provided in 310 CMR 10.03(7) within ten business days from the date of issuance of this Order. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant.

Any appellants seeking to appeal the Department’s Superseding Order of Resource Area Delineation will be required to demonstrate prior participation in the review of this project. Previous participation in the permit proceeding means the submission of written information to the Conservation Commission prior to the close of the public hearing, requesting a Superseding Order or Determination, or providing written information to the Department prior to issuance of a Superseding Order or Determination.

The request shall state clearly and concisely the objections to the Order which is being appealed and how the Order does not contribute to the protection of the interests identified in the Massachusetts Wetlands Protection Act, (M.G.L. c. 131, § 40) and is inconsistent with the wetlands regulations (310 CMR 10.00). To the extent that the Order is based on a municipal bylaw or ordinance, and not on the Massachusetts Wetlands Protection Act or regulations, the Department of Environmental Protection has no appellate jurisdiction.
E. Signatures

Please indicate the number of members who will sign this form.

Signature of Conservation Commission Member

Signature of Conservation Commission Member

Signature of Conservation Commission Member

Signature of Conservation Commission Member

Signature of Conservation Commission Member

This Order is valid for three years from the date of issuance.

If this Order constitutes an Amended Order of Resource Area Delineation, this Order does not extend the issuance date of the original Final Order, which expires unless extended in writing by the issuing authority.

This Order is issued to the applicant and the property owner (if different) as follows:

2. By hand delivery on
   a. Date

3. By certified mail, return receipt requested on
   a. Date
A. Request Information

1. Person or party making request (if appropriate, name the citizen group's representative):

   Name

   Mailing Address

   City/Town     State     Zip Code

   Phone Number

   Project Location

   Mailing Address

   City/Town     State     Zip Code

2. Applicant (as shown on Notice of Intent (Form 3), Abbreviated Notice of Resource Area Delineation (Form 4A); or Request for Determination of Applicability (Form 1)):

   Name

   Mailing Address

   City/Town     State     Zip Code

   Phone Number

   Fax Number (if applicable)

3. DEP File Number:

B. Instructions

1. When the Departmental action request is for (check one):

   [ ] Superseding Order of Conditions

   [ ] Superseding Determination of Applicability

   [ ] Superseding Order of Resource Area Delineation

Send this form and check or money order for $120.00 (single family house projects) or $245.00 (all other projects), payable to the Commonwealth of Massachusetts to:

Department of Environmental Protection
Box 4062
Boston, MA 02211
B. Instructions (cont.)

2. On a separate sheet attached to this form, state clearly and concisely the objections to the Determination or Order which is being appealed. To the extent that the Determination or Order is based on a municipal bylaw, and not on the Massachusetts Wetlands Protection Act or regulations, the Department has no appellate jurisdiction.

3. Send a copy of this form and a copy of the check or money order with the Request for a Superseding Determination or Order by certified mail or hand delivery to the appropriate DEP Regional Office (see http://www.mass.gov/eea/agencies/massdep/about/contacts/find-the-massdep-regional-office-for-your-city-or-town.html).

4. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant.
SWPPP
Appendix C
Special Permit Application Approval Issued by
Carver Planning Board
May 9, 2017

Ms. Lynn Doyle, Town Clerk
Town of Carver
108 Main St.
Carver, MA 02330

Dear Ms. Doyle,

Re: Decision — Route 44 Development LLC Phase II- Special Permit — Section 4300

Applicant: Route 44 Development LLC
Applicant Address: 500 Harrison Avenue Suite 4R, Boston MA 02118
Location: 3-4 Park Avenue Carver MA 02330
Zoning District: Green Business Park
Title Reference: Book: 43733 Page: 3
Land Owner: Route 44 Development LLC

In accordance to MGL Ch. 40A, Sections 9 and 11, and Carver Zoning By Law Sections 4300 and 5300, a public hearing, duly posted and advertised was held March 28, 2017 and April 25, 2017 and closed on April 25, 2017 on the application of Route 44 Development LLC, 3-4 Park Avenue Carver MA 02330, for a Special Permit for Phase II of site preparations under the Water Resource Protection Section 4300, at 3-4 Park Avenue shown on Assessors Map 20 Lot 2 in the GBP Zoning District. On May 9, 2017 the Planning Board voted 4-0 to approve the Special Permit for Route 44 Development LLC Phase II as follows:

The Board finds the following facts:

1. Special Permit per Section 4300 Site preparation in a GBP District
   a.) Is in accordance with the provisions of Section 4360 -The Planning Board finds that the proposal meets the Design and Operation Standards of the Town of Carver and that proper safeguards have been implemented in this decision to protect the water quality; ground water; and soils of the site and the surrounding area.

Special Permit- Phase II - Route 44 Development LLC decision May 9, 2017
May 9, 2017

Ms. Lynn Doyle, Town Clerk
Town of Carver
108 Main St.
Carver, MA 02330

Dear Ms. Doyle,

Re: Decision — Route 44 Development LLC Phase II- Special Permit — Section 4300

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The Board finds the following facts:

1. Special Permit per Section 4300 Site preparation in a GBP District
   a.) Is in accordance with the provisions of Section 4360 -The Planning Board finds that the proposal meets the Design and Operation Standards of the Town of Carver and that proper safeguards have been implemented in this decision to protect the water quality; ground water; and soils of the site and the surrounding area.

Special Permit- Phase II - Route 44 Development LLC decision May 9, 2017
b.) Is in harmony with the purpose and intent of this bylaw – The Planning Board finds that through the series of conditions as outlined in this decision the intent of the By Law has been satisfied.

c.) Is appropriate to the natural topography, soils and other characteristics of the site to be developed – The Planning Board finds that due to the nature of the existing conditions of this site, the proposal will effectively improve the conditions of the site with clean soils; quality water management and the licensed cleanup of contaminated areas.

d.) Will not, during construction or thereafter, have an adverse environmental impact on the aquifer or recharge area (i.e., quality, or quantity of groundwater) - The Planning Board finds that no adverse effect will occur during the construction of this site and that all proper measures have been taken to protect the quality of the groundwater.

e.) Will not adversely affect an existing or potential water resource – No existing or potential water resource have been identified on or near this site.

2. **Section 5300 Special Permit**

a.) Social, economic, or community needs which are served by the proposal- The Planning Board finds that the social, economic, and community needs have been met. The property has been zoned Industrial; Highway Commercial; and now Green Business Park for many years and has been identified as the number one priority development site in the Town of Carver in its 2001 Master Plan. It was also designated by the Planning Board; Board of Selectman and Town Meeting as a Priority Development Site (PDS) in its designation as an Expedited Permit Site.

b.) Traffic flow and safety, including parking and loading – The Planning Board finds that all traffic and safety concerns have been met. The proposed improvements to both Park Avenue and Montello Street satisfy the Planning Boards concern over truck traffic generated from this site and any conflicts that may occur.

c.) Adequacy of utilities and other public services - The Planning Board finds that all proposed utilities and other public services are sufficient for this proposal. No utilities are necessary at this time.

d.). Neighborhood character and social structures – The Planning Board finds that the proposed development will have minimal detrimental impact on the neighborhood character or social structure. As stated previously this site has long been identified as a priority development site.

e.) Impacts on the natural environment – The Planning Board find that there will be no negative impact on the natural environment with this proposal. The project involves a positive change to the natural environment. In fact, this phase of the project is just one phase of many that will properly remedy many cited contaminations on the site and rectify the site into a marketable usable condition.

Special Permit- Phase II - Route 44 Development LLC decision May 9, 2017
f.) Potential fiscal impact, including impact on town services, tax base, and employment – The Planning Board finds that there will be no negative impact on town services, tax base or employment with this proposal. Eventual development of this site will substantially increase the town's tax base and potentially provide numerous employment opportunities.

The Planning Board at their regularly scheduled meeting on May 9, 2017 voted 4 in favor (Maki; Sinclair; Robinson and Hoffman) and 0 against to grant a Special Permit to allow Phase II site preparations on the application by Route 44 Development 44 LLC for 3-4 Park Avenue, Carver.

The granting of this petition is subject to the following conditions:

1. The project shall be substantially completed no later than four (4) years from the date of expiration of the appeal period from this decision, assuming no appeal is taken therefrom.

2. The Planning Board and its Staff shall have access to the project site to ensure that these conditions are complied with.

3. Any plan revisions shall be submitted to and approved by the Planning Board and construction shall conform to those final plans so approved. The Planning Board reserves the right to approve, without the need for a new noticed public hearing, any minor modifications.

4. Prior to the commencement of operations, a true photocopy of the Planning Board's decision as registered at the “Plymouth County Registry of Deeds” shall be submitted to the Carver Planning Department.

5. The Town of Carver or its representative shall conduct periodic site inspections to verify compliance with the approved plans and to determine whether additional erosion and sedimentation controls are required to protect adjacent properties or drainage systems. Dust control is required during construction.

6. The developer is responsible for the proper operation and maintenance of the construction site and shall inspect, repair, replace, and supplement controls as needed to minimize soil erosion and sedimentation.

7. Any significant revisions to plans will require approval from the Town of Carver Planning Board as a modification to the Special Permit and Site Plan Review.

Special Permit- Phase II - Route 44 Development LLC decision May 9, 2017
8. Any outstanding balance in the Review and Inspection deposit shall be paid immediately by the applicant. Failure to do so in a timely manner shall at the discretion of the Planning Board require the applicant to cease and desist all operations until the balance is restored.

9. Public roadways servicing the site shall be swept as needed during construction.

10. Construction waste shall be controlled and disposed of offsite in conformance with applicable state and/or federal laws.

11. All future phases of this site remediation project shall come before the Planning Board as a Special Permit.

12. ABC processing shall be limited to 7AM to 5PM Monday through Friday and shall adhere to MASSDEP’s Noise Policy as well as to the Town of Carver Zoning by Laws Section 3600 regarding noise.

13. ABC Processing Hours: “Fourteen (14) days written notice will be provided to the Planning Board prior to the commencement of any on-site processing of asphalt, brick and concrete (ABC) materials. Any single processing period for ABC shall not to exceed 30 calendar days in length from the start of processing operations unless subsequent notice is provided to the Planning Board and approval for an extension is granted.”

14. Trucks shall be inspected to insure they are not tracking soil on to Montello Street during rainy days. A water truck with a pressure washer will be available on-site to wash trucks when necessary.

15. If operations create unanticipated odors on-site, the operator will take immediate action to mitigate odors and insure they do not leave the site.

16. There shall be a continued designated truck route and at no times will trucks be allowed to exit left on to Montello Street going north.

17. Prior to the commencement of Phase II operations, the surety currently in place with the Planning Board for $50,000 shall be continued to cover costs in the event the operation is abandoned.

Special Permit- Phase II - Route 44 Development LLC decision May 9, 2017
18. The operation shall be subject to unannounced site inspections by the Town’s License Site Professional. These inspections shall not exceed (1) one inspection per month on average over a (6) six month period. The applicant shall be responsible for all costs accrued for these services not to exceed $20,000.

19. Applicant shall be subject to a review of all soil packages by the Town’s License Site Professional at the expense of the applicant not to exceed $10,000.

20. Montello Street culvert will be inspected by the Applicant’s engineer every three (3) months with a report submitted to the Planning Board and DPW Superintendent.

21. Trucks will be limited to Monday through Friday from 7AM to a ½ hour prior to sundown or 7PM, whichever is applicable and not on Holidays.

22. During the entirety of Phase II activities, both Park Avenue and Montello Street and its intersections, including pavement markings, repair of potholes and damage to Montello Street, signage, vegetation removal and road widening (where necessary) shall be properly maintained by the applicant at the direction and approval of the Director of Planning and Development and the DPW Superintendent.

23. Proper security for the site shall be maintained including but not limited to Security Cameras and Gates for the site.

24. Six (6) months after the commencement of Phase II operations, the Applicant shall meet with the Director of Planning and Community Development to discuss progress of the site and any violations or issues regarding this decision. It will be at the discretion of the Director of Planning and Community Development whether any issues or violations will be brought to the Planning Boards attention.

25. Prior to the start of Phase II operations the applicant shall submit an application to the Carver Earth Removal Committee (ERC) under the remediation clause of the ERC by Laws.
If substantial use and construction permitted by this Special Permit is not commenced within two (2) years from the date on which a copy of this Decision is filed with the Carver Town Clerk, excluding the amount of time required for the appeal period to expire or the amount of time required to pursue and await the determination of any such appeal, then this Special Permit shall expire.

This Decision shall not take effect until a copy of this Decision, certified by the Town Clerk that twenty (20) days have elapsed since the Decision was filed with the Town Clerk without any appeal having been filed therefrom, or that any such appeal has been finally determined, has been filed at the Plymouth County Registry of Deeds, and a certified copy indicating such Registry recording has been filed with the Carver Planning Board.

Any appeal of this decision must be filed pursuant to MGL Chapter 40A, Section 17, and shall be filed within 20 days of the filing of this decision with the Town Clerk.

Carver Planning Board

Bruce Maki, Chair

Will Sinclair

Kevin Robinson

Jim Hoffman

DATE 8/9/17

Special Permit- Phase II - Route 44 Development LLC decision May 9, 2017
This chapter describes specific Best Management Practices (BMPs) for common construction activities that may contaminate storm water. Chapter 2 led you through the steps of identifying activities at your site that can contaminate storm water, while Chapter 3 provided guidance with BMP selection. This chapter will provide you with the BMPs that best fill your site's needs.

BMPs fact sheets are provided for each of the following contractor's activities, and are consistent with Worksheet 1 in Chapter 2.

Construction Practices
- CP1 Dewatering Operations
- CP2 Paving Operations
- CP3 Structure Construction and Painting

Material Management
- MM1 Material Delivery and Storage
- MM2 Material Use
- MM3 Spill Prevention and Control

Waste Management
- WM1 Solid Waste Management
- WM2 Hazardous Waste Management
- WM3 Contaminated Soil Management
- WM4 Concrete Waste Management
- WM5 Sanitary/Septic Waste Management

Vehicle and Equipment Management
- VM1 Vehicle and Equipment Cleaning
- VM2 Vehicle and Equipment Fueling
- VM3 Vehicle and Equipment Maintenance

Each fact sheet contains a cover sheet with:
- A description of the BMP
- Approach
- Requirements
  - Costs, including capital costs, and operations and maintenance (O&M)
  - Maintenance (including administrative and staffing)
- Limitations
- References

The side bar presents information on which BMP objective applies, targeted constituents, and an indication of the level of effort and costs to implement. For some BMPs, further information is provided in additional sheets.
BMP: DEWATERING OPERATIONS

OBJECTIVES
Housekeeping Practices
- Contain Waste
Minimize Disturbed Areas
- Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from dewatering operations by using sediment controls and by testing the water for contamination.

APPROACH
There are two general classes of pollutants that may result from dewatering operations: sediment, and toxics and petroleum products. A high sediment content in dewatering discharges is common because of the nature of the operation. On the other hand, toxics and petroleum products are not commonly found in dewatering discharges unless the site or surrounding area has been used for light or heavy industrial activities, or the area has a history of groundwater contamination.

The following steps will help reduce storm water pollution from dewatering discharges:

Sediment
- Use sediment controls to remove sediment from water generated from dewatering. See Sediment Trap (ST7) and Sediment Basin (ST8) in Chapter 5 for more information.
- Use filtration to remove sediment from a sediment trap or basin. Filtration can be achieved with:
  - Sump pit and a standpipe in the center with holes and wrapped in filter fabric. The standpipe is surrounded by stones which filters the water as it collects in the pit before being pumped out;
  - Floating suction hose allowing cleaner surface water to be pumped out; or
  - Standpipe in the sediment basin with slits and wrapped in filter fabric to remove sediments.

Toxics and Petroleum Products
- In areas suspected of having groundwater contamination, protect yourself early in the excavation process by sampling and having the water tested at a certified laboratory. Check with the Regional Water Quality Control Board and the local sewage treatment plant for their requirements, including additional water quality tests and disposal options.
  - Contaminated water can be expensive to treat and/or dispose of properly. However, addressing the problem before building construction is much less expensive than after the buildings are in place.

REQUIREMENTS
Costs (Capital, O&M)
- Sediment controls are low cost measures.
- Treatment and/or discharge of contaminated water can be quite expensive.

Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

 Likely to Have Significant Impact
  Probable Low or Unknown Impact

Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

High
Low

SYMBOL
CP1

LOGO
BMP: PAVING OPERATIONS

Objectives
Housekeeping Practices
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Description
Prevent or reduce the discharge of pollutants from paving operations by paving as little area as possible, using measures to prevent runoff and runoff, properly disposing of wastes, and training employees and subcontractors.

Approach
Paving operations usually involve the use of either concrete or asphalt to create impervious surface areas to act as thoroughfares such as sidewalks and roads. The easiest and least expensive measure is to:
- Pave as little area as possible. The creation of impervious surface areas causes storm water quantity and quality problems. See SC2 (Impervious Area Minimization) in the Municipal Handbook and PS3 (Preservation of Existing Vegetation) in Chapter 5 of this handbook for more information.

If you must pave, the following steps will help reduce the impacts to storm water:
- Avoid paving just before or during wet weather.
- Keep construction materials and equipment covered when not in use.
- Store materials in a bermed area located away from drainage courses to prevent storm water runoff.
- Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials rather than burying. See VM3 (Vehicle and Equipment Maintenance) and MM3 (Spill Prevention and Control) in this chapter for more information.
- If paving involves concrete, see WM4 (Concrete Waste Management) in this chapter for more information.
- If paving involves asphalt, follow these steps:
  - Mix asphalt in proper proportions. Excess fluid is likely to contain toxic levels of petroleum, and can contaminate soil and runoff.
  - Compact asphalt and base to prevent void spaces which may contain toxic liquids, and to provide adequate drainage.
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks. Properly dispose of this waste by referring to BMP WM1 (Solid Waste Management) in this chapter.
  - Old asphalt is a hazardous waste. However, it may be recycled by using a licensed hazardous waste hauler. Collect all broken asphalt so this hazardous waste is not left on-site.
- Train employees and subcontractors.

Targeted Pollutants
○ Sediment
○ Nutrients
○ Toxic Materials
○ Oil & Grease
○ Floatable Materials
○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements
○ Capital Costs
○ O&M Costs
○ Maintenance
○ Training
○ Suitability for Slopes >5%

High
Low

Symbol
CP2

Logo
REQUIREMENTS
- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect employees and subcontractors to ensure that measures to reduce the storm water impacts of paving are being followed.
  - Keep ample supplies of drip pans or absorbent materials on-site.

LIMITATIONS
- There are no major limitations to this best management practice.

REFERENCES
Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control (Draft); Santa Clara Valley Nonpoint Source Pollution Control Program, 1992
**DESCRIPTION**

Prevent or reduce the discharge of pollutants to storm water from structure construction and painting by enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees and subcontractors.

**APPROACH**

- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area.
- Use soil erosion control techniques if bare ground is exposed. See chapter 5 of this handbook.
- Buy recycled or less hazardous products to the maximum extent practical.
- Enclose painting operations, consistent with local air quality and OSHA regulations.
- Properly store paints and solvents. See MM1 (Material Delivery and Storage) in this chapter.
- Properly store and dispose waste materials generated from the activity. See the waste management BMPs in this chapter.
- Recycle residual paints, solvents, lumber, and other materials to the maximum extent practical.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.
- Clean the storm drain system in the immediate vicinity of the construction activity after it is completed.
- Educate employees who are doing the work.
- Inform subcontractors of company policy on these matters and include appropriate provisions in their contract to make certain proper housekeeping and disposal practices are implemented.

**REQUIREMENTS**

- Costs (Capital, O&M)
  - These BMPs are generally of low to moderate cost.
- Maintenance
  - Maintenance should be minimal.

**LIMITATIONS**

- Safer alternative products may not be available, suitable, or effective in every case.
- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler.
- Be certain that actions to help storm water quality are consistent with Cal- and Fed-OSHA and air quality regulations.
Additional Information — Structure Construction and Painting

Construction and painting activities can generate pollutants that can reach storm water if proper care is not taken. The sources of these contaminants may be solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos insulation. For specific information on some of these wastes see the following BMPs in this chapter:

WM1 Solid Waste,
WM2 Hazardous Waste, and
WM4 Concrete Waste.

More specific information on structure construction practices is listed below.

Erosion and Sediment Control
If the work involves exposing large areas of soil or if old buildings are being torn down and not replaced in the near future, employ the appropriate soil erosion and control techniques described in chapter 5 of this handbook.

Storm/Sanitary Sewer Connections
Carefully install all plumbing and drainage systems. Cross connections between the sanitary and storm drain systems, as well as any other connections into the drainage system from inside a building, are illegal. Color code or flag pipelines on the project site to prevent such connections, and train construction personnel.

Painting
Painting operations should be properly enclosed or covered to avoid drift. Use temporary scaffolding to hang drop cloths or draperies to prevent drift. Application equipment that minimizes overspray also helps. Local air pollution regulations may, in many areas of the state, specify painting procedures which if properly carried out are usually sufficient to protect water quality. When using sealants on wood, pavement, roofs, etc, quickly clean up spills. Remove excess liquid with absorbent material or rags.

If painting requires scraping or sand blasting of the existing surface, use a ground cloth to collect the chips. Dispose the residue properly. If the paint contains lead or tributyl tin, it is considered a hazardous waste. Refer to the waste management BMPs in this chapter for more information.

Mix paint indoors before using so that any spill will not be exposed to rain. Do so even during dry weather because cleanup of a spill will never be 100% effective. Dried paint will erode from a surface and be washed away by storms. If using water based paints, clean the application equipment in a sink that is connected to the sanitary sewer. Properly store leftover paints if they are to be kept for the next job, or dispose properly.

Roof work
When working on roofs, if small particles have accumulated in the gutter, either sweep out the gutter or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is tight lined, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vacuum truck, and clean the catch basin sump where you placed the plug.

REFERENCES
Best Management Practices for Industrial Storm Water Pollution Control (Draft), Santa Clara Valley Nonpoint Source Pollution Control Program, 1992
**BMP: MATERIAL DELIVERY AND STORAGE**

### GRAPHIC

#### DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from material delivery and storage by minimizing the storage of hazardous materials on-site, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see MM2 (Material Use), or MM3 (Spill Prevention and Control). For information on wastes, see the waste management BMPs in this chapter.

#### APPROACH
The following materials are commonly stored on construction sites:
- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Storage of these materials on-site can pose the following risks:
- Storm water contamination,
- Injury to workers or visitors,
- Groundwater contamination, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:
- Designate an area of the construction site for material delivery and storage.
  - Place near the construction entrance, away from waterways.
  - Avoid transport near drainage paths or waterways.
  - Surround with earth berms (see DR1, Earth Dike).
  - Place in an area which will be used to stabilize any residential materials.
- Store of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- Keep an accurate, up-to-date inventory in your SWPPP of the materials delivered and stored on-site.
- Keep your inventory down. Store only the amount you need, for only as long as you need it.
- Store as few hazardous materials on-site as possible.
- Handle hazardous materials as infrequently as possible.
- Designate a secure material storage area away from drainage courses and near the site entrance.

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Construction Handbook  4 - 8  September 1, 1992
BMP: Material Delivery and Storage (Continue)

- Whenever possible, store materials in a covered area with secondary containment such as an earthen dike, horse trough, or even kid’s wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in “bus boy” trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items in secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids and to reduce corrosion.
- Try to keep chemicals in their original containers, and keep them well labeled.
- Train employees and subcontractors.
- Employees trained in emergency spill cleanup procedures should be present when dangerous materials or liquid chemicals are unloaded.

REQUIREMENTS
Cost (Capital, O&M)
- All of the above are low cost measures.

Maintenance
- Keep the designated storage area clean and well organized.
- Conduct routine weekly inspections and check for external corrosion of material containers.
- Keep an ample supply of spill cleanup materials near the storage area.

LIMITATIONS
- Storage sheds often must meet building and fire code requirements.

REFERENCES
Storm Water Pollution Prevention for Construction Activities (Draft): USEPA, April 1992


Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control (Draft): Santa Clara Valley Nonpoint Source Pollution Control Program, 1992

Construction Handbook 4 - 9
September 1, 1992
BMP: MATERIAL USE

DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from material use by using alternative products, minimizing hazardous material use on-site, and training employees and subcontractors.

APPROACH
The following materials are commonly used on construction sites:
- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Use of these materials on-site can pose the following risks:
- Storm water contamination,
- Injury to workers or visitors,
- Groundwater contamination, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:
- Use less hazardous, alternative materials as much as possible.
- Use as few hazardous materials on-site as possible.
- Limit material usage to designated areas only.
- Follow manufacturer's instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- For pesticides in particular, personnel who use pesticides should be trained in their use. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Till fertilizers and lime into the soil rather than hydroseeding. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains.
- Train employees and subcontractors in proper material use.
BMP: Material Use (Continue)

REQUIREMENTS
Costs (Capital, O&M)
- All of the above are low cost measures.
Maintenance
- Maintenance of this best management practice is minimal.

LIMITATIONS
- Alternative materials may not be available, suitable, or effective in every case.

REFERENCES
Storm Water Pollution Prevention for Construction Activities (Draft); USEPA, April 1992


Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control (Draft); Santa Clara Valley Nonpoint Source Pollution Control Program, 1992
DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, MM1 (Material Delivery and Storage) and MM2 (Material Use), also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this chapter.

APPROACH
The following steps will help reduce the storm water impacts of leaks and spills:

**General Measures**
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.

**Cleanup**
- Clean up leaks and spills immediately.
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Sweep up or excavate the material and dispose of properly. See the waste management BMPs in this chapter for specific information.

**Reporting**
- Report spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).

Use the following measures related to specific activities:

**Vehicle and Equipment Maintenance**
- If maintenance must occur on-site, use a designated area, located away from drainage courses, to prevent the runoff of storm water and the runoff of spills.
BMP: Spill Prevention and Control (Continue)

- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don’t leave full drip pans or other open containers lying around.
- Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling
- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Discourage “topping-off” of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/leaks.

REQUIREMENTS
Costs (Capital, O&M)
- Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.

Maintenance
- Keep ample supplies of spill control and cleanup materials on-site, near storage, unloading, and maintenance areas.
- Update your spill cleanup materials as changes occur in the types of chemicals on-site.

LIMITATIONS
- If necessary, use a private spill cleanup company.

REFERENCES
Storm Water Pollution Prevention for Construction Activities (Draft); USEPA, April 1992

Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control (Draft); Santa Clara Valley Nonpoint Source Pollution Control Program, 1992
BMP: SOLID WASTE MANAGEMENT

DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

APPROACH
Solid waste is one of the major pollutants resulting from construction. Construction debris includes:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction;
- Packaging materials including wood, paper and plastic;
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products; and
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, and plastic wrappers, and cigarettes.

The following steps will help keep a clean site and reduce storm water pollution:

- Select a designated waste collection area on-site.
- When possible, locate containers in a covered area.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it’s windy.
- Collect site trash daily.
- Erosion and sediment control devices tend to collect litter. Remove this solid waste promptly.
- Salvage or recycle any useful material. For example, trees and shrubs from land clearing can be used as a brush barrier (see ST3), or converted into wood chips, then used as mulch on graded areas (see VS2).
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- If a container does spill, clean up immediately.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.
- Train employees and subcontractors in proper solid waste management.

REQUIREMENTS
Costs (Capital, O&M)

- All of the above are low cost measures.

Objectives
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

- Likely to Have Significant Impact
- Probable Low or Unknown Impact

Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

Symbol
WM1

Logo

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BMP: Solid Waste Management (Continue)

Maintenance
- Collect site trash daily.
- Inspect construction waste area regularly.
- Arrange for regular waste collection.

LIMITATIONS
- There are no major limitations to this best management practice.

REFERENCES
Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/9-73-007, 1973

Storm Water Pollution Prevention for Construction Activities (Draft); USEPA, April 1992

Best Management Practices and Erosion Control Manual for Construction Sites (Draft); Flood Control District of Maricopa County, AZ, July 1992
## BMP: HAZARDOUS WASTE MANAGEMENT

### DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

### APPROACH
Many of the chemicals used on-site can be hazardous materials which become hazardous waste upon disposal. These wastes may include:
- Paints and solvents;
- Petroleum products such as oils, fuels, and grease;
- Fertilizers;
- Herbicides and pesticides;
- Acids for cleaning masonry;
- Soil stabilization additives such as calcium carbonate;
- Asphalt products; and
- Concrete curing compounds.

In addition, sites with existing structures may contain wastes which must be disposed of in accordance with Federal, State, and local regulations. These wastes include:
- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints;
- Asbestos; and
- PCBs (particularly in older transformers).

The following steps will help reduce storm water pollution from hazardous wastes:

### Material Use
- Use all of the product before disposing of the container.
- Do not remove the original product label, it contains important safety and disposal information.
- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Till fertilizers and lime into the soil rather than hydroseeding. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with Federal and State regulations.

### Waste Recycling/Disposal
- Select a designated waste collection area on-site.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.

### Objectives
- Housekeeping Practices
  - Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

### Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

- **Likely to Have Significant Impact**
- **Probable Low or Unknown Impact**

### Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Storms >5%
BMP: Hazardous Waste Management (Continue)

- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, make recycling impossible, and complicate disposal.
- Recycle any useful material such as used oil.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.

Training
- Train employees and subcontractors in proper hazardous waste management.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Requirements
Costs (Capital, O&M)
- All of the above are low cost measures.
Maintenance
- Inspect hazardous waste receptacles and area regularly.
- Arrange for regular hazardous waste collection.

Limitations
- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler.

References
Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 4309-73-007, 1973

Storm Water Pollution Prevention for Construction Activities (Draft); USEPA, April 1992

Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control (Draft); Santa Clara Valley Nonpoint Source Pollution Control Program, 1992
BMP: CONTAMINATED SOIL MANAGEMENT

DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

APPROACH
Contaminated soils may occur on your site for a several reasons including:
- Past site uses and activities;
- Detected or undetected spills and leaks; and
- Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline-forming elements.

The following steps will help reduce storm water pollution from contaminated soil:
- Conduct thorough site planning including pre-construction geologic surveys.
- Look for contaminated soil as evidenced by discoloration, odors, or differences in soil properties.
- Seal bedrock fractures with grout or bentonite to reduce seepage from excavation.
- Prevent leaks and spills to the maximum extent practicable. Contaminated soil can be expensive to treat and/or dispose of properly. However, addressing the problem before building construction is much less expensive than after the buildings are in place.
- Test suspected soils at a certified laboratory.
- If the soil is contaminated, work with the local regulatory agencies to develop options for treatment and/or disposal.

REQUIREMENTS
Costs (Capital, O&M)
- Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil can be quite expensive.

Maintenance
- Inspect excavated areas daily for signs of contaminated soil.
- Implement MM3, Spill Prevention and Control, to prevent leaks and spills as much as possible.

LIMITATIONS
- Contaminated soils that cannot be treated on-site must be disposed of off-site by a licensed hazardous waste hauler.
- The presence of contaminated soil may indicate contaminated water as well. See CPI (Dewatering Operations) in this chapter for more information.
REFERENCES
Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity: USEPA, 430/9-73-007, 1973

Storm Water Pollution Prevention for Construction Activities (Draft); USEPA, April 1992

Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control (Draft); Santa Clara Valley Nonpoint Source Pollution Control Program, 1992
BMP: VEHICLE AND EQUIPMENT FUELING

GRAPHIC

DESCRIPTION
Prevent fuel spills and leaks, and reduce their impacts to storm water by using off-site facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors.

APPROACH
- Use off-site fueling stations as much as possible. Fueling vehicles and equipment outdoors or in areas where fuel may spill/leak onto the ground can pollute storm water. If you fuel a large number of vehicles or pieces of equipment, consider using an off-site fueling station. These businesses are better equipped to handle fuel and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the ranon of storm water and the runoff of spills.
- Discourage “topping-off” of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/leaks.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Carry out all Federal and State requirements regarding stationary above ground storage tanks.
- Do not use mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and perhaps small forklifts, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.

REQUIREMENTS
- Costs (Capital, O&M)
  - All of the above measures are low cost, except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.
- Maintenance
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect fueling areas and storage tanks on a regular schedule.

LIMITATIONS
- Sending vehicles/equipment off-site should be done in conjunction with PS7 (Stabilized Construction Entrance).
BMP: VEHICLE AND EQUIPMENT MAINTENANCE

DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment maintenance by running a “dry site”. This involves using off-site facilities, performing work in designated areas only, providing cover for materials stored outside, checking for leaks and spills, containing and cleaning up spills immediately, and training employees and subcontractors.

APPROACH
- Keep vehicles and equipment clean, don’t allow excessive build-up of oil and grease.
- Use off-site repair shops as much as possible. Maintaining vehicles and equipment outdoors or in areas where vehicle or equipment fluids may spill or leak onto the ground can pollute storm water. If you maintain a large number of vehicles or pieces of equipment, consider using an off-site repair shop. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work off-site can also be economical by eliminating the need for separate maintenance equipment.
- If maintenance must occur on-site, use designated areas, located away from drainage courses, to prevent the runoff of storm water and the runoff of spills.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Regularly check on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.

REQUIREMENTS
- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect maintenance areas on a regular schedule.

LIMITATIONS
- Sending vehicles/equipment off-site should be done in conjunction with BMP C/PS8 (Stabilized Construction Entrance).

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Additional Information — Vehicle and Equipment Maintenance

Outdoor vehicle or equipment maintenance is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service, particularly changing or replacement of fluids, and outdoor equipment storage and parking (dripping engines). For further information on vehicle or equipment servicing, see VM1, Vehicle and Equipment Cleaning, and VM2, Vehicle and Equipment Fueling.

Listed below is further information if you must perform vehicle or equipment maintenance on-site.

**Waste Reduction**
Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane, or methylene chloride. Many of these parts cleaners are harmful and must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents (1,1,1-trichloroethane, methylene chloride, etc.) with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

**Recycling/Disposal**
Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don’t leave full drip pans or other open containers lying around.

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Do not bury used tires.

**REFERENCES**

Best Management Practices and Erosion Control Manual for Construction Sites (Draft); Flood Control District of Maricopa County, AZ, July 1992

Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control (Draft); Santa Clara Valley Nonpoint Source Pollution Control Program, 1992

SYMBOL

VM3

LOGO
This chapter describes specific Best Management Practices (BMPs) for common construction activities that result in erosion of the construction site and the generation of sediment which impacts waterways and offsite property. Chapter 2 led you through the steps of identifying activities at your site that can cause erosion, while Chapter 3 provided guidance with BMP selection. This chapter will provide you with the BMPs that best fill your site's needs.

BMPs fact sheets are provided for each of the following BMP categories, and are consistent with Worksheet 1 in Chapter 2.

Site Planning Considerations
   SP1 Scheduling
   SP2 Watercourse Protection
   SP3 Preservation of Existing Vegetation

Vegetative Stabilization
   VS1 Seeding and Planing
   VS2 Mulching

Physical Stabilization
   PS1 Geotextiles and Mats
   PS2 Stream Bank Stabilization
   PS3 Retaining Walls and Sheetng
   PS4 Dust Control
   PS5 Temporary Stream Crossing
   PS6 Construction Road Stabilization
   PS7 Stabilized Construction Entrance

Diversion of Runoff
   DR1 Earth Dike
   DR2 Drainage Swale
   DR3 Temporary Storm Drain
   DR4 Pipe Slope Drain
   DR5 Subsurface Drain

Velocity Reduction
   VR1 Outlet Protection
   VR2 Check Dams
   VR3 Surface Roughing

Sediment Trapping/Filtering
   ST1 Silt Fence
   ST2 Straw Bale Barrier
   ST3 Brush Barrier
   ST4 SandBag Barrier
   ST5 Rock Filter Berm
   ST6 Storm Drain Inlet Protection
   ST7 Sediment Trap.
   ST8 Sediment Basin

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Suitable Applications
- Installation/Application Criteria
- Requirements
  - Costs, including capital costs, and operations and maintenance (O&M)
  - Maintenance (including administrative and staffing)
- Limitations

The sidebar presents information on which BMP objective applies, targeted constituents, and an indication of the level of effort and costs to implement. The remainder of the fact sheet provides further information on some or all of these topics, and provides references for additional guidelines.
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<td>ST8 Sediment Basin</td>
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## BMP: SEEDING AND PLANTING

### GENERAL DESCRIPTION
Seeding of grasses and plantings of trees, shrubs, vines and ground covers provide long-term stabilization of soil. In some areas, with suitable climates, grasses can be planted for temporary stabilization.

### SUITABLE APPLICATIONS
- Any graded/cleared areas where construction activities have ceased
- Open space cut and fill areas
- Steep slopes
- Spoil piles
  - Vegetated swales
  - Landscape corridors
  - Stream banks

### INSTALLATION/APPLICATION CRITERIA
Type of vegetation, site & seedbed preparation, planting time, fertilization and water requirements should be considered for each application.

**Grasses:**
- Ground preparation: fertilization, mechanically stabilized soil
- Tolerant of short-term temperature extremes and waterlogged soil conditions
- Soil Conditions: shallow soil base, good drainage, slope 2:1 or flatter
- Develop well and quickly from seeds
- Mowing, irrigation and fertilizer

**Trees & Shrubs:**
- Vigor, species, size, shape & wildlife food source
- Soil conditions: drainage & acidity
- Wind exposure
- Temperature extremes
- Irrigation needs

**Vines & Ground Covers:**
- Ground preparation: lime and fertilizer preparation
- Proper seeding rates
- Soil conditions: drainage, acidity, slopes
- Generally avoid species requiring irrigation

### Objectives
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

### Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

### Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for slopes >5%

### SYMBOL
- VS1

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REQUIREMENTS
- Maintenance
  - Shrubs and trees must be adequately watered and fertilized and if needed pruned
  - Grasses may need to be watered and mowed.
- Cost
  - Grasses range from $1 to $3 per square yard. Adverse site conditions may increase cost.

LIMITATIONS
- Permanent and temporary vegetation may not be appropriate in dry periods without irrigation
- Fertilizer requirements may have potential to create water quality problems
Additional Information — Seeding and planting

Permanent seeding of grasses, sodding, and plantings of trees, shrubs, vines and ground covers can provide long-term stabilization of soil. While contributing to long-term site aesthetics, permanent seeding and planting, helps reduce erosion by reducing the velocity of runoff, allowing infiltration to occur, filtering sediments, and by holding soil particles in place.

Seeding and planting should be applied to all graded and cleared areas of the construction site where plant cover is ultimately desired, as soon as final grading is done. For example, vegetation may be established along landscaped corridors and buffer zones where this may act as filter strips (see Municipal Handbook). Additionally, vegetated swales, steep and/or rocky slopes and stream banks can also serve as appropriate areas for seeding and plantings.

Preserving and protecting existing vegetation can often result in more stable soil conditions during construction. Careful site planning and identification of plantings to preserve can provide erosion and sedimentation controls during construction, and contribute to the aesthetics of the development. For example, in Sacramento County a tree ordinance has been adopted that protects the native California Oak tree. Provisions to protect the tree and its root system during construction must be specified in the project plans, and an area must be provided where the soil stability may not be disturbed. No grading or construction storage within the tree dripline is allowed.

INSTALLATION/APPLICATION CRITERIA

Application of appropriate vegetation must consider the seedbed or plantbed, proper seasonal planting times, water requirements, fertilizer requirements and availability of the selected vegetation within the project's region. Permanent plantings during the construction stage of projects require careful coordination between the local agency inspectors, project managers, construction managers, and landscape contractor. Protocols for coordination and implementation procedures regarding site access, construction staging, and short and long-term planting areas should be developed prior to the construction bid process, where possible, these protocols should be established by and remain the responsibility of the site operator.

Because of the many available types of plants and ground covers and because site conditions and land use vary so widely within California, a set of general guidelines is included for installation/application of grasses, trees and shrubs, vines and ground covers.

Grasses

Grasses, depending on the type, provide short-term soil stabilization during construction or can serve as long-term/permanent soil stabilization for disturbed areas. In general, grasses provide low maintenance to areas that have been cleared, graded and mechanically stabilized.

Selection:
The selection of the grass type is determined by the climate, irrigation, mowing frequency, maintenance effort and soilbed conditions. Although grasses provide quick germination and rapid growth, they also have a shallow root system and are not as effective in stabilizing deep soils, where trees, shrubs and deep rooted ground covers may be more appropriate. Several grasses are adaptable to the various California climates. Figure VS1.1, appropriate grasses for regions within California are shown. Bluegrass is well adapted throughout California except for in the valley regions. The bluegrass is found on dry, sandy soils that have good drainage. Bermuda Grass, on the other hand is well adapted in the valley region where soils are dry, coarse and heavier. Specific seed mix and/or varieties for each site should be provided by an approved/qualified plant materials specialist.
Additional Information — Seeding and planting

Planting:
The following steps should be followed to insure established growth:
1. Select the proper grass for the site.
2. Prepare the seedbed, soil should be fertilized and contain good topsoil or soil at least a 2:1 or flatter slope.
3. Broadcast the seedings in the late fall or early spring. In the late fall, seedings should be planted by mid-September to have established grass by the October rainy season.
4. Initial irrigation will be required often for most grasses, with follow-up irrigation and fertilization as needed. Mulching may be required in dry climates or during drought years.

Trees & Shrubs

Selection:
Trees and shrubs, when properly selected, are low maintenance plantings that stabilize adjacent soils, moderate the adjacent temperatures, filter air pollutants, and serve as a barrier to wind. Some desirable characteristics to consider in selecting trees and shrubs include: vigor, species, age, size and shape, and use as a wildlife food source and habitat.

Trees and shrubs to be saved should be clearly marked so that no construction activity will take place within the dripline of the plant. The sites for new plantings should be evaluated. Consider the prior use of the land: adverse soil conditions such as poor drainage or acidity; exposure to wind; temperature extremes; location of utilities, paved areas, and security lighting and traffic problems.

Transplanting:
Time of Year - Late fall through winter (November to February) is the preferred time for transplanting.

Preparation - Proper digging of a tree/shrub includes the conservation of as much of the root system as possible. Soil adhering to the roots should be damp when the tree is dug, and kept moist until re-planting. The soil ball should be 12 inches in diameter for each inch of diameter of the trunk.

Site preparation - Refer to landscape plans and specifications for site and soil preparation, and for ability to coordinate construction strategy with permanent vegetation.

Supporting the trunk - Many newly planted trees/shrubs need artificial support to prevent excessive swaying.

Watering - Soil around the tree should be thoroughly watered after the tree is set in place. When the soil becomes dry, the tree should be watered deeply, but not often. Mulching around the base of the tree is helpful in preventing roots from drying out.

Vines & Ground Covers

Selection:
Vines, ground covers, and low growing plants, that can quickly spread, come in many types, colors, and growth habits. Some are suitable only as part of a small maintained landscape area, while some can stabilize large areas with little maintenance. Flowers, which provide little long-term erosion control may be planted to add color and varietal appearances.
Additional Information — Seeding and planting

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The following steps should be followed to insure established growth:
1. Select the proper grass for the site.
2. Prepare the seedbed, soil should be fertilized and contain good topsoil or soil at least a 2:1 or flatter slope.
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Vines, ground covers, and low growing plants that can quickly spread, come in many types, colors, and growth habits. Some are suitable only as part of a small maintained landscape area, while some can stabilize large areas with little maintenance. Flowers, which provide little long-term erosion control may be planted to add color and varietal appearances.
Additional Information — Seeding and planting

Caution should be exercised in the non-native vegetation because of impacts to native vegetation on adjacent lands. For example, species that may be planted at the construction site can quickly spread and compete with originally undisturbed vegetation such as the California Poppy and California buckwheat, both of which complete poorly with introduced grasses. Additionally, planting wild oats is illegal in California.

In addition to stabilizing disturbed soil, vines and ground covers can perform the following functions:

1. Provide attractive cover that does not need mowing.
2. Help to define traffic areas and control pedestrian movement.

Site Preparation:
Ground covers are plants that naturally grow very close together, causing severe competition for space nutrients and water. Soil for ground covers should be well prepared. The entire area should be spaded, disc'd, or rototilled to a depth of six to eight inches. Two to three inches of organic material, such as good topsoil or peat, should be spread over the entire area.

Planting:
The following steps will help insure good plant growth.

1. Make the plantings following the contours of the land.
2. Dig the holes 1/3 larger than the plant root ball.
3. Know what depth to place the plants.
4. Use good topsoil or soil mixture with a lot of organic matter.
5. Fill hole 1/3 to 1/2 full, shake plants to settle soil among roots, then water.
6. Leave saucer-shaped depression around the plant to hold water.
7. Water thoroughly and regularly.
8. Space plants according to the type of plant and the extent of covering desired.

Materials:
There are many different species of vines and ground covers from which to choose, but care must be taken in their selection. It is essential to select planting materials suited to both the intended use and specific site characteristics. The plants discussed in this handbook are those which are known to be adapted to California, and commonly available from commercial nurseries. Additional information can be obtained from local nurserymen, landscape architects, and extension agents. An approved low water use plant list may be obtained from the State Department of Water Resources or the Soils Conservation Service.

REQUIREMENTS

Maintenance

General requirements include:

- Grass maintenance should be minimal to none. Irrigation and regular fertilizing may be required for some types of grasses. Mowing is only required in areas where aesthetics or fire hazards are a concern.
**Additional Information — Seeding and planting**

- Young trees should receive an inch of water each week for the first two years after planting. The tree should be watered deeply, but not more often than once per week.

- Transplanted trees should be fertilized on an annual basis.

- Proper pruning, watering, and application of fertilizer is necessary to maintain healthy and vigorous shrubs. A heavy layer of mulch applied around the shrubs reduces weeds and retains moisture.

- Trim old growth as needed to improve the appearance of ground covers. Most covers need once-a-year trimming to promote growth.

**LIMITATIONS**

- Construction activities are likely to injure or kill trees unless adequate protective measures are taken. Direct contact by equipment is the most obvious problem, but damage is also caused by root stress from filling, excavation, or compacting too close to trees.

- Temporary seeding can only be viable when adequate time is available for plants to grow and establish.

- Over fertilizing of plants may cause pollution of storm water runoff.

- Irrigation source and supply may be limiting.

**REFERENCES**


2. Kiowa Engineering, Interim Erosion and Sedimentation Control for Construction Activities, Urban Drainage and Flood Control District, Denver, Colorado


BMP: MULCHING

GENERAL DESCRIPTION
Mulching is used to temporarily and permanently stabilize cleared or freshly seeded areas. Types of mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite, and gravel.

SUITABLE APPLICATIONS
- Temporary stabilization of freshly seeded and planted areas
- Temporary stabilization during periods unsuitable for growing vegetation
- Temporary stabilization of areas that cannot be seeded or planted (e.g., insufficient rain, steep slope)

INSTALLATION/APPLICATION CRITERIA
Mulch prevents erosion by protecting the soil surface and fostering growth of new seedings that do not stabilize by themselves.
- May be used with netting to supplement soil stabilization
- Apply to planting areas where slopes are 2:1 or greater
- Binders may be required for steep areas, or if wind and runoff is a problem
- Type of mulch, binders, and application rates should be recommended by manufacturer/contractor.

REQUIREMENTS
- Cost
  - Reference CalTrans Cost Schedule for regional cost ranges
- Maintenance
  - Must be inspected weekly and after rain for damage or deterioration.

LIMITATIONS
- Wood fiber mulches should be used only in areas with over 20 inches annual precipitation.
- Organic mulches are not permanent erosion control measures.
- Mulches tend to lower the soil surface temperature, and may delay germination of some seeds.
- Permanent mulches for arid regions should include gravel and decomposed soils.

Objectives
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

Implementation
- Likely to Have Significant Impact
- Probable Low or Unknown Impact
- High
- Low

SYMBOL
- VS2

LOGO
Additional Information — Mulching

Mulching protects the soil from rainfall impact; increases infiltration; conserves moisture around trees, shrubs and seedlings; prevents compaction and cracking of soil; and aids plant growth for seedlings and plantings by holding the seeds, fertilizers and topsoil in place until growth occurs. Mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite and gravel. A variety of nettings or mats of organic or non-organic materials and chemical soil stabilization are practices that may be used conjunctively with mulching.

Mulching may be applied to all graded and cleared areas of the construction site:

- Areas which have been permanently seeded to assist in retaining moisture, and to hold seedlings;
- Areas which need temporary soil surface protection because seeding cannot occur due to the season;
- Areas between trees, shrubs and certain ground covers;
- Areas where climatic conditions require a soil moisture retention aid to avoid cracking of the soil and associated compaction, and require soil temperature modification.

INSTALLATION/APPLICATION CRITERIA

Because of the various climates, soil conditions and land uses in California, a set of general guidelines is included for application and installation of mulching on disturbed lands. Installation of mulch consists of furnishing all materials, preparing the soil surface and applying the mulch to all soil surface areas designated on the project plans or established by the Engineer.

MATERIALS

Organic mulch materials, such as straw, wood chips, bark and wood fiber, have been found to be most effective where re-vegetation will be provided by reseeding. The choice of mulch should be based on the size of the area, site slopes, surface conditions such as hardness and moisture; weed growth and availability of mulch materials.

Wood Fiber Mulches: Wood fiber mulches consist of specially prepared wood fiber processed to contain no growth germination inhibiting factors. The mulch should be from virgin wood, and be manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form a homogenous slurry. The fiber lengths should be as long as possible to increase the effectiveness for erosion control. Wood fiber mulching should not be used in areas of extremely hot summer and late fall seasons because of fire danger. When used as a tackifier with straw mulch, wood fiber mulches are good for steep slopes and severe climates. The California office of the Soils Conservation Service recommends a non-toxic mulch green dye be used to provide a visual aid in metering applications.

Wood Chips and Bark Chips: Wood and bark chips are suitable for application in landscaped areas that will not be closely mowed. Wood chips do not require tacking, but do require nitrogen treatment (12 pounds/ton) to prevent nutrient deficiency. Bark chips do not require additional nitrogen fertilizer. When the wood source is near the project site, wood and bark chips can be very inexpensive. Caution must be used in areas of steep slopes, since both wood and bark chips tend to wash down slopes exceeding 6 percent.

Straw Mulch: Straw mulch is a good short-term protection most commonly used with seeding. The mulch should be from the current season’s crop. A letter of certification from the supplier should be required to show that the straw was baled less than 12 months from the delivery date. Wheat or oat straw is recommended.

Emulsified Asphalt: Asphalt is used to adhere the mulch to the ground surface, preventing the mulch from blowing or washing off. The type and quantity of asphalt used should not result in a storm water pollution problem.
Additional Information — Mulching

Binder: Binder shall be free flowing, noncorrosive powder produced from natural plant gum marketed under M-Binder, M145 Binder, AZ-TAC or approved equal. Synthetic, spray-on materials are not recommended since they tend to create an impervious surface, and may enter the stormwater sewer system via discharge runoff.

PREPARATION/METHODS AND EQUIPMENT
The equipment and methods used to distribute materials shall be such as to provide an even and uniform application at the specified rate for the material. Mulch can be spread by hand or by mulch-blowing equipment.

Applying Mulch: Mulch shall be immediately affixed by either crimping or tacking. The engineer shall determine which areas are not conducive to anchoring by crimping and will direct the contractor to anchor such mulch by tacking. Wood fiber mulch should be applied by hydroseeder at rates of 1000-1500 pounds per acre.

Within 24 hours after each area is planted, straw mulch should be uniformly applied at the rate of approximately 2-1/2 tons per acre for crimped areas and 1-3/4 tons per acre for tacked areas. Straw mulch should be tacked to insure against excessive losses by wind and stormwater runoff.

Anchorage by Crimping: Mulch should be anchored into the soil with a heavy disc with flat, serrated discs at least 1/4 inch thick having dull edges and spaced no more than nine inches apart. Anchor the mulch to a depth of at least two inches and do not cover with an excessive amount of soil. Anchoring operations should be across the slopes where practical with no more than two passes of the anchoring equipment.

Anchoring by Tacking: Immediately following the crimping operation the crimped area should be tacked. Using either emulsified asphalt uniformly applied at the rate of approximately 500 gallons per acre or a slurry consisting of a minimum of 150 pounds of binder, 400 pounds of wood fiber mulch, and 700 gallons of water per acre. Potential water quality problems may result from the use of asphalt tacking.

REQUIREMENTS
Maintenance: Mulched areas require frequent inspection for damage and deterioration. Requirements will vary greatly based on the type of mulch used and the type of vegetation to be established. Mulches are not intended to be permanent, but are extended only as a base for re-seeding or re-vegetation. Where a permanent anchor for vegetation is required, along steep slopes or areas of higher velocity flows, then a geotextile mat or net is recommended.

REFERENCES
2. "Environmental Criteria Manual", City of Austin, Texas
Additional Information — Mulching


GENERAL DESCRIPTION
Matings made of natural or synthetic material which are used to temporarily or permanently stabilize soil.

SUITABLE APPLICATIONS
- Channels & streams
- Steep slopes
- Temporary stabilization for areas which have been seeded

INSTALLATION/APPLICATION CRITERIA
Matings may be applied to disturbed soils and where existing vegetation has been removed. The following matting materials provide temporary protection until permanent vegetation is established, or when seasonal circumstances dictate the need for temporary stabilization until weather or construction delays are resolved.

- Jute mattings
- Straw mattings
- Excelsior Matting
- Glass fiber matting
- Staples
- Other mulch nettings

REQUIREMENTS
- Maintenance
  - Inspect monthly and after significant rainfall.
  - Re-anchor loosened matting and replace missing matting and staples as required.
- Cost
  - Relatively high compared to other BMPs.

LIMITATIONS
- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g., channels, steep slopes)
- May delay seed germination, due to reduction in soil temperature.
- Installation requires experienced contractor to ensure soil stabilization and erosion protection.
Additional Information — Geotextiles and Mats

Matings are used to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matings may be used to stabilize soils until vegetation is established. This practice may be used alone or with a mulch during the establishment of protective cover on critical slopes (see VS2, Mulching).

SUITABLE APPLICATIONS
Matings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Matings are also used on stream banks where moving water at velocities between 3 fps and 6 fps is likely to wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. Matting may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). Erosion control matting should be considered when the soils are fine grained and potentially erosive.

The following natural or synthetic mattings are commonly used:

- Organic Matting
  - Jute matting
  - Straw matting
- Synthetic Matting
  - Excelsior matting
  - Glass fiber matting
  - Staples
  - Mulch netting

INSTALLATION/APPLICATION CRITERIA
Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness and moisture; weed growth and availability of materials. Matting strengths and uses vary, therefore, manufacturer’s specifications must be followed. Proper installation of matting is critical in order to obtain firm, continuous contact with the soil.

Site Preparation: After the site has been shaped and graded to the approved design, prepare a friable seed bed relatively free from clods and rocks more than 1 inches in diameter and any foreign material that will prevent contact of the protective mat with the soil surface.

Planting: Fertilize and seed in accordance with seeding or other type of landscaping plan. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over sprigged areas where grass has been planted. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Erosion Stops: Erosion stops are made of glass fiber strips, excelsior matting strips or tight-folded jute matting blanket or strips for use on steep, highly erodible watercourses. The stops are placed in narrow trenches six to twelve inches deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Laying and Securing Matting: Before laying the matting, all erosion stops should be installed and the friable seed bed made free from clods, rocks, and roots. The surface upon which the separation fabric will be placed should be compacted and finished according to the requirements of the manufacturer’s recommendations.
Additional Information — Geotextiles and Mats

Most matting comes with the manufacturer’s recommendations for installation. Most channels will require multiple widths of matting, and the matting should be unrolled starting at the upper end of the channel, allowing a four inch overlap of matting along the center of the channel. To secure, bury the top ends of the matting in a narrow trench, a minimum of six inches deep. Backfill trench and tamp firmly to conform to channel cross section. Secure with a row of staples about four inches down slope from the trench with staples twelve inches apart.

Where matting crosses erosion stops, reinforce with a double row of staples at six inch spacing, using a staggered pattern on either side of the erosion stop. When the matting is overlapped, the discharge end of the matting liner should be similarly secured with a double row of staples.

Mechanical or manual laydown equipment should be capable of handling full rolls of fabric, and laying the fabric smoothly, without wrinkles or folds. The equipment should meet the fabric manufacturer’s recommendations or as approved by the Engineer.

Materials:

**Jute Mat** - should be cloth of a uniform plain weave of undyed and unbleached single jute yarn, 48” in width, and weighing an average of 1.2 pounds per linear yard of cloth with a tolerance of plus or minus five (5%) percent, with approximately 78 warp ends per width of cloth and 41 weft ends per linear yard of cloth. The yarn should be of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than its normal diameter.

**Straw Mat** - should be a machine produced mat consisting of 70% (±3%) agricultural straw and 30% (±3%) coconut fiber. The blanket should be of consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat. The blanket should be covered on the top side with polypropylene netting having an approximate 5/8” x 5/8” mesh containing ultraviolet additives to resist breakdown, and on the bottom with a polypropylene netting with an approximate “ x “ mesh. The blanket should be sewn together with cotton thread.

**Excelsior Mat** - should be wood excelsior, 48 inches in width plus or minus one inch and weighing 0.8 pound per square yard plus or minus ten percent. The excelsior material should be covered with a netting to facilitate handling and to increase strength.

**Glass Fiber Matting** - should be of bonded textile glass fibers with an average fiber diameter of eight to twelve microns, two to four inch strands of fiber bonded with phenol formaldehyde resin. Mat should be roll type, water permeable, minimum thickness inch, maximum thickness inch, density not less than three pounds per cubic foot.

**Staples** for anchoring soil stabilizing materials should be Number 11 gauge wire or heavier. Their length should be six to ten inches, with longer staples used in loose, unstable soils.

**Other Mulch Netting** - such as paper, plastic, cotton or fiber glass matting should be installed according to the manufacturer’s recommendations.
Additional Information — Geotextiles and Mats

Final Check:
Check the following after the matting is installed:

- Make sure matting is uniformly in contact with the soil.
- All lap joints are secure.
- All staples are flush with the ground.
- All disturbed areas seeded.

LIMITATIONS
Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.

Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs, otherwise the material will not stabilize the soil and erosion will occur beneath the material. Ultraviolet protection may be required on some geotextiles. Matting strengths and uses vary; the manufacturer's specifications should be followed.

REFERENCES


ANCHOR SLOT: Bury the up-channel end of the net in a 3' deep trench. Tamp the soil firmly. Staple at 12" intervals across the net.

OVERLAP: Overlap edges of the strips at least 4'. Staple every 3 feet down the center of the strip.

FLOW

JOINING STRIPS: Insert the new roll or net in a trench, as with the anchor slot. Overlap the up-channel end of the previous roll 13" and turn the end of the previous roll just below the anchor slot and at the end at 12" intervals.

CHECK SLOTS: On erodible soils or steep slopes, check slots should be made every 15 feet. Insert a fold of the net into a 6' trench and tramp firmly. Staple at 12" intervals across the net. Lay the net smoothly on the surface of the soil - do not stretch the net, and do not allow wrinkles.

ANCHORING ENDS AT STRUCTURES: Place the end of the net in a 6' slot on the up-channel side of the structure. Fill the trench and tamp firmly. Roll the net up the channel. Place staples at 12" intervals along the anchor end of the net.
ON SHALLOW SLOPES, STRIPS OF NETTING MAY BE APPLIED ACROSS THE SLOPE.

SECTION

PLAN

(SHALLOW SLOPES)

IN DITCHES, APPLY NETTING PARALLEL TO THE DIRECTION OF FLOW. USE CHECK SLOTS EVERY 15 FEET. DO NOT JOIN STRIPS IN THE CENTER OF THE DITCH.

SECTION

FLOW

(BETWEEN)

PLAN

OBTAINMENT OF NETTING AND MATERIALS

ON STEEP SLOPES, APPLY STRIPS OF NETTING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY.

SECTION

PLAN

(BETWEEN)

BRING NETTING DOWN TO A LEVEL BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 5" AND STAPLE AT 12" INTERVALS.

WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE NETTING OVER THE BERM AND ANCHOR IT BEHIND THE BERM.

Construction Handbook 5 - 19 September 1, 1992
**BMP: PRESERVATION OF EXISTING VEGETATION**

**GRAPHIC**

**GENERAL DESCRIPTION**
Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs and/or grasses that serve as erosion controls.

**SUITABLE APPLICATIONS**
- Areas within site where no construction activity will occur, or will occur at a later stage.
- Sensitive areas where natural vegetation exist and should be preserved, such as: steep slopes, watercourses, and building sites in wooded areas.
- Areas where local, state and federal government requires preservation, such as: vernal pools, wetlands, marshes, certain oak trees, etc.

**INSTALLATION/APPLICATION CRITERIA**
- Clearly mark, flag or fence vegetation or areas where vegetation should be preserved.
- Prepare landscaping plans which include as much existing vegetation as possible and state proper care of this vegetation both during and after construction.
- Define and protect with berms, fencing, signs, etc., a setback area from vegetation to be preserved. Setback area size should be based on the location, species, size, age and potential impact of adjacent construction activities or permanent improvements.
- Proposed landscaping plans which do not include plant species that compete with the existing vegetation.
- Do not locate construction traffic routes, spoil piles, etc., where significant adverse impact on existing vegetation may occur.

**REQUIREMENTS**
- **Maintenance:**
  - Inspection and maintenance requirements for protection of vegetation are low.
  - During construction the limits of grading or disturbance should be clearly marked at all times.
  - Irrigation or maintenance of native trees or vegetation should conform to specifications on the Landscape Plan.
- **Cost:**

**LIMITATIONS**
- Requires forward planning by the owner/developer, contractor and design staff.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactorily for the planned development.
Additional Information — Preservation of existing vegetation

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to insure the survival of desirable vegetation for shade, beautification, and erosion protection. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. Also, vegetation helps to keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

The following criteria may be used for deciding which vegetation will remain on the site:

- **Aesthetic values:** Consideration should be given to foliage, flowering habits, bark and crown characteristics (for trees).
- **Freedom from disease and rot.**
- **Life span of trees:** Short-lived trees need not be preserved.
- **Environmental values:** Habitat; screening; and buffers.
- **Sudden exposure:** Save vegetation which grows in direct sunlight and is able to withstand radiated heat from proposed buildings and pavement.
- **Space needed:** Sufficient space must be provided between the vegetation and any structures, electric and telephone lines, water and sewer lines, driveways and streets. Mark trees and shrubs with bright paint or ribbon so there is no doubt as to which trees and shrubs are to be left and protected from damage during construction.

Saving existing vegetation and mature trees on-site, beautifies the area and may save money by reducing new landscaping requirements. Mature trees also increase property values and satisfy consumer aesthetic needs.

**INSTALLATION/APPLICATION**

Building sites may be planned to integrate existing vegetation and trees. Construction impacts must be considered. Trench width for pipe construction projects and the location of permanent structures, such as buildings, needs to be considered when preserving existing vegetation, including mature trees and their root system. Native vegetation should be preserved since it is able to adapt to the climate. The USDA Soil Conservation Service should be contacted about existing vegetation for sites throughout California. Mature trees are generally preferable to newly planted trees because of the greater soil stabilization provided by the extensive root system of a mature tree.

Methods for protecting existing vegetation and trees:

- Stake off root system limits (drip line of tree). Some counties limit construction within 5 feet of the tree drip line.
- Fence off the area to be preserved or along the tree drip line.
- Flag or mark trees to remain in place.
- Tree wells and retaining walls (permanent) help preserve existing vegetation, but must be large enough to protect the root system (see below).
- For the California Oak tree, no trenching or irrigation should be allowed within the driplines of the tree, since both these activities are detrimental to the preservation of the tree.
Where grading under trees is necessary, excavation and fill should be limited to 1 foot within the driplines.

Tree Wells

For trees, protection with Tree Wells is encouraged where necessary. Materials required to construct tree wells should be shown on landscape plans (see attached Tree Well Detail).

Rock Mulch:

The following gradation of rock mulch should be used unless local or State requirements dictate otherwise.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inch</td>
<td>75-100</td>
</tr>
<tr>
<td>2 inch</td>
<td>25-75</td>
</tr>
<tr>
<td>1.5 inch</td>
<td>0-25</td>
</tr>
</tbody>
</table>

Tree Well Walls:

The rock must be clean, durable, free from segregations, seams, cracks and other structural defects or imperfections, be approved by a Professional Engineer, and should meet the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 inch</td>
<td>75-100</td>
</tr>
<tr>
<td>8 inch</td>
<td>25-75</td>
</tr>
<tr>
<td>6 inch</td>
<td>0-25</td>
</tr>
</tbody>
</table>

Mortar used for Tree Well Walls typically consists of one (1) part portland cement and two (2) parts fine aggregate by volume, as defined within CalTrans Standard Specifications. Hydrated lime shall conform to the requirements of ASTM C-207, Type N. Hydrated lime, to the extent of 10% by volume of cement, may be added to the mortar. Hydrated lime shall be treated as an addition to and not as a replacement for cement.

Maple, Dogwood, Red alder, Western hemlock, Western red cedar, Douglas fir Pacific silver fir and the California Native oak are trees within California that demand particular attention by local and state officials. These trees are all sensitive to changes to their environment. Irrigation, thinning operations and disturbance of their root systems can cause serious root disease problems, subjecting them to insect attack, tip-over potential, and decline in vigor. Specific vegetation preservation methods should be provided by a qualified specialist with experience in Californian vegetation.

REFERENCES
Additional Information — Preservation of existing vegetation


4. County of Sacramento Tree Preservation Ordinance - September 1981
**BMP: DUST CONTROLS**

### GENERAL DESCRIPTION
Dust control measures are used to stabilize soil from wind erosion, and reduce dust generated by construction activities. Dust which settles on surfaces both onsite and offsite may be washed by storm water into waterways.

### SUITABLE APPLICATIONS
- Clearing and grading activities
- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Sediment tracking onto paved roads
- Soil and debris storage piles
- Batch drop from front end loaders
- Areas with unstabilized soil

### INSTALLATION/APPLICATION CRITERIA
- Schedule construction activities to minimize the area where, and time period when soils are exposed
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering
- Identify and stabilize key access points prior to commencement of construction
- Minimizing the impact of dust by anticipating the direction of prevailing winds
- Direct most construction traffic to stabilized roadways within the project site

### REQUIREMENTS
- Maintenance
- Most dust control measures require frequent, often daily, attention
- Cost
- Reference CalTrans Cost Schedule for regional cost ranges

### LIMITATIONS
- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective
- Overwatering may cause a contaminated erosion
- Oils should not be used for dust control because it may migrate into drainageway and/or seep into the soil
- Certain chemically-treated subgrades may make soil water repellent, increasing runoff

### Objectives
- Housekeeping Practices
  - Contain Waste
  - Minimize Disturbed Areas
  - Stabilize Disturbed Areas
  - Protect Slopes/Channels
  - Control Site Perimeter
  - Control Internal Erosion

### Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

### Likely to Have Significant Impact
- Likely to Have Significant Impact
- Probable Low or Unknown Impact

### Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

### SYMBOL
- **PS4**

---

Construction Handbook  

5 - 25  

September 1, 1992
Additional Information — Dust Controls

California’s Mediterranean climate, with short wet seasons and long hot dry seasons, allow the soils to thoroughly dry out. During these dry seasons, construction activities are at their peak, and disturbance and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment.

Dust control, as a BMP, is a practice that is already in place for many construction activities. Los Angeles, the North Coast and Sacramento, among others have enacted dust control ordinances for construction activities that cause dust to be transported beyond the construction project property line. Recently, the State Air Resources Control Board has, under the authority of the Clean Air Act, started to address air quality in relation to inhalable particulate matter less than 10 microns (PM-10). 90% of the SC particles are considered to be dust. Existing dust control regulations by local agencies, municipal departments, public works department, and/or public health departments are in place in some regions within California. For jurisdictions that have no formal dust control regulations and/or standards, Sections 10, 17 and 18 of CalTrans’ Standard Specifications provide detailed provisions for dust control practices.

Many local agencies require dust control in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. The following are measures that local agencies may have already implemented as requirements for dust control from contractors:

- **Construction & Grading Permits**: Require provisions for dust control plans;
- **Opacity Emission Limits**: Enforce compliance with California air pollution control laws;
- **Increase overall enforcement activities**: Priority given to cases involving citizen complaints;
- **Maintain Field Application Records**: Require records of dust control measures from contractor;
- **Stormwater Pollution Prevention Plan (SWPPP)**: Integrate dust control measures into SWPPP.

**DUST CONTROL PRACTICES**

Dust control BMP’s generally stabilize exposed surfaces and minimize activities that suspend or track dust particles.

Table PS4.1 shows which Dust Control BMP’s apply to site conditions which cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel or asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching and sand fences can be employed for areas of occasional or no construction traffic. Preventive measures would include minimizing surface areas to be disturbed.

Many of the reasonably available control measures for controlling dust from construction sites can also be implemented as BMPs for storm water pollution prevention. Those BMP’s include:

- **Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads**
- **Provide covers for haul trucks transporting materials that contribute to dust**
- **Provide for wet suppression or chemical stabilization of exposed soils**
- **Provide for rapid clean-up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas.**
- **Stabilize unpaved haul roads, parking and staging areas. Reduce speed and trips on unpaved roads**
- **Implement dust control measures for material stockpiles**
- **Prevent drainage of sediment laden storm water onto paved surfaces.**
- **Stabilize abandoned construction sites using vegetation or chemical stabilization methods.**
- **Limit the amount of areas disturbed by clearing and earth moving operations by scheduling these activities in phases**
Additiona Information — Dust Controls

For the chemical stabilization, there are many products available as dust palliatives for chemically stabilizing gravel roadways and stockpiles. The types of chemicals available and recommendations for their use are tabulated in Table PS4.2, Commonly Used Chemical Dust Palliatives.

In addition, there are many other BMPs identified in this handbook that provide dust control including:

- Seeding and Plantings
- Stabilized Construction Entrances
- Construction Road Stabilization
- Mulching

LIMITATIONS

- Oil treated subgrades should not be used because the oil may migrate into drainageways and/or seep into the soil.
- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration, and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- Asphalt, as a mulch tack or chemical mulch, requires a 24 hour curing time to avoid adherence to equipment, worker shoes, etc. Application should be limited because asphalt surfacing may eventually migrate into the drainage system.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.

REFERENCES

1. CalTrans, Standard Specifications, Sections 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative"
2. USDA Soil Conservation Service, "Guides for Erosion and Sediment Control"
3. Sacramento County, Winterization Ordinance & Dust control ordinance (example)
**BMP: TEMPORARY STREAM CROSSING**

### GENERAL DESCRIPTION
A temporary access stream crossing is a temporary culvert, ford or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to be used to maintain traffic for the general public.

### SUITABLE APPLICATIONS
Temporary stream crossings should be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels which may be significantly eroded by construction traffic.

### INSTALLATION/APPLICATION CRITERIA
Requires knowledge of stream flows and soil strength and should be designed under the direction of a California registered engineer with knowledge of both hydraulics and construction loading requirements for structures.

### REQUIREMENTS
- Maintenance
  - Inspect weekly and after each significant rainfall, including assessment of foundations.
  - Periodically remove silt from crossings.
  - Replace lost aggregate from inlets and outlets of culverts.

- Cost
  - CalTrans Construction Cost Index for temporary bridge crossing cost, $45-95/sf.

### LIMITATIONS
- May be an expensive temporary cost
- Requires other BMPs for soil disturbance upon installation and removal
- Fords should only be used in dry weather

### Objectives
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

### Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

### Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

### SYMBOL
- PS5

### LOGO
Additional Information — Temporary Stream Crossing

A temporary access stream crossing is a culvert, ford, or bridge placed across a waterway to provide access for construction for a period of less than one year. Temporary access crossings are not intended to be used for general public traffic.

The purpose of the temporary access waterway crossing BMP is to provide a safe, erosion-free access across a stream for construction equipment. Minimum standards and specifications for the design, construction, maintenance, and removal of the structure should be established by an engineer registered in California. Temporary access stream crossings may be necessary to prevent construction equipment from causing erosion of the stream and tracking sediment and other pollutants into the stream.

Temporary stream crossings are used as access points to construction sites when other detour routes may be too long or burdensome for the construction equipment. Often heavy construction equipment must cross streams or creeks, and detour routes may impose too many constraints such as being too narrow or poor soil strength for the equipment loadings. Additionally, the contractor may find a temporary stream crossing more economical for light-duty vehicles to use for frequent crossings, and may have less environmental impact than construction of a temporary access road.

INSTALLATION/APPLICATION
Temporary access stream crossings should be sized and installed per the requirements of the local municipality. Design criteria should be based on standard engineering practices for culvert design with provisions for minimizing impacts on disturbed crossing areas. Three types of temporary access stream crossings may be considered:

Temporary Access Culvert: A temporary access culvert is effective in controlling erosion but will cause erosion during installation and removal. A temporary culvert can be easily constructed and allows for heavy equipment loads.

Temporary Access Ford: A temporary access ford provides little sediment and erosion control and is ineffective in controlling erosion in the stream channel. A temporary ford is the least expensive stream crossing and allows for maximum load limits. It also offers very low maintenance.

Temporary Access Bridge: With the appropriate materials and designs, a temporary access bridge causes the least erosion of the stream channel crossing during its installation and removal.

Most streams and creeks in California remain generally dry or have significantly low-flow volumes, and often receives moderate to heavy runoff volumes during and after rainfalls. During the long summer construction seasons, and due to the infrequent rainfalls, no construction crossing may be necessary. Consideration for the time of year, length of construction access and requirements for construction access should be considered. For streams with intermittent flows or low summer flow volumes, access fords and culverts should be considered.

Temporary stream crossings should be sized based on the design criteria established by the local municipality. Standard drainage crossing design techniques should be employed.

LIMITATIONS
Special care must be taken when crossing an environmentally sensitive waterway. Oils or other potentially hazardous materials shall not be used for surface treatments. Street runoff should not be allowed to spill down crossing sideslopes. Construction in watercourses should be at or near the natural elevation of the stream bed to prevent any potential flooding upstream of the crossing. In addition, the following limitations may apply:

- May be expensive temporary cost
Additional Information — Temporary Stream Crossing

- Increased soil disturbance upon installation and removal
- Temporary culverts need regular maintenance and can cause erosion if the culvert becomes clogged.
- A temporary ford offers little if any erosion control and can often make erosion worse. Fords should only be used in the dry season on dry streams.

Construction in waterways is subject to additional permit requirements. Contact the local municipal stormwater agency for additional information.

REFERENCES
1. Bank and Shore Protection, CalTrans - November 1970

TEMPORARY ACCESS CULVERT
AGGREGATE APPROACH
5:1 MAXIMUM SLOPE ON ROAD

TEMPORARY ACCESS FORD
GENERAL DESCRIPTION
Access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes should be stabilized with gravel or by chemical stabilization immediately after grading to prevent erosion and control dust.

SUITABLE APPLICATIONS
- Temporary construction traffic.
- Phased construction projects and off-site road access.
- Detour roads.
- Construction during wet weather.

INSTALLATION/APPLICATION CRITERIA
- Minimum 8-inch, 2-3 inch aggregate base applied immediately after grading, or as recommended by soils engineer.
- Chemical stabilization may also be used (see Dust Control PS-4).
- Road should follow topography contours to prevent the road from eroding.
- The roadway slope should not exceed 15 percent.

REQUIREMENTS
- Maintenance
  - Periodically apply additional aggregate
  - Inspect weekly, and after each rain
  - Repair any eroded areas immediately
- Cost

LIMITATIONS
- The roadway must be removed when construction is complete.
- Certain chemical stabilization methods may cause storm water or soil pollution and should not be used (see Dust Control PS-4).
- Management of construction traffic is subject to dust control measures. Contact the local air quality management agency.
Additional Information — Construction Road Stabilization

Areas which are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires which generate significant quantities of sediment that may pollute nearby streams or be transported off-site on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems.

Efficient construction road stabilization not only reduces on-site erosion but can significantly speed on-site work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather.

INSTALLATION/APPLICATION CRITERIA

Where feasible, alternative routes should be made for construction traffic; one for use in dry condition, the other for wet conditions which incorporate the measures listed for this BMP.

Apply a 6-inch course of 2 to 4-inch crushed rock, gravel base, or crushed surfacing base course immediately after grading or the completion of utility installation within the right-of-way. A 4-inch course of aggregate base course may be used in lieu of the crushed rock. Chemical stabilization may also be used upon compacted native sub-grade (see the Dust Control BMP PS-4). These chemical controls should be applied per the manufacturer’s directions.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15 percent. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section, or one side in the case of super-elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment-laden water from entering the storm sewer system (see “Storm Drain Inlet Protection” BMP ST-6).

REFERENCES
6. U.S.D.A. Soils Conservation Service
BMP: STABILIZED CONSTRUCTION ENTRANCE

<table>
<thead>
<tr>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housekeeping Practices</td>
</tr>
<tr>
<td>Contain Waste</td>
</tr>
<tr>
<td>Minimize Disturbed Areas</td>
</tr>
<tr>
<td>Stabilize Disturbed Areas</td>
</tr>
<tr>
<td>Protect Slopes/Channels</td>
</tr>
<tr>
<td>Control Site Perimeter</td>
</tr>
<tr>
<td>Control Internal Erosion</td>
</tr>
</tbody>
</table>

**GENERAL DESCRIPTION**
The construction entrance practice is a stabilized pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area.

**SUITABLE APPLICATIONS**
- All points of construction ingress and egress
- Unpaved areas where sediment tracking occurs from site onto paved roads

**INSTALLATION/APPLICATION CRITERIA**
- Construct on level ground where possible
- Stones should be 2-3 inches
- Minimum depth of stones should be 8 inches or as recommended by soils engineer
- Length should be 50-foot minimum, and 15-foot minimum width
- Provide ample turning radii as part of entrance

**REQUIREMENTS**
- Maintenance
  - Inspect monthly and after each rainfall
  - Replace gravel material when surface voids are visible
  - Remove all sediment deposited on paved roadways within 24 hours
  - Remove gravel and filter fabric at completion of construction
- Cost
  - Ranges from $750 to $1200 depending upon region and availability of material

**LIMITATIONS**
- Requires periodic top dressing with additional stones
- Should be used in conjunction with Wash Rack BMP, if appropriate
- Should be used in conjunction with street sweeping on adjacent public right-of-way

**Targeted Pollutants**
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

**Implementation Requirements**
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

**Symbol**
- **PS7**

**Logo**
Additional Information — Stabilized Construction Entrance

A stabilized pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights-of-way or streets. Reducing trackout of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving, a stabilized construction entrance should be used at all points of construction ingress and egress. NPDES permits require that appropriate measures be implemented to prevent trackout of sediments onto paved roadways, which is a significant source of sediments derived from mud and dirt carryout from the unpaved roads and construction sites.

Stabilized construction entrances are not very effective in removing sediment from equipment leaving a construction site. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance. The entrance should be built on the level ground. Advantages of the Stabilized Construction Entrance is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations.

Design & sizing considerations include the aggregate for stabilized construction entrance aprons shall be 2 to 3 inches in size, washed, well-graded gravel or crushed rock. The minimum apron dimensions will be 15 ft. x 50 ft. and 8 inches deep for one-way ingress/egress traffic.

Entrance must be properly graded to prevent runoff from leaving the construction site. When wash areas are provided, washing shall be done on an area stabilized with crushed stone which drains into a properly constructed sediment trap or basin (pond). Sediment barriers shall be provided to prevent sediments from entering into the stormwater sewer system, ditch, or waterway.

LIMITATIONS

The stabilized construction entrance plan should be reviewed as part of the project traffic control plan.

- Construct on level ground.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.
- Requires periodic top dressing with additional stones.
- Should be used in conjunction with Wash Rack BMP, if appropriate.
- Should be used in conjunction with street sweeping on adjacent public right-of-way.

REFERENCES


6. U.S.D.A. Soils Conservation Service
Ditch to carry wash water to sediment basin or trap

Wash Rack

6'-7'

Drain space
Reinforced concrete

Wash Rack

Hard surface
Public road

50' min

Filter fabric
Coarse aggregate 1" to 3"

Stabilized construction entrance
## BMP: EARTH DIKE

### GENERAL DESCRIPTION
The temporary earth dike is a temporary berm or ridge of compacted soil, used to divert runoff to channel water to a desired location.

### SUITABLE APPLICATIONS
Earth dikes are usually used to divert concentrated runoff through disturbed areas into another BMP (e.g., sediment basins), to divert runoff away from disturbed or unstable slopes, and to divert runoff from off-site and undisturbed areas around disturbed areas. The dikes should remain in place until the disturbed areas are permanently stabilized. The dikes must be on-site and must safely convey anticipated flood flows.

### INSTALLATION/APPLICATION CRITERIA
1. All dikes should be compacted by earth-moving equipment.
2. All dikes should have positive drainage to a stabilized outlet.
3. Top width may be wider and side slopes may be flatter at crossings for construction traffic.
4. Dikes should direct sediment-laden runoff into a sediment trapping device.
5. Dikes should be stabilized with vegetation, chemicals, or physical devices.

### REQUIREMENTS
- **Maintenance:**
  - Inspect periodically and after every significant rainfall; repair as necessary
- **Cost:**
  - Cost ranges from $15 to $55 per foot for both earthwork and stabilization and depends on availability of material, site location, and access.

### LIMITATIONS
Dikes should not be used for drainage areas greater than 10 acres, or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local municipality.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately which adds cost and maintenance concerns.
- Diverted stormwater flow may cause flood damage to adjacent areas.
- Dikes should not be constructed of soils which may be easily eroded.
- Regrading the site to remove the site may add additional cost.

### Objectives
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

### Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

- **Likely to Have Significant Impact**
- **Probable Low or Unknown Impact**

### Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

- **High**
- **Low**

### SYMBOL
DR1

### LOGO
Additional Information — Earth Dike

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert storm water to a sediment trapping device or stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off-site and from undisturbed areas away from disturbed areas, and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff; a dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

- The advantages of the temporary earth dike include the ability to handle flows from large drainage areas.
- Once stabilized, earth dikes require relatively little maintenance. Additionally, the earth dikes are relatively inexpensive to install since the soil material required for construction may be available on-site, and can be constructed as part of the initial grading operations, while the equipment is on-site.
- Uses on site materials.

INSTALLATION/APPLICATION CRITERIA
Temporary earth dikes are a practical, inexpensive BMP used to divert storm water runoff. Temporary diversion dikes should be installed in the following manner:

1. All dikes should be compacted by earth-moving equipment.
2. All dikes should have positive drainage to an outlet.
3. All dikes should have 2:1 side slopes, 18 inches minimum height, and a minimum top width of 24 inches. Top width may be wider and side slopes may be flatter at crossings for construction traffic.
4. Earth dikes shall have an outlet that functions with a minimum of erosion. Runoff shall be conveyed to a sediment trapping device such as a sediment trap or sediment basin when either the dike channel or the drainage area above the dike are not adequately stabilized.
5. Temporary stabilization, when necessary, shall include seed and mulching for slopes less than 5%, and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain. Riprap, when used, should meet the following specifications:

<table>
<thead>
<tr>
<th>CHANNEL</th>
<th>RIPRAP</th>
<th>STABILIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5-1.0%</td>
<td>4&quot; Rock</td>
<td>Rip-Rap 8-12&quot;</td>
</tr>
<tr>
<td>1.1-2.0%</td>
<td>6&quot; Rock</td>
<td></td>
</tr>
<tr>
<td>2.1-4.0%</td>
<td>8&quot; Rock</td>
<td></td>
</tr>
<tr>
<td>4.1-5.0%</td>
<td>Rip-Rap</td>
<td></td>
</tr>
</tbody>
</table>

A. Stone or recycled concrete equivalent, in a layer at least 8 inches in thickness and be pressed into the soil with construction equipment.

B. Rip-Rap to be in a layer at least two times the D50 and pressed into the soil.

C. Approved equivalents can be substituted for any of the above materials.
TEMPORARY DIVERSION DIKE

<table>
<thead>
<tr>
<th></th>
<th>DIKE 1 (5 ACRES OR LESS)</th>
<th>DIKE 2 (5-10 ACRES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - DIKE HEIGHT</td>
<td>18&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td>B - DIKE WIDTH</td>
<td>24&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td>C - FLOW WIDTH</td>
<td>4&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>D - FLOW DEPTH</td>
<td>6&quot;</td>
<td>15&quot;</td>
</tr>
</tbody>
</table>
Additional Information — Earth Dike

6. Filter cloth may be used to cover dikes in use for long periods.

7. Construction activity on the earth dike should be kept to a minimum.

REFERENCES


Compaction fill

1 1/2 : 1 slope or flatter

Grade line

Cut or fill slope

Stabilization as required on steep slopes excavate to provide required flow width at flow depth

<table>
<thead>
<tr>
<th></th>
<th>Dike 1 (5 acres or less)</th>
<th>Dike 2 (3-10 acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Dike Height</td>
<td>18&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td>B - Dike Width</td>
<td>24&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td>C - Flow Width</td>
<td>6&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>D - Flow Depth</td>
<td>8&quot;</td>
<td>15&quot;</td>
</tr>
</tbody>
</table>

Temporary diversion dike
# BMP: DRAINAGE SWALE

## Objectives
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

## Graphic

## General Description
A temporary drainage swale is used to divert off-site runoff around the construction site, divert runoff from stabilized areas around disturbed areas, and direct runoff into sediment basins or traps.

## Suitable Applications
Temporary drainage swales are appropriate for diverting any upslope runoff around unstabilized or disturbed areas of the construction site:
- Prevent slope failures.
- Prevent damage to adjacent property.
- Prevents erosion and transport of sediments into waterways.
- Increases the potential for infiltration.
- Diverts sediment-laden runoff into sediment basins or traps.

## Installation/Application Criteria
Temporary drainage swales will effectively convey runoff and avoid erosion if built with the proper type of geometry and lining:
- Size temporary drainage swales using local drainage design criteria.
- A permanent drainage channel must be designed by a professional engineer if the upstream drainage area exceeds 5 acres (see the local drainage design criteria for proper design).
- At a minimum, the swale should conform to predevelopment drainage patterns and capacities.
- Construct the swale with an uninterrupted, positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the swale can reach an erosive velocity.

## Requirements
- **Maintenance**
  - Inspect weekly and after each rain
  - Repair any erosion immediately
  - Remove sediment which builds up in the swale and restricts its flow capacity
- **Cost**

## Limitations
- Temporary drainage swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drainage swales must conform to local floodplain management regulations.
Additional Information — Drainage Swale

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike (see DR1) at the top of a slope can safely divert runoff to a location where it can safely be brought to the bottom of the slope (see Pipe Slope Drain DR4). A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and compacted by a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded, and remain in place until post-construction BMPs are installed and/or the slopes are stabilized.

Diversion practices concentrate the volume of surface runoff, increasing its velocity and erosive force. Thus, the flow out of the swale must be directed into a stabilized area or into a grade stabilization structure. The swale itself should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization. Any swale which conveys sediment-laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

INSTALLATION/APPLICATION CRITERIA

Diversion swales are only effective if they are properly installed. Swales more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost-effective diversion unless equipment access is limited.

Standard engineering design criteria for small open channel and conveyance systems should be used (see the local drainage design manual). Unless local drainage design criteria state otherwise, swales should be designed as follows:

- No more than 5 acres may drain to a temporary swale
- Place the swale above, not on, a cut and fill slope
- Bottom width should be at least 2 ft
- Depth of the swale should be at least 18 inches
- Side slopes should be 2:1 or flatter
- Swale should be layed at a grade of at least 1 percent, but not more than 15 percent
- The swale must not be overtopped by the 10-year, 24-hour storm, irrespective of the design criteria stated above
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built
- Compact any fill material along the path of the swale
- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- The cost of swales and other diversion devices is generally included in the earthwork cost, as a separate item under the grading budget of the project construction contract.

REFERENCES


6. U.S.D.A. Soils Conservation Service
Additional Information — Pipe Slope Drain

The pipe slope drain may be a rigid pipe, such as corrugated metal, or a flexible conduit with the inlet placed on the top of a slope. The pipe conveys concentrated runoff down to the bottom of the slope. The BMP typically is used in combination with a diversion control, such as a temporary dike or swale, at the top of the slope, and serves as a temporary BMP to reduce or eliminate slope erosion until permanent BMPs are installed and the slope is stabilized.

The pipe slope drain is applicable for any construction site where concentrated surface runoff can accumulate and must be conveyed down the slope in order to prevent erosion. The pipe slope drain is effective because it prevents the storm water from flowing directly down the slope by confining all the runoff into an enclosed pipe. Due to the time lag between grading slopes and installation of permanent storm water collection systems and slope stabilization measures, temporary provisions to intercept runoff are sometimes necessary. Particularly in steep terrain, pipe slope drains can protect unstabilized areas from erosion. Typical uses include:

- Emergency spillway for a sediment basin.
- Drainage for top of cut/fill slopes where storm water can accumulate and must be conveyed down the slope.

INSTALLATION/APPLICATION CRITERIA

Temporary pipe slope drains are highly effective in eliminating slope erosion. Installation and maintenance requirements are small, especially when flexible pipe is used. General criteria:

- Gully erosion is the major problem with pipe slope drains. Inlet structures must be securely entrenched and compacted to avoid severe gully erosion.
- The pipe must be securely anchored to the slope and must be adequately sized to carry the capacity of the design storm and associated forces.
- The outlet must be stabilized with rip-rap, concrete or other type of energy dissipator.
- A debris rack is recommended at the pipe inlet, and should be encouraged for larger pipes and at the outlet as a safety device to prevent small children from entering the pipe.

Materials:
Material selection and criteria for the pipe slope drain is often established by the local municipality. Soil type, rainfall patterns, construction schedule, and available supply are some of the factors to be considered. The following types of pipe slope drains are commonly used:

- **Rigid Pipe:** This type of pipe slope drain is also known as a pipe drop. The pipe usually consists of corrugated metal pipe or rigid plastic pipe. The pipe is placed on undisturbed or compacted soil and secured into the slope. One foot minimum cover is required on the pipe, and concrete thrust blocks must be used when required by the municipality or warranted by the calculated thrust forces. Collars should be properly installed and secured with metal strappings or watertight collars.
- **Flexible Pipe:** The flexible pipe slope drain consists of a flexible conduit of heavy duty material. The conduit material is securely anchored into the slope and connections are watertight. The conduit should be securely fastened to the metal inlet and outlet conduit sections with metal strappings or water tight collars.
- **Sectional Downdrain:** The sectional downdrain consists of pre-fabricated, sectional conduit of half-round or third-round material. The sectional downdrain performs similar to a flume or chute. The pipe must be placed on undisturbed or compacted soil and secured into the slope.
**BMP: PIPE SLOPE DRAIN**

**GENERAL DESCRIPTION**
A temporary pipe to drain the top of a slope to a stable discharge point at the bottom of a slope without causing erosion.

**SUITABLE APPLICATIONS**
- Pipe slope drains are used where concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion.
- Drainage for top of slope diversion dikes or swales.
- Emergency spillway for a sediment basin.
- Drainage for top of cut/fill slopes where water can accumulate.

The types of pipe slope drain can include:
- Pipe Drops.
- Flexible downdrains.
- Sectional downdrains.

**INSTALLATION/APPLICATION CRITERIA**
- Secure inlet and surround with dikes to prevent gully erosion, and anchor pipe to slope.
- Size to convey at least the peak of a 10-year, 24-hour storm (see local flood control agency for requirements).
- Stabilize outlet.

**REQUIREMENTS**
- Maintenance
  - Structure must be inspected regularly and after storms.
  - Inlet must be free of undercutting and no water should circumvent the entry.
  - Outlet should not produce erosion; velocity dissipators must be maintained.
  - Pipe anchors must be checked to ensure that the pipe remains anchored to the slope.
- Cost
  - Reference CalTrans Cost Schedule for regional cost ranges.

**LIMITATIONS**
- Maximum drainage area per pipe slope drain is 5 acres. (For large areas use a paved chute, rock lined channel or additional pipes.)
- Clogged pipe slope drains will force water around the pipe and cause slope erosion.
- Dissipation of high flow velocities at the pipe outlet required to avoid downstream erosion.
- Failure can result in flooding and severe erosion.

**Objectives**
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

**Targeted Pollutants**
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

**Implementation Requirements**
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

**Symbol**
DR4
TEMPORARY DRAINAGE SWALE
REFERENCES


RIPRAP APRON

SIDE SLOPE = 2:1
EARTH DIKE

CORRUGATED METAL PIPE

DIAMETER (D)

4" MIN.

STANDARD FLARED ENTRANCE SECTION MIN. INLET SLOPE 3%

H = D + 12"

AT LESS THAN 1% SLOPE

D  60

3D + 2

RIPRAP SHALL CONSIST OF 6" DIAMETER STONE PLACED AS SHOWN AND SHALL BE MINIMUM OF 12" IN THICKNESS.

PIPE SLOPE DRAIN (RIGID)
RIPRAP SHALL CONSIST OF 6" DIA STONE PLACED AS SHOWN.
DEPTH OF APRON SHALL EQUAL THE PIPE DIA AND RIPRAP SHALL BE A MINIMUM OF 12" IN THICKNESS.

PIPE SLOPE DRAIN (FLEXIBLE)
**BMP: OUTLET PROTECTION**

**GENERAL DESCRIPTION**
Rock outlet protection is a physical device composed of rock, grated rip-rap, or concrete rubble which is placed at the outlet of a pipe to prevent scour of the soil caused by high pipe flow velocities, and to absorb flow energy to produce non-erosive velocities.

**SUITABLE APPLICATIONS**
Rock outlet protection should be used wherever discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the next downstream reach. Rock outlet protection is best suited for temporary use during construction because it is usually less expensive and easier to install than concrete aprons or energy dissipators. It also serves to trap sediment and reduce flow velocities. Rock size should be increased for high velocity flows. If runoff is sediment laden, a sediment trap below the pipe outlet is recommended. Permanent rock riprap protection should be designed and sized by the engineer as part of the culvert, conduit or channel design.

**INSTALLATION/APPLICATION CRITERIA**
Rock outlet protection is effective when the rock is sized and placed properly. When this is accomplished, rock outlets do much to limit erosion at pipe outlets. General recommendations for rock size and length of outlet protection mat are shown in the attached figure. Best results are obtained when sound, durable, angular rock is used. CalTrans Standard Specifications or the local municipality can provide specifications for constructing outlet protection devices.

**REQUIREMENTS**
- **Maintenance**
  - Inspect after each significant rain for erosion and/or disruption of the rock, and repair immediately.
  - Grouted or wire-tied rock riprap can minimize maintenance requirements.
- **Cost**
  - Reference CalTrans Cost Schedule for regional cost ranges

**LIMITATIONS**
- Large storms often wash away the rock outlet protection and leave the area susceptible to erosion.
- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.

**Objectives**
- Housekeeping Practices
  - Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

**Targeted Pollutants**
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

**Likely to Have Significant Impact**
〇 Likely to Have Significant Impact
〇 Probable Low or Unknown Impact

**Implementation Requirements**
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

**SYMBOL**
VR1

**LOGO**
Additional Information — Outlet Protection

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the inlet or outlet from developing small eroded pools (plunge pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipators. It also serves to trap sediment and reduce flow velocities.

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat is shown in the rock outlet protection figure. Best results are obtained when sound, durable, angular rock is used. Rock depth and outlet protection length are governed by the discharge pipe size, but hydraulic calculations and velocities should be used to determine length. Your local municipality or CalTrans should be consulted for appropriate sizing criteria in your area.

REFERENCES
1. County of Sacramento Improvement Standards, Sacramento County - May 1989
5. Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983
SECTION A-A
PIPE OUTLET TO FLAT AREA WITH NO DEFINED CHANNEL

NOTES
1. APRON LINING MAY BE RIPRAP, GROUTED RIPRAP, OR CONCRETE.
2. WHERE AS TECHNICAL DESIGN PROCEDURES EXIST FOR DETERMINING LA, FCDML RECOMMENDS USE OF THE FOLLOWING TABLE FOR TEMPORARY ROCK OUTLET PROTECTION.

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>AVERAGE ROCK DIA</th>
<th>LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>5&quot;</td>
<td>12&quot;</td>
</tr>
<tr>
<td>15&quot;</td>
<td>10&quot;</td>
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<td>15&quot;</td>
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<td>21&quot;</td>
<td>15&quot;</td>
<td>25&quot;</td>
</tr>
<tr>
<td>24&quot;</td>
<td>15&quot;</td>
<td>30&quot;</td>
</tr>
</tbody>
</table>

3. \( d = 1.5 \) TIMES THE MAXIMUM STONE DIAMETER BUT NOT LESS THAN 6 INCHES.
BMP: CHECK DAMS

Objectives
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

- Likely to Have Significant Impact
- Probable Low or Unknown Impact

Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

- High
- Low

Symbol
VR2

Logo

GENERAL DESCRIPTION
Small temporary dams constructed across a swale or drainage ditch. Check dams reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch, and to slow water velocity to allow sediment capture.

SUITABLE APPLICATIONS
Check dams are used to prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales. Check dams may also promote sedimentation behind the dam, but should not be considered to be a primary sediment trapping device because subsequent storms will scour and resuspend much of the trapped sediment.

INSTALLATION/APPLICATION CRITERIA
- Check dams should be placed at a distance and height to allow small pools to form between each one.
- Backwater from a downstream check dam should reach the toe of the upstream check dam.
- Major floods (2 year storm or larger) should safely flow over the check dam without an increase in upstream flooding or destruction of the checkdam.
- Primarily used in small, steep channels where velocities exceed 2 fps.
- Used in steep train where velocity reduction is required.
- A deep sump should be provided immediately upstream of the check dam to capture excessive sediment.
- Check dams may be built of rocks or logs, which are secured against damage during significant floods.

REQUIREMENTS
- Maintenance
  - Inspect for sediment buildup behind the check dam and signs of erosion around the check dam after each rain.
  - Remove accumulated sediment whenever it reaches one-half the sump depth.

LIMITATIONS
- Use only in small open channels which drain 10 acres of less.
- Not to be used in live streams.
- Do not install in lined or vegetated channels.
Additional Information — Check Dams

Small temporary dams constructed across a small swale or drainage ditch to (1) reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch, and (2) to slow water velocity to allow sediment capture.

Check dams are used to reduce the velocity of stormwater flow, thereby reducing the erosion of the swale or ditch. Check dams reduce the need for more stringent temporary channel bank stabilization measures in the swale. Although sediment, in small amounts, is trapped by the check dam, it should not be used as a sediment-trapping device. Check dams should not be placed in streams which flow continually during the rainy season. This practice is limited to use in small open channels which drain 10 acres or less.

INSTALLATION/APPLICATION CRITERIA
Check dams only perform their function of reducing velocities of concentrated flows and energy if they have been sized and constructed correctly and are maintained properly.

Check dams can be constructed of either rock or logs. Use of other natural materials available on-site that can withstand the stormwater flow velocities is acceptable, such as pea-gravel filled in sandbags. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Provide a deep sump immediately upstream of the check dam. The sump should be sized to trap sediment resulting from a ___-year storm. The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam, and the center section of the dam should be lower than the edge sections so that the check dam will act like a weir during major floods.

Rock check dams shall be constructed of appropriately sized rock equal to 8"-12". The rock must be placed by hand or mechanical placement (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges. The rock used must be large enough to stay in place given the expected design flow through the channel.

Log check dams shall be constructed of 4 to 6-inch diameter logs. The logs shall be embedded into the soil at least 18 inches.

In the case of grass-lined ditches and swales, check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

REFERENCES
LOG CHECK DAM

ROCK CHECK DAM

L = THE DISTANCE SUCH THAT POINTS A & B ARE OF EQUAL ELEVATION

SPACING BETWEEN CHECK DAMS
BMP: SURFACE ROUGHING

GENERAL DEFINITION
Surface roughening aids in the establishment of vegetation cover, reduces runoff velocity, increases infiltration, and provides small depressions for trapping sediment.

SUITSABLE APPLICATIONS
- Any cleared area prior to seeding and planting
- Required for cleared, erodible slopes steeper than 3:1 and higher than 5 feet prior to seeding and planting

INSTALLATION/APPLICATION CRITERIA
Surface roughening is performed in several ways:
- Stair-step grading
- Grooving
- Furrowing
- Tracking
- Rough grading
- No grading

REQUIREMENTS
- Maintenance
  - Inspect roughened slopes weekly and after rainfall for excessive erosion
  - Revegetate as quickly as possible
- Cost

LIMITATIONS
- Roughening is of limited effectiveness on its own, but is used to speed revegetation.

Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

Likely to Have Significant Impact

Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

High  Low
Additional Information — Surface Roughing

Surface roughening creates uneven depressions, steps or grooves on the soil surface to aid in establishment of vegetative cover, reduce runoff velocity, and increase infiltration, and provide for sediment trapping.

Surface roughening may be applied to all slopes steeper than 3:1, and greater than 5 vertical feet, providing some instant erosion protection on bare soil while vegetative cover is being established. It is an inexpensive, simple and short-term erosion control measure for roadways cut slopes.

INSTALLATION/APPLICATION
Graded areas with smooth, hard surfaces give a false impression of “finished grading” and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but they encourage water infiltration, speed the establishment of vegetation, and decreased runoff velocity.

Rough, loose soil surfaces give lime, fertilizer, and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.

2. Graded areas steeper than 3:1 should be stair-stepped with benches as shown in the attached figure. The stair-stepping will help vegetation become attached and also trap soil eroded from the slopes above. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each “step” catches material which sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment.

3. Areas which will be mowed (these areas should have slopes less than 3:1) may have small furrows left by disk, harrowing, raking, or seed-planting machinery operated on the contour.

4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased. Tracking can be accomplished in a variety of ways, including “track walking,” or driving a crawler tractor up and down the slope, in leaving a pattern of cleat imprints parallel to slope contours.

REFERENCES
3. Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983
Debris from slope above is caught by steps.

Drainage

WATER, SOIL, AND FERTILIZER ARE HELD BY STEPS - PLANTS CAN BECOME ESTABLISHED ON THE STEPS.

STAIR STEPPING CUT SLOPES

Grooving is cutting furrows along the contour of a slope. Irregularities in the soil surface catch rainwater and provide some coverage of lime, fertilizer and seed.

GROOVING SLOPES

STAIR-STEPPING CUT SLOPES AND GROOVING SLOPES
BMP: SILT FENCE

GENERAL DESCRIPTION
A silt fence is made of a filter fabric which has been entrenched, attached to supporting
poles, and sometimes backed by a wire fence for support. The silt fence detains sediment-
laden water, promoting sedimentation behind the fence.

SUITABLE APPLICATIONS
- Along the perimeter of the site
- Along streams and channels
- Across swales with small catchments
- Below the toe of a cleared slope
- Around temporary spoil areas
- Below other small cleared areas

INSTALLATION/APPLICATION
- Use principally in areas where sheet or rill flow occurs.
- Install along a level contour, so water does not pond more than 1.5 feet at any point.
- No more than 1 acre, 100 ft., or 0.5 cfs of concentrated flow should drain to any point
  along the silt fence.
- Turn ends of fence uphill.
- Provide area behind the fence for runoff to pond and sediment to settle.
- Select filter fabric which retains 85% of the soil, by weight, based on sieve analysis, but is not finer than EOS70.

REQUIREMENTS
- Maintenance
  - Inspect weekly and after each rainfall
  - Repair wherever fence is damaged
  - Remove sediment when it reaches 1/3 the height of the fence
  - Cost

LIMITATIONS
- Do not use where 85% of the soil, by weight, passes through a No. 200 sieve because the
  filter fabric will clog.
- Do not place fence on a slope, or across any contour line
- Do not use in streams, channels, or anywhere flow has concentrated
- Do not use in locations where ponded water may cause flooding

Objectives
Housekeeping Practices
  Contain Waste
  Minimize Disturbed Areas
  Stabilize Disturbed Areas
  Protect Slopes/Channels
  Control Site Perimeter
  Control Internal Erosion

Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

Likely to Have Significant Impact
Probable Low or Unknown Impact

Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

High Low

SYMBOL
ST1

LOGO
A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of the fabric used, supported with wire fence. Silt fences trap sediment in two ways: (1) by intercepting and detaining small amounts of sediment from disturbed areas during construction operations in order to promote sediment from behind the fence; and (2) by decreasing the velocity of flows up to 0.5 cfs in swales.

Silt fences may be used for perimeter control, placed upstream of the point(s) of discharge of runoff from a site, but before the flow becomes concentrated. They may also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion, and perpendicular to minor swales or ditch lines for up to one acre contributing drainage areas. Silt fences are not intended for use in detaining concentrated flows, and are only applicable for sheet or overland flows.

**INSTALLATION/APPLICATION**

Planning:
Silt fences are preferable to straw barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw barriers, there are many instances where silt fences have been improperly installed. The following installation methods can improve performance and should be followed:

- Construct along a level contour.
- Silt fences should remain in place until the disturbed area is permanently stabilized.
- Provide sufficient room for sediment removal equipment between the silt fence and toes of slopes or other obstructions.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately downslope from the fence.
- Do not place in live streams or intermittently flowing channels.

Design:
Limit the upstream drainage area to 1 acre or less when used alone or in combination with sediment basin in a larger site.

Limit the maximum slope perpendicular to the fence line, should be 1:1.

Limit the maximum sheet or overland flow path length to any point along the fence to 100 feet.

Limit the concentrated flows reaching the fence to 0.5 cfs.

Selection of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer shall specify a filter fabric that retains the soil found on the construction site yet will have openings large enough to permit drainage and prevent clogging. The following criteria is recommended for selection of the equivalent opening size:

1. If 50 percent or less of the soil, by weight, will pass the U.S. standard sieve No. 200, select the EOS to retain 85 percent of the soil. The EOS should not be finer than EOS 70.
2. For all other soil types, the EOS should be no larger than the openings in the U.S. Standard Sieve No. 70 (0.0083 in. (0.21 mm.)) except where direct discharge to a stream, lake, or wetland will occur, then the EOS shall be no larger than Standard Sieve No. 100.

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100 (0.0059 in. (0.15 mm.)). If 85 percent or more of a soil, by weight, passes through the openings in a No. 200 sieve (0.0029 in. (0.074 mm.)), filter fabric shall not be used. Most of the particles in such a soil would not be retained if the EOS was too large, and they would clog the fabric quickly if the EOS was small enough to capture the soil.

The fence should be supported by a wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F to 120°F.

Installation Guidelines:
Filter fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

a. Posts should be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 30 inches.
b. A trench should be excavated approximately 8 inches wide and 12 inches deep along the line of posts and upslope from the barrier.
c. When standard strength filter fabric is used, a wire mesh support fence should be fastened securely to the upslope side of the posts using heavy-duty wire staples at least 1 inch long, tie wires or hog rings. The wire should extend into the trench a minimum of 4 inches.
d. The standard strength filter fabric should be stapled or wired to the fence, and 20 inches of the fabric should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the wire mesh support fence may be eliminated and the filter fabric stapled or wired directly to the posts.
e. The filter fabric should be purchased in a continuous, cut to the length of the barrier to avoid use of joints. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 inch overlap, and both ends securely fastened to the post.
f. The trench should be backfilled with 3/4-inch minimum diameter washed gravel or compacted native material.

REQUIREMENTS
Maintenance:

Inspect monthly during dry periods and immediately after each rainfall. Repair as necessary. Sediment must be removed when it reaches approximately one third the height of the fence, especially if heavy rains are expected.

Filter fences should not be removed until the upslope area has been permanently stabilized.

Cost:
<insert cost schedule/range>
Additional Information — Silt Fence

LIMITATIONS
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence which may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Filter fences are not practical where large flows of water are involved, hence the need to restrict their use to drainage areas of one acre or less, and flow rates of less than 0.5 cfs.
- Problems may arise from incorrect selection of pore size and/or improper installation.
- Do not allow water depth to exceed 1.5' at any point.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.

REFERENCES
SILT FENCE

2" x 4" WOOD POST, STANDARD OR BETTER OR EQUAL ALTERNATE: STEEL FENCE POST

FILTER FABRIC MATERIAL 60" WIDE ROLLS, USE STAPLES OR WIRE RINGS TO ATTACH FABRIC TO WIRE

2" x 2" 14 GA WIRE FABRIC OR EQUIV.

BEYOND BOTTOM OF FILTER MATERIAL IN 3" x 12" TRENCH

5' MAX.

FILTER FABRIC MATERIAL

2" x 2" 14 GA WIRE FABRIC OR EQUIV.

FOLD & SET FILTER FABRIC INTO SOIL

GRAVEL SET INTO SOIL FOR STABILITY

PROVIDE 3/4" - 1 1/2" WASHED GRAVEL BACKFILL IN TRENCH AND ON BOTH SIDES OR FILTER FENCE FABRIC ON THE SURFACE

2" x 4" WOOD POST ALT: STEEL FENCE POSTS
BMP: STRAW BALE BARRIERS

GRAPHIC

GENERAL DEFINITION
A straw bale barrier consists of straw bales placed along a level contour in a shallow trench and staked to hold them in place. The barrier detains runoff, creating a pond behind the barrier where sedimentation occurs.

SUITABLE APPLICATIONS
- Along the perimeter of the site
- Along streams and channels
- Across swales with small catchments
- Around temporary spoil areas
- Below other small, cleared areas

INSTALLATION/APPLICATION CRITERIA
- Use primarily in areas where sheet or rill flow occurs
- No more than 1/4 acre per 100 feet of barrier should drain to the barrier
- Installation along a level contour
- Place in a 4-inch deep trench
- Secure each bale with two stakes
- Leave enough area behind the barrier for runoff to pond (no more than 1.5 ft or 0.5 cfs) and sediment to settle

REQUIREMENTS
- Maintenance
  - Inspect weekly and after each rain
  - Replace bales which have decomposed or whose bindings have broken
  - Remove sediment behind the barrier when it reaches a depth of 6 inches
- Costs
  - Straw bale typically cost about $4 per linear foot.

LIMITATIONS
- Straw bale dikes are not to be used for extended periods of time because they tend to rot and fall apart.
- Suitable only for sheet flow on slopes of 2% or flatter.
- Not appropriate for large drainage areas, limit to 1 acre or less.
- Straw bales lose their effectiveness rapidly due to rotting, thus constant maintenance is required.
- Not recommended for concentrated flow, channel flow, and live streams.
- Bale bindings of jute or cotton not recommended.
- Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainage ways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow.
Additional Information — Straw Bale Barrier

A straw bale barrier consists of a series of secured anchored bales placed to intercept sediment-laden runoff from small drainage areas of disturbed soil. The barrier ponds runoff and allow sediment to settle. Straw bale dikes should not be used for extended periods of time because they tend to rot and fall apart.

The straw bale dike is used where there are no concentrations of water in a channel or drainage way, and where erosion would occur from sheet flow. These barriers are typically constructed, below disturbed areas subject to sheet flow of runoff to intercept and detain sediment.

INSTALLATION/APPLICATION

Straw bale barriers should be used for drainage areas no more than 1/4 acre per 100 feet of barrier length in any size, with no more than 100 ft upstream of any port along the barrier. The barrier should be placed along a level contour no greater than 2:1. When installed and maintained according to the guidelines on this fact sheet, straw bale dikes remove approximately 67% of the sediment transported in construction site runoff. This optimum efficiency can only be achieved through careful maintenance with special attention to replacing rooted or broken bales. Barrier should be constructed on a level contour to prevent concentration of flow against a small portion of the barrier.

An effective straw bale barrier should be installed in the following manner:

1. Bales should be placed on the contour and in a row with ends tightly abutting the adjacent bales.
2. Leave area for runoff to pond upstream of the barrier by locating barrier away from the toe of slopes. This also provides access for maintenance.
3. Each bale should be embedded in the soil a minimum of (4) inches and placed so the bindings are horizontal. Bindings placed on soil will soon disintegrate and cause the barrier to fail.
4. Bales should be securely anchored in place by either two stakes or re-bars driven through the bale. The first stake in each bale shall be driven toward the previously laid bale at an angle to force the bales together. Stakes should be driven flush with the bale.
5. Remove when it has served its usefulness so as not to block or impede storm flow or drainage.

REFERENCES

2. “Environmental Criteria Manual”, City of Austin, Texas
- Promotes on site sedimentation by creating a temporary pond.

**REDDING DETAIL**

Angle first stake toward previously laid bale.

Bound bales placed on contour.

2 2"x2" stakes 1 1/2" to 3" in ground, drive stakes flush with bales.

Substitution of steel bars for wooden stakes is not recommended due to potential for damaging construction equipment.

**ANCHORING DETAIL**

**STRAW BALE BARRIERS**
**BMP: SAND BAG BARRIER**

**Objectives**
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

**GENERAL DEFINITION**
Stacking sandbags along a level contour creates a barrier which detains sediment-laden water, ponding water upstream of the barrier and promoting sedimentation.

**SUITABLE APPLICATIONS**
- Along the perimeter of the site
- Check dams across streams and channels
- Along streams and channels
- Barrier for utility trenches in a channel
- Across swales with small catchments
- Diversion dikes or berms
- Below the toe of a cleared slope
- Create a temporary sediment trap
- Around temporary spoil areas
- Below other small cleared areas

**INSTALLATION/APPLICATION CRITERIA**
- May be used in drainage areas up to 5 acres
- Install along a level contour
- Base of sandbag barrier should be at least 18 inches
- Height of sandbag barrier should be at least 18 inches
- 4 inch PVC pipe may be installed between the top layer of sandbags to drain large flood flows
- Provide area behind barrier for runoff to pond and sediment to settle
- Place below the toe of a slope
- Use sandbags large enough and sturdy enough to withstand major flooding

**REQUIREMENTS**
- Maintenance
  - Inspect after each rain
  - Reshape or replace damaged sandbags immediately
  - Remove sediment when it reaches six inches in depth
- Cost

**LIMITATIONS**
- Sandbags are more expensive than other barriers, but also more durable
- Burlap should not be used for sandbags
**SUITABLE APPLICATIONS**

Sandbag berms may be used during construction activities in stream beds and utility construction in channels, temporary channel crossing for construction equipment, etc. Sandbag berms may also be installed parallel to roadway construction. Sandbag berms may also be used to create temporary sediment traps, retention basins and in place of straw bales or silt fences. Examples of applications include:

- Check dams across stream channels.
- Barrier for utility trenches or other construction in a stream channel.
- Temporary channel crossing.
- Barrier on a slope in place of straw bales or silt fences.
- Direct or divert flow.
- Create temporary sediment basin or retention basin.
- Near the toe of slopes.
- At construction perimeter.

**ADVANTAGES**

- Provides a semi-permeable barrier in potentially wet areas.
- More permanent than silt fences or straw bales.
- Allows for easy relocation on site to meet changing needs during construction.

**INSTALLATION/APPLICATION**

Sandbag berms are appropriate to use when construction of check dams or sumps in a stream is undesirable. The sandbag berms can provide the same function as a check dam without disturbing the stream or vegetation. The sandbag berm will also allow a small sediment retention area to be created prior to construction of final detention basins. For installation of a sandbag berm, the following criteria should be observed:

- **Drainage Area** - Up to five (5) acres.
- **Height of Berm** - 18 inches minimum height, measured from the top of the existing ground at the upslope toe to the toe of the barrier.
- **Width of Berm** - 48 inches minimum width measured at the bottom of the barrier, 18 inches at the top.
- **Sandbag Size** - Length 24 to 30 inches, width 16 to 18 inches and thickness six (6) to eight (8) inches. Weight 90 to 125 pounds.
- **Sandbag Material** - Polypropylene, polyethylene or polyamide woven fabric, minimum unit weight four (4) ounces per square yard, mullen burst strength exceeding 300 psi and ultraviolet stability exceeding 70 percent. Use of burlap is discouraged since it rots and deteriorates easily.
- **Grade of Sand** - Coarse sand, gravel.
- **Runoff water shall flow over the tops of the sandbags or through four (4) inch polyvinyl chloride pipes embedded below the top layer of bags.**

**REFERENCES**


2" PVC PIPE

FLOW

18" MIN

48" MIN

CROSS-SECTION

WOVEN FABRIC SANDBAG FILLED WITH COARSE SAND—MIN WEIGHT 40 LBS.

4" PVC PIPE FOR DRAINAGE DEPENDING ON FIELD CONDITIONS

24" MIN

FRONT VIEW

SANDBAG BERM
**GENERAL DEFINITION**
A rock filter berm is made of rock 3/4 to 3 inches in diameter and placed along a level contour where sheet flow may be detained and ponded, promoting sedimentation.

**SUITEABLE APPLICATIONS**
- As check dams across mildly sloped construction roads
- Below the toe of slopes
- Along the site perimeter
- Along streams and channels
- Around temporary spoil areas
- Below other small cleared areas

**INSTALLATION/APPLICATION CRITERIA**
- Use principally in areas where sheet or rill flow occurs
- Use larger rock, and place in a staked, woven wire sheathing if place where concentrated flows occur
- Install along a level contour
- Leave area behind berm where runoff can pond and sediment can settle
- Drainage area should not exceed 5 acres

**REQUIREMENTS**
- Maintenance:
  - Inspect monthly and after each rainfall
  - If berm damaged, reshape and replace lost/dislodged rock
  - Remove sediments when depth reaches 1/3 of berm height, or 1 ft.
- Cost:

**LIMITATIONS**
- Rock berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Not appropriate for drainage areas greater than 5 acres.
Additional Information — Rock Filter Berm

A rock filter berm consists of open graded rock installed at the toe of a slope, along the perimeter of a developing or disturbed area, and as a checkdam across construction roads. Their purpose is to intercept sediment laden runoff from disturbed areas of the site, allow the runoff to pond, promote sedimentation behind the berm, and slowly release water from an unprotected area, detain the sediment and release the water in sheet flow.

Filter beams are appropriate where a temporary measure is needed to prevent sediments from entering right-of-ways of traffic areas such as near the toe of slopes, or at construction site perimeters. Filter berms may also be used as checkdams across one or more lanes of construction traffic temporary roads, or unsurfaced rights of way subject to construction traffic.

Advantages of the rock filter berms is that they may be less costly than other temporary barriers, and are relatively efficient at sediment removal.

INSTALLATION/APPLICATION:
Planning:
- Rock filter berms should be placed in appropriate locations to be effective.
- Construct along a level contour to intercept sheet flow.
- Allow ample room for ponding, sedimentation, and access by sediment removal equipment between the berm and the toes of slopes.
- Flow through the berm should occur as sheet flow into an undisturbed or stabilized area.
- Installation in stream beds requires large rock, staking of woven wire sheathing, and daily inspection.

Design & Sizing Criteria
The following design criteria are commonly used to construct filter berms:

In Non-Traffic Areas:
- Maximum flow through rate per square foot of berm = 60 gpm
- Height = 18" minimum
- Top width = 24" minimum
- Side slopes = 2:1 or flatter
- Woven wire sheathing (poultry netting) is recommended in areas of concentrated flow. The wire should be 1" diameter hexagonal mesh, galvanized 20 gauge.
- Build the berm along on a level contour.
- Rock: 3/4" to 3" open graded for sheet flow, 3" to 5" open graded for concentrated flow.

In Construction Traffic Areas:
- Height = 12" maximum
- Provide multiple berms in series, spaced as shown.
  - Every 300' on slopes less than 5 percent
  - Every 200' on slopes 5 to 10 percent
  - Every 100' on slopes greater than 10 percent.

REFERENCES
Additional Information — Rock Filter Berm


3. Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983
### BMP: STORM DRAIN INLET PROTECTION

**Objectives**
- Housekeeping Practices
  - Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

### Graphic

### General Definition
One of several devices designed to detain sediment-laden runoff allowing it to settle prior to discharge into a storm drain inlet or catch basin.

### Suitable Applications
- Every storm drain inlet receiving sediment-laden runoff should be protected, either by covering the inlet or promoting sedimentation upstream of the inlet.

### Installation/Application
- Four types of inlet protection may be used:
  - Filter Fabric Fence: Appropriate for drainage basins less than one acre with less than a 5 percent slope.
  - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
  - Gravel and Wire Mesh Filter: Used on curb or drop inlets where construction equipment must drive over the inlet.
  - Excavated Drop Inlet Sediment Trap: Excavate an area around the inlet to trap sediment (see Sediment Trap ST7).
- Select the appropriate type of inlet protection and design as described in this fact sheet.
- Use only for drainage areas smaller than one acre unless a sediment trap first intercepts the runoff.
- Provide area around the inlet for water to pond without flooding structures and property.

### Requirements
- Maintenance
  - Inspect weekly and after each rain.
  - Replace clogged filter fabric or stone filters immediately.
  - Remove sediment when depth exceeds half the height of the filter, or half the depth of the sediment trap.
  - Remove as soon as upstream soils are stabilized and streets are swept.
- Cost

### Limitations
- Drainage area should not exceed 1 acre.
- Runoff will bypass protected inlets on slopes.
- Ponding will occur at a protected inlet, with possible short-term flooding.

### Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

- Likely to Have Significant Impact
- Probable Low or Unknown Impact

### Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

### Symbol
ST6

### Logo
**Additional Information — Storm Drain Inlet Protection**

Storm drain inlet protection consists of a sediment filter or an excavated impounding area around a storm drain, drop inlet, or curb inlet. This erosion and sedimentation control BMP prevents excessive sediment from entering storm drainage systems prior to permanent stabilization of the disturbed area.

All on-site storm drain inlets should be protected. Off-site, inlets should be protected in areas where construction activity tracks sediment onto paved areas or where inlets receive runoff from disturbed areas.

**INSTALLATION/APPLICATION CRITERIA**

**Planning**

Large amounts of sediment may enter the storm sewer system when storm sewers are installed before the upslope drainage area is stabilized, or where construction is adjacent to an existing storm sewer. In cases of extreme sediment loading, the storm sewer itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through a Temporary Sediment Trap (see ST1). Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Inlet protection methods not presented in this handbook should be approved by the local storm water management agency.

**General Design and sizing criteria:**
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Place sediment sumps 1 to 2 feet deep with 2:1 side slopes around all inlets in unpaved areas.

**Installation procedures for filter fabric fence:**

a. Place 2 inch by 2 inch wooden stakes around the perimeter of the inlet a maximum of 3 feet apart and drive them at least 8 inches into the ground. The stakes must be at least 3 feet long.

b. Excavate a trench approximately 8 inches wide and 12 inches deep around the outside perimeter of the stakes.

c. Staple the filter fabric (for materials and specifications, see Silt Fence ST1) to wooden stakes so that 32 inches of the fabric extends out and can be formed into the trench. Use heavy-duty wire staples at least 1 inch in length.

d. Backfill the trench with 3/4 inch or less washed gravel all the way around.

**Installation procedure for block and gravel filter:**

a. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with one-half inch openings. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.

b. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 inches, 8 inches, and 12 inches wide. The row of blocks should be at least 12 inches but no greater than 24 inches high.

c. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with one half inch openings.

d. Pile washed stone against the wire mesh to the top of the blocks. Use 3/4 to 3 inch gravel.
Additional Information — Storm Drain Inlet Protection

Installation procedure for gravel and wire mesh filters:

a. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with 1 inch openings. If more than one strip of mesh is necessary, overlap the strips. Place filter fabric over wire mesh.

b. Extend the filter fence/wire mesh beyond the inlet opening at least 18 inches on all sides. Place 3/4 to 3 inch gravel over the filter fabric/wire mesh. The depth of the gravel should be at least 12 inches over the entire inlet opening (see attached figure).

MAINTENANCE REQUIREMENTS

- For filter fabric fences: inspections should be made on a regular basis, especially after large storm events. If the fabric becomes clogged, it should be replaced. Sediment should be removed when it reaches approximately one-half the height of the fence. If a sump is used, sediment should be removed when it fills approximately one-half the depth of the hole.

- For gravel filters: If the gravel becomes clogged with sediment, it must be carefully removed from the inlet, and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, use the sediment-laden stone instead as fill and put fresh stone around the inlet.

- The inlet protection should be removed 30 days after the upslope area has been fully stabilized. Any sediment around the inlet must be carefully removed and disposed.

REFERENCES


FILTER FABRIC FENCE DROP INLET FILTER
CURB INLET PROTECTION
Specific Application

This method of inlet protection is applicable where heavy flows are expected and where an overflow capability and ease of maintenance are desirable.

Excavated Drop Inlet, Sediment Trap
BLOCK AND GRAVEL FILTER AT DROP INLET

GRAVEL AND WIRE MESH FILTER
BMP: SEDIMENT TRAP

GENERAL DEFINITION
A sediment trap is a small, excavated or bermmed area where runoff from small drainage areas is detained and sediment can settle.

SUITABLE APPLICATIONS
- Any disturbed area less than 5 acres.
- Along the perimeter of the site at locations where sediment-laden runoff is discharged off-site.
- Around and/or upslope from storm drain inlet protection measures.
- At any point within the site where sediment-laden runoff can enter stabilized or natural areas or waterways.

INSTALLATION/APPLICATION CRITERIA
- Sediment traps are usually sized to remove coarse sediment (sedimentation basins are usually sized to remove finer sediment).
- Build outside the area to be graded before clearing, grubbing, and grading begin.
- Locate where the trap can be easily cleared of sediment.
- Trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see Sedimentation Basin ST8). As a rule of thumb, coarse sediment will be removed if the sediment storage zone is at least 2 feet deep and the trap has a surface area of 260 sq. ft. per acre of drainage area.
- The deeper the trap, the less frequently sediment must be removed.
- The outlet of the trap must be stabilized with rock, vegetation, or another suitable material.
- A stable emergency spillway must be installed to safely convey major floods (see your local flood control agency).

REQUIREMENTS
- Maintenance
  - Remove sediment when the sediment storage zone is no more than 1 ft. from being full.
  - Inspect weekly and after each rain.
- Cost

LIMITATIONS
- Only use for drainage areas up to 5 acres (see Sedimentation Basin BMP ST8 for larger areas).
- Only removes coarse sediment (medium silt size and larger) unless sized like a sedimentation basin.
Additional Information — Sediment Trap

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation and/or by constructing an earthen embankment. Its purpose is to collect and store sediment from sites cleared and/or graded during construction. It is intended for use on small drainage areas, with no unusual drainage features, and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately 6 months, and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

APPLICATION CRITERIA

Planning:
Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to Sediment Basins (ST8), or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed of, such as for in fill areas on-site, or removal to an approved off-site dump. Sediment traps used as a perimeter control should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. Also, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks.

1. Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
2. Restrict basin side slopes to 3:1 or flatter.

Design:
- The sediment trap may be formed completely by excavation or by construction of a compacted embankment. It should have a 2 ft. deep sump for sediment storage. The outlet may be either a weir/spillway section, with the area below the weir acting as a filter for sediment and the upper area as the overflow spillway depth, or a riser perforated with 1/2-inch diameter holes about 1 ft. apart.
- The effectiveness of sediment traps is directly related to the size of the trap. A rule of thumb is that there should be 260 sq. ft. of sediment trap surface area per acre of drainage.
- A 3:1 or flatter aspect ratio between the trap length and width of the trap is desirable. Length is defined as the average distance from the inlet to the outlet of the trap.
- Determine the total trap dimensions by adding the depth required for the 2-year 24-hour design storm above the surface of the sediment storage volume, while not exceeding 3:1 side slopes (see attached figure).

INSTALLATION

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a barrier or low-head dam. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainageways. The following steps must be followed during installation.

1. The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
2. The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material; or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.

3. The trap is removed and the area stabilized when the upslope drainage area has been properly stabilized.

4. All cut-and-fill slopes should be 3:1 or flatter.

5. When a riser is used, all pipe joints must be watertight.

6. When a riser is used, at least the top two-thirds of the riser shall be perforated with 1/2-inch diameter holes spaced 8 inches vertically and 10 to 12 inches horizontally.

7. When an earth or stone outlet is used, the outlet crest elevation should be at least 1 foot below the top of the embankment.

8. When a crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

REFERENCES

2. "Environmental Criteria Manual", City of Austin, Texas


## BMP: SEDIMENT BASIN

### GENERAL DEFINITION
A pond created by excavation or constructing an embankment, and designed to retain or detain runoff sufficiently to allow excessive sediment to settle.

### SUITABLE APPLICATIONS
- At the outlet of all disturbed watershed 10 acres or larger.
- At the outlet of smaller disturbed watersheds, as necessary.
- Where post construction detention basins will be located.
- Should be used in association with dikes, temporary channels, and pipes used to divert disturbed areas into the basin and undisturbed areas around the basin.

### INSTALLATION/APPLICATION
- Construct before clearing and grading work begins.
- Do not locate in a stream.
- All basin sites should be located where failure of the embankment would not cause loss of life/property damage.
- Large basins are subject to local dam safety requirements.
- Securely anchor and install an anti-seep collar on the outlet pipe/riser, and provide an emergency spillway for passing major floods (see local flood control agency).
- A basin volume of 3600 cu. yd. per acre of upstream drainage and a detention time of 24 to 40 hours should allow 70 to 80 percent of medium silt sediment to settle.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 foot deep.
  - A settling zone at least 2 feet deep.
- The length to settling depth ratio (L/SD) should be less than 200.
- The length to width ratio should be greater than 6:1, or baffles are required to prevent short circuiting.

### REQUIREMENTS
- Maintenance
  - Inspect weekly and after each rain.
  - Remove sediment where the sediment storage zone is half full.
- Cost

### LIMITATIONS
- The basin should have shallow side slopes (minimum 4:1) or be fenced to prevent drowning.
- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Standing water may cause mosquitoes or other pests to breed.

### Objectives
- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

### Targeted Pollutants
- Sediment
- Nutrients
- Toxic Materials
- Oil & Grease
- Floatable Materials
- Other Construction Waste

### Implementation Requirements
- Capital Costs
- O&M Costs
- Maintenance
- Training
- Suitability for Slopes >5%

### SYMBOL

**ST8**
Additional Information — Sediment Basin

A sediment basin is a controlled storm water release structure formed by excavation or by constructing an embankment of compacted soil across a drainageway, or other suitable location. Its purpose is to collect and store sediment from sites cleared and/or graded during construction or for extended periods of time before reestablishment of permanent vegetation and/or construction of permanent drainage structures. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure (with a design life of 12 to 18 months) and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sedimentation basins are suitable for nearly all types of construction projects. Whenever possible, construct the sedimentation basins before clearing and grading work begins.

Basins should be located at the stormwater outlet from the site, but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet.

Many development projects in California will be required by local ordinances to provide a storm water detention basin for post-construction flood control, desiltation, or storm water pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70-80 percent of the sediment which flows into them if designed according to this handbook. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

INSTALLATION/APPLICATION CRITERIA

Planning:
To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations are generally low areas below disturbed areas. Drainage into the basin can be improved by the use of diversion dikes and ditches. The basin must not be located in a stream but should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Design:
- The sedimentation basin volume consists of two zones:
  - The sediment storage zone (at least 1 foot in depth).
  - A settling zone at least 2 feet in depth.
- The sedimentation basin may be formed by partial excavation and/or by construction of a compacted embankment. It may have one or more inflow points.
- A securely anchored riser pipe with an anti-seep collar is the principal outlet, along with an emergency overflow spillway. A solid riser pipe with two 1-inch diameter dewatering holes located at the top of the sediment storage volume on opposite sides of the riser pipe usually provides sufficient detention time for basins draining about 10 acres. Rock, rip-rap, or other suitable outlet protection is provided to reduce erosion at the riser pipe outlet.
- Settling Zone Volume

The settling zone volume is determined by the following equation:

\[
(V) = 1.2(SD)Q_{10}/V_{SED}
\]
Additional Information — Sediment Basin

\[ Q_{10} = \text{design inflow based on the peak discharge from a 10-year, 24-hour duration design storm event from the tributary drainage area as computed using the methods required by the local flood control agency. Provide a minimum of 3600 cubic feet of settling volume per acre of drainage.} \]

\[ V_{\text{SED}} = \text{the settling velocity of the design soil particle. The design particle chosen is medium silt (0.02 mm). This has a settling velocity (} V_{\text{SED}} \text{) of 0.00096 ft/sec. As a general rule it will not be necessary to design for a particle of size less than 0.02 mm, especially since the surface area requirement increases dramatically for smaller particle sizes. For example, a design particle of 0.01 mm requires about three times the surface area of 0.02 mm. Note also that choosing } V_{\text{SED}} \text{ of 0.00096 ft/sec equates to a surface area (SA) of 1250 sq. ft. per cfs of inflow.} \]

\[ SD = \text{settling depth, which should be at least 2 ft., and no shallower than the average distance from the inlet to the outlet of the pond (L) divided by 200 (i.e., } SD > L/200) \]

- Completing the design of the sediment basin:

  Total sediment basin volume and dimension are determined as outlined below:

  a. The details shown in the attached figure may be useful in designing the sediment basin.
  b. Determine basin geometry for the sediment storage volume calculated above using a minimum of 1 ft depth and 3:1 side slopes from the bottom of the basin. Note, the basin bottom is level.
  c. Extend the basin side slopes (at 3:1 max.) as necessary to obtain the settling zone volume as determined above.
  d. Adjust the geometry of the basin to effectively combine the settling zone volume and sediment storage volumes while preserving the depth and side slope criteria.
  e. Provide an emergency spillway with a crest elevation 1'-0 above the top of the riser pipe.
  f. The ratio between the basin length and width of the pond should either be greater than 6:1, or baffles should be installed to prevent short-circuiting.

**LIMITATIONS**

Sediment traps and ponds must be installed only within the property limits. Failure of the structure must not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the pond is required, the type of fence and its location shall be shown in the SWPPP and in the construction specifications.

- Generally, temporary sedimentation ponds are limited to drainage of 5 acres or more.
- Sediment ponds may be capable of trapping smaller sediment particles if additional detention time is provided. However, they are most effective when used in conjunction with other BMPs such as seeding or mulching.
- Ponds may become an “attractive nuisance” and care must be taken to adhere to all safety practices.
- Sediment ponds designed according to this handbook are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) will pass through untreated emphasizing the need to stabilize the soil quickly.
REFERENCES

2. "Environmental Criteria Manual", City of Austin, Texas


Sediment Pond

pond length ≥ 3x pond width

filter fabric fence

inflow

level bottom

perforated drain pipe* in gravel-filled trench

riser pipe* w/ weighted base

outlet pipe

Note: Sediment dewatering may be accomplished with perforated pipe in trench as shown or with a perforated riser pipe covered with filter fabric and a gravel "cone". A control structure may also be required; see Conditions Where Practice Applies.

1' spillway depth

1' freeboard riser pipe, open at top (principal spillway)
dewatering outlets

max. 4"

min. 2' settling depth

sediment storage 3' maximum depth

provide a rebar trash rack on riser pipes ≥ 18"

6' min. emergency overflow spillway crest

filter fabric fence

outlet pipe

anti-seep collars

weighted base to prevent floatation

energy dissipating rock

perforated drain pipe in gravel-filled trench for silt dewatering; trench wrapped w/ filter fabric full length
Sedimentation Pond Baffles

\[ \frac{A}{V_e} = \frac{L_1}{L_2} \]

- \( V_e \): effective volume of basin
- \( A \): surface area of basin
- \( L_1 \): flow path from inlet to weir
- \( L_2 \): shortest travel distances around the basin from inlet to outlet

If riser is placed here no baffles is required.

If baffle is placed here no riser is required.

In this case it is important to place bane to that \( L_1 = L_2 \)

Elevation of riser crest

Depth of water in basin when \( H \) is Max.

Elevation of basin bottom

Pass a line through at least 3 points of water at least 3 ft. over ground.
6. MONITORING

INTRODUCTION

One of the final steps in the preparation of the Storm Water Pollution Prevention Plan (SWPPP) is to develop a program to monitor how well the BMPs are being implemented, and to evaluate whether additional BMPs are required. The construction general permit requires that such a program be a component of the SWPPP. It has to meet these objectives:

- To inspect BMPs prior to and after a storm event.
- To aid in implementation of the SWPPP.
- To measure the effectiveness of the BMPs.

To meet these objectives the monitoring effort has these elements:

- Site inspection
- Certification of compliance
- BMPs monitoring
- Record keeping
- SWPPP review and modifications

According to the general permit, a tracking or follow-up procedure is required to ensure appropriate response has been taken in response to an inspection.

The results of the inspection and assessment must be written. Include the date of the inspection, the person(s) who performed the inspection, and the observations. Inspection records must be retained for three years. A sample inspection form is provided at the end of this chapter.

It is possible that activities may have changed since the last inspection, by type or location. These should be noted. New BMPs and adjustments to the SWPPP may be necessary.

CERTIFICATION OF COMPLIANCE

You must certify, based on the annual inspection, that your facility is in compliance with the requirements of the general permit and the SWPPP. If the inspection indicates you are not in compliance, you are to notify your Regional Water Quality Control Board. The notification is to identify the type(s) of noncompliance, the actions identified to come into compliance, and a time schedule to achieve compliance.

SITE INSPECTIONS

Inspections before and after a storm event are required by the construction general permit. At the onset of a construction project (e.g., clearing, grubbing, earth movement) it may be more appropriate to perform inspection of the BMPs on a regular basis instead of just before and after a storm. This will allow sufficient time for any corrections or improvements to be made in time before the storm. An inspector should be appointed for monitoring the BMPs and such inspection can be performed as part of a regular construction inspection program.

BMPs MONITORING

The type of BMP monitoring depends on which BMP is implemented. In the case of contractor activity BMPs the monitoring consists of visual inspection to ensure that the BMP was implemented and maintained according to the SWPPP. Such inspection would include:

- looking for evidence of spills and resulting clean-up procedures (e.g., supplies of spill cleanup material);
- examining integrity of containment structures;
- verifying use of employees education programs for the various activities;
- noting the location of activity (e.g., outdoor vs. indoor, concrete vs. grass);
- verifying adequacy of trash receptacles;
- verifying waste disposal practices (e.g., recycle vs. hazardous waste bins);

Other inspection areas are described in the fact sheets found in Chapter 4.

In the case of sediment and erosion control BMPs, the monitoring program should consist of regular inspection to determine the following:

**Are the BMPs installed effective?**

The effectiveness of the BMP would be based on the presence of silt behind or within control devices, the presence of silt downstream of the site and signs of erosion in stabilized areas after a storm event. The system may be deemed ineffective if:

1. Silt is present outside of the control area;
2. Structural controls are breached or fail under storm events of minor (less than 2 year, 24 hour) intensity;
3. Rills and gullies are present in stabilized slopes;
4. Evidence of silt buildup in downstream storm sewers and drainage ways is apparent; and
5. Controls are not maintained in accordance with design guidelines.

**Have drainage patterns changed?**

If the site has undergone significant grading operations, changing the drainage patterns, adjustments to the BMP controls will likely be required to address this change. The inspector shall determine the extent of the drainage pattern changes, if the changes are addressed in the SWPPP and if modifications to the erosion and sediment controls are required to address this change.

**Are sediment and erosion BMPs installed properly?**

The SWPPP BMPs should include details or references to allow for the proper construction of structural or vegetative erosion and sediment control devices. The inspector should ensure that these systems are installed according to the SWPPP in the proper locations.

**Are areas stabilized as quickly as possible after completion of construction activities in an area?**

In active construction areas (inactive construction areas may be defined as areas in which no construction activity will occur for a period of 30 days or longer) which have been disturbed will require stabilization through the use of vegetation, mulch, erosion control matting or structural methods within 7 calendar days from the last construction activity in the area.

**Are the BMPs properly maintained?**

Maintenance of the erosion and sediment control devices is the most critical as well as the potentially most expensive erosion control plan. The inspector should inspect the site on a weekly basis and after any storm of 0.5 inches or greater to determine maintenance requirements and general condition of the installed system. The local jurisdiction may also inspect the site on a typical bi-weekly basis to assess the maintenance performed on the systems. The following maintenance tasks should be performed on a regular basis. All maintenance related to a storm event should be completed within 48 hours of the storm event.

1. Removal of silt from barriers and sedimentation devices.
2. Replacement or repair of worn or damaged geotextile fabric.
3. Repair or replacement of damaged structural controls.

4. Seeding or mulching of damaged stabilized areas.

5. Additional chemicals or fuels not addressed in the SWPPP are required on-site.

6. Other control maintenance as defined in the BMP fact sheet of this handbook or part of the approved SWPPP.

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**RECORD KEEPING**

Records of all annual inspections, compliance certifications, and noncompliance reporting, and Registered Professional Engineer certifications as required, are to be retained for at least three years.

It is suggested that incidents such as spills, or other episodic releases be kept. Analyzing a history of this information can provide insight into modifying the BMPs. The history may suggest a predominance or spills in particular locations, form particular activities, and/or of particular materials. Efforts can be focused accordingly. Photographs may be useful. Also keep a record of maintenance activities or any other BMPs that are of an "action" nature. It is easy to demonstrate that a BMP that involves a physical change, such as berming or covering, has been accomplished. But actions that relate to good housekeeping can only be demonstrated by record keeping. Keeping a record of sediment trap cleaning, for example, also provides insight into how soon it takes for the trap to refill.

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**SWPPP REVIEW AND MODIFICATIONS**

During the course of construction, unanticipated changes may occur which affects the SWPPP, such as schedule changes, phasing changes, staging area modifications, offsite drainage impacts and repeated failures of designed controls. These changes must be made known and SWPPP revised accordingly. During the preparation and review of the modified SWPPP, construction may continue with temporary modifications to the erosion and sediment control BMPs.

Revisions to the SWPPP are also required when the properly installed systems are ineffective in the prevention of silt transport off of the site. This may be due to unforeseen site conditions or construction techniques which adversely affect the system as designed. Revisions to the SWPPP are also required if there is a new, deleted, or moved activity that could result in a significant amount of pollutants discharged in the storm water.
SAMPLE
Construction General Permit
Inspection Checklist

[ ] Weekly Inspection  [ ] Rainfall Event Inspection (Before)
[ ] Rainfall Event Inspection (After) ____ Rainfall ____ Inches

Inspected By: ___________________________ Date: _______________________

Project: ________________________________

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<th>YES</th>
<th>NO</th>
<th>DOES NOT APPLY</th>
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<tr>
<td></td>
<td></td>
<td>Are the BMPs called for on the SWPPP installed in the proper location and according to the specifications for the SWPPP?</td>
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<tr>
<td></td>
<td></td>
<td>Are all operational storm sewer inlets protected from sediment inflow?</td>
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<tr>
<td></td>
<td></td>
<td>Do any structural practices require repair or clean-out to maintain adequate function? If yes, indicate which ones:</td>
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<tr>
<td></td>
<td></td>
<td>Are construction on-site traffic routes, parking, and storage of equipment and supplies restricted to areas specifically designated for those uses?</td>
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<td></td>
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<td>Are locations of temporary soil stock piles or construction materials in approved areas?</td>
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<tr>
<td></td>
<td></td>
<td>Do any seeded or landscaped areas require maintenance, irrigation, fertilization, seeding, or mulching?</td>
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<tr>
<td></td>
<td></td>
<td>Is there any evidence that sediment is leaving the site?</td>
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<tr>
<td></td>
<td></td>
<td>Is there any evidence of erosion or cut or fill slopes?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Is there any evidence of sediment, debris, or mud on public roads at intersections with site access roads?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does the Storm Water Pollution Prevention Plan require revisions? If yes, explain:</td>
</tr>
</tbody>
</table>

Construction Handbook  6 - 4  September 1, 1992
SWPPP
Appendix E
Stormwater Analysis – Phase II
Existing and Proposed Conditions
Stormwater Calculations-
Existing Conditions
Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: Existing Area 1 - subcatchment**
- Runoff Area=10.555 ac
- Runoff Depth=0.17"
- Flow Length=1,262’
- Tc=18.6 min
- CN=59
- Runoff=0.77 cfs, 0.152 af

**Subcatchment 5S: Existing Area 2 - subcatchment**
- Runoff Area=421,067 sf
- Runoff Depth=0.13"
- Flow Length=1,172’
- Tc=18.5 min
- CN=57
- Runoff=0.43 cfs, 0.106 af

**Total Runoff Area = 20.221 ac**
**Runoff Volume = 0.258 af**
**Average Runoff Depth = 0.15"**
Subcatchment 1S: Existing Area 1 - subcatchment

Runoff = 0.77 cfs @ 12.53 hrs, Volume = 0.152 af, Depth = 0.17"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs
Type III 24-hr 1-yr-MA Rainfall=2.70"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
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<tbody>
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<td>Brush, Fair, HSG B</td>
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<tr>
<td>0.696</td>
<td>85</td>
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<td>Paved parking &amp; roofs</td>
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Subcatchment 1S: Existing Area 1 - subcatchment

Hydrograph

Type III 24-hr 1-yr-MA Rainfall=2.70"
Runoff Area=10.555 ac
Runoff Volume=0.152 af
Runoff Depth=0.17"
Flow Length=1,262'
Tc=18.6 min
CN=59
Subcatchment 5S: Existing Area 2 -subcatchmnet

Runoff = 0.43 cfs @ 12.58 hrs, Volume = 0.106 af, Depth = 0.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs
Type III 24-hr 1-yr-MA Rainfall = 2.70"

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<td>Shallow Concentrated Flow, Shallow Flow Nearly Bare &amp; Untilled Kv = 10.0 fps</td>
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Subcatchment 5S: Existing Area 2 -subcatchmnet

Hydrograph

Type III 24-hr 1-yr-MA Rainfall = 2.70"
Runoff Area = 421,067 sf
Runoff Volume = 0.106 af
Runoff Depth = 0.13"
Flow Length = 1,172'
Tc = 18.5 min
CN = 57
Type III 24-hr 2-yr-MA Rainfall=3.30"

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Area 1 - subcatchment
Runoff Area=10.555 ac  Runoff Depth=0.35"
Flow Length=1,262’  Tc=18.6 min  CN=59  Runoff=2.14 cfs  0.312 af

Subcatchment 5S: Existing Area 2 -subcatchment
Runoff Area=421,067 sf  Runoff Depth=0.29"
Flow Length=1,172’  Tc=18.5 min  CN=57  Runoff=1.45 cfs  0.235 af

Total Runoff Area = 20.221 ac  Runoff Volume = 0.547 af  Average Runoff Depth = 0.32"
Subcatchment 1S: Existing Area 1 - subcatchment

Runoff = 2.14 cfs @ 12.41 hrs, Volume= 0.312 af, Depth= 0.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr-MA Rainfall=3.30"

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Subcatchment 1S: Existing Area 1 - subcatchment

Type III 24-hr 2-yr-MA Rainfall=3.30"
Runoff Area=10.555 ac
Runoff Volume=0.312 af
Runoff Depth=0.35"
Flow Length=1,262'
Tc=18.6 min
CN=59
Subcatchment 5S: Existing Area 2 - subcatchment

Runoff = 1.45 cfs @ 12.46 hrs, Volume = 0.235 af, Depth = 0.29"

Runoff by SCS TR-20 method, UH = SCS, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs
Type III 24-hr 2-yr-MA Rainfall = 3.30"

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Subcatchment 5S: Existing Area 2 - subcatchment

Type III 24-hr 2-yr-MA Rainfall = 3.30"
Runoff Area = 421,067 sf
Runoff Volume = 0.235 af
Runoff Depth = 0.29"
Flow Length = 1,172'
Tc = 18.5 min
CN = 57
Type III 24-hr 10-yr-MA Rainfall=5.00"

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Area 1 - subcatchment
Runoff Area=10.555 ac  Runoff Depth=1.10"
Flow Length=1,262’  Tc=18.6 min  CN=59  Runoff=9.23 cfs  0.972 af

Subcatchment 5S: Existing Area 2 - subcatchment
Runoff Area=421,067 sf  Runoff Depth=0.98"
Flow Length=1,172’  Tc=18.5 min  CN=57  Runoff=7.27 cfs  0.792 af

Total Runoff Area = 20.221 ac  Runoff Volume = 1.764 af  Average Runoff Depth = 1.05"
Subcatchment 1S: Existing Area 1 - subcatchment

Runoff = 9.23 cfs @ 12.30 hrs, Volume = 0.972 af, Depth = 1.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs
Type III 24-hr 10-yr-MA Rainfall = 5.00"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
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<tbody>
<tr>
<td>9.642</td>
<td>56</td>
<td>Brush, Fair, HSG B</td>
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<tr>
<td>0.696</td>
<td>85</td>
<td>Gravel roads, HSG B</td>
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<td>0.217</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
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<tr>
<td>10.555</td>
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<tr>
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<td>7.4</td>
<td>178</td>
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<td>Sheet Flow, Sheet flow off pile</td>
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<td>1.8</td>
<td>343</td>
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<td>3.1</td>
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</tr>
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<td>Unpaved  Kv = 16.1 fps</td>
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<td></td>
<td>Paved   Kv = 20.3 fps</td>
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18.6 1,262 Total

Subcatchment 1S: Existing Area 1 - subcatchment

Hydrograph

Type III 24-hr 10-yr-MA Rainfall = 5.00"
Runoff Area = 10.555 ac
Runoff Volume = 0.972 af
Runoff Depth = 1.10"
Flow Length = 1,262'
Tc = 18.6 min
CN = 59
Subcatchment 5S: Existing Area 2 -subcatchmnet

Runoff = 7.27 cfs @ 12.30 hrs, Volume= 0.792 af, Depth= 0.98" 

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr-MA Rainfall=5.00" 

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
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<tbody>
<tr>
<td>400,678</td>
<td>56</td>
<td>Brush, Fair, HSG B</td>
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<td>20,389</td>
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<td>Gravel roads, HSG B</td>
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<td>421,067</td>
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<td>Smooth surfaces n= 0.011 P2= 3.30&quot;</td>
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<tr>
<td>17.8</td>
<td>1,122</td>
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<td>1.0</td>
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<td>Shallow Concentrated Flow, Shallow Flow</td>
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<td>Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
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<tr>
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Subcatchment 5S: Existing Area 2 -subcatchmnet

Hydrograph

Type III 24-hr 10-yr-MA Rainfall=5.00"
Runoff Area=421,067 sf
Runoff Volume=0.792 af
Runoff Depth=0.98"
Flow Length=1,172'
Tc=18.5 min
CN=57
Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: Existing Area 1 - subcatchment**
- Runoff Area=10.555 ac  Runoff Depth=1.78"
- Flow Length=1,262’  Tc=18.6 min  CN=59  Runoff=15.75 cfs  1.568 af

**Subcatchment 5S: Existing Area 2 - subcatchment**
- Runoff Area=421,067 sf  Runoff Depth=1.62"
- Flow Length=1,172’  Tc=18.5 min  CN=57  Runoff=12.93 cfs  1.307 af

**Total Runoff Area = 20.221 ac  Runoff Volume = 2.875 af  Average Runoff Depth = 1.71"**
Subcatchment 1S: Existing Area 1 - subcatchment

Runoff = 15.75 cfs @ 12.28 hrs, Volume = 1.568 af, Depth = 1.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs
Type III 24-hr 25-yr-MA Rainfall = 6.20"

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<td>1,262</td>
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<td></td>
<td>Total</td>
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</tbody>
</table>

Subcatchment 1S: Existing Area 1 - subcatchment

Type III 24-hr 25-yr-MA Rainfall = 6.20"
Runoff Area = 10.555 ac
Runoff Volume = 1.568 af
Runoff Depth = 1.78"
Flow Length = 1,262'
Tc = 18.6 min
CN = 59
Subcatchment 5S: Existing Area 2 -subcatchmnet

Runoff = 12.93 cfs @ 12.28 hrs, Volume= 1.307 af, Depth= 1.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr-MA Rainfall=6.20"

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<td>1.2</td>
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<td>Sheet Flow, gravel road Smooth surfaces n= 0.011 P2= 3.30&quot;</td>
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<td>0.0110</td>
<td>1.0</td>
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<td>Shallow Concentrated Flow, Shallow Flow Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
</tr>
</tbody>
</table>

18.5 1,172 Total

Subcatchment 5S: Existing Area 2 -subcatchmnet

Hydrograph

Type III 24-hr 25-yr-MA Rainfall=6.20"
Runoff Area=421,067 sf
Runoff Volume=1.307 af
Runoff Depth=1.62"
Flow Length=1,172'
Tc=18.5 min
CN=57
Type III 24-hr 100-yr-MA Rainfall=8.70"

Carver

Prepared by {enter your company name here}

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Area 1 - subcatchment

Runoff Area=10.555 ac  Runoff Depth=3.44"
Flow Length=1,262’  Tc=18.6 min  CN=59  Runoff=31.63 cfs  3.028 af

Subcatchment 5S: Existing Area 2 -subcatchmnet

Runoff Area=421,067 sf  Runoff Depth=3.21"
Flow Length=1,172’  Tc=18.5 min  CN=57  Runoff=26.98 cfs  2.589 af

Total Runoff Area = 20.221 ac  Runoff Volume = 5.617 af  Average Runoff Depth = 3.33"
Subcatchment 1S: Existing Area 1 - subcatchment

Runoff = 31.63 cfs @ 12.27 hrs, Volume= 3.028 af, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr-MA Rainfall=8.70"

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<td>Weighted Average</td>
</tr>
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Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
| 7.4| 178| 0.0926| 0.4 | Sheet Flow, Sheet flow off pile
|    |    |      |     | Range n= 0.130 P2= 3.30" |
| 1.8| 343| 0.0379| 3.1 | Shallow Concentrated Flow, Gravel Road
|    |    |      |     | Unpaved Kv= 16.1 fps |
| 0.8| 80 | 0.0063| 1.6 | Shallow Concentrated Flow, Paved Road
|    |    |      |     | Paved Kv= 20.3 fps   |
| 8.6| 661| 0.0166| 1.3 | Shallow Concentrated Flow, Open area
|    |    |      |     | Nearly Bare & Untilled Kv= 10.0 fps |
| 18.6| 1,262 | Total |

Subcatchment 1S: Existing Area 1 - subcatchment

Hydrograph

Type III 24-hr 100-yr-MA Rainfall=8.70"
Runoff Area=10.555 ac
Runoff Volume=3.028 af
Runoff Depth=3.44"
Flow Length=1,262'
Tc=18.6 min
CN=59
Subcatchment 5S: Existing Area 2 -subcatchmnet

Runoff = 26.98 cfs @ 12.27 hrs, Volume= 2.589 af, Depth= 3.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr-MA Rainfall=8.70"

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<td>85</td>
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<td>0.0200</td>
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<td><strong>Sheet Flow, gravel road</strong> Smooth surfaces n= 0.011 P2= 3.30&quot;</td>
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<tr>
<td>17.8</td>
<td>1,122</td>
<td>0.0110</td>
<td>1.0</td>
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<td><strong>Shallow Concentrated Flow, Shallow Flow</strong> Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
</tr>
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<td>18.5</td>
<td>1,172</td>
<td></td>
<td></td>
<td></td>
<td><strong>Total</strong></td>
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Subcatchment 5S: Existing Area 2 -subcatchmnet

Type III 24-hr 100-yr-MA Rainfall=8.70"
Runoff Area=421,067 sf
Runoff Volume=2.589 af
Runoff Depth=3.21"
Flow Length=1,172'
Tc=18.5 min
CN=57
Stormwater Calculations-
Proposed Phase II Conditions
**Carver Phase II**

Type III 24-hr 2-Year Rainfall = 3.30"

Prepared by Microsoft

3/3/2017 Printed

Page 2

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---

**Time span** = 0.00-24.00 hrs, **dt** = 0.05 hrs, 481 points

Runoff by SCS TR-20 method, **UH** = SCS, Weighted-CN

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

---

**Subcatchment 1S: PDA 1**

Runoff Area = 685,844 sf  2.02% Impervious  Runoff Depth > 1.92"

Flow Length = 1,151'  Tc = 18.2 min  CN = 86  Runoff = 24.80 cfs  109,501 cf

---

**Subcatchment 2S: PDA 2**

Runoff Area = 732,129 sf  0.00% Impervious  Runoff Depth > 1.92"

Flow Length = 683'  Slope = 0.0200 '/'  Tc = 8.2 min  CN = 86  Runoff = 34.64 cfs  117,129 cf

---

**Subcatchment 3S: PDA 3**

Runoff Area = 752,270 sf  0.00% Impervious  Runoff Depth > 1.92"

Flow Length = 706'  Slope = 0.0200 '/'  Tc = 8.4 min  CN = 86  Runoff = 35.34 cfs  120,346 cf

---

**Pond 1P: SW Basin 1**

Peak Elev = 87.22'  Storage = 109,460 cf  Inflow = 24.80 cfs  109,501 cf

Outflow = 0.00 cfs  0 cf

---

**Pond 2P: SW Basin 2**

Peak Elev = 86.59'  Storage = 117,088 cf  Inflow = 34.64 cfs  117,129 cf

Outflow = 0.00 cfs  0 cf

---

**Pond 3P: SW Basin 3**

Peak Elev = 86.33'  Storage = 120,304 cf  Inflow = 35.34 cfs  120,346 cf

Outflow = 0.00 cfs  0 cf

---

**Total Runoff Area** = 2,170,243 sf  **Runoff Volume** = 346,976 cf  **Average Runoff Depth** = 1.92"

99.36% Pervious = 2,156,372 sf  0.64% Impervious = 13,871 sf
Summary for Subcatchment 1S: PDA 1

Runoff = 24.80 cfs @ 12.25 hrs, Volume = 109,501 cf, Depth > 1.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 0.00-24.00 hrs, dt = 0.05 hrs
Type III 24-hr 2-Year Rainfall = 3.30"

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<tr>
<td>13,871</td>
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<td>Paved parking, HSG B</td>
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<td>685,844</td>
<td>86</td>
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<tr>
<td>671,973</td>
<td>97.98% Pervious Area</td>
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<td>13,871</td>
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<td>Shallow Concentrated Flow, Nearly Bare &amp; Untilled  Kv = 10.0 fps</td>
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Total Tc = 18.2 min

Subcatchment 1S: PDA 1

Type III 24-hr 2-Year Rainfall = 3.30"
Runoff Area = 685,844 sf
Runoff Volume = 109,501 cf
Runoff Depth > 1.92"
Flow Length = 1,151'
Tc = 18.2 min
CN = 86
Summary for Subcatchment 2S: PDA 2

Runoff = 34.64 cfs @ 12.12 hrs, Volume= 117,129 cf, Depth> 1.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr  2-Year Rainfall=3.30"

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<td></td>
<td>Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
</tr>
</tbody>
</table>

8.2 683 Total

Subcatchment 2S: PDA 2

Hydrograph

Type III 24-hr 2-Year Rainfall=3.30"
Runoff Area=732,129 sf
Runoff Volume=117,129 cf
Runoff Depth>1.92"
Flow Length=683'
Slope=0.0200 '/'
Tc=8.2 min
CN=86
Summary for Subcatchment 3S: PDA 3

Runoff = 35.34 cfs @ 12.12 hrs, Volume= 120,346 cf, Depth> 1.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>752,270</td>
<td>86</td>
<td>Newly graded area, HSG B</td>
</tr>
<tr>
<td>752,270</td>
<td>100.00%</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>0.4</td>
<td>25</td>
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<td>1.04</td>
<td></td>
<td><strong>Sheet Flow</strong>, Smooth surfaces  n= 0.011  P2= 3.20&quot;</td>
</tr>
<tr>
<td>8.0</td>
<td>681</td>
<td>0.0200</td>
<td>1.41</td>
<td></td>
<td><strong>Shallow Concentrated Flow</strong>, Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
</tr>
<tr>
<td>8.4</td>
<td>706</td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

Subcatchment 3S: PDA 3

Hydrograph

Type III 24-hr
2-Year Rainfall=3.30"
Runoff Area=752,270 sf
Runoff Volume=120,346 cf
Runoff Depth>1.92"
Flow Length=706'
Slope=0.0200 '/'
Tc=8.4 min
CN=86
Summary for Pond 1P: SW Basin 1

Inflow Area = 685,844 sf, 2.02% Impervious, Inflow Depth > 1.92" for 2-Year event

Inflow = 24.80 cfs @ 12.25 hrs, Volume= 109,501 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 87.22' @ 24.00 hrs    Surf.Area= 49,835 sf   Storage= 109,460 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>84.00'</td>
<td>301,795 cf</td>
<td>Custom Stage Data (Irregular) Listed below (Recalc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>84.00</td>
<td>21,060</td>
<td>797.0</td>
<td>0</td>
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<td>21,060</td>
</tr>
<tr>
<td>86.00</td>
<td>36,573</td>
<td>1,226.0</td>
<td>56,924</td>
<td>56,924</td>
<td>90,152</td>
</tr>
<tr>
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<td>59,369</td>
<td>1,964.0</td>
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<td>151,950</td>
<td>277,522</td>
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<td>90.00</td>
<td>91,639</td>
<td>3,101.0</td>
<td>149,845</td>
<td>301,795</td>
<td>735,829</td>
</tr>
</tbody>
</table>

Pond 1P: SW Basin 1

Hydrograph

Inflow Area=685,844 sf
Peak Elev=87.22'
Storage=109,460 cf
Summary for Pond 2P: SW Basin 2

Inflow Area = 732,129 sf, 0.00% Impervious, Inflow Depth > 1.92" for 2-Year event
Inflow = 34.64 cfs @ 12.12 hrs, Volume= 117,129 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 86.59' @ 24.00 hrs Surf.Area= 62,749 sf Storage= 117,088 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>84.00'</td>
<td>432,262 cf</td>
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Listed below (Recalc)

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<td>241,009</td>
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<td>87.00</td>
<td>67,472</td>
<td>2,265.0</td>
<td>61,762</td>
<td>143,702</td>
<td>252,333</td>
</tr>
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<td>88.00</td>
<td>88,396</td>
<td>2,933.0</td>
<td>77,699</td>
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<td>543,965</td>
</tr>
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<td>90.00</td>
<td>127,659</td>
<td>3,638.0</td>
<td>115,185</td>
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<td>897,609</td>
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Pond 2P: SW Basin 2

Hydrograph

Inflow Area=732,129 sf
Peak Elev=86.59'
Storage=117,088 cf
Summary for Pond 3P: SW Basin 3

Inflow Area = 752,270 sf, 0.00% Impervious, Inflow Depth > 1.92” for 2-Year event
Inflow = 35.34 cfs @ 12.12 hrs, Volume= 120,346 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 86.33’ @ 24.00 hrs Surf.Area= 67,958 sf Storage= 120,304 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
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<th>Avail.Storage</th>
<th>Storage Description</th>
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<td>487,594 cf</td>
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Pond 3P: SW Basin 3

Hydrograph

Flow (cfs)

0 2 4 6 8 10 12 14 16 18 20 22 24

Time (hours)

Inflow Area=752,270 sf
Peak Elev=86.33'
Storage=120,304 cf
Subcatchment 1S: PDA 1
Runoff Area=685,844 sf  2.02% Impervious  Runoff Depth>3.46"
Flow Length=1,151’  Tc=18.2 min  CN=86  Runoff=44.25 cfs  197,559 cf

Subcatchment 2S: PDA 2
Runoff Area=732,129 sf  0.00% Impervious  Runoff Depth>3.46"
Flow Length=683’  Slope=0.0200 '/'  Tc=8.2 min  CN=86  Runoff=61.70 cfs  211,276 cf

Subcatchment 3S: PDA 3
Runoff Area=752,270 sf  0.00% Impervious  Runoff Depth>3.46"
Flow Length=706’  Slope=0.0200 '/'  Tc=8.4 min  CN=86  Runoff=62.96 cfs  217,080 cf

Pond 1P: SW Basin 1
Peak Elev=88.71’  Storage=197,493 cf  Inflow=44.25 cfs  197,559 cf
Outflow=0.00 cfs  0 cf

Pond 2P: SW Basin 2
Peak Elev=87.88’  Storage=211,207 cf  Inflow=61.70 cfs  211,276 cf
Outflow=0.00 cfs  0 cf

Pond 3P: SW Basin 3
Peak Elev=87.57’  Storage=217,009 cf  Inflow=62.96 cfs  217,080 cf
Outflow=0.00 cfs  0 cf

Total Runoff Area = 2,170,243 sf  Runoff Volume = 625,915 cf  Average Runoff Depth = 3.46"
99.36% Pervious = 2,156,372 sf  0.64% Impervious = 13,871 sf
Summary for Subcatchment 1S: PDA 1

Runoff = 44.25 cfs @ 12.25 hrs, Volume = 197,559 cf, Depth > 3.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 0.00-24.00 hrs, dt = 0.05 hrs
Type III 24-hr 10-Year Rainfall = 5.00"

<table>
<thead>
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<th>Area (sf)</th>
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<th>Description</th>
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<tbody>
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<td>671,973</td>
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</tr>
<tr>
<td>13,871</td>
<td>98</td>
<td>Paved parking, HSG B</td>
</tr>
<tr>
<td>685,844</td>
<td>86</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>671,973</td>
<td>97.98% Pervious Area</td>
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</tr>
<tr>
<td>13,871</td>
<td>2.02% Impervious Area</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>25</td>
<td>0.0200</td>
<td>1.04</td>
<td></td>
<td>Sheet Flow, Smooth surfaces n = 0.011 P2 = 3.20&quot;</td>
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<tr>
<td>8.7</td>
<td>740</td>
<td>0.0200</td>
<td>1.41</td>
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<td>Shallow Concentrated Flow, Nearly Bare &amp; Untilled Kv = 10.0 fps</td>
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<tr>
<td>9.1</td>
<td>386</td>
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<td>Shallow Concentrated Flow, Nearly Bare &amp; Untilled Kv = 10.0 fps</td>
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<tr>
<td>18.2</td>
<td>1,151</td>
<td>Total</td>
<td></td>
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Subcatchment 1S: PDA 1

Type III 24-hr 10-Year Rainfall = 5.00"
Runoff Area = 685,844 sf
Runoff Volume = 197,559 cf
Runoff Depth > 3.46"
Flow Length = 1,151'
Tc = 18.2 min
CN = 86
Summary for Subcatchment 2S: PDA 2

Runoff = 61.70 cfs @ 12.12 hrs, Volume = 211,276 cf, Depth > 3.46"

Runoff by SCS TR-20 method, UH = SCS, Weighted-CN, Time Span = 0.00-24.00 hrs, dt = 0.05 hrs

Type III 24-hr 10-Year Rainfall = 5.00"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>732,129</td>
<td>86</td>
<td>Newly graded area, HSG B</td>
</tr>
<tr>
<td>732,129</td>
<td>100</td>
<td>100.00% Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>25</td>
<td>0.0200</td>
<td>1.04</td>
<td></td>
<td>Sheet Flow, Smooth surfaces  n = 0.011  P2 = 3.20&quot;</td>
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<tr>
<td>7.8</td>
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<td>1.41</td>
<td></td>
<td>Shallow Concentrated Flow, Nearly Bare &amp; Untilled  Kv = 10.0 fps</td>
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<tr>
<td>8.2</td>
<td>683</td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
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Subcatchment 2S: PDA 2

Hydrograph

Type III 24-hr 10-Year Rainfall = 5.00"
Runoff Area = 732,129 sf
Runoff Volume = 211,276 cf
Runoff Depth > 3.46"
Flow Length = 683'
Slope = 0.0200 '/'
Tc = 8.2 min
CN = 86
Summary for Subcatchment 3S: PDA 3

Runoff = 62.96 cfs @ 12.12 hrs, Volume = 217,080 cf, Depth > 3.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall = 5.00"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>752,270</td>
<td>86</td>
<td>Newly graded area, HSG B</td>
</tr>
<tr>
<td>752,270</td>
<td>100</td>
<td>100.00% Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>25</td>
<td>0.0200</td>
<td>1.04</td>
<td></td>
<td>Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20&quot;</td>
</tr>
<tr>
<td>8.0</td>
<td>681</td>
<td>0.0200</td>
<td>1.41</td>
<td></td>
<td>Shallow Concentrated Flow, Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
</tr>
<tr>
<td>8.4</td>
<td>706</td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

Subcatchment 3S: PDA 3

Type III 24-hr 10-Year Rainfall = 5.00"
Runoff Area = 752,270 sf
Runoff Volume = 217,080 cf
Runoff Depth > 3.46"
Flow Length = 706'
Slope = 0.0200 '/'
Tc = 8.4 min
CN = 86
Summary for Pond 1P: SW Basin 1

Inflow Area = 685,844 sf, 2.02% Impervious, Inflow Depth > 3.46" for 10-Year event
Inflow = 44.25 cfs @ 12.25 hrs, Volume= 197,559 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 88.71' @ 24.00 hrs Surf.Area= 69,950 sf Storage= 197,493 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>84.00'</td>
<td>301,795 cf</td>
<td>Custom Stage Data (Irregular)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>84.00</td>
<td>21,060</td>
<td>797.0</td>
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<td>149,845</td>
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<td>735,829</td>
</tr>
</tbody>
</table>

Pond 1P: SW Basin 1

Hydrograph

Inflow Area=685,844 sf
Peak Elev=88.71'
Storage=197,493 cf
Summary for Pond 2P: SW Basin 2

Inflow Area = 732,129 sf, 0.00% Impervious, Inflow Depth > 3.46" for 10-Year event
Inflow = 61.70 cfs @ 12.12 hrs, Volume= 211,276 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Attenuation= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 87.88' @ 24.00 hrs Surf.Area= 85,801 sf Storage= 211,207 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>84.00'</td>
<td>432,262 cf</td>
<td><strong>Custom Stage Data (Irregular)</strong> Listed below (Recalc)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th></th>
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<td>38,751</td>
</tr>
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<td>3,638.0</td>
<td>115,185</td>
<td>432,262</td>
<td>897,609</td>
</tr>
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Pond 2P: SW Basin 2

Hydrograph

Inflow Area=732,129 sf
Peak Elev=87.88'
Storage=211,207 cf
Summary for Pond 3P: SW Basin 3

Inflow Area = 752,270 sf, 0.00% Impervious, Inflow Depth > 3.46" for 10-Year event
Inflow = 62.96 cfs @ 12.12 hrs, Volume= 217,080 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 87.57' @ 24.00 hrs Surf.Area= 88,402 sf Storage= 217,009 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume Invert Avail.Storage Storage Description
#1 84.00' 487,594 cf Custom Stage Data (Irregular) Listed below (Recalc)

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<thead>
<tr>
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<tbody>
<tr>
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<td>86.00</td>
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<td>98,536</td>
<td>98,536</td>
<td>259,842</td>
</tr>
<tr>
<td>88.00</td>
<td>96,056</td>
<td>3,015.0</td>
<td>157,825</td>
<td>256,361</td>
<td>566,317</td>
</tr>
<tr>
<td>90.00</td>
<td>136,350</td>
<td>3,726.0</td>
<td>231,233</td>
<td>487,594</td>
<td>947,780</td>
</tr>
</tbody>
</table>

Pond 3P: SW Basin 3

Hydrograph

Inflow Area=752,270 sf  
Peak Elev=87.57'
Storage=217,009 cf
Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA 1
- Runoff Area=685,844 sf 2.02% Impervious  Runoff Depth>4.11"
- Flow Length=1,151’  Tc=18.2 min  CN=86  Runoff=52.33 cfs 235,071 cf

Subcatchment 2S: PDA 2
- Runoff Area=732,129 sf 0.00% Impervious  Runoff Depth>4.12"
- Flow Length=683'  Slope=0.0200 '/'  Tc=8.2 min  CN=86  Runoff=72.93 cfs 251,380 cf

Subcatchment 3S: PDA 3
- Runoff Area=752,270 sf 0.00% Impervious  Runoff Depth>4.12"
- Flow Length=706’  Slope=0.0200 '/'  Tc=8.4 min  CN=86  Runoff=74.42 cfs 258,287 cf

Pond 1P: SW Basin 1
- Peak Elev=89.21’ Storage=235,000 cf  Inflow=52.33 cfs 235,071 cf
- Outflow=0.00 cfs 0 cf

Pond 2P: SW Basin 2
- Peak Elev=88.33’ Storage=251,306 cf  Inflow=72.93 cfs 251,380 cf
- Outflow=0.00 cfs 0 cf

Pond 3P: SW Basin 3
- Peak Elev=88.02’ Storage=258,214 cf  Inflow=74.42 cfs 258,287 cf
- Outflow=0.00 cfs 0 cf

Total Runoff Area = 2,170,243 sf  Runoff Volume = 744,738 cf  Average Runoff Depth = 4.12"
99.36% Pervious = 2,156,372 sf  0.64% Impervious = 13,871 sf
Summary for Subcatchment 1S: PDA 1

Runoff = 52.33 cfs @ 12.25 hrs, Volume= 235,071 cf, Depth> 4.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.70"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
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<tbody>
<tr>
<td>671,973</td>
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<td>Newly graded area, HSG B</td>
</tr>
<tr>
<td>13,871</td>
<td>98</td>
<td>Paved parking, HSG B</td>
</tr>
<tr>
<td>685,844</td>
<td>86</td>
<td>Weighted Average</td>
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<tr>
<td>671,973</td>
<td>97.98%</td>
<td>Pervious Area</td>
</tr>
<tr>
<td>13,871</td>
<td>2.02%</td>
<td>Impervious Area</td>
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<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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<tbody>
<tr>
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<td>25</td>
<td>0.0200</td>
<td>1.04</td>
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<td>Sheet Flow, Smooth surfaces n= 0.011 P^2= 3.20&quot;</td>
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<tr>
<td>8.7</td>
<td>740</td>
<td>0.0200</td>
<td>1.41</td>
<td></td>
<td>Shallow Concentrated Flow, Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
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<tr>
<td>9.1</td>
<td>386</td>
<td>0.0050</td>
<td>0.71</td>
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<td>Shallow Concentrated Flow, Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
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| Tc=18.2 min | Flow Length=1,151' |

Subcatchment 1S: PDA 1

Type III 24-hr 25-Year Rainfall=5.70"
Runoff Area=685,844 sf
Runoff Volume=235,071 cf
Runoff Depth>4.11"
Flow Length=1,151'
Tc=18.2 min
CN=86
Summary for Subcatchment 2S: PDA 2

Runoff = 72.93 cfs @ 12.11 hrs, Volume = 251,380 cf, Depth > 4.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 0.00-24.00 hrs, dt = 0.05 hrs
Type III 24-hr 25-Year Rainfall = 5.70"

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<td>100.00% Pervious Area</td>
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<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
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<td>1.04</td>
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<td>Sheet Flow, Smooth surfaces n = 0.011 P2 = 3.20&quot;</td>
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<tr>
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<td>Total</td>
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Subcatchment 2S: PDA 2

Type III 24-hr
25-Year Rainfall = 5.70"
Runoff Area = 732,129 sf
Runoff Volume = 251,380 cf
Runoff Depth > 4.12"
Flow Length = 683'
Slope = 0.0200 '/'
Tc = 8.2 min
CN = 86
Summary for Subcatchment 3S: PDA 3

Runoff = 74.42 cfs @ 12.12 hrs, Volume= 258,287 cf, Depth> 4.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr  25-Year Rainfall=5.70"

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<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
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<tr>
<td>0.4</td>
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<td>Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20&quot;</td>
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<td>8.4</td>
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<td>Total</td>
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Subcatchment 3S: PDA 3

Type III 24-hr
25-Year Rainfall=5.70"
Runoff Area=752,270 sf
Runoff Volume=258,287 cf
Runoff Depth>4.12"
Flow Length=706'
Slope=0.0200 '/'
Tc=8.4 min
CN=86
Summary for Pond 1P: SW Basin 1

Inflow Area = 685,844 sf, 2.02% Impervious, Inflow Depth > 4.11” for 25-Year event
Inflow = 52.33 cfs @ 12.25 hrs, Volume = 235,071 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume = 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 89.21' @ 24.00 hrs  Surf.Area= 78,093 sf  Storage= 235,000 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

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<td>#1</td>
<td>84.00'</td>
<td>301,795 cf</td>
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Inflow Area=685,844 sf
Peak Elev=89.21'
Storage=235,000 cf
Summary for Pond 2P: SW Basin 2

Inflow Area = 732,129 sf, 0.00% Impervious, Inflow Depth > 4.12" for 25-Year event
Inflow = 72.93 cfs @ 12.11 hrs, Volume= 251,380 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 88.33' @ 24.00 hrs Surf.Area= 93,131 sf Storage= 251,306 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
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<th>Avail.Storage</th>
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<tbody>
<tr>
<td>#1</td>
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<td>432,262 cf</td>
<td>Custom Stage Data (Irregular)</td>
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<td>432,262</td>
<td>897,609</td>
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Pond 2P: SW Basin 2

Hydrograph

Inflow Area=732,129 sf
Peak Elev=88.33'
Storage=251,306 cf
Summary for Pond 3P: SW Basin 3

Inflow Area = 752,270 sf, 0.00% Impervious, Inflow Depth > 4.12” for 25-Year event
Inflow = 74.42 cfs @ 12.12 hrs, Volume= 258,287 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 88.02' @ 24.00 hrs Surf.Area= 96,410 sf Storage= 258,214 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
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<tbody>
<tr>
<td>#1</td>
<td>84.00'</td>
<td>487,594 cf</td>
<td>Custom Stage Data (Irregular) Listed below (Recalc)</td>
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</table>

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>84.00</td>
<td>36,769</td>
<td>1,561.0</td>
<td>0</td>
<td>0</td>
<td>36,769</td>
</tr>
<tr>
<td>86.00</td>
<td>62,932</td>
<td>2,289.0</td>
<td>98,536</td>
<td>98,536</td>
<td>259,842</td>
</tr>
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<td>88.00</td>
<td>96,056</td>
<td>3,015.0</td>
<td>157,825</td>
<td>256,361</td>
<td>566,317</td>
</tr>
<tr>
<td>90.00</td>
<td>136,350</td>
<td>3,726.0</td>
<td>231,233</td>
<td>487,594</td>
<td>947,780</td>
</tr>
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</table>

Pond 3P: SW Basin 3

Hydrograph

Inflow Area=752,270 sf
Peak Elev=88.02'
Storage=258,214 cf
Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA 1
Runoff Area=685,844 sf  2.02% Impervious  Runoff Depth>4.97"
Flow Length=1,151'  Tc=18.2 min  CN=86  Runoff=62.72 cfs  283,928 cf

Subcatchment 2S: PDA 2
Runoff Area=732,129 sf  0.00% Impervious  Runoff Depth>4.98"
Flow Length=683'  Slope=0.0200 '/'  Tc=8.2 min  CN=86  Runoff=87.36 cfs  303,611 cf

Subcatchment 3S: PDA 3
Runoff Area=752,270 sf  0.00% Impervious  Runoff Depth>4.98"
Flow Length=706'  Slope=0.0200 '/'  Tc=8.4 min  CN=86  Runoff=89.14 cfs  311,953 cf

Pond 1P: SW Basin 1
Peak Elev=89.80'  Storage=283,842 cf  Inflow=62.72 cfs  283,928 cf  Outflow=0.00 cfs  0 cf

Pond 2P: SW Basin 2
Peak Elev=88.87'  Storage=303,525 cf  Inflow=87.36 cfs  303,611 cf  Outflow=0.00 cfs  0 cf

Pond 3P: SW Basin 3
Peak Elev=88.55'  Storage=311,862 cf  Inflow=89.14 cfs  311,953 cf  Outflow=0.00 cfs  0 cf

Total Runoff Area = 2,170,243 sf  Runoff Volume = 899,492 cf  Average Runoff Depth = 4.97"
99.36% Pervious = 2,156,372 sf  0.64% Impervious = 13,871 sf
Summary for Subcatchment 1S: PDA 1

Runoff = 62.72 cfs @ 12.24 hrs, Volume = 283,928 cf, Depth > 4.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 0.00-24.00 hrs, dt = 0.05 hrs
Type III 24-hr 100-Year Rainfall = 6.60"

<table>
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<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
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<tbody>
<tr>
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<tr>
<td>13,871</td>
<td>98</td>
<td>Paved parking, HSG B</td>
</tr>
<tr>
<td>685,844</td>
<td>86</td>
<td>Weighted Average</td>
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<td>97.98%</td>
<td>Pervious Area</td>
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<td>13,871</td>
<td>2.02%</td>
<td>Impervious Area</td>
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<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
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<td>1.04</td>
<td></td>
<td><strong>Sheet Flow</strong>, Smooth surfaces n = 0.011 P2 = 3.20&quot;</td>
</tr>
<tr>
<td>8.7</td>
<td>740</td>
<td>0.0200</td>
<td>1.41</td>
<td></td>
<td><strong>Shallow Concentrated Flow</strong>, Nearly Bare &amp; Untilled Kv = 10.0 fps</td>
</tr>
<tr>
<td>9.1</td>
<td>386</td>
<td>0.0050</td>
<td>0.71</td>
<td></td>
<td><strong>Shallow Concentrated Flow</strong>, Nearly Bare &amp; Untilled Kv = 10.0 fps</td>
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18.2 1,151 Total

Subcatchment 1S: PDA 1

Type III 24-hr 100-Year Rainfall = 6.60"
Runoff Area = 685,844 sf
Runoff Volume = 283,928 cf
Runoff Depth > 4.97"
Flow Length = 1,151'
Tc = 18.2 min
CN = 86
Summary for Subcatchment 2S: PDA 2

Runoff = 87.36 cfs @ 12.11 hrs, Volume= 303,611 cf, Depth> 4.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr  100-Year Rainfall=6.60"

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<th>CN</th>
<th>Description</th>
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<tr>
<td>732,129</td>
<td>100.00% Pervious Area</td>
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<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
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<tr>
<td>0.4</td>
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<td>0.0200</td>
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<td>Sheet Flow, Smooth surfaces  n= 0.011 P2= 3.20&quot;</td>
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<tr>
<td>7.8</td>
<td>658</td>
<td>0.0200</td>
<td>1.41</td>
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Subcatchment 2S: PDA 2

Type III 24-hr
100-Year Rainfall=6.60"
Runoff Area=732,129 sf
Runoff Volume=303,611 cf
Runoff Depth>4.98"
Flow Length=683'
Slope=0.0200 '/'
Tc=8.2 min
CN=86
Summary for Subcatchment 3S: PDA 3

Runoff = 89.14 cfs @ 12.12 hrs, Volume= 311,953 cf, Depth> 4.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.60"

### Area (sf) CN Description
752,270 86 Newly graded area, HSG B
752,270 100.00% Pervious Area

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>25</td>
<td>0.0200</td>
<td>1.04</td>
<td></td>
<td>Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20&quot;</td>
</tr>
<tr>
<td>8.0</td>
<td>681</td>
<td>0.0200</td>
<td>1.41</td>
<td></td>
<td>Shallow Concentrated Flow, Nearly Bare &amp; Untilled Kv= 10.0 fps</td>
</tr>
<tr>
<td>8.4</td>
<td>706</td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

Subcatchment 3S: PDA 3

Type III 24-hr
100-Year Rainfall=6.60"
Runoff Area=752,270 sf
Runoff Volume=311,953 cf
Runoff Depth>4.98"
Flow Length=706'
Slope=0.0200 '/'
Tc=8.4 min
CN=86
Summary for Pond 1P: SW Basin 1

Inflow Area = 685,844 sf, 2.02% Impervious, Inflow Depth > 4.97" for 100-Year event
Inflow = 62.72 cfs @ 12.24 hrs, Volume = 283,928 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume = 0 cf, Atten = 100%, Lag = 0.0 min

Routing by Stor-Ind method, Time Span = 0.00-24.00 hrs, dt = 0.05 hrs
Peak Elev = 89.80' @ 24.00 hrs Surf.Area = 88,102 sf Storage = 283,842 cf

Plug-Flow detention time = (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time = (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>84.00'</td>
<td>301,795 cf</td>
<td>Custom Stage Data (Irregular) Listed below (Recalc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>84.00</td>
<td>21,060</td>
<td>797.0</td>
<td>0</td>
<td>0</td>
<td>21,060</td>
</tr>
<tr>
<td>86.00</td>
<td>36,573</td>
<td>1,226.0</td>
<td>56,924</td>
<td>56,924</td>
<td>90,152</td>
</tr>
<tr>
<td>88.00</td>
<td>59,369</td>
<td>1,964.0</td>
<td>95,026</td>
<td>151,950</td>
<td>277,522</td>
</tr>
<tr>
<td>90.00</td>
<td>91,639</td>
<td>3,101.0</td>
<td>149,845</td>
<td>301,795</td>
<td>735,829</td>
</tr>
</tbody>
</table>

Pond 1P: SW Basin 1

Inflow Area = 685,844 sf
Peak Elev = 89.80'
Storage = 283,842 cf
Summary for Pond 2P: SW Basin 2

Inflow Area = 732,129 sf, 0.00% Impervious, Inflow Depth > 4.98” for 100-Year event
Inflow = 87.36 cfs @ 12.11 hrs, Volume= 303,611 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 88.87′ @ 24.00 hrs  Surf.Area= 101,123 sf  Storage= 303,525 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>84.00′</td>
<td>432,262 cf</td>
<td>Custom Stage Data (Irregular) Listed below (Recalc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>84.00</td>
<td>30,951</td>
<td>1,534.0</td>
<td>0</td>
<td>0</td>
<td>30,951</td>
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<tr>
<td>85.00</td>
<td>38,698</td>
<td>1,656.0</td>
<td>34,752</td>
<td>34,752</td>
<td>38,751</td>
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<tr>
<td>86.00</td>
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<td>2,234.0</td>
<td>47,188</td>
<td>81,941</td>
<td>241,009</td>
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<td>87.00</td>
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<td>61,762</td>
<td>143,702</td>
<td>252,333</td>
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<tr>
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<td>88,396</td>
<td>2,933.0</td>
<td>77,699</td>
<td>221,401</td>
<td>528,659</td>
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<tr>
<td>89.00</td>
<td>103,146</td>
<td>2,965.0</td>
<td>95,676</td>
<td>317,077</td>
<td>543,965</td>
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<tr>
<td>90.00</td>
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<td>897,609</td>
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</tbody>
</table>

Pond 2P: SW Basin 2

**Hydrograph**

Inflow Area=732,129 sf
Peak Elev=88.87′
Storage=303,525 cf
Summary for Pond 3P: SW Basin 3

Inflow Area = 752,270 sf, 0.00% Impervious, Inflow Depth > 4.98” for 100-Year event
Inflow = 89.14 cfs @ 12.12 hrs, Volume= 311,953 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 88.55’ @ 24.00 hrs  Surf.Area= 106,406 sf  Storage= 311,862 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>84.00’</td>
<td>487,594 cf</td>
<td>Custom Stage Data (Irregular) Listed below (Recalc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>84.00</td>
<td>36,769</td>
<td>1,561.0</td>
<td>0</td>
<td>0</td>
<td>36,769</td>
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<td>86.00</td>
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<td>2,289.0</td>
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<td>98,536</td>
<td>259,842</td>
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<td>88.00</td>
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<td>3,015.0</td>
<td>157,825</td>
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<tr>
<td>90.00</td>
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<td>3,726.0</td>
<td>231,233</td>
<td>487,594</td>
<td>947,780</td>
</tr>
</tbody>
</table>

Pond 3P: SW Basin 3

Hydrograph

Inflow Area=752,270 sf
Peak Elev=88.55'
Storage=311,862 cf