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November 29, 2006

DOCKET
06-AFC-3
DATE NOV 29 2006
RECD. NOV 29 2006

Mr. Bill Pfanner
Project Manager
Systems Assessment and Facility Siting Division
California Energy Commission
1516 Ninth Street, MS-15
Sacramento, CA 95814-5512

Subject: LSP South Bay, LLC - South Bay Replacement Project AFC (06-AFC-3): Data Response, Set 1A

Dear Mr. Pfanner:

On behalf of LSP South Bay, LLC, please find attached 12 copies and one original of the Data Responses, Set 1A, in response to Staff's Data Requests dated October 31, 2006. For docketing purpose, also find attached the Proof of Service declaration. We have also file copies of this Data Response electronically.

We will coordinate this submittal with the Commission's Docket Unit.

LSP South Bay, LLC appreciates the continued opportunity to work with CEC staff on this important project. Please call me if you have any questions.

Sincerely,

CH2M HILL

Robert C. Mason
Senior Project Director

c: Docket Unit - California Energy Commission
Kevin Johnson, LSP South Bay, LLC
Proof of Service List

EY062006001SAC/334533/063330001 (CVR LTR.DOC)

Oversize Document(s)

1. MAP(S) #_____

Too Large to Scan

"Data Response

2. PICTURE(S) #_____

For more information contact:

California Energy Commission
Docket Unit
1516 9th Street, MS-4
Sacramento, CA 965814-5512

Telephone (916) 654-5076
docket@energy.state.ca.us

LS Power

South Bay Energy Facility

Drainage Erosion and Sediment Control Plan

DRAFT

B&V Project No. 136469

November 2006

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ENERGY WATER INFORMATION GOVERNMENT

1.0 Introduction

This plan consists of the following sections and attachments:

- Section 1.0--Introduction.
- Section 2.0--Vicinity Map.
- Section 3.0--Site Delineation.
- Section 4.0--Watercourses and Critical Areas.
- Section 5.0--Drainage Map.
- Section 6.0--Drainage of Project Site Narrative.
- Section 7.0--Clearing and Grading Plans.
- Section 8.0--Clearing and Grading Narrative.
- Section 9.0--Best Management Practices Plan.
- Section 10.0--Best Management Practices Narrative.
- Attachment A--Project Drawings.
- Attachment B--BMP Data Sheets
- Attachment C--Hydraulic Analysis

1.1 San Diego RWQCB Order No. 2001-01

Pursuant to the Clean Water Act, a Municipal Stormwater NPDES Permit (Order No. 2001-01, NPDES No. CAS0108758) was issued to San Diego County, the Port, and 18 cities (including Chula Vista) by the San Diego Regional Water Quality Control Board (RWQCB) on February 21, 2001. This Municipal Permit was issued pursuant to the US Environmental Protection Agency's Phase I Municipal Program and requires the development and implementation of a program addressing stormwater runoff pollution issues in development planning for public and private projects. The South Bay Replacement Project (SBRP) will implement BMPs to reduce pollutants to the maximum extent practicable during construction (including demolition) and operations, as described in this DESCP.

1.2 San Diego Unified Port District

Article 10 of the San Diego Unified Port District Code (Ordinance 2105, Stormwater Management and Discharge Control) sets forth uniform requirements and prohibitions for stormwater discharges. This ordinance addresses stormwater pollution prevention, pollutant source controls and treatment controls, runoff diversion, and the regulation of discharges to the Port-controlled storm drain system and/or the Bay. It was developed to reduce pollution from stormwater discharges and to protect public health, natural resources, and the environment. This applies to all dischargers and places located on tidelands within the Port's jurisdiction that discharge stormwater or non-stormwater into any stormwater system or receiving waters.

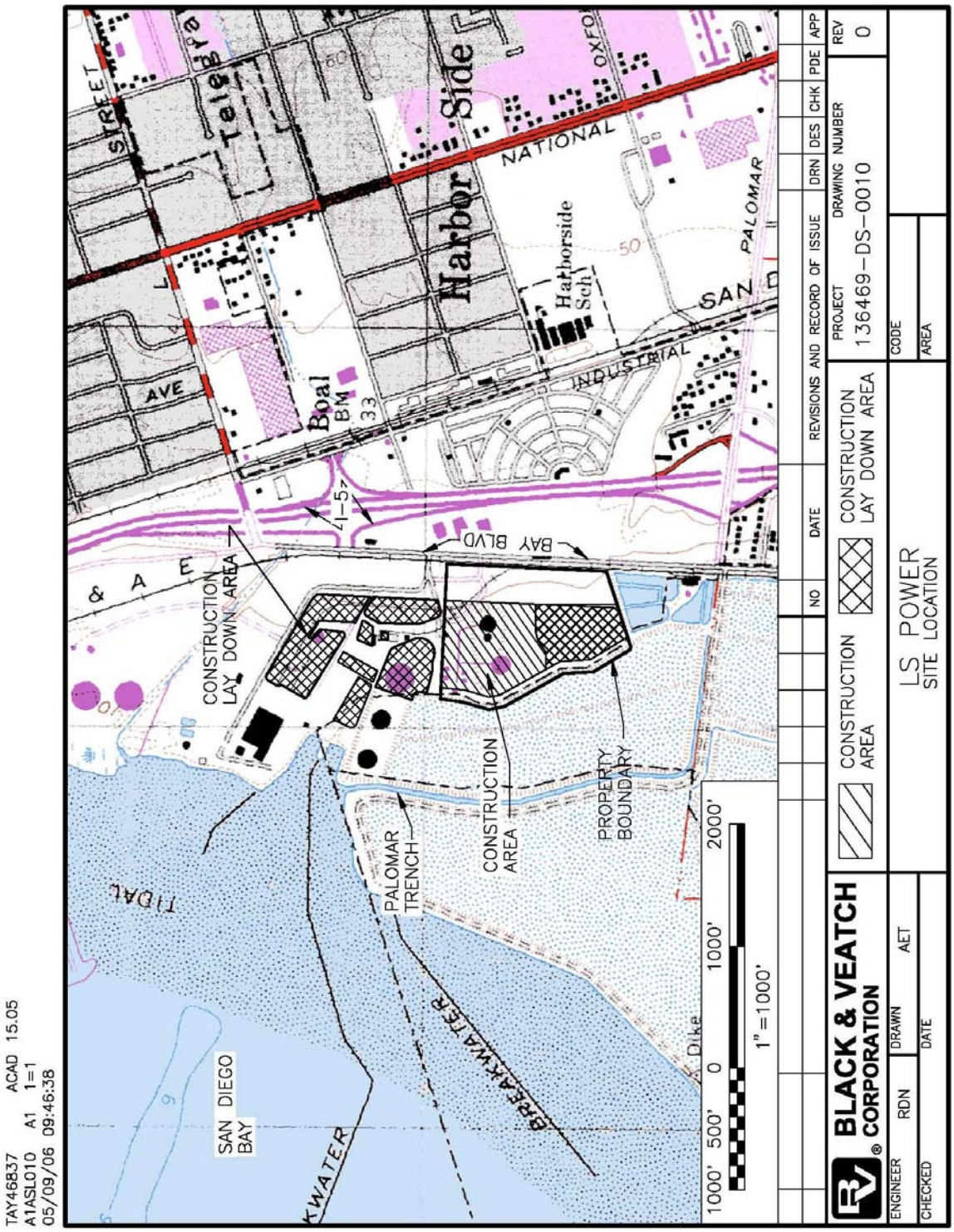
The Port has developed a model Standard Urban Storm Water Mitigation Plan (SUSMP) to reduce pollutants and runoff flows from all new development and significant redevelopment projects falling under the priority project categories. The SBRP and

demolition of the existing SBPP fall into the category of “redevelopment” and will follow the guidelines outlined in the SUSMP. Guidelines of the SUSMP include steps to identify and mitigate pollutants and conditions of concern. Compliance with the SUSMP will compliment the requirement to prepare and implement a SWPPP for industrial activities.

Ordinance 2105 also requires any person performing construction work on district tidelands to, the maximum extent practicable, prevent pollutants from entering the stormwater system. In accordance with Ordinance 2105, the Applicant will include stormwater best management practices during project construction, demolition, and in the design of the SBRP, as described in this DESCP.

2.0 Vicinity Map

The construction project vicinity map showing the project location is shown on the following page.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SAN DIEGO BAY
TIDAL
BREAKWATER
PALOMAR TRENCH
CONSTRUCTION AREA
PROPERTY BOUNDARY
CONSTRUCTION LAY DOWN AREA
BAY BLVD
I-5
Boal BM 33
Harbor Side
Harborside Sch
NATIONAL
INDUSTRIAL
PALOMAR
AVE
STREET
1000' 500' 0 1000' 2000'
1"=1000'
NO DATE REVISIONS AND RECORD OF ISSUE DRN DES CHK PDE APP
CONSTRUCTION AREA
CONSTRUCTION LAY DOWN AREA
LS POWER
SITE LOCATION
PROJECT 136469-DS-0010
DRAWING NUMBER
REV 0
CODE
AREA
BLACK & VEATCH CORPORATION
ENGINEER RDN
DRAWN AET
CHECKED
DATE

3.0 Site Delineation

See Attachment A for drawing 136469-DS-3801 for the Site Construction Facilities Plan.

4.0 Watercourses and Critical Areas

See Attachment A for Figures 8.14.1 for a depiction of regional surface waters near the site. See drawings listed in Sections 5.0 and 7.0 below for site specific existing and proposed drainage schemes.

5.0 Drainage Map

See Attachment A for drawing 136469-SS-0001 for the Preconstruction Runoff and Drainage Plan which shows the existing contours and drainage area boundaries. The proposed grading plan is shown in drawings listed in Section 7.0 below.

6.0 Drainage of Project Site Narrative

The completed power block complex will be fully developed with either asphalt paving or aggregate surfacing. Currently, the area is partially developed and covered with grass and incidental, small vegetation, except where roadway surfaces and the remnants of abandoned foundations remain. Storm water runoff generally flows to the northwest, directed by swales and a concrete line ditch to the Palomar Trench, which discharges into San Diego Bay. Existing onsite berms contain much of the storm water runoff, which ponds within the bermed area and eventually leaves the site through evapotranspiration. Low points in the southwest and southeast corners of the site collect the remaining runoff for the south half of the site.

Site drainage within the new power block complex will be based on a system of swales, trenches, and culverts leading to a storm water detention basin that is south of the power block complex. Storm water collected in the detention basin will be discharged through a regulating structure that will limit peak discharge rates to flows no greater than the corresponding values for the present site. From the detention basin, the storm water will be routed through a 15 inch corrugated metal pipe and discharge at the existing concrete-lined ditch. Site Grading and Drainage Plans (listed in Section 7.0) show the proposed general drainage scheme and a conceptual site grading plan.

5.81 acres contribute to pre-development flow to the existing concrete ditch, resulting in a peak discharge of 11 cfs (cubic feet per second). Post-development will direct 20.28 acres through a detention basin and into the concrete ditch. The detention basin has been designed to limit peak post-development discharge to 9 cfs. See Attachment C for the summary pages from the hydraulic analysis (computer modeling output not included).

7.0 Clearing and Grading Plans

The grading plan drawings are listed below and can be found in Attachment A.

Grading and Drainage – Site Key Plan	136469-CSTF-S3000
Grading and Drainage Plan Sheets	136469-CSTF-S3001 through S3005
Site Grading and Drainage Typical Details	136469-CSTF-S3900

8.0 Clearing and Grading Narrative

The table below quantifies the total soil volumes removed for demolition. In most cases, the soil will be returned to its original location.

Table 7-1
Demolition Soil Volumes

Description	Qty	Units	End Use
Phase I Demolition			
LNG Foundations	500	CY	Replaced where removed (see note 1)
South Tank Farm and Eastern Berm Area	4200	CY	Moved to North Tank Farm
TOTAL PHASE I SOIL VOLUMES	4700	CY	
Phase II Demolition			
Power Plant Structures	10,000	CY	Replaced where removed (see note 1)
Support Structures	1,000	CY	Replaced where removed (see note 1)
Support Tanks and Equipment	0	CY	
Support Tanks and Equipment Cont	0	CY	
South Tank Farm Tanks & Berms	8,000	CY	Replaced where removed (see note 1)
CW Intake / Discharge Structure	1,800	CY	Replaced where removed (see note 1)
East/West Utility Loop	1,500	CY	Replaced where removed (see note 1)
Combustion Turbine Fuel Site	500	CY	Replaced where removed (see note 1)
North Tank Farm Support Structures	1,000	CY	Replaced where removed (see note 1)
Former Wastewater Pond Area	2,000	CY	Replaced where removed (see note 1)
TOTAL PHASE II SOIL VOLUMES	25,800	CY	
Phase III Demolition			
Existing Waste Water Treatment Plant	2,000	CY	Replaced where removed (see note 1)
North Tank Farm Berms	40,000	CY	Replaced where removed (see note 1)
Construction/Demo Support Structures	500	CY	Replaced where removed (see note 1)
Misc. Materials	1,000	CY	Replaced where removed (see note 1)
TOTAL PHASE III SOIL VOLUMES	43,500	CY	
TOTAL SOIL VOLUMES ALL PHASES	**74,000**	**CY**	

Note 1: Soil will be removed to provide access during demolition and will be placed back in the original location once demo activities are completed. This will require double handling of material.

Implementation of the detention basins and ditches will require imported fill to maintain gravity drainage into the existing concrete ditch in the northwest area of the site. Total permanent imported fill material is approximately 166,000 cubic yards.

9.0 Best Management Practices Plan

Best Management Practices (BMPs) control locations and details are shown in following drawings. See Attachment A for drawings.

Erosion and Sediment Control Key Plan	136469-CSTF-S3100
Erosion and Sediment Control Plan Sheets	136469-CSTF-S3101 through S3102
Erosion and Sediment Control Site Details and Sections	136469-SS-3920

10.0 Best Management Practices Narrative

The best management practices used are listed below in the following categories: Erosion Control, Sediment Control, Tracking Control, Wind Erosion Control, Non-storm water control, and Waste Management and Material Pollution Control. See Attachment B for data sheets from the California Stormwater BMP handbook for individual descriptions of each BMP regarding implementation, design, inspection and maintenance.

10.1 Erosion Control

Erosion control, also referred to as soil stabilization, consists of source control measures that are designed to prevent soil particles from detaching and becoming transported in storm water runoff. Erosion control BMPs protect the soil surface by covering or binding soil particles. This project will incorporate erosion control measures required by the contract documents, and other measures selected by the Contractor, Storm Water Pollution Prevention Manager (SWPPM), or Owner. This project will implement the following practices for effective temporary and final erosion control during construction:

(1) Preservation of existing vegetation where required and when feasible.
(2) Application of temporary erosion control to remaining active and nonactive areas as required by the *California Stormwater BMPs Handbook – Construction*, and the contract documents. Reapplication as necessary to maintain effectiveness.
(3) Implementation of temporary erosion control measures at regular intervals throughout the defined rainy season to achieve and maintain the contract's

disturbed soil area requirements. Implementation of erosion control prior to the defined rainy season.

(4) Stabilization of nonactive areas as soon as feasible after the cessation of construction activities.

(5) Erosion control in concentrated flow paths by applying erosion control blankets, seeding, and lining swales as required in the contract documents.

(6) Application of seed to areas deemed substantially complete by the Owner during the defined rainy season.

(7) Application of permanent erosion control to all remaining disturbed soils upon the completion of construction.

Sufficient erosion control materials will be maintained onsite to allow implementation in conformance with Permit requirements and as described in this SWPPP. This includes implementation requirements for active areas and nonactive areas that require deployment before the onset of rain.

Implementation and location of temporary erosion control BMPs are shown on the drawings listed in Section 9.0 and described in this section. The BMPs that will be implemented to control erosion on the construction site include the following:

- EC-1, Scheduling.
- EC-2, Preservation of Existing Vegetation.
- EC-9, Earth Dikes and Drainage Swales.
- EC-10, Velocity Dissipation Devices.

Refer to Attachment B for BMP individual fact sheets.

10.2 Sediment Control

Sediment controls are structural measures that are intended to complement and enhance the selected erosion control measures and to reduce sediment discharges from active construction areas. Sediment controls are designed to intercept and settle out soil particles that have been detached and transported by the force of water. This project will incorporate sediment control measures required by the contract documents and other measures selected by the Contractor, SWPPM, or Owner.

Sufficient quantities of temporary sediment control materials will be maintained onsite throughout the duration of the project to allow implementation of temporary sediment controls in the event of predicted rain and for rapid response to failures or emergencies (in conformance with other Permit requirements and as described in the SWPPP). This includes implementation requirements for active areas and nonactive areas before the onset of rain.

Implementation and location of temporary sediment control BMPs are shown on the drawings listed in Section 9.0. The BMPs that will be implemented to control sediment on the construction site include the following:

- SC-1, Silt Fence.

- SC-4, Check Dam.
- SC-9, Straw Bale Barrier.

Refer to Attachment B for BMP individual fact sheets.

10.3 Tracking Control

The following BMPs have been selected to reduce sediment tracking from the construction site onto private or public roads:

- TC-1, Stabilized Construction Entrance/Exit.
- TC-3, Entrance/Outlet Tire Wash.
- SE-7, Street Sweeping and Vacuuming.

Refer to Attachment B for BMP individual fact sheets.

10.4 Wind Erosion Control

The following BMP has been selected to control dust from the construction site:

- WE-1, Wind Erosion Control.

10.5 Nonstorm Water Control

The following is a list of construction materials that will be used and that will have the potential to contribute pollutants (other than sediment) to storm water runoff.

- Vehicle fluids, including oil, grease, petroleum, and coolants.
- Asphaltic emulsions associated with asphalt-concrete paving operations.
- Cement materials associated with portland cement concrete (PCC) paving operations, drainage structures, median barriers, and bridge construction.
- Base and subbase material.
- Joint and curing compounds.
- Concrete curing compounds.
- Paints.
- Solvents, thinners, acids.
- Sandblasting materials.
- Mortar mix.
- Raw landscaping materials and wastes (topsoil, plant materials, herbicides, fertilizers, mulch, pesticides).
- BMP materials (sandbags, liquid copolymer).
- Treated lumber (materials and waste).
- PCC rubble.
- Masonry block rubble.
- General litter.

Construction activities that have the potential to contribute sediment to storm water discharges include the following:

- Clearing and grubbing operations.
- Grading operations.
- Soil import operations.
- Utility excavation operations.
- Sandblasting operations.
- Landscaping operations.

The following list indicates the BMPs that have been selected to control nonstorm water pollution on the construction site:

- NS-6, Illicit Connection/Illegal Discharge Detection and Reporting.
- NS-8, Vehicle and Equipment Cleaning.
- NS-9, Vehicle and Equipment Fueling.
- NS-10, Vehicle and Equipment Maintenance.
- NS-12, Concrete Curing.
- NS-13, Concrete Finishing.

Implementation and location of some nonstorm water control BMPs are shown on the drawings listed in Section 9.0.

Refer to Attachment B for BMP individual fact sheets.

10.6 Waste Management and Materials Pollution Control

The following list indicates the BMPs that have been selected to handle materials and control construction site wastes:

- WM-1, Material Delivery and Storage.
- WM-2, Material Use.
- WM-3, Stockpile Management.
- WM-4, Spill Prevention and Control.
- WM-5, Solid Waste Management.
- WM-9, Sanitary/Septic Waste Management.

Refer to Attachment B for BMP individual fact sheets.

10.7 Implementation Schedule

In general, the plant will be constructed following the sequence indicated below:

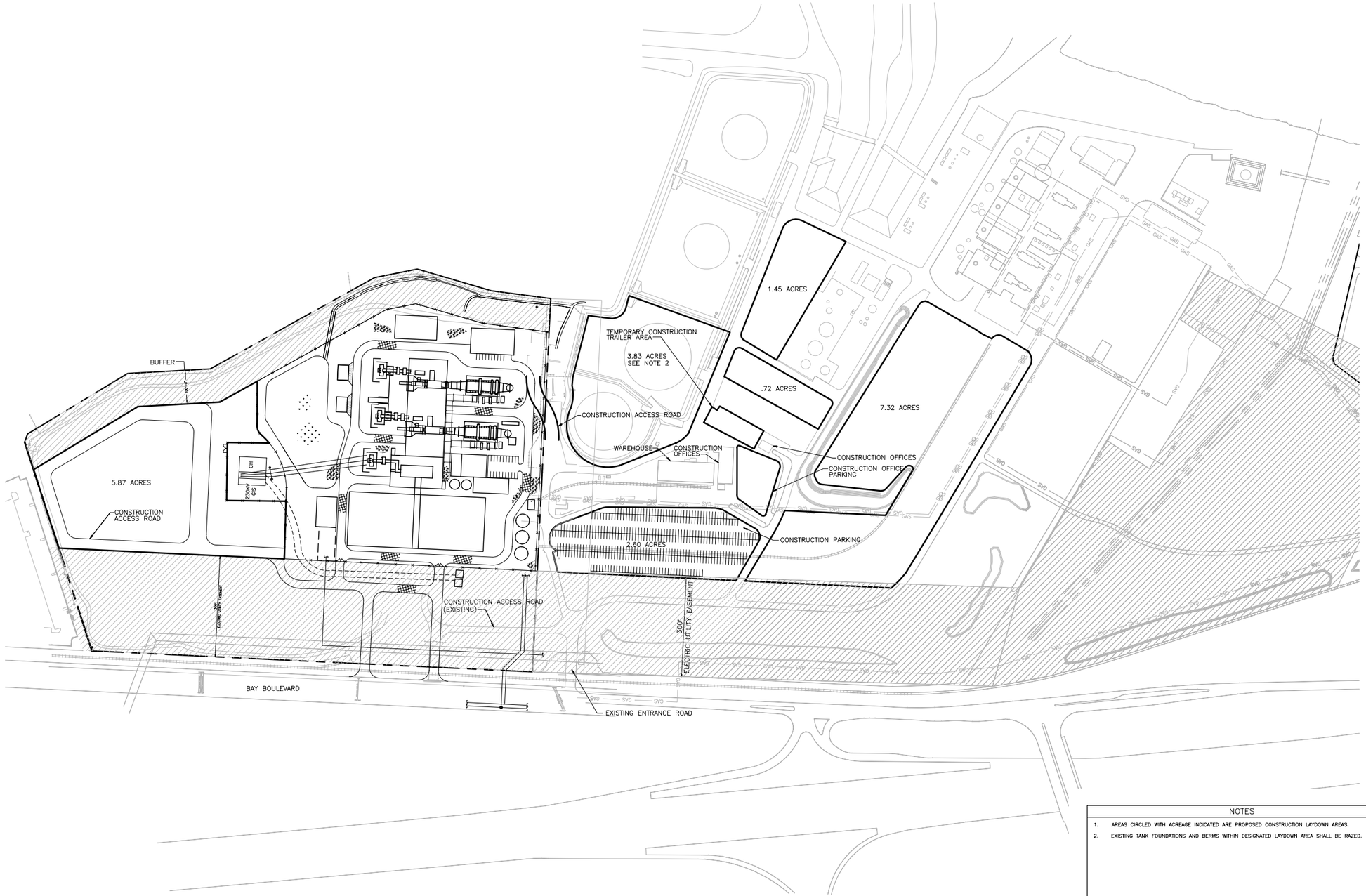
Phase 1:

- Install sediment control BMPs on the perimeter of the construction area(s), where necessary.
- Demolish all former building and equipment foundations.
- Strip ground surface in preparation for site fill material.
- Treat or dispose of contaminated materials according to applicable regulations.
- Haul earthen fill material to site and place and compact the fill material according to required levels.
- Provide temporary stabilization of site area.
- Construct storm water collection system.
- Install internal sediment control BMPs, and connect storm water drains to the existing outfall structures.
- Install underground utilities.
- Construct major foundations.

Phase 2:

- Erect major equipment and buildings.
- Finish road surfaces.
- Perform final site grading.
- Complete stabilization (paving) of site.
- Submit Notice of Termination.
- Remove temporary BMPs.

Attachment A



NOTES

1. AREAS CIRCLED WITH ACREAGE INDICATED ARE PROPOSED CONSTRUCTION LAYDOWN AREAS.
2. EXISTING TANK FOUNDATIONS AND BERMS WITHIN DESIGNATED LAYDOWN AREA SHALL BE RAZED.

NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
C	05/08/06	CLIENT REVIEW	AET	RDN			CJS
B	04/04/06	CLIENT REVIEW	AET	RDN			CJS
A	03/29/06	CLIENT REVIEW	AET	RDN			CJS

SCALE: 1" = 100'

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ENGINEER RDN DRAWN AET
CHECKED DATE

DUKE ENERGY
SOUTH BAY REPLACEMENT GENERATION FACILITY

SITE CONSTRUCTION FACILITIES PLAN

PROJECT DRAWING NUMBER: 136469–DS–3801
REV: C
CODE
AREA

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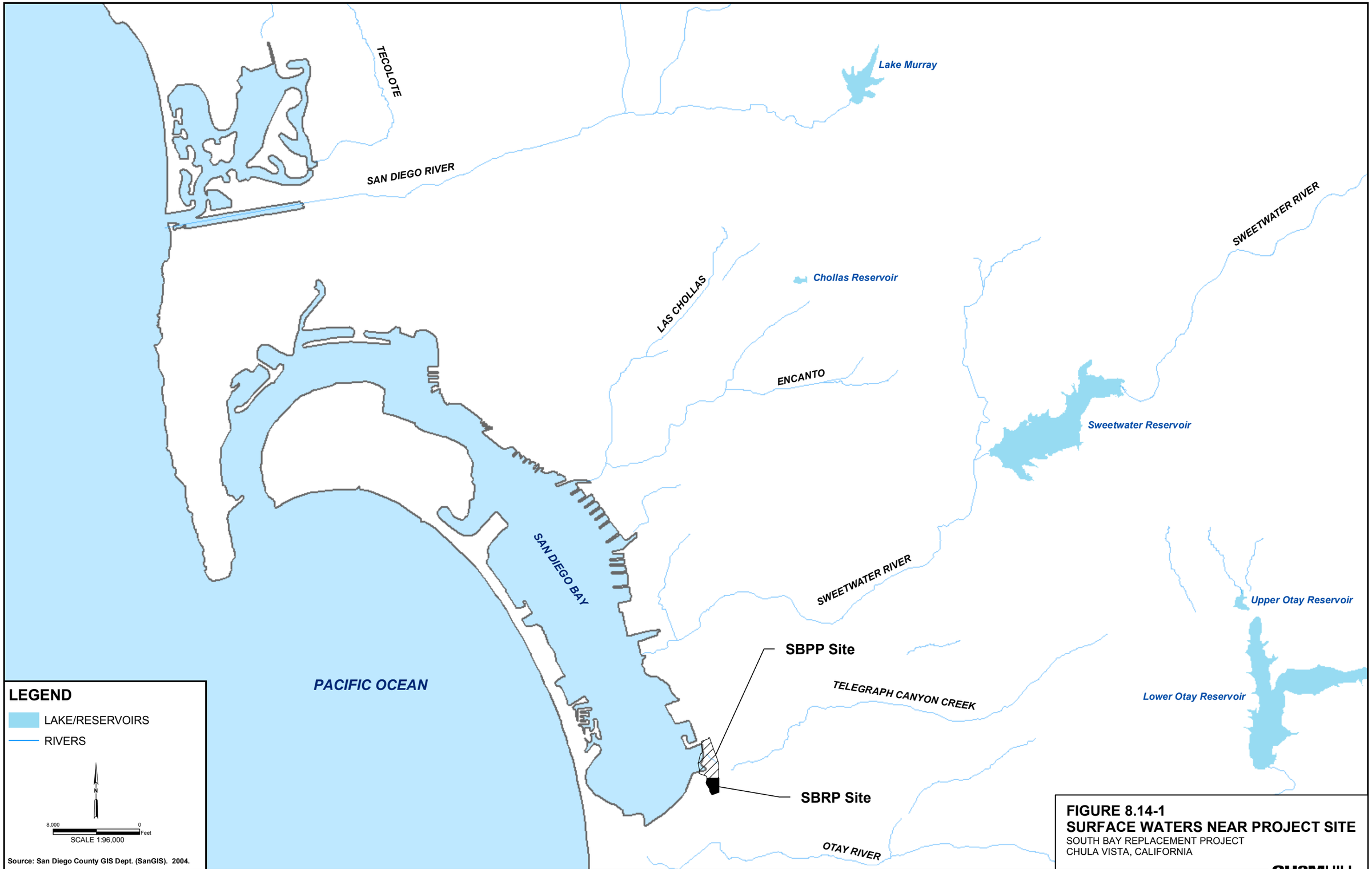

FIGURE 8.14-1
SURFACE WATERS NEAR PROJECT SITE
SOUTH BAY REPLACEMENT PROJECT
CHULA VISTA, CALIFORNIA

CH2MHILL

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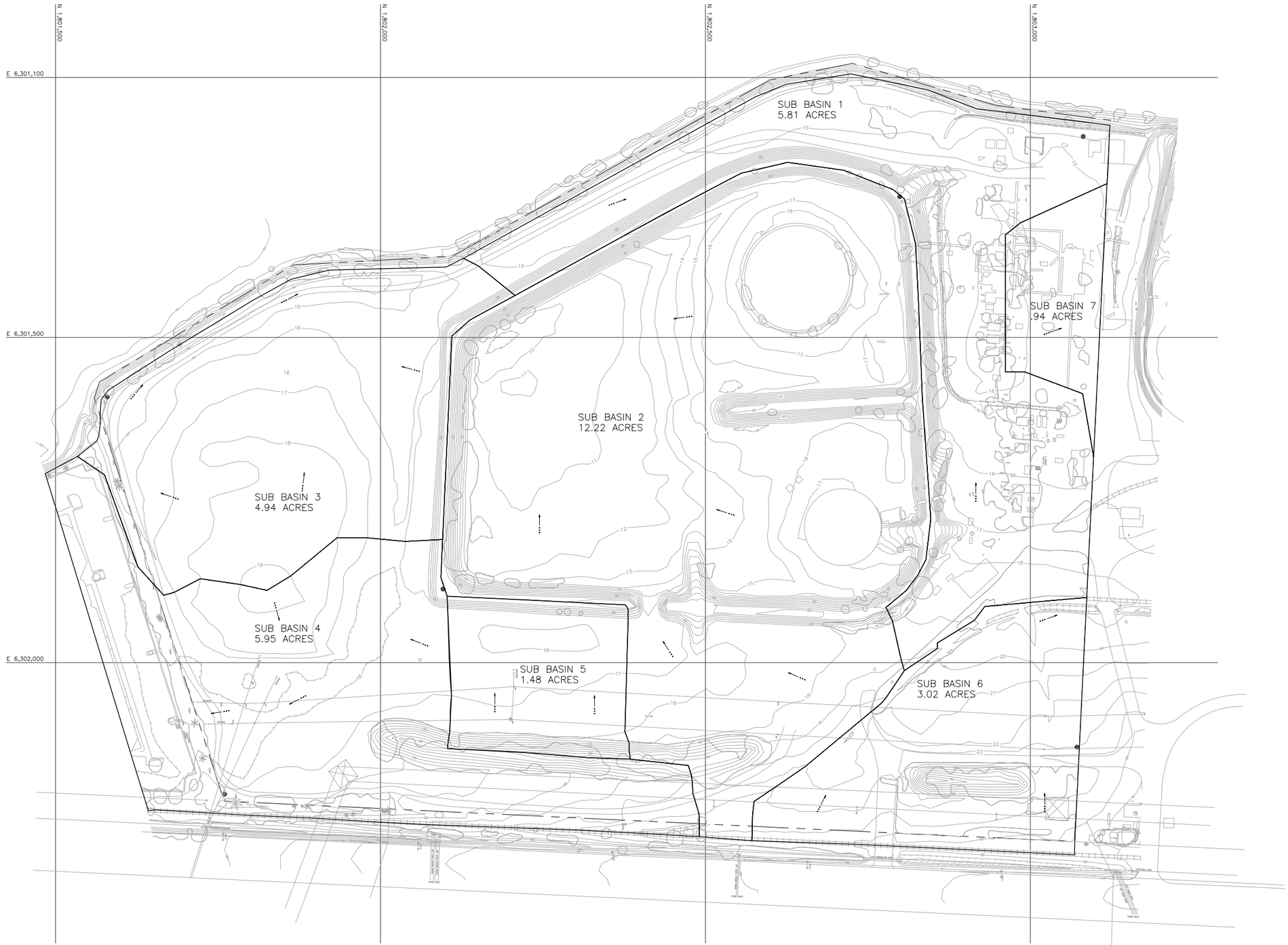

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SCALE: 1"=50'

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ENGINEER DRAWN
CHECKED DATE

DUKE ENERGY
SOUTH BAY REPLACEMENT GENERATION FACILITY

PRE-CONSTRUCTION
RUN-OFF AND DRAINAGE PLAN

PROJECT DRAWING NUMBER 136469-SS-0001
REV A
CODE
AREA

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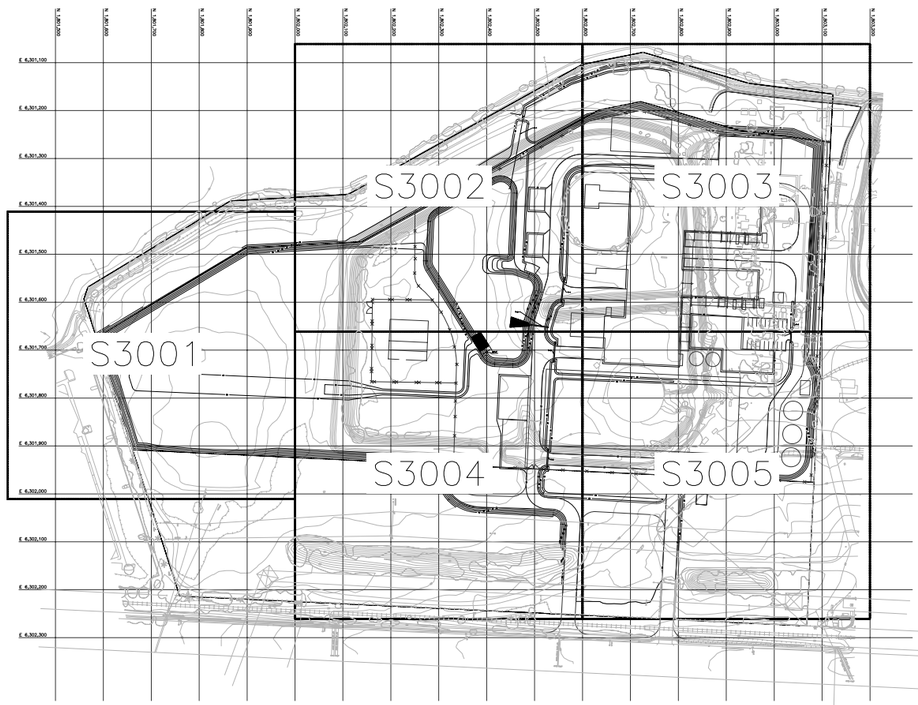

LEGEND APPLICABLE TO ALL S3000 DRAWINGS

- PROPERTY LINE
- R/W — LIMIT OF RIGHT-OF-WAY
- NEW SECURITY FENCE
- SWITCHYARD FENCE
- 99 — NEW CONTOUR
- AREA INLET
- NEW STORM WATER SYSTEM
- C-1 — NEW CULVERT
- DITCH/SWALE FLOW INDICATOR
- GRADE SURFACE FLOW INDICATOR
- 123.45 + — NEW SPOT ELEVATION
- SURVEY CONTROL MONUMENT
- EXISTING FENCE
- 99 — EXISTING CONTOUR
- NEW TRENCH DRAIN SEE NOTE 6
- ASPHALT SURFACING
- AGGREGATE SURFACING
- CONCRETE
- EARTH
- RIPRAP
- SAND/BEDDING MAT'L
- GRASS
- WETLANDS
- 1 / S3000 — SECTION OR DETAIL NUMBER / DRAWING DESIGNATION NUMBER

ABBREVIATIONS APPLICABLE TO ALL S3000 DRAWINGS

A	ARC LENGTH	LS	LIFT STATION
AGG	AGGREGATE	LTR	LATER
APPROX	APPROXIMATE	MATL	MATERIAL
ASPH	ASPHALT	MH	MANHOLE
AVG	AVERAGE	MSL	MEAN SEA LEVEL
BLDG	BUILDING	MW	MONITORING WELL
B/MH	BOTTOM OF MANHOLE ELEVATION	N	NORTH
BOD	BOTTOM OF ELECTRICAL DUCT BANK	NO.	NUMBER
BOP	BOTTOM OF PIPE	NTS	NOT TO SCALE
BU	BELL UP	OD	OUTSIDE DIAMETER
CHDPE	CORRUGATED HIGH DENSITY POLYETHYLENE PIPE	OWS	OIL/WATER SEPARATOR
CJ	CONTRACTION JOINT	PC	POINT OF CURVATURE
CL	CENTERLINE	PE	PLAIN END
CMP	CORRUGATED METAL PIPE	PI	POINT OF INTERSECTION
CO	CLEAN OUT	PL	PROPERTY LINE
D	DEGREE OF CURVE	PLCS	PLACES
Δ	DELTA ANGLE OF HORIZONTAL CURVE	PRC	POINT OF REVERSE CURVE
DI	DUCTILE IRON	PT	POINT OF TANGENT
DIA	DIAMETER	PVC	POINT OF VERTICAL CURVE
DIM	DIMENSION	PVI	POINT OF VERTICAL INTERSECTION
DWG	DRAWING	PVT	POINT OF VERTICAL TANGENT
E	EAST	R	RADIUS
EA	EACH	RCP	REINFORCED CONCRETE PIPE
EF	EACH FACE	RD	ROOF DRAIN
EGP	EDGE OF PAVEMENT	RED	REDUCER
EGS	EDGE OF SHOULDER	REQ'D	REQUIRED
EHH	ELECTRICAL HANDHOLE	REV	REVISION
EL	ELEVATION	R/W	RIGHT-OF-WAY
EJ	EXPANSION JOINT	S	SOUTH
EW	EACH WAY	SE	SUPERELEVATION
EXP	EXPANSION	SIM	SIMILAR
FD	FLOOR DRAIN	STA	STATION
FDN	FOUNDATION	T	TANGENT LENGTH
FF	FINISHED FLOOR	TMH	TOP OF MANHOLE
FG	FINISHED GRADE	TOC	TOP OF CONCRETE
FRP	FIBER REINFORCED PIPE	TOG	TOP OF GRATING
FT	FOOT	TOP	TOP OF PAVEMENT
HC	HANDICAPPED	TYP	TYPICAL
HDPE	HIGH DENSITY POLYETHYLENE	UNO	UNLESS NOTED OTHERWISE
HVCM	HORIZ & VERT CONTROL MONUMENT	V	DESIGN SPEED
HP	HIGH POINT	VERT	VERTICAL
ID	INSIDE DIAMETER	W	WEST
IN	INCH	W/	WITH
INV	INVERT	W/O	WITHOUT
L	LENGTH	WP	WORK POINT
LC	LENGTH OF VERTICAL CURVE		

GENERAL NOTES

1. GENERAL NOTES APPLICABLE TO ALL S3000 SERIES DRAWINGS.
2. GRADE BETWEEN NEW CONTOURS SHALL SLOPE UNIFORMLY UNLESS NOTED OTHERWISE.
3. ELEVATION SHOWN ARE TOP OF SURFACING.
4. SEE DRAWING S3900 FOR GRADING AND DRAINAGE DETAILS.
5. PIPE BEDDING SHALL BE CLASS B FOR ALL CULVERTS.
6. SEE DRAWINGS S3900 FOR TYPICAL TRENCH SECTION.

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FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
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B	05/12/06	ISSUED FOR OWNER REVIEW	AET	RDN		CJS	
A	12/16/05	ISSUED FOR IN-HOUSE REVIEW	SLS	RDN		CJS	

SCALE: 1" = 100' (100' 50' 0 100' 200')

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DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER RDN DRAWN SLS
CHECKED DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

GRADING AND DRAINAGE – SITE
KEY PLAN, GENERAL NOTES AND LEGEND

PROJECT DRAWING NUMBER: 136469–CSTF–S3000
REV: C
CODE
AREA

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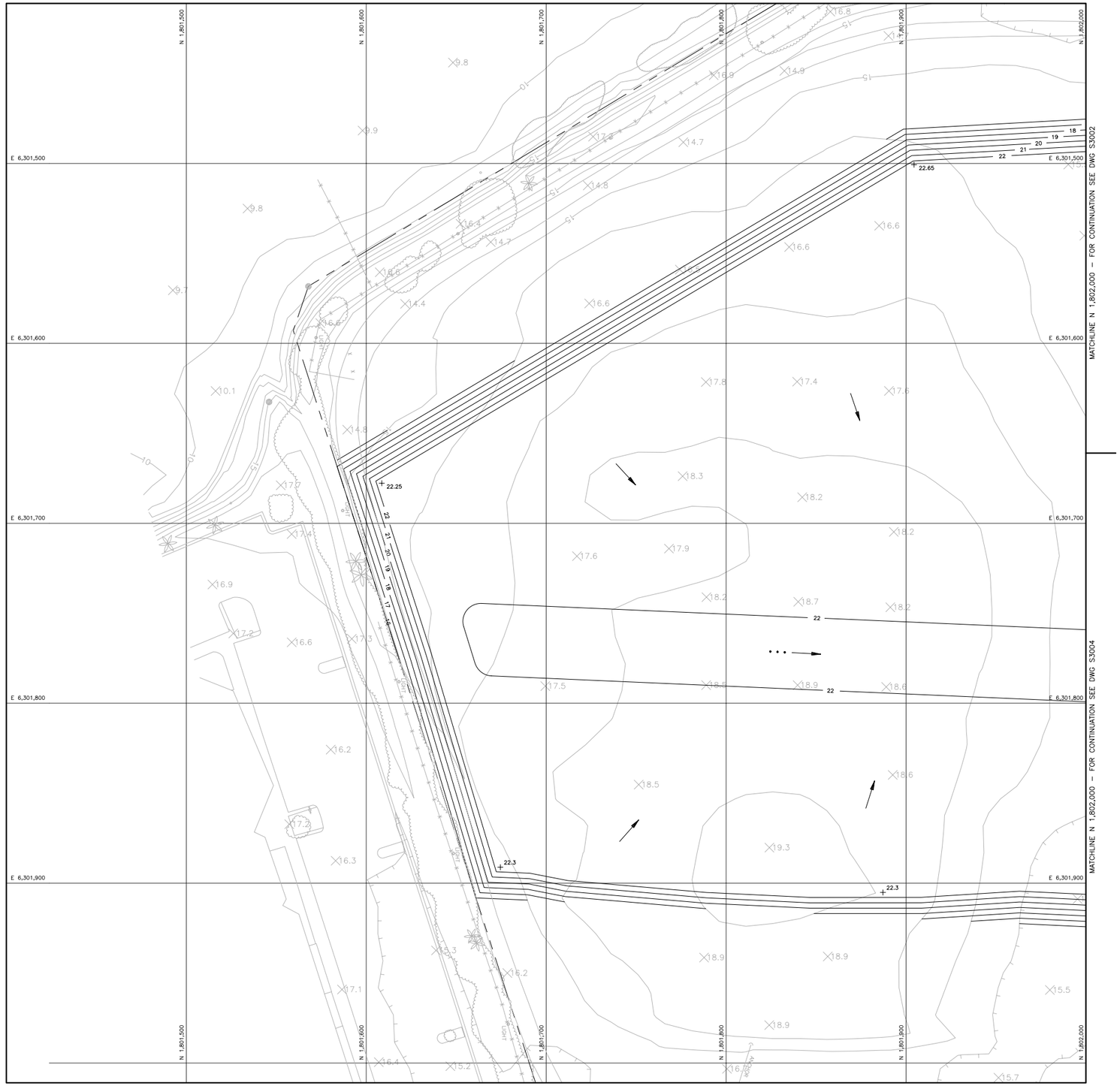
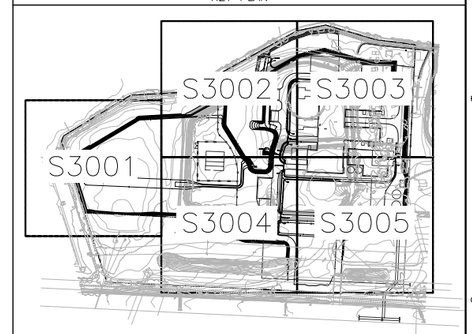


NOTES

1. SEE DRAWING S3000 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.

KEY PLAN



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SCALE: 1"=20'

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DATE _____ REG NO. _____

BLACK & VEATCH CORPORATION

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CHECKED | DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

GRADING AND DRAINAGE – SITE PLAN – AREA 1

PROJECT | DRAWING NUMBER: 136469–CSTF–S3001 | REV: B

CODE

AREA

TAY46837 ACAD 15.05
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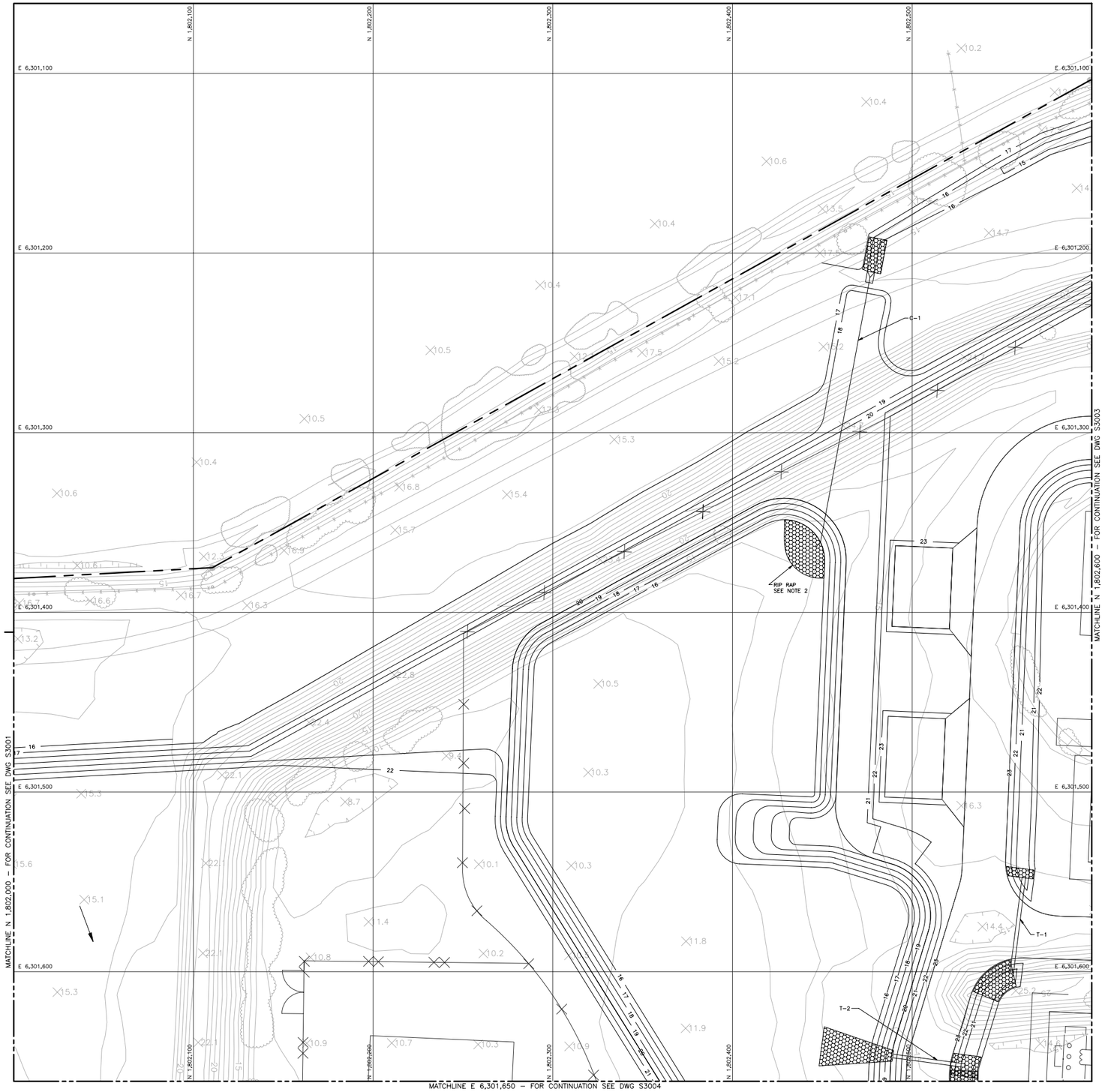
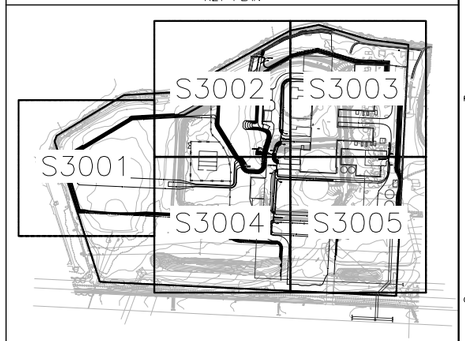


NOTES

1. SEE DRAWING S3000 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.
2. RIP RAP SHALL BE D50 OF 6" AND 9" MINIMUM THICKNESS.

KEY PLAN



NOT TO BE USED
FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
B	05/12/06	ISSUED FOR OWNER REVIEW	AET	RDN		CJS	
A	12/16/05	ISSUED FOR IN-HOUSE REVIEW	SLS	RDN		CJS	

20' 10' 0 20' 40'
SCALE: 1"=20'

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SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER RDN DRAWN SLS
CHECKED DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

GRADING AND DRAINAGE – SITE PLAN – AREA 2

PROJECT DRAWING NUMBER 136469–CSTF–S3002 REV B
CODE
AREA

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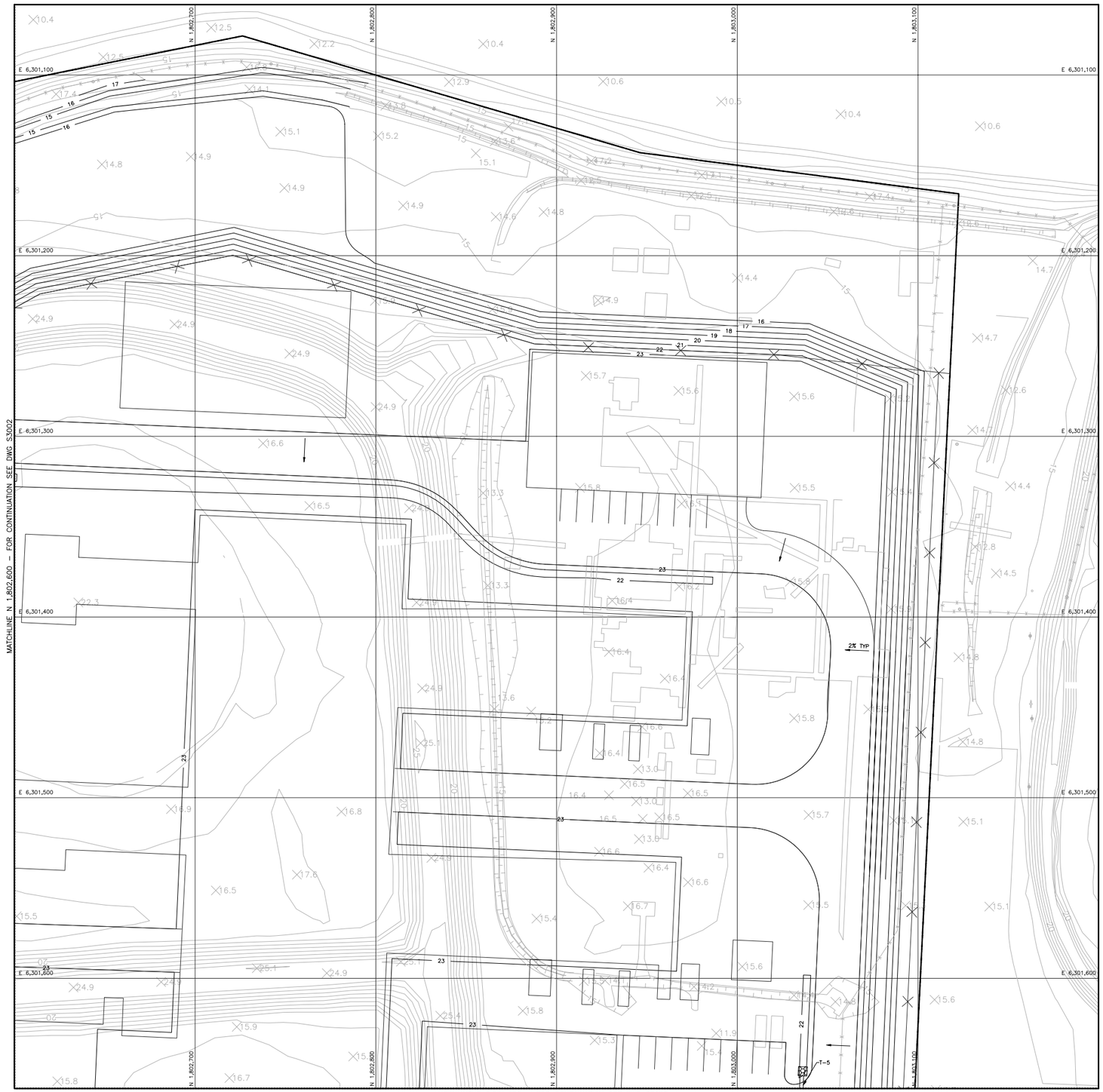
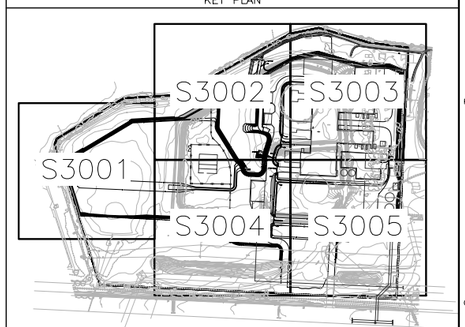
LAYOUT: E1
TAV46517
ALAN STEWART
03/02/06 12:52:00



NOTES

1. SEE DRAWING S3000 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.

KEY PLAN



NOT TO BE USED
FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
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B	05/12/06	ISSUED FOR OWNER REVIEW	AET	RDN		CJS	
A	12/16/05	ISSUED FOR IN-HOUSE REVIEW	SLS	RDN		CJS	

20' 10' 0 20' 40'
SCALE: 1"=20'

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DATE _____ REG NO. _____

BLACK & VEATCH CORPORATION
ENGINEER RDN | DRAWN SLS
CHECKED | DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

GRADING AND DRAINAGE – SITE
PLAN – AREA 3

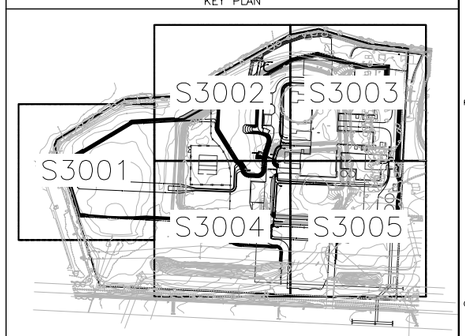
PROJECT | DRAWING NUMBER: 136469–CSTF–S3003 | REV: C
CODE
AREA

ACAD 15.05
1=1
E1
15:03:43
TAY46837
A1ASL017
05/12/06

NOTES

1. SEE DRAWING S3000 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.
2. RIP RAP SHALL BE D50 OF 6" AND 9" MINIMUM THICKNESS.

KEY PLAN



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FOR CONSTRUCTION

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A	12/16/05	ISSUED FOR IN-HOUSE REVIEW	SLSRDN			CJS	

SCALE: 1"=20' (20' 10' 0 20' 40')

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DATE _____ REG NO. _____

BLACK & VEATCH CORPORATION

ENGINEER RDN DRAWN SLS
CHECKED DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

GRADING AND DRAINAGE – SITE PLAN – AREA 4

PROJECT DRAWING NUMBER: 136469–CSTF–S3004
REV: B
CODE
AREA

ACAD 15.05
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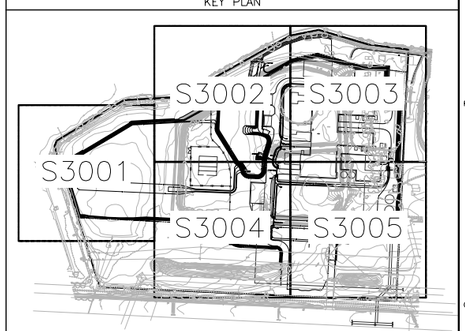
TW46537
03/02/06

NOTES

1. SEE DRAWING S3000 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.

KEY PLAN



NOT TO BE USED
FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
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A	12/16/05	ISSUED FOR IN-HOUSE REVIEW	SLS	RDN		CJS	

SCALE: 1"=20'

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DATE _____ REG NO. _____

BLACK & VEATCH CORPORATION

ENGINEER RDN | DRAWN SLS

CHECKED | DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

GRADING AND DRAINAGE – SITE
PLAN – AREA 5

PROJECT | DRAWING NUMBER: 136469–CSTF–S3005 | REV: B

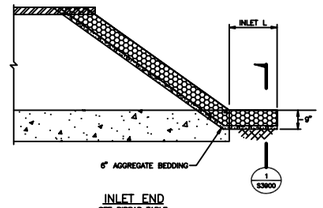
CODE

AREA

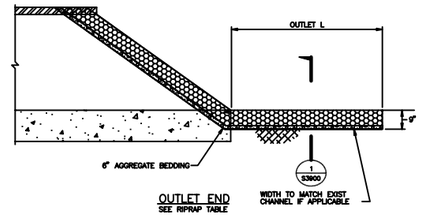
TAY46837 ACAD 15.05
A1ASL017 E1 1=1
03/02/06 15:51:12

TRENCH DRAIN RIPRAP TABLE			
TRENCH NO.	INLET L	OUTLET L	D50
T-1	5'	19'	6"
T-2	5'	40'	6"
T-3	5'	31'	6"
T-4	5'	17'	6"
T-5	5'	16'	6"

TRENCH DRAIN TABLE							
TRENCH NO.	CENTERLINE COORDINATES				LENGTH	INLET INV ELEVATION	OUTLET INV ELEVATION
	INLET END		OUTLET END				
	NORTH	EAST	NORTH	EAST			
T-1	1802562.13	6301547.69	1802555.34	6301601.28	54	20.39	20.26
T-2	1802529.22	6301652.25	1802489.58	6301646.92	40	20.10	20.00
T-3	1802539.72	6301726.01	1802542.60	6301682.10	44	20.30	20.19
T-4	1802525.70	6301946.09	1802528.32	6301906.18	40	20.85	20.75
T-5	1803035.73	6301853.99	1803034.42	6301883.96	30	21.86	21.79

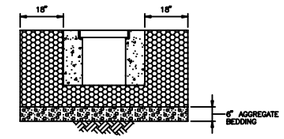


INLET END
SEE RIPRAP TABLE

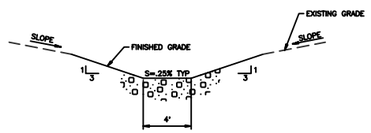


OUTLET END
SEE RIPRAP TABLE

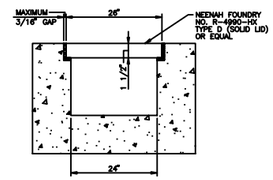
TYPICAL TRENCH RIPRAP
NO SCALE



SECTION 1
NO SCALE
SEE THIS DWG
SEE RIPRAP TABLE



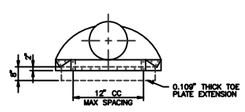
TYPICAL DITCH DETAIL
NO SCALE
SEE PLAN SHEETS



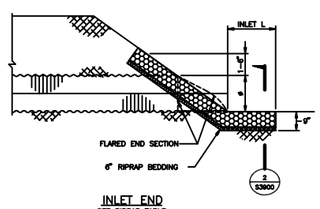
TYPICAL TRENCH SECTION
NO SCALE
SEE PLAN SHEETS

RIPRAP TABLE					
CULVERT NO.	INLET L	OUTLET L	INLET W	OUTLET W	D50
C-1	20'	19'	SEE DWG S3002	SEE DWG S3002	6"

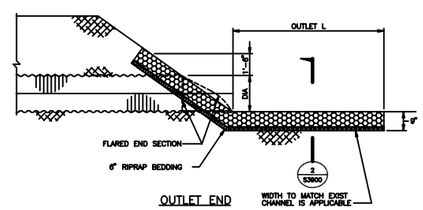
CULVERT TABLE										
CULVERT NO.	CENTERLINE COORDINATES				LENGTH	INLET INV ELEVATION	OUTLET INV ELEVATION	END TYPE	PIPE DIAMETER	PIPE MATERIAL
	INLET END		OUTLET END							
	NORTH	EAST	NORTH	EAST						
C-1	1802448.97	6301360.98	1802476.55	6301213.54	150'	18.00	15.43	FLARED END SECTION	15"	CMP



TYPICAL TREATMENT OF FLARED END SECTION
NO SCALE

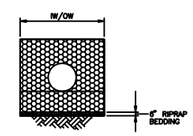


INLET END
SEE RIPRAP TABLE



OUTLET END

TYPICAL CULVERT RIPRAP
NO SCALE



SECTION 2
NO SCALE
SEE THIS DWG
SEE RIPRAP TABLE

NOTES

1. SEE DRAWINGS S3000 – S3005 FOR KEY PLAN, GENERAL NOTES, AND LEGEND.
2. RIP RAP MATERIAL SHALL CONFORM TO THE STANDARD RIP RAP AS DEFINED BY THE CALTRANS SPECIFICATIONS.

NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	05/12/06	ISSUED FOR OWNER REVIEW	AET	RDN		CJS	

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SIGNED _____
DATE _____ REG NO. _____

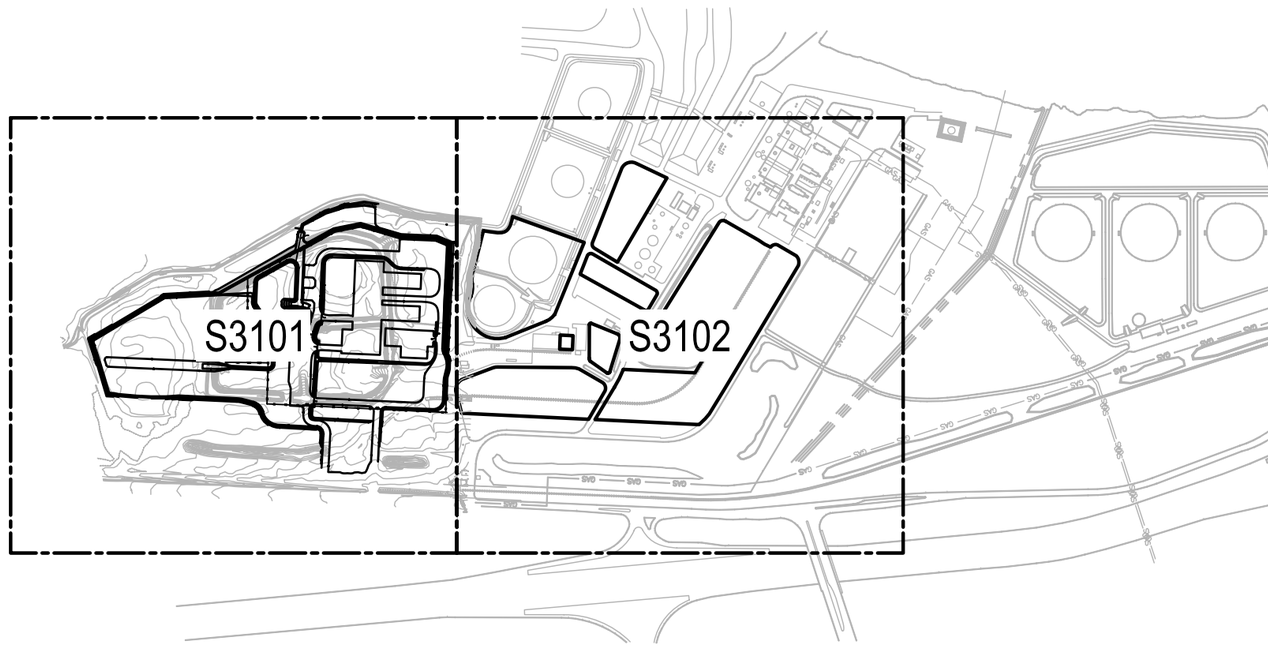
BLACK & VEATCH CORPORATION
ENGINEER RDN DRAWN AET
CHECKED DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

SITE-GRADING AND DRAINAGE
TYPICAL DETAILS

PROJECT / DRAWING NUMBER: 136469-CSTF-S3900
REV: A
CODE
AREA

ACAD 15.05
RLAND2025
ACAD 2007
04/05/06 13:03:27



SEDIMENT & EROSION CONTROL PLAN NOTES

1. THESE GUIDELINES SHALL APPLY TO ALL WORK CONSISTING OF ANY AND ALL TEMPORARY AND/OR PERMANENT MEASURES TO CONTROL WATER POLLUTION AND SOIL EROSION, AS MAY BE REQUIRED, DURING THE CONSTRUCTION OF THE PROJECT.

2. IN GENERAL, ALL CONSTRUCTION ACTIVITIES SHALL PROCEED IN SUCH A MANNER SO AS NOT TO POLLUTE ANY WETLANDS, WATERCOURSE, WATERBODY, AND CONDUIT CARRYING WATER, ETC.. THE SUBCONTRACTOR SHALL LIMIT, INSOFAR AS POSSIBLE, THE SURFACE AREA OF EARTH MATERIALS EXPOSED BY CONSTRUCTION METHODS AND IMMEDIATELY PROVIDE PERMANENT AND TEMPORARY POLLUTION CONTROL MEASURES TO PREVENT CONTAMINATION OF ADJACENT WETLANDS, WATERCOURSES, AND WATERBODIES, AND TO PREVENT, INSOFAR AS POSSIBLE, EROSION ON THE SITE.

3. PRESERVATION OF EXISTING VEGETATION

   PROVIDE FOR PRESERVATION OF EXISTING VEGETATION PRIOR TO THE COMMENCEMENT OF CLEARING AND GRUBBING OPERATIONS OR OTHER SOIL DISTURBING ACTIVITIES IN AREAS WHERE NO CONSTRUCTION ACTIVITY IS PLANNED OR WILL OCCUR AT A LATER DATE.

4. INLET/OUTLET PROTECTION

   SEE DRAWINGS 136469-CSTF-S3100 – S3102 FOR RIPRAP LOCATIONS AND DRAWING 136469-CSTF-S3920 FOR TYPICAL DETAILS. RIPRAP MATERIAL SHALL CONFORM TO THE STANDARD AS DEFINED BY CALTRANS SPECIFICATIONS.

5. WIND EROSION CONTROL

   A. QUICKLY STABILIZE EXPOSED SOILS USING VEGETATION, MULCHING, SPRAY-ON ADHESIVES, CALCIUM CHLORIDE, SPRINKLING, AND STONE/GRAVEL LAYERING.

   B. IDENTIFY AND STABILIZE KEY ACCESS POINTS PRIOR TO COMMENCEMENT OF CONSTRUCTION.

   C. MINIMIZE THE IMPACT OF DUST BY ANTICIPATING THE DIRECTION OF PREVAILING WINDS.

   D. DIRECT MOST CONSTRUCTION TRAFFIC TO STABILIZED ROADWAYS WITHIN THE PROJECT SITE.

   E. WATER SHOULD BE APPLIED BY MEANS OF PRESURE-TYPE DISTRIBUTORS OR PIPELINES EQUIPPED WITH A SPRAY SYSTEM OR HOSES AND NOZZLES THAT WILL ENSURE EVEN DISTRIBUTION.

   F. ALL DISTRIBUTION EQUIPMENT SHOULD BE EQUIPPED WITH A POSITIVE MEANS OF SHUTOFF.

   G. UNLESS WATER IS APPLIED BY MEANS OF PIPELINES, AT LEAST ONE MOBILE UNIT SHOULD BE AVAILABLE AT ALL TIMES TO APPLY WATER OR DUST PALLIATIVE TO THE PROJECT.

   H. IF RECLAIMED WASTE WATER IS USED, THE SOURCES AND DISCHARGE MUST MEET CALIFORNIA DEPARTMENT OF HEALTH SERVICES WATER RECLAMATION CRITERIA AND THE REGIONAL WATER QUALITY CONTROL BOARD REQUIREMENTS. NON-POTABLE WATER SHOULD NOT BE CONVEYED IN TANKS OR DRAIN PIPES THAT WILL BE USED TO CONVEY POTABLE WATER AND THERE SHOULD BE NO CONNECTION BETWEEN POTABLE AND NON-POTABLE SUPPLIES. NON-POTABLE TANKS, PIPES, AND OTHER CONVEYANCES SHOULD BE MARKED, "NON-POTABLE WATER – DO NOT DRINK".

   I. PROVIDE COVERS FOR HAUL TRUCKS TRANSPORTING MATERIALS THAT CONTRIBUTE TO DUST.

   J. PROVIDE FOR WET SUPPRESSION OR CHEMICAL STABILIZATION OF EXPOSED SOILS.

   K. PROVIDE FOR RAPID CLEAN UP OF SEDIMENTS DEPOSITED ON PAVED ROADS. FURNISH STABILIZED CONSTRUCTION ROAD ENTRANCES AND VEHICLE WASH DOWN AREAS.

   L. STABILIZE INACTIVE CONSTRUCTION SITES USING VEGETATION OR CHEMICAL STABILIZATION METHODS.

   M. IF CHEMICAL STABILIZATION IS USED, THE CHEMICALS SHOULD NOT CREATE ANY ADVERSE EFFECTS ON STORM WATER, PLANT LIFE, OR GROUND WATER.

SITE GRADING

1. THE RESHAPING OF THE GROUND SURFACE BY EXCAVATION AND FILLING OR A COMBINATION OF BOTH, TO OBTAIN PLANNED GRADES, SHALL PROCEED IN ACCORDANCE WITH THE FOLLOWING CRITERIA:

   A. THE PERMANENT CUT FACE OF EARTH EXCAVATION SHALL NOT BE STEEPER THAN THREE HORIZONTAL TO ONE VERTICAL (3:1), UNLESS NOTED OTHERWISE.

   B. THE PERMANENT EXPOSED FACES OF FILLS SHALL NOT BE STEEPER THAN THREE HORIZONTAL TO ONE VERTICAL (3:1), UNLESS NOTED OTHERWISE.

   C. TEMPORARY CONSTRUCTION FACES OF FILLS AND EXCAVATION CUTS SHALL NOT BE STEEPER THAN ONE AND ONE HALF HORIZONTAL TO ONE VERTICAL (1.5:1).

   D. PROVISION SHOULD BE MADE TO CONDUCT SURFACE WATER SAFELY TO DRAINAGE DITCHES TO PREVENT SURFACE RUNOFF FROM DAMAGING CUT FACES AND FILL SLOPES.

   E. EXCAVATIONS SHOULD NOT BE MADE SO CLOSE TO PROPERTY LINES AS TO ENDANGER ADJOINING PROPERTY WITHOUT PROTECTING SUCH PROPERTY FROM EROSION, SLIDING, SETTLING, OR CRACKING.

   F. NO FILL SHOULD BE PLACED WHERE IT WILL SLIDE OR WASH UPON THE PREMISES OF ANOTHER OWNER OR UPON ADJACENT WETLANDS, WATERCOURSES, OR WATERBODIES.

   G. PRIOR TO ANY REGRADING, A STABILIZED CONSTRUCTION ENTRANCE SHALL BE PLACED AT THE ENTRANCE TO THE WORK AREA IN ORDER TO REDUCE MUD AND OTHER SEDIMENTS FROM LEAVING THE SITE.

GENERAL LEGEND

SILT FENCE N 10.94 E 34.39	SILT FENCE		RIPRAP
	CONSTRUCTION LAYDOWN BOUNDARY		WETLANDS
IP	INLET PROTECTION		STABILIZED CONSTRUCTION ENTRANCE
OP	OUTLET PROTECTION	SAP 1	SAMPLING LOCATION (SEE NOTE 7)
CD	CHECK DAM		

GENERAL NOTES

1. SEE THIS DWG FOR GENERAL NOTES AND LEGEND.
2. SEE DWG 136469-STE-S3920 FOR EROSION CONTROL SECTIONS & DETAILS.
3. SUBCONTRACTOR IS RESPONSIBLE FOR MAINTAINING EROSION CONTROL.
4. EROSION CONTROL MEASURES TO BE INSTALLED BY SUBCONTRACTOR IN ACCORDANCE WITH THE STORMWATER POLLUTION PREVENTION PLAN.
5. SILT FENCE LOCATIONS SHOWN ON DRAWINGS MAY BE RELOCATED AT THE DISCRETION OF THE SITE MANAGER TO ACCOUNT FOR INTERFERENCES WITH PAVEMENTS, ROAD CROSSINGS, WOODED AREAS, ETC. RELOCATION OF SILT FENCE SHALL PROVIDE THE INTENDED SILT BARRIER AND PROTECTION OF UNDISTURBED LAND AS SHOWN ON THE DRAWINGS.
6. AREA SHALL BE ROUGH GRADED WITH BERM REMOVAL PRIOR TO USE.
7. SEE SECTION 6.5 OF STORMWATER POLLUTION PREVENTION PLAN (SWPPP) FOR SAMPLING AND ANALYSIS PLAN.

NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
B	05/24/06	ISSUED FOR CLIENT REVIEW	AET	RDN		CJS	
A	05/18/06	ISSUED FOR CLIENT REVIEW	AET	RDN		CJS	

200' 100' 0 200' 400'
SCALE: 1"=200'

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SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER RDN DRAWN AET
CHECKED DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

EROSION AND SEDIMENT CONTROL KEY PLAN

PROJECT DRAWING NUMBER: 136469-CSTF-S3100
REV: B
CODE
AREA

ACAD 15.05
TAY46577
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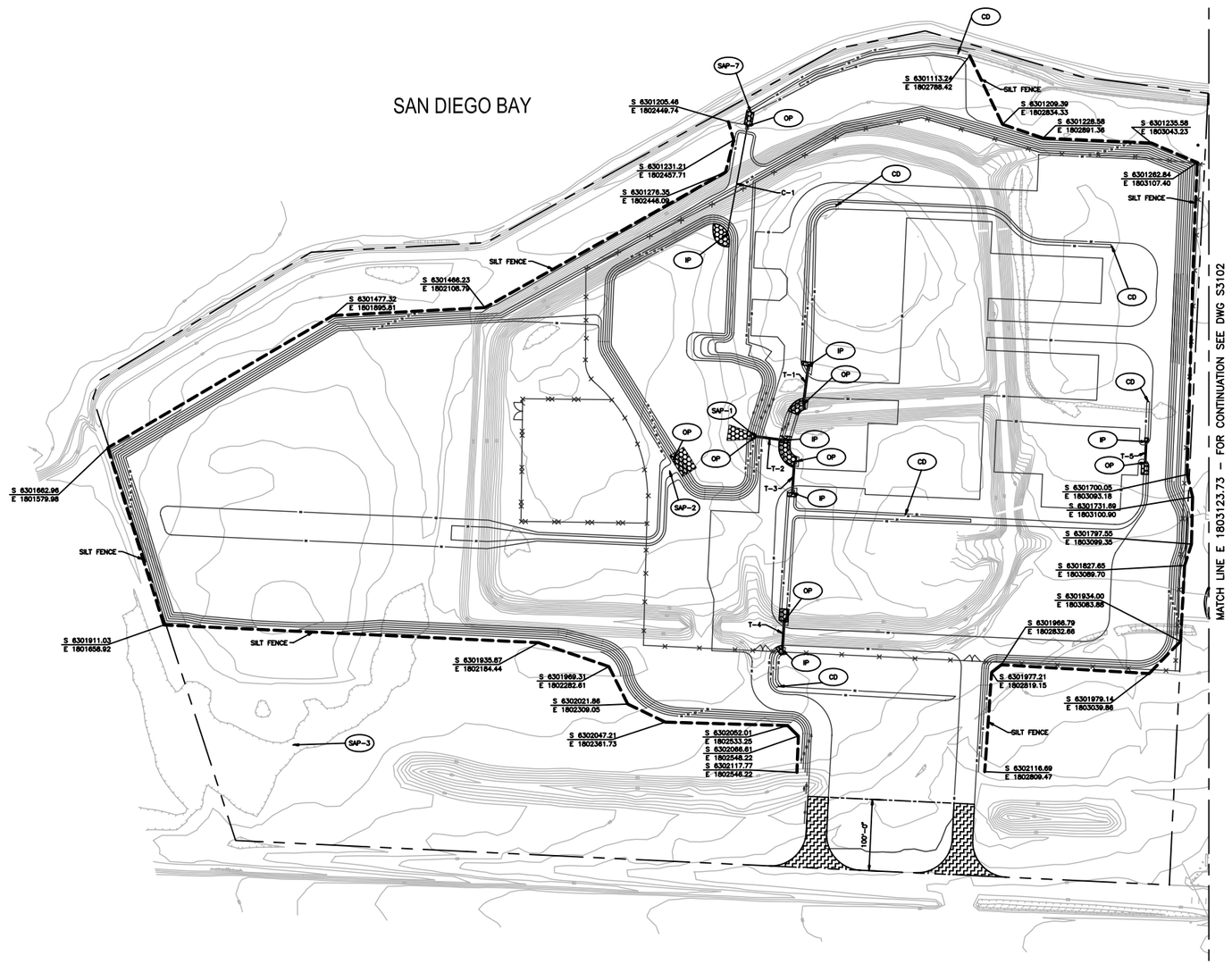

GENERAL NOTES

1. SEE DWG 136469-CSTF-S3100 FOR GENERAL NOTES & LENGEND.

NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
B	05/24/06	ISSUED FOR CLIENT REVIEW	AETRON			CJS	
A	05/18/06	ISSUED FOR CLIENT REVIEW	AETRON			CJS	

N

60' 30' 0 60' 120'
SCALE: 1"=60'

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF CALIFORNIA.
SIGNED _____
DATE _____ REG NO. _____

BLACK & VEATCH CORPORATION
ENGINEER RON DRAWN AET
CHECKED DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

EROSION AND SEDIMENT CONTROL PLAN AREA 1

PROJECT DRAWING NUMBER: 136469-CSTF-S3101
REV: B
CODE
AREA

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LAYOUT: E1
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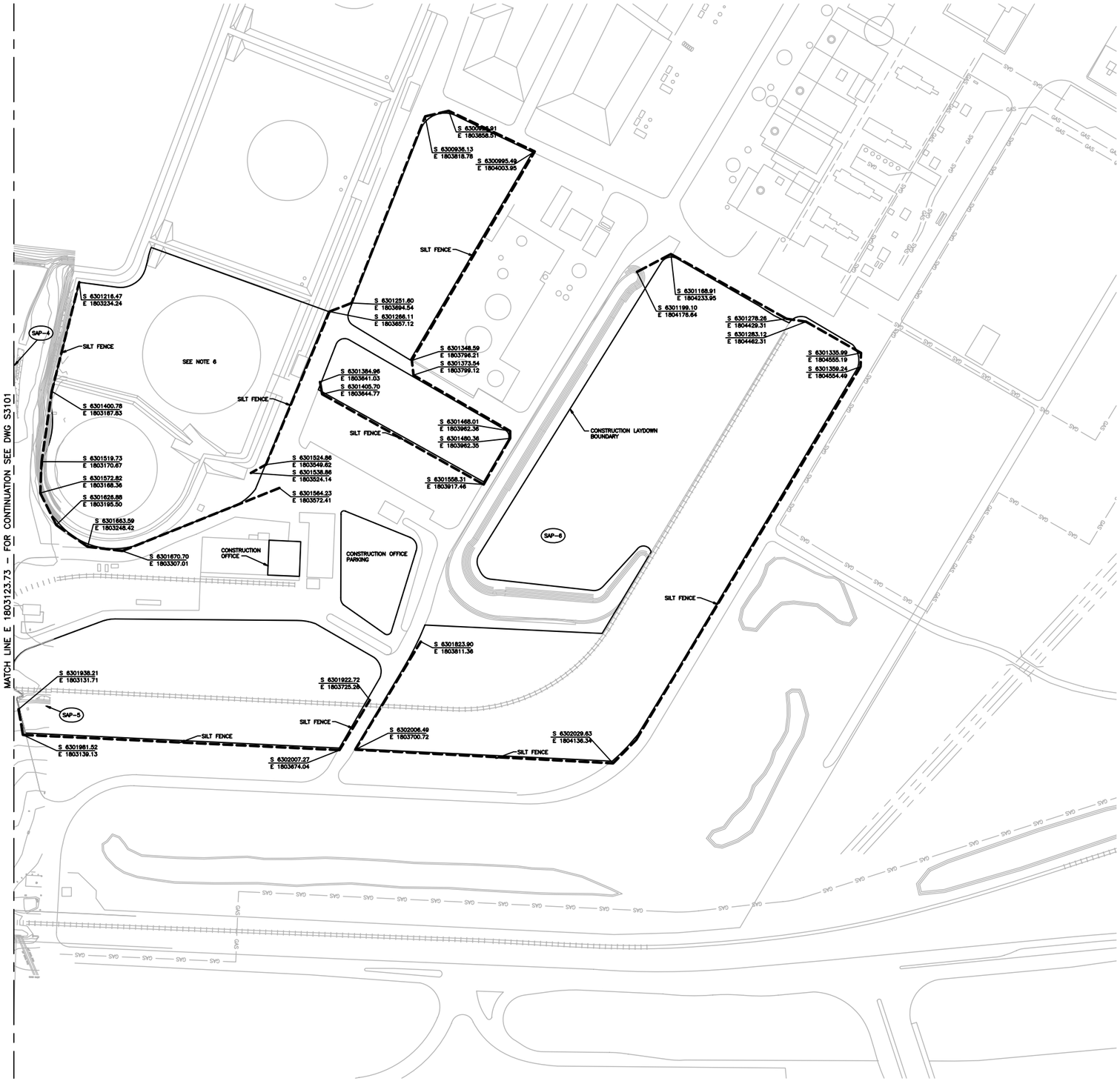

GENERAL NOTES

1. SEE DWG 136469-CSTF-S3100 FOR GENERAL NOTES & LEGEND.

NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
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60' 30' 0 60' 120'
SCALE: 1"=60'

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SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER RDN DRAWN AET
CHECKED DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY

EROSION AND SEDIMENT CONTROL PLAN AREA 2

PROJECT DRAWING NUMBER 136469-CSTF-S3102 REV A
CODE
AREA

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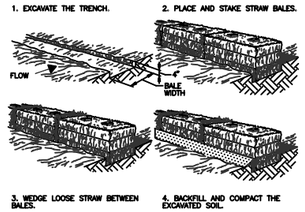
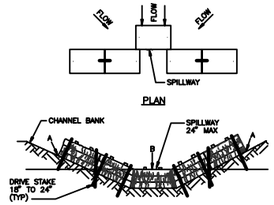
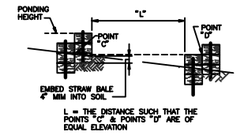


STRAW BALE BARRIER CONSTRUCTION DETAIL
NO SCALE

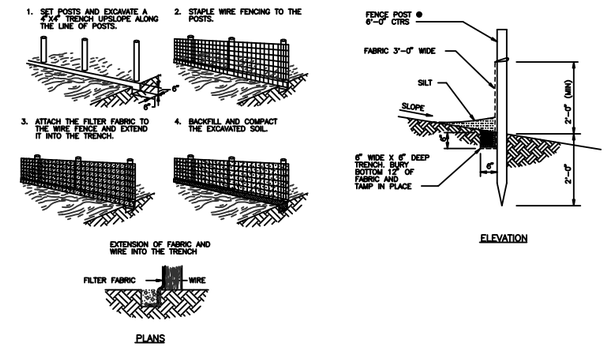


NOTES:
1. EMBED BALES 4" INTO SOIL AND "KEY" BALES INTO CHANNEL BANKS.
2. POINT "A" MUST BE HIGHER THAN POINT "B" (SPILLWAY HEIGHT)
3. PLACE BALES PERPENDICULAR TO THE FLOW WITH ENDS TIGHTLY ABUTTING.
4. SPILLWAY HEIGHT SHALL NOT EXCEED 24".
5. INSPECT AFTER EACH SIGNIFICANT STORM, MAINTAIN AND REPAIR PROMPTLY.

STRAW BALE CHECK DAM IN DRAINAGE WAY
NO SCALE

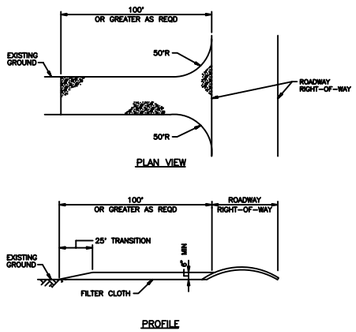


SPACING BETWEEN CHECK DAMS
NO SCALE

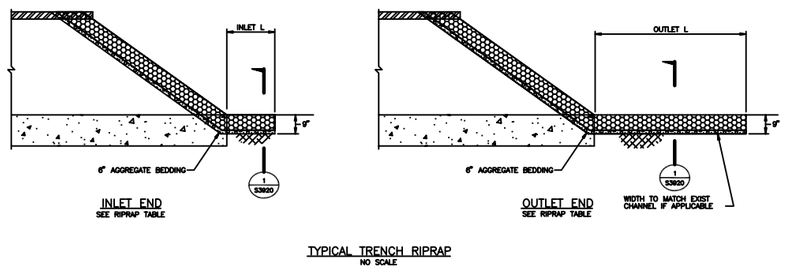


SILT FENCE DETAIL
NO SCALE

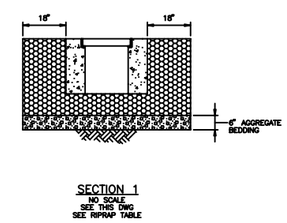
TRENCH DRAIN RIPRAP TABLE			
TRENCH NO.	INLET L	OUTLET L	D50
T-1	5'	19"	6"
T-2	5'	40"	6"
T-3	5'	31"	6"
T-4	5'	17"	6"
T-5	5'	16"	6"



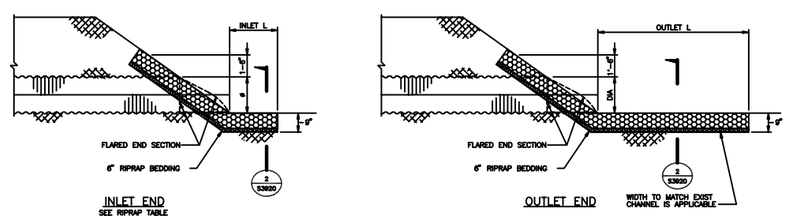
TYPICAL STABILIZED CONSTRUCTION ENTRANCE
NO SCALE
SEE NOTE 2, 3, AND 4



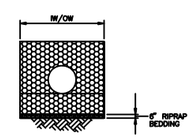
TYPICAL TRENCH RIPRAP
NO SCALE



CULVERT RIPRAP TABLE					
CULVERT NO.	INLET L	OUTLET L	INLET W	OUTLET W	D50
C-1	20'	19"	SEE DWG S3002	SEE DWG S3002	6"



TYPICAL CULVERT RIPRAP
NO SCALE



SECTION 2
NO SCALE
SEE THIS DWG
SEE RIPRAP TABLE

NOTES

1. SEE DWG S3100 FOR GENERAL NOTES AND LEGEND.
2. PROVIDE APPROPRIATE TRANSITION BETWEEN STABILIZED CONSTRUCTION ENTRANCE AND PUBLIC R.O.W.
3. DESIGN CRITERIA FOR STABILIZED CONSTRUCTION ENTRANCE.
   A. STONE SIZE – USE ASTM C-33, SIZE NO 2 OR 3, USE CRUSHED STONE.
   B. THICKNESS – NOT LESS THAN 8 INCHES.
   C. WIDTH – NOT LESS THAN FULL WIDTH OF POINTS OF INGRESS OR EGRESS.
   D. LENGTH – 100 FEET MINIMUM
      WHERE SOILS ARE CLAYS OR SILTS, EXCEPT WHERE THE TRAVELED LENGTH IS LESS THAN 100 FEET. THIS LENGTH MAY BE INCREASED WHERE FIELD CONDITIONS DICTATE.
   E. FILTER CLOTH – WILL BE PLACED OVER ENTIRE AREA PRIOR TO PLACING OF STONE.
   F. MAINTENANCE – THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ON TO PUBLIC RIGHT-OF-WAY THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR ADDITIONAL LENGTH AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHT-OF-WAY MUST BE REMOVED IMMEDIATELY.
4. TRACKING CONTROL: ENTRANCE/OUTLET TIRE WASH
   A. INCORPORATE WITH A STABILIZED CONSTRUCTION ENTRANCE/EXIT.
   B. CONSTRUCT ON LEVEL GROUND WHEN POSSIBLE, ON A PAD OF COARSE AGGREGATE GREATER THAN 3 IN. BUT SMALLER THAN 8 IN. A GEOTEXTILE FABRIC SHOULD BE PLACED BELOW THE AGGREGATE.
   C. WASH RACK SHOULD BE DESIGNED AND CONSTRUCTED/MANUFACTURED FOR ANTICIPATED TRAFFIC LOADS.
   D. PROVIDE A TEMPORARY DRAINAGE DITCH THAT WILL CONVEY THE RUNOFF FROM THE WASH AREA TO A SEDIMENT TRAPPING DEVICE. THE DRAINAGE DITCH SHOULD BE OF SUFFICIENT GRADE, WIDTH, AND DEPTH TO CARRY THE WASH RUNOFF.
   E. USE HOSES WITH AUTOMATIC SHUTOFF NOZZLES TO PREVENT HOSES FROM BEING LEFT ON.
   F. REQUIRE THAT ALL EMPLOYEES, SUBCONTRACTORS, AND OTHERS THAT LEAVE THE SITE WITH MUD CAKED TIRES AND UNDERCARRIAGES TO USE THE WASH FACILITY.
   G. VISIBLE SEDIMENT TRACKING SHOULD BE SWEPT OR VACUUMED AND INSPECTED ON A DAILY BASIS.

NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	05/18/06	ISSUED FOR CLIETN REVIEW	AET	RDN			

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF CALIFORNIA
SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER DRAWN
CHECKED DATE

LS POWER
SOUTH BAY REPLACEMENT GENERATION FACILITY
ERSOSION AND SEDIMENT CONTROL SECTIONS AND DETAILS

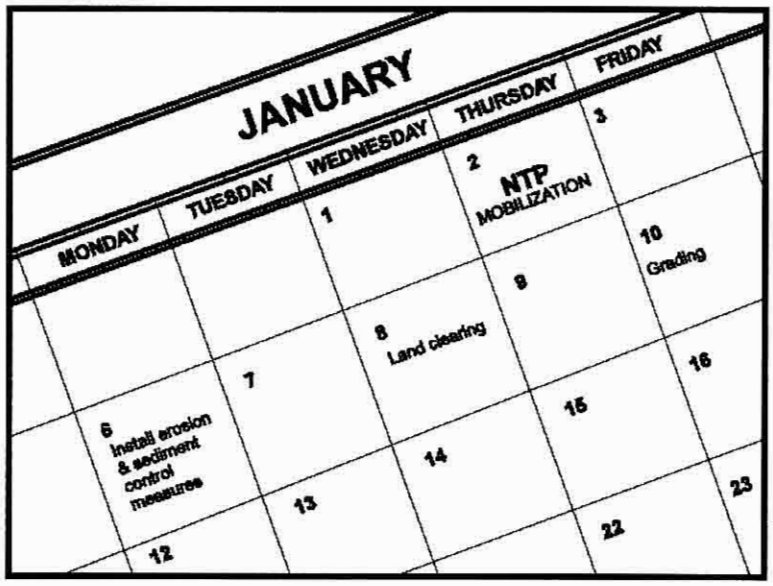
PROJECT DRAWING NUMBER: 136469-CSTF-S3920
REV: A
CODE
AREA

TAY46577 E1 A.DWG 05/18/06 10:04:15 ACAD 15.05 1:1

Attachment B

Scheduling

EC-1



Objectives

EC	Erosion Control	☑
SE	Sediment Control	☒
TR	Tracking Control	☒
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ Primary Objective

☒ Secondary Objective

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Suitable Applications

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project especially during rainy season. Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

Limitations

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.

Implementation

- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.
- Plan the project and develop a schedule showing each phase of construction. Clearly show how the rainy season relates to soil

disturbing and re-stabilization activities. Incorporate the construction schedule into the SWPPP.

- Include on the schedule, details on the rainy season implementation and deployment of:
  - Erosion control BMPs
  - Sediment control BMPs
  - Tracking control BMPs
  - Wind erosion control BMPs
  - Non-stormwater BMPs
  - Waste management and materials pollution control BMPs
- Include dates for activities that may require non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring utilities installation, etc., to minimize the active construction area during the rainy season.
  - Sequence trenching activities so that most open portions are closed before new trenching begins.
  - Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
  - Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.

Costs

Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost effectiveness of scheduling techniques should be compared with the other less effective erosion and sedimentation controls to achieve a cost effective balance.

Inspection and Maintenance

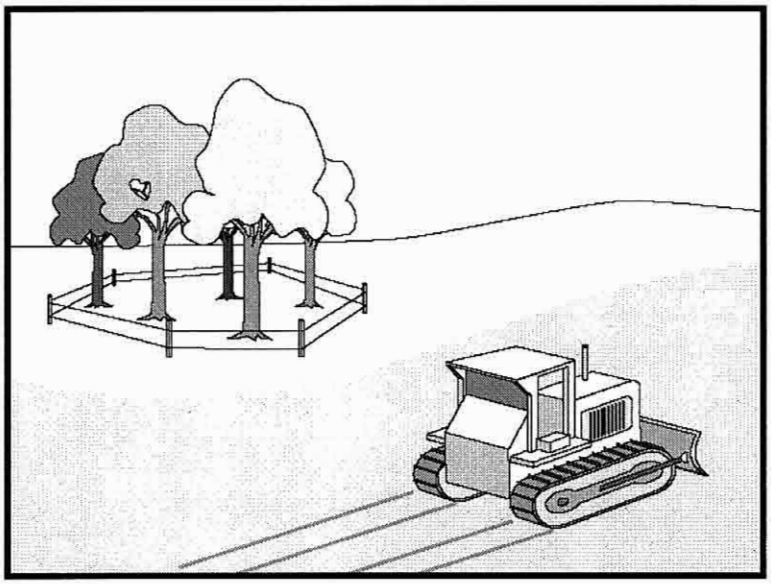
- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005), U.S. Environmental Protection Agency, Office of Water, September 1992.

Preservation Of Existing Vegetation EC-2



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ Primary Objective

☒ Secondary Objective

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.
- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.
- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.
- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

EC-2 Preservation Of Existing Vegetation

Limitations

- Requires forward planning by the owner/developer, contractor, and design staff.
- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

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 ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps 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.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.
  - Orange colored plastic mesh fencing works well.
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization
  - Fertilize stressed or damaged broadleaf trees to aid recovery.
  - Fertilize trees in the late fall or early spring.

- Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.

- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

References

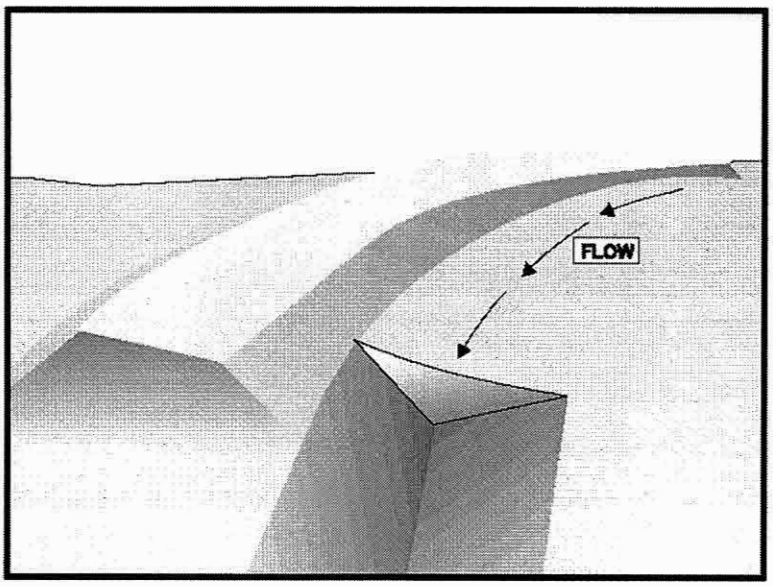
County of Sacramento Tree Preservation Ordinance, September 1981.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Earth Dikes and Drainage Swales EC-9



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ Primary Objective
☒ Secondary Objective

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

An earth dike is a temporary berm or ridge of compacted soil used to divert runoff or channel water to a desired location. A drainage swale is a shaped and sloped depression in the soil surface used to convey runoff to a desired location. Earth dikes and drainage swales are used to divert off site runoff around the construction site, divert runoff from stabilized areas and disturbed areas, and direct runoff into sediment basins or traps.

Suitable Applications

Earth dikes and drainage swales are suitable for use, individually or together, where runoff needs to be diverted from one area and conveyed to another.

- Earth dikes and drainage swales may be used:
  - To convey surface runoff down sloping land
  - To intercept and divert runoff to avoid sheet flow over sloped surfaces
  - To divert and direct runoff towards a stabilized watercourse, drainage pipe or channel
  - To intercept runoff from paved surfaces
  - Below steep grades where runoff begins to concentrate
  - Along roadways and facility improvements subject to flood drainage

- At the top of slopes to divert runon from adjacent or undisturbed slopes
- At bottom and mid slope locations to intercept sheet flow and convey concentrated flows
- Divert sediment laden runoff into sediment basins or traps

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 municipal requirements.

- 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 may cause downstream flood damage.
- Dikes should not be constructed of soils that may be easily eroded.
- Regrading the site to remove the dike may add additional cost.
- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales must conform to local floodplain management requirements.
- Earth dikes/drainage swales are not suitable as sediment trapping devices.
- It may be necessary to use other soil stabilization and sediment controls such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales, and ditches.

Implementation

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert stormwater to a sediment trapping device or a 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%.

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 at the top of a slope can divert runoff to a location where it can be brought to the bottom of the slope (see EC-11, Slope Drains). 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 the slopes are stabilized.

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

General

- Care must be applied to correctly size and locate earth dikes, drainage swales. Excessively steep, unlined dikes, and swales are subject to erosion and gully formation.
- Conveyances should be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, overtopping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff onto other property without securing written authorization from the property owner.
- When possible, install and utilize permanent dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Earth Dikes

Temporary earth dikes are a practical, inexpensive BMP used to divert stormwater runoff. Temporary diversion dikes should be installed in the following manner:

- All dikes should be compacted by earth moving equipment.
- All dikes should have positive drainage to an outlet.
- All dikes should have 2:1 or flatter side slopes, 18 in. minimum height, and a minimum top width of 24 in. Wide top widths and flat slopes are usually needed at crossings for construction traffic.
- The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a Sediment Trap (SE-3) or Sediment Basin (SE-2) when either the dike channel or the drainage area above the dike are not adequately stabilized.

- Temporary stabilization may be achieved using 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.
- If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

Channel Grade	Riprap Stabilization
0.5-1.0%	4 in. Rock
1.1-2.0%	6 in. Rock
2.1-4.0%	8 in. Rock
4.1-5.0%	8 in. -12 in. Riprap

- The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment.
- Filter cloth may be used to cover dikes in use for long periods.
- Construction activity on the earth dike should be kept to a minimum.

Drainage Swales

Drainage swales are only effective if they are properly installed. Swales are 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.

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

- No more than 5 acres may drain to a temporary drainage swale.
- Place drainage swales above or below, not on, a cut or fill slope.
- Swale bottom width should be at least 2 ft
- Depth of the swale should be at least 18 in.
- Side slopes should be 2:1 or flatter.
- Drainage or swales should be laid at a grade of at least 1 percent, but not more than 15 percent.
- The swale must not be overtopped by the peak discharge from a 10-year 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. For temporary swales, geotextiles and mats (EC-7) may provide immediate stabilization.
- Irrigation may be required to establish sufficient vegetation to prevent erosion.
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- Permanent drainage facilities must be designed by a professional engineer (see the local drainage design criteria for proper design).
- At a minimum, the drainage swale should conform to predevelopment drainage patterns and capacities.
- Construct the drainage swale with a positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the drainage swale can reach an erosive velocity.

Costs

- Cost ranges from $15 to $55 per ft for both earthwork and stabilization and depends on availability of material, site location, and access.
- Small dikes: $2.50 - $6.50/linear ft; Large dikes: $2.50/yd^3.
- The cost of a drainage swale increases with drainage area and slope. Typical swales for controlling internal erosion are inexpensive, as they are quickly formed during routine earthwork.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction

References

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursetynsky, P.E., McGraw Hill Book Company, 1986.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Association of Home Builders (NAHB). Stormwater Runoff & Nonpoint Source Pollution Control Guide for Builders and Developers. National Association of Home Builders, Washington, D.C., 1995

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

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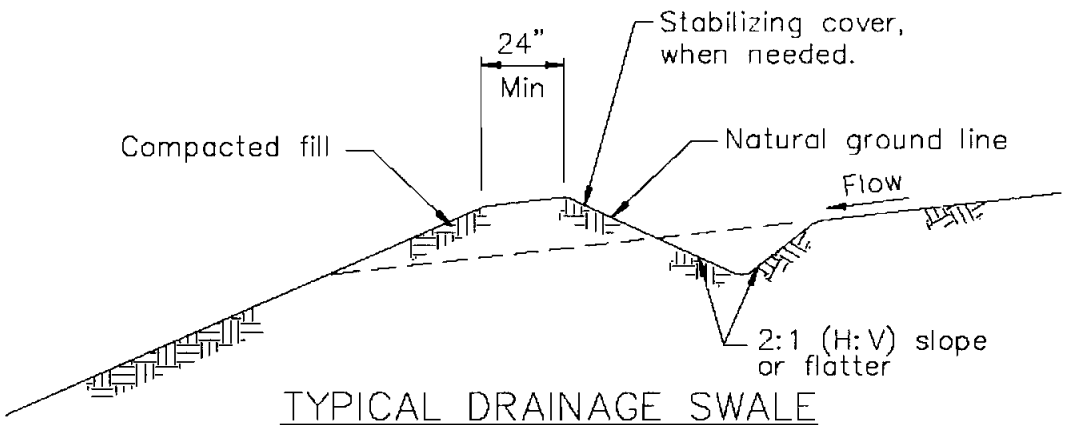
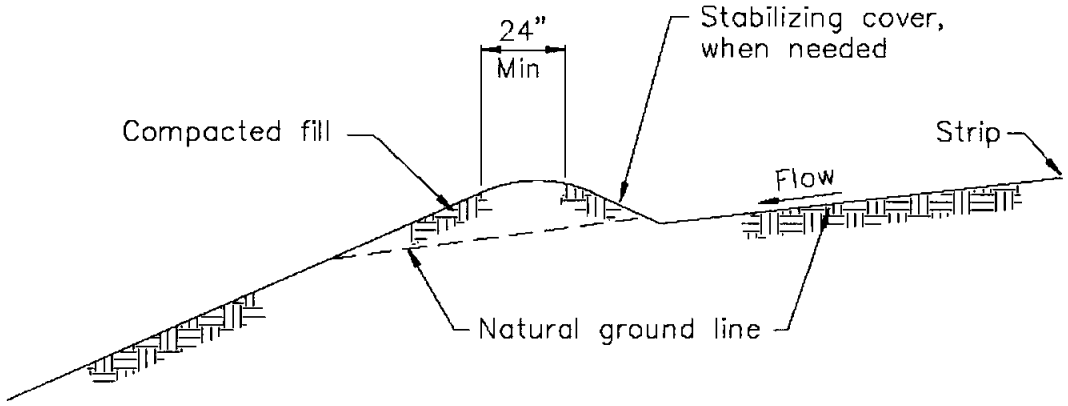


TYPICAL DRAINAGE SWALE
NOT TO SCALE

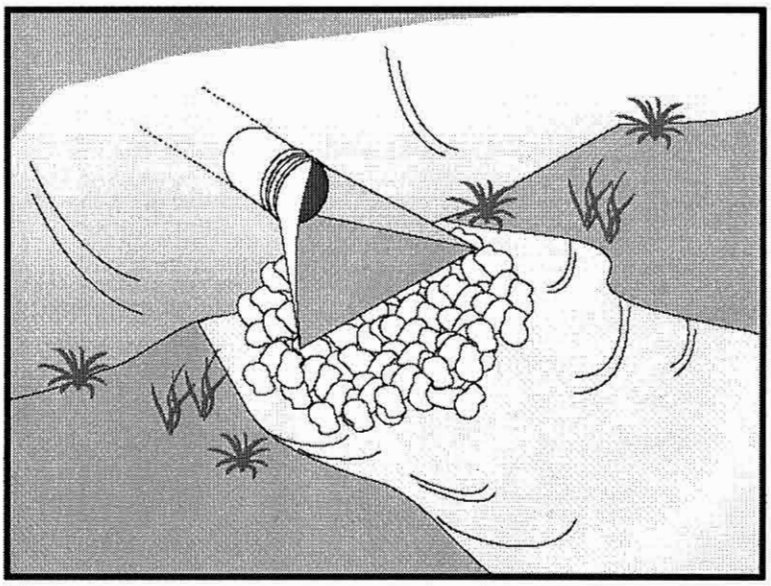
NOTES:

1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade.



TYPICAL EARTH DIKE
NOT TO SCALE

Velocity Dissipation Devices EC-10



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ Primary Objective

☒ Secondary Objective

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, which is placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

Suitable Applications

Whenever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This includes temporary diversion structures to divert runon during construction.

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels.
  - Outlets located at the bottom of mild to steep slopes.
  - Discharge outlets that carry continuous flows of water.
  - Outlets subject to short, intense flows of water, such as flash floods.
  - Points where lined conveyances discharge to unlined conveyances

Limitations

- Large storms or high flows can 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.
- Outlet protection may negatively impact the channel habitat.
- Grouted riprap may break up in areas of freeze and thaw.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.

Implementation

General

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 outlet from developing small eroded pools (plange pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Design and Layout

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 are shown in the rock outlet protection figure in this BMP and should be considered minimums. The apron length and rock size gradation are determined using a combination of the discharge pipe diameter and estimate discharge rate: Select the longest apron length and largest rock size suggested by the pipe size and discharge rate. Where flows are conveyed in open channels such as ditches and swales, use the estimated discharge rate for selecting the apron length and rock size. Flows should be same as the culvert or channel design flow but never the less than the peak 5 year flow for temporary structures planned for one rainy season, or the 10 year peak flow for temporary structures planned for two or three rainy seasons.

- There are many types of energy dissipaters, with rock being the one that is represented in the attached figure.
- Best results are obtained when sound, durable, and angular rock is used.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
- Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.
- Carefully place riprap to avoid damaging the filter fabric.
    - Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.
    - Stone 8 in. to 12 in. must be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.

- Stone greater than 12 in. shall only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D_{50} rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.

- For proper operation of apron: Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron.

- Outlets on slopes steeper than 10 percent should have additional protection.

Costs

Costs are low if material is readily available. If material is imported, costs will be higher. Average installed cost is $150 per device.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharges occur.

- Inspect apron for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material.

- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.

- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

References

County of Sacramento Improvement Standards, Sacramento County, May 1989.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

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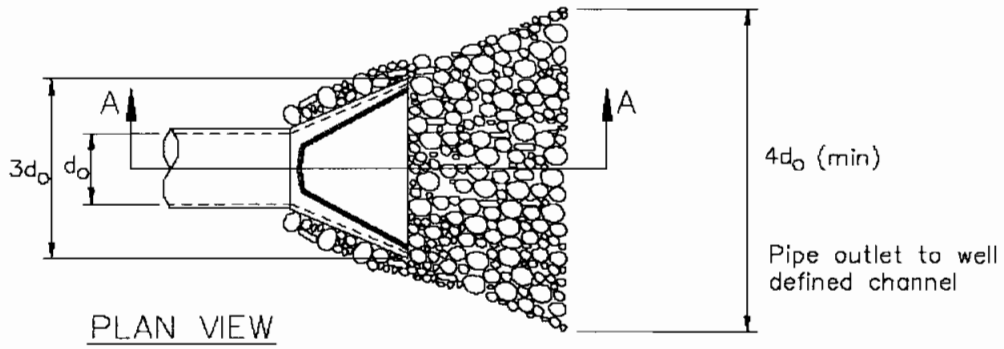
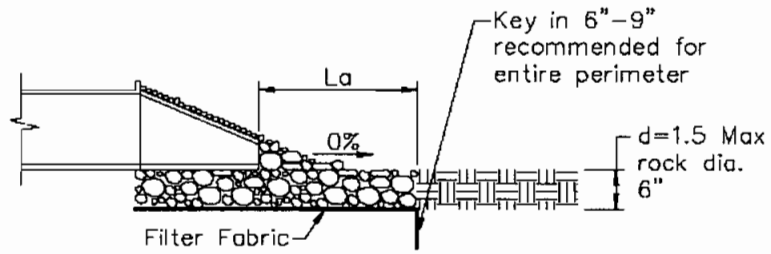


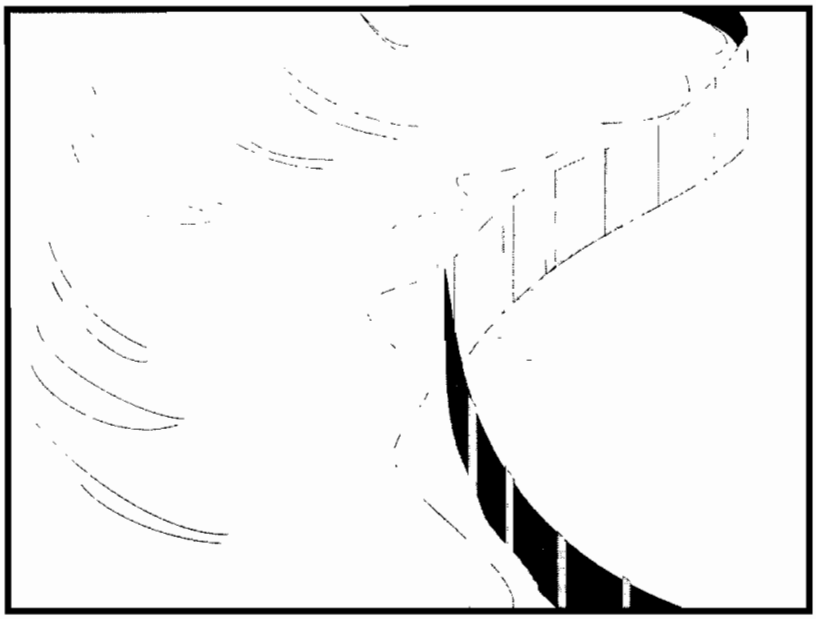


SECTION A–A

Pipe Diameter inches	Discharge ft^3/s	Apron Length, La ft	Rip Rap D_{50} Diameter Min inches
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
24	30	16	8
	40	26	8
	50	26	12
	60	30	16

For larger or higher flows consult a Registered Civil Engineer
Source: USDA - SCS

Silt Fence SE-1



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

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

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They should also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.

- Do not use in locations where ponded water may cause flooding.
- Do not place fence on a slope, or across any contour line. If not installed at the same elevation throughout, silt fences will create erosion.
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.
  - Not effective unless trenched and keyed in.
  - Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
  - Do not allow water depth to exceed 1.5 ft at any point.

Implementation

General

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 fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

Silt fences are preferable to straw bale 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 bale barriers, there are many instances where silt fences have been improperly installed. The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs.
- Don't use in streams, channels, or anywhere flow is concentrated. Don't use silt fences to divert flow.
- Don't use below slopes subject to creep, slumping, or landslides.
- Select filter fabric that retains 85% of soil by weight, based on sieve analysis, but that is not finer than an equivalent opening size of 70.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.

- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.
- Silt fences should remain in place until the disturbed area is permanently stabilized.

Design and Layout

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 should specify a filter fabric that retains the soil found on the construction site yet that it has 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 % 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 except where direct discharge to a stream, lake, or wetland will occur, then the EOS should 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. If 85% or more of a soil, by weight, passes through the openings in a No. 200 sieve, filter fabric should 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 were small enough to capture the soil.

The fence should be supported by a plastic or 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 should contain ultraviolet 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.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Materials

- Silt fence fabric should be woven polypropylene with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D4491.

- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

- There are new products that may use prefabricated plastic holders for the silt fence and use bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement.

Installation Guidelines

Silt 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 trench should be excavated approximately 6 in. wide and 6 in. deep along the line the proposed silt fence.

- Bottom of the silt fence should be keyed-in a minimum of 12 in.

- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.

- When standard strength filter fabric is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the mesh support fence may be eliminated. Filter fabric should be purchased in a long roll, and then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.

- The trench should be backfilled with compacted native material.

- Construct silt fences with a setback of at least 3 ft from the toe of a slope. Where a silt fence is determined to be not practicable due to specific site conditions, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and difficult to maintain.

- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.

Costs

- Average annual cost for installation and maintenance (assumes 6 month useful life): $7 per lineal foot ($850 per drainage acre). Range of cost is $3.50 - $9.10 per lineal foot.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed of, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence must be inspected and maintained.
- Holes, depressions, or other ground disturbance caused by the removal of the silt fences should be backfilled and repaired.

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Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

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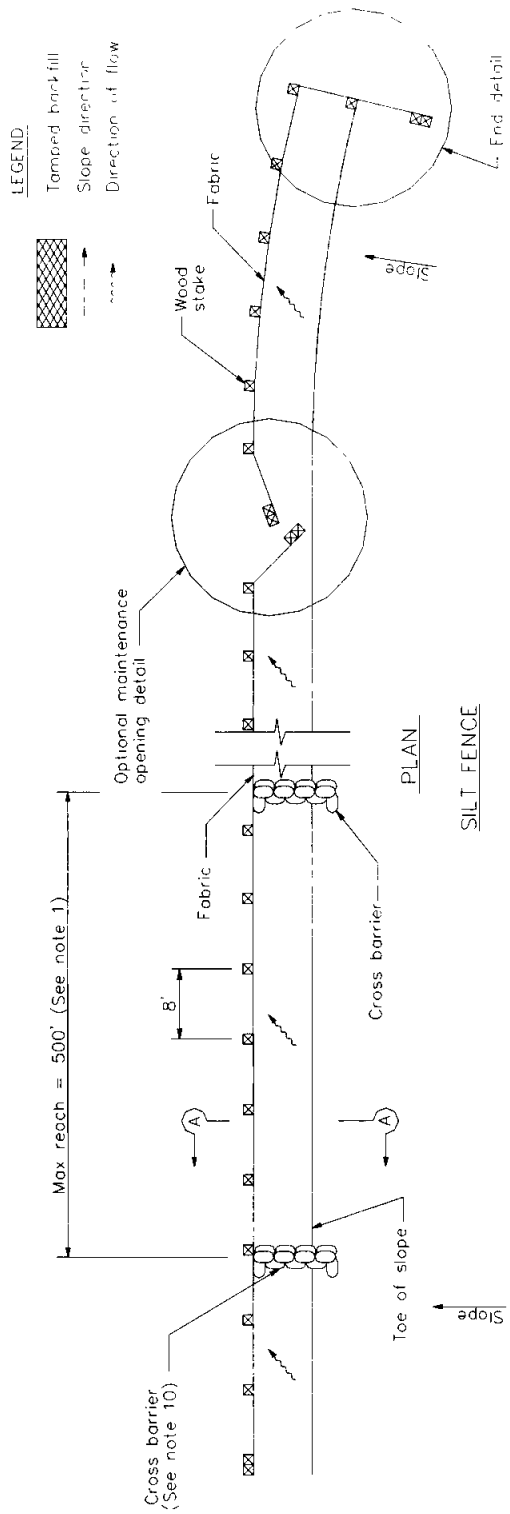
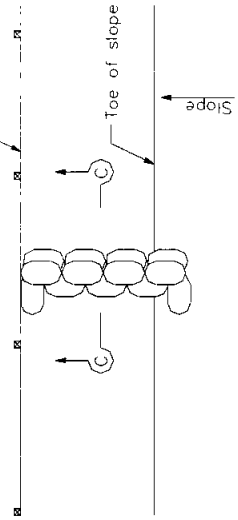
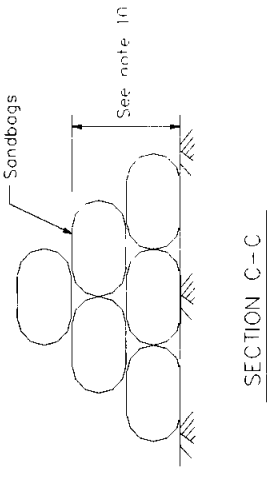
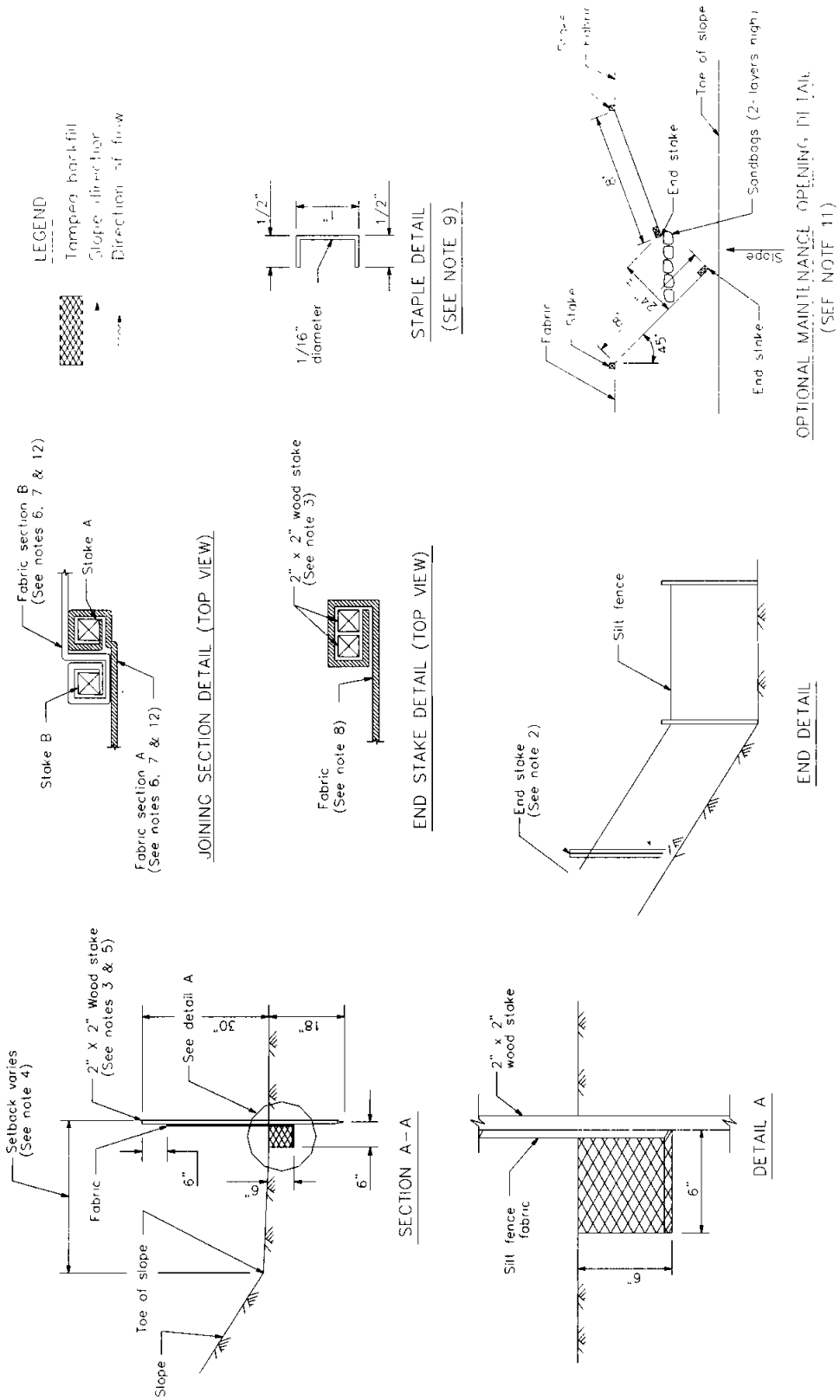




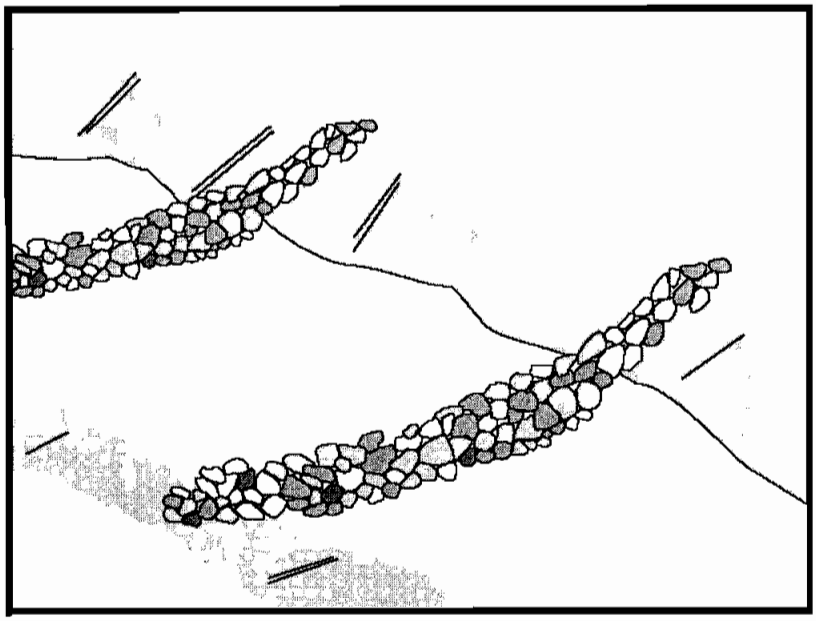


NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'
2. The last 8'-0" of fence shall be turned up slope
3. Stake dimensions are nominal
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'-0" maximum and shall be positioned on downstream side of fence
6. Stakes to overlap and fence fabric to fold around each stake one full turn Secure fabric to stake with 4 staples
7. Stakes shall be driven tightly together to prevent potential flow-through of sediment at joint. The tops of the stakes shall be secured with wire
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples
9. Minimum 4 staples per stake. Dimensions shown are typical
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset to eliminate gaps.


LEGEND
Tamped backfill
Slope direction
Direction of flow
1/2"
1/16" diameter
1/2"
STAPLE DETAIL
(SEE NOTE 9)
Fabric section B
(See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A
(See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake
(See note 3)
Fabric
(See note 8)
END STAKE DETAIL (TOP VIEW)
Fabric
Stake
45°
End stake
Sandbags (2-layers high)
Top of slope
Slope
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Silt fence
End stake
(See note 2)
END DETAIL
Setback varies
(See note 4)
2" X 2" Wood stake
(See notes 3 & 5)
See detail A
30"
18"
Fabric
6"
6"
6"
Toe of slope
Slope
SECTION A-A
2" x 2"
wood stake
Silt fence
fabric
6"
6"
DETAIL A

Check Dams SE-4



Objectives

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Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.

Limitations

- Not to be used in live streams or in channels with extended base flows.

- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Reduced slopes reduce the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Use of check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity must be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, there are several options:

- Don't use check dams. Consider alternative BMPs.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center section of the dam should be lower than the edge sections so that the check dam will direct flows to the center of the ditch or swale.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products manufactured specifically for use as check dams are also being used, and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Straw bales can also be used for check dams and can work if correctly installed; but in practice, straw bale check dams have a high failure rate. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam must completely span the ditch

or swale to prevent washout. The rock used must be large enough to stay in place given the expected design flow through the channel.

Log check dams are usually constructed of 4 to 6 in. diameter logs. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

Gravel bag and sandbag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet.

Manufactured products should be installed in accordance with the manufacturer's instructions.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- Backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap must be cleaned following each storm event.
- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.
- Gravel bags may be used as check dams with the following specifications:

Materials

Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms. Sandbags used for check dams should conform to SE-8, Sandbag Barrier. Fiber rolls used for check dams should conform to SE-5, Fiber Rolls. Straw bales used for check dams should conform to SE-9, Straw Bale Barrier.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section. Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Fiber rolls and straw bales must be trenched in and firmly staked in place.

Costs

Cost consists of only installation costs if materials are readily available. If material must be imported, costs may increase. For material costs, see SE-5, SE-6, SE-8 and SE-9.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Replace missing rock, bags, bales, etc. Replace bags or bales that have degraded or have become damaged.
- If the check dam is used as a sediment capture device, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

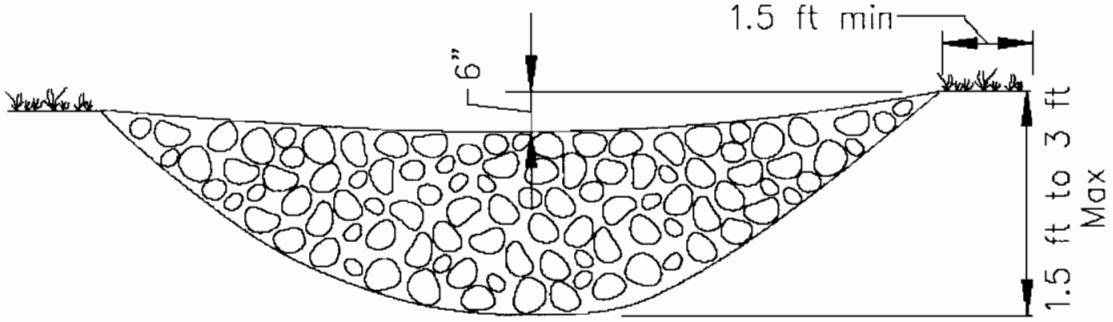
References

Draft – Sedimentation and Erosion Control, and Inventory of Current Practices, USEPA, April 1990.

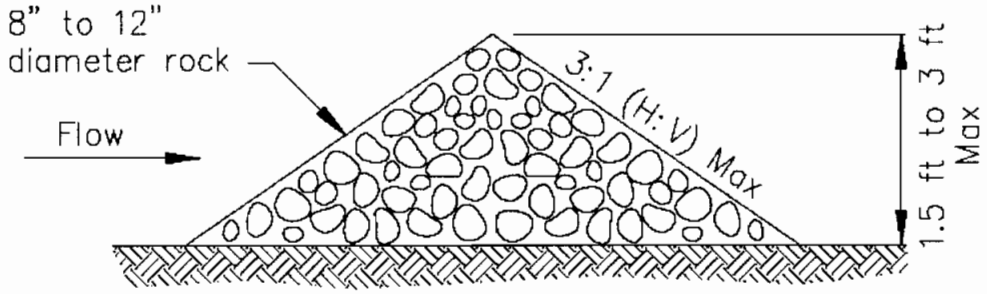
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

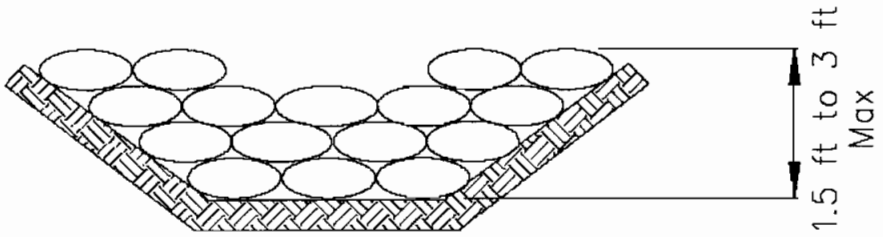


ELEVATION



TYPICAL ROCK CHECK DAM SECTION

ROCK CHECK DAM
NOT TO SCALE



GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE

Street Sweeping and Vacuuming SE-7

Objectives		
EC	Erosion Control	
SE	Sediment Control	☒
TR	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.

- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.
- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from $58/hour (3 yd^3 hopper) to $88/hour (9 yd^3 hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

Inspection and Maintenance

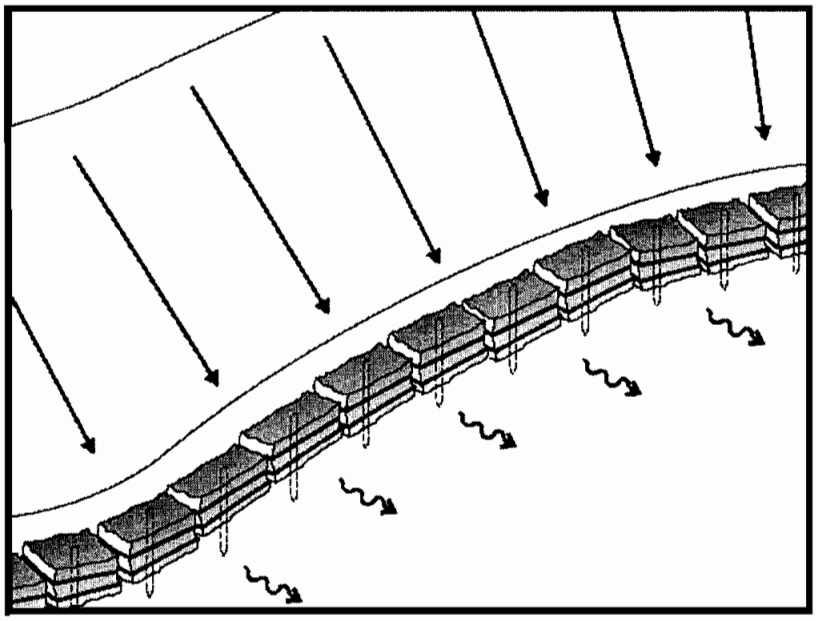
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Straw Bale Barrier SE-9



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A straw bale barrier is a series of straw bales placed on a level contour to intercept sheet flows. Straw bale barriers pond sheet- flow runoff, allowing sediment to settle out.

Suitable Applications

Straw bale barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow

- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

Straw bale barriers:

- Are not to be used for extended periods of time because they tend to rot and fall apart
- Are suitable only for sheet flow on slopes of 10 % or flatter
- Are not appropriate for large drainage areas, limit to one acre or less
- May require constant maintenance due to rotting
- Are not recommended for concentrated flow, inlet protection, channel flow, and live streams
- Cannot be made of bale bindings of jute or cotton
- Require labor-intensive installation and maintenance
- Cannot be used on paved surfaces
- Should not to be used for drain inlet protection
- Should not be used on lined ditches
- May introduce undesirable non-native plants to the area

Implementation

General

A straw bale barrier consists of a row of straw bales placed on a level contour. When appropriately placed, a straw bale barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. Straw bale barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils.

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. Use of straw bale barriers in accordance with this BMP should produce acceptable results.

Design and Layout

- Locate straw bale barriers on a level contour.
  - Slopes up to 10:1 (H:V): Straw bales should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the toe of slope.
  - Slopes greater than 10:1 (H:V): Not recommended.

- Turn the ends of the straw bale barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the barrier away from the slope toe to facilitate cleaning. To prevent flow behind the barrier, sand bags can be placed perpendicular to the barrier to serve as cross barriers.
- Drainage area should not exceed 1 acre, or 0.25 acre per 100 ft of barrier.
- Maximum flow path to the barrier should be limited to 100 ft.
- Straw bale barriers should consist of two parallel rows.
  - Butt ends of bales tightly
  - Stagger butt joints between front and back row
  - Each row of bales must be trenched in and firmly staked
- Straw bale barriers are limited in height to one bale laid on its side.
- Anchor bales with either two wood stakes or four bars driven through the bale and into the soil. Drive the first stake towards the butt joint with the adjacent bale to force the bales together.
- See attached figure for installation details.

Materials

- ***Straw Bale Size:*** Each straw bale should be a minimum of 14 in. wide, 18 in. in height, 36 in. in length and should have a minimum mass of 50 lbs. The straw bale should be composed entirely of vegetative matter, except for the binding material.
- ***Bale Bindings:*** Bales should be bound by steel wire, nylon or polypropylene string placed horizontally. Jute and cotton binding should not be used. Baling wire should be a minimum diameter of 14 gauge. Nylon or polypropylene string should be approximately 12 gauge in diameter with a breaking strength of 80 lbs force.
- ***Stakes:*** Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Steel bar reinforcement should be equal to a #4 designation or greater. End protection should be provided for any exposed bar reinforcement.

Costs

Straw bales cost $5 - $7 each. Adequate labor should be budgeted for installation and maintenance.

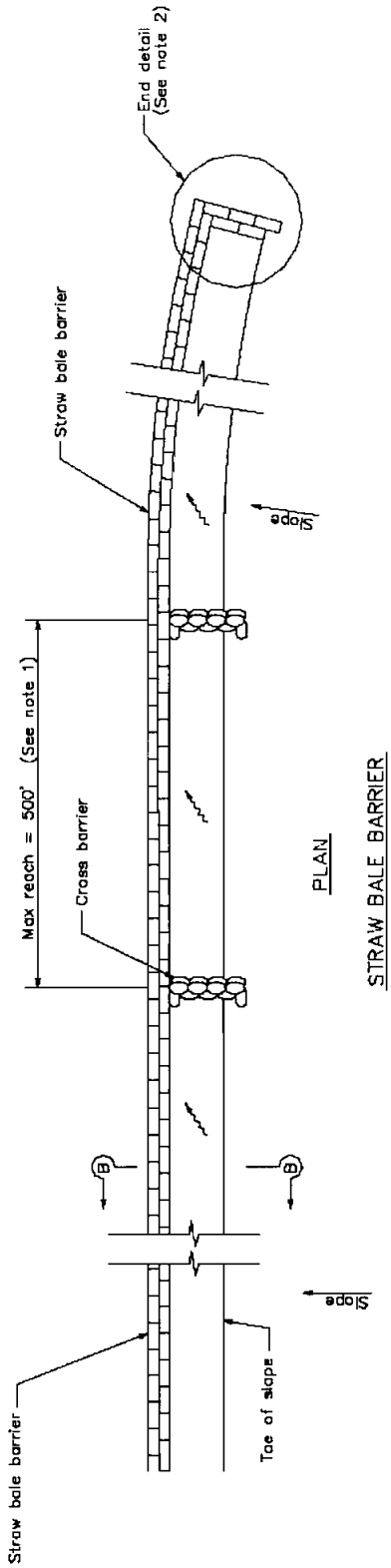
Inspection and Maintenance

Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Straw bales degrade, especially when exposed to moisture. Rotting bales will need to be replaced on a regular basis.
- Replace or repair damaged bales as needed.
- Repair washouts or other damages as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove straw bales when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



PLAN

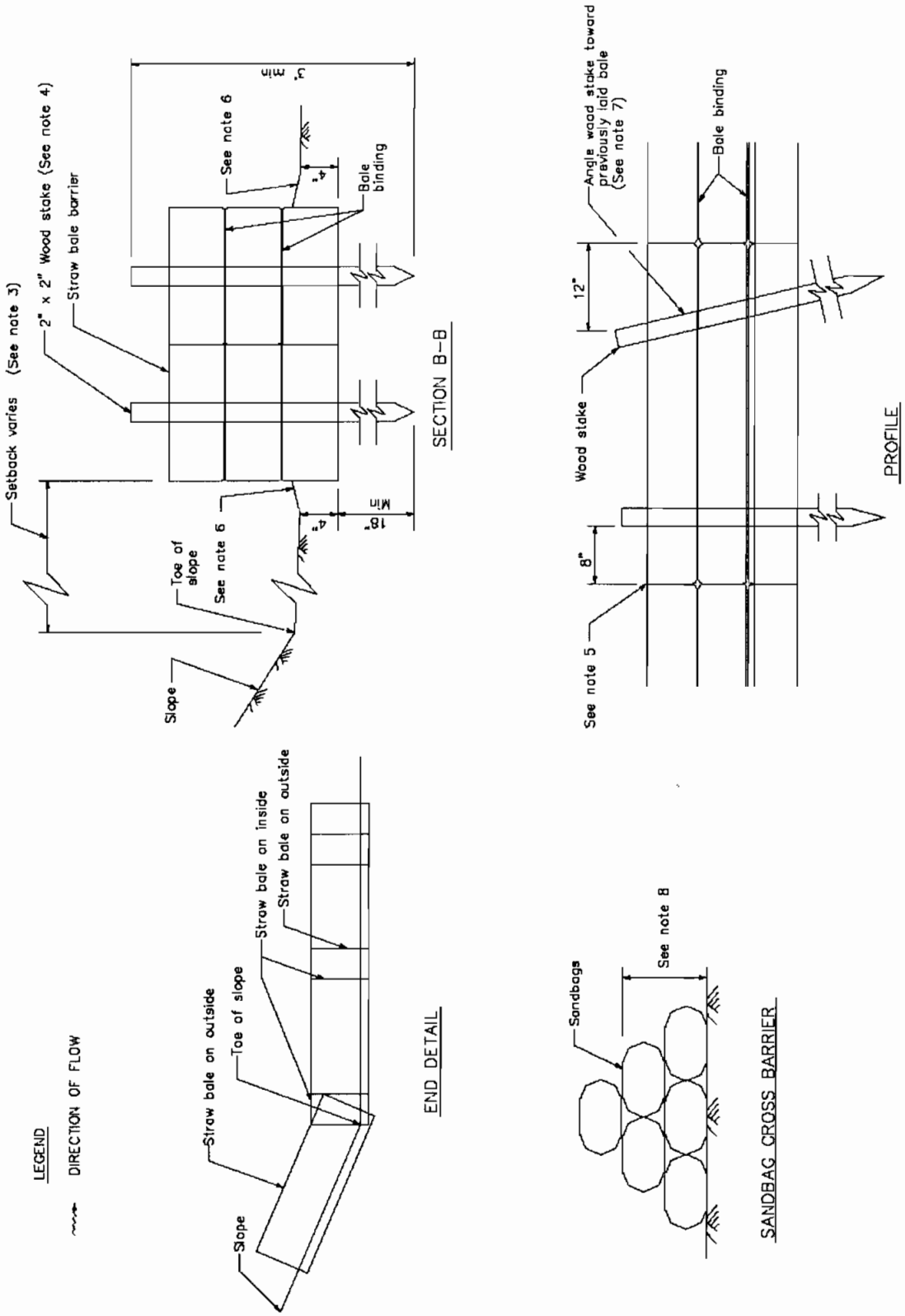
STRAW BALE BARRIER

LEGEND

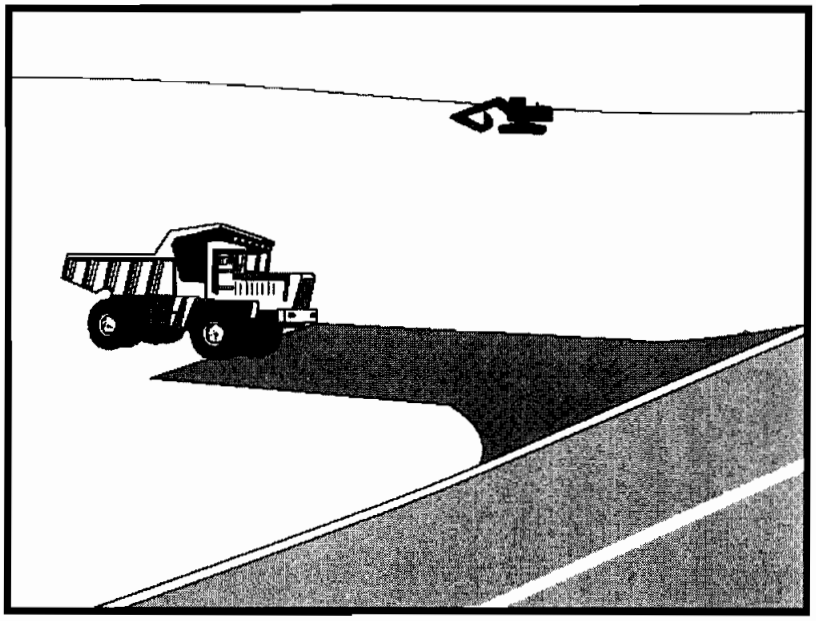
DIRECTION OF FLOW

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. The end of barrier shall be turned up slope.
3. Dimension may vary to fit field condition.
4. Stake dimensions are nominal.
5. Place straw bales tightly together.
6. Tamp embedment spoils against sides of installed bales.
7. Drive angled wood stake before vertical stake to ensure tight abutment to adjacent bale.
8. Sandbag cross barriers should be a min of 1/2 and a max of 2/3 the height of the linear barrier.
9. Sandbag rows and layers should be offset to eliminate gaps.


Setback varies (See note 3)
2" x 2" Wood stake (See note 4)
Straw bale barrier
See note 6
3' min
4"
Bale binding
Toe of slope
See note 6
4"
18" Min
Slope
SECTION B-B
Angle wood stake toward previously laid bale (See note 7)
Bale binding
12"
Wood stake
8"
See note 5
PROFILE
LEGEND
DIRECTION OF FLOW
Straw bale on outside
Toe of slope
Straw bale on inside
Straw bale on outside
Slope
END DETAIL
Sandbags
See note 8
SANDBAG CROSS BARRIER

Stabilized Construction Entrance/Exit TC-1



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- 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.

Implementation

General

A stabilized construction entrance is a 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 tracking 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 the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be built on level ground. Advantages of the Stabilized Construction Entrance/Exit is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones.
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft minimum, and 30 ft minimum width.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
- Implement SE-7, Street Sweeping and Vacuuming, as needed.
- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.
- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.
- Keep all temporary roadway ditches clear.
- Check for damage and repair as needed.
- 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

Costs

Average annual cost for installation and maintenance may vary from $1,200 to $4,800 each, averaging $2,400 per entrance. Costs will increase with addition of washing rack, and sediment trap. With wash rack, costs range from $1,200 - $6,000 each, averaging $3,600 per entrance.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

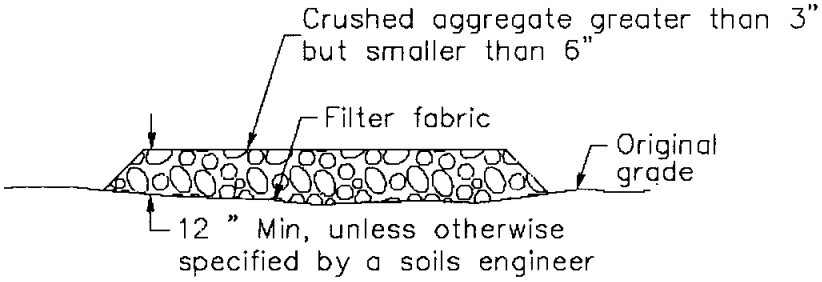
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

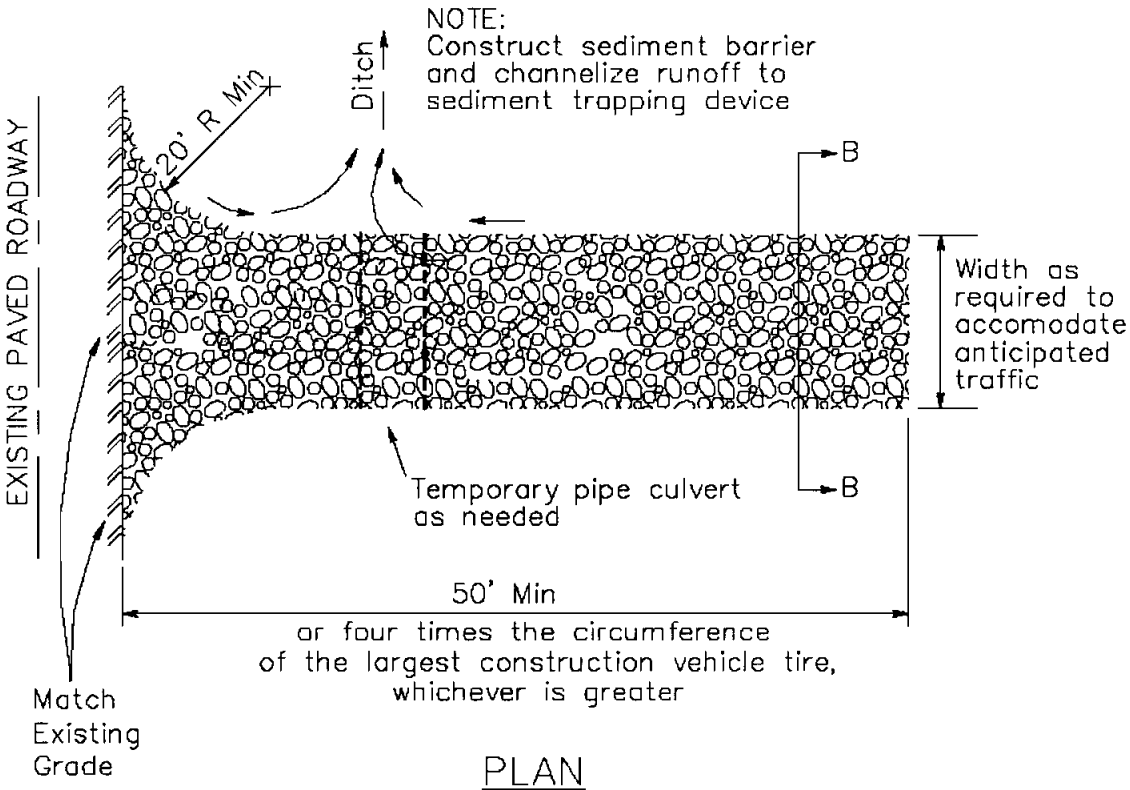
Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters, EPA 840-B-9-002, USEPA, Office of Water, Washington, DC, 1993.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Stabilized Construction Entrance/Exit TC-1

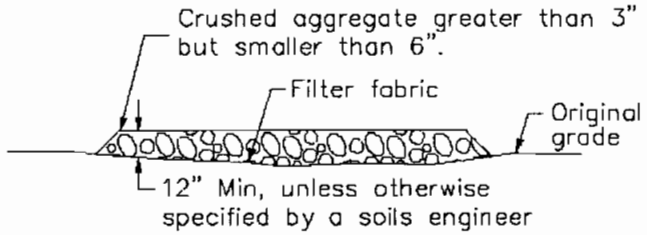


SECTION B–B
NTS



PLAN
NTS

Stabilized Construction Entrance/Exit TC-1



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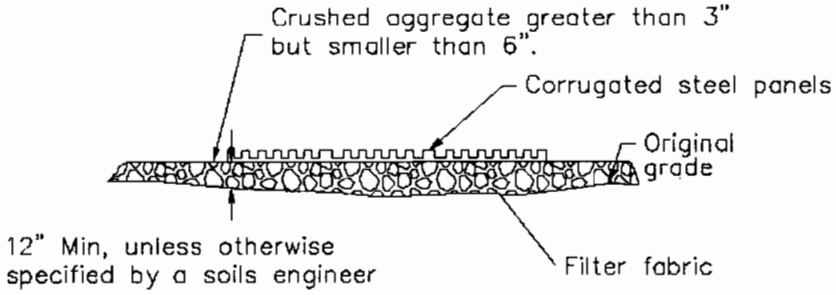

SECTION A–A
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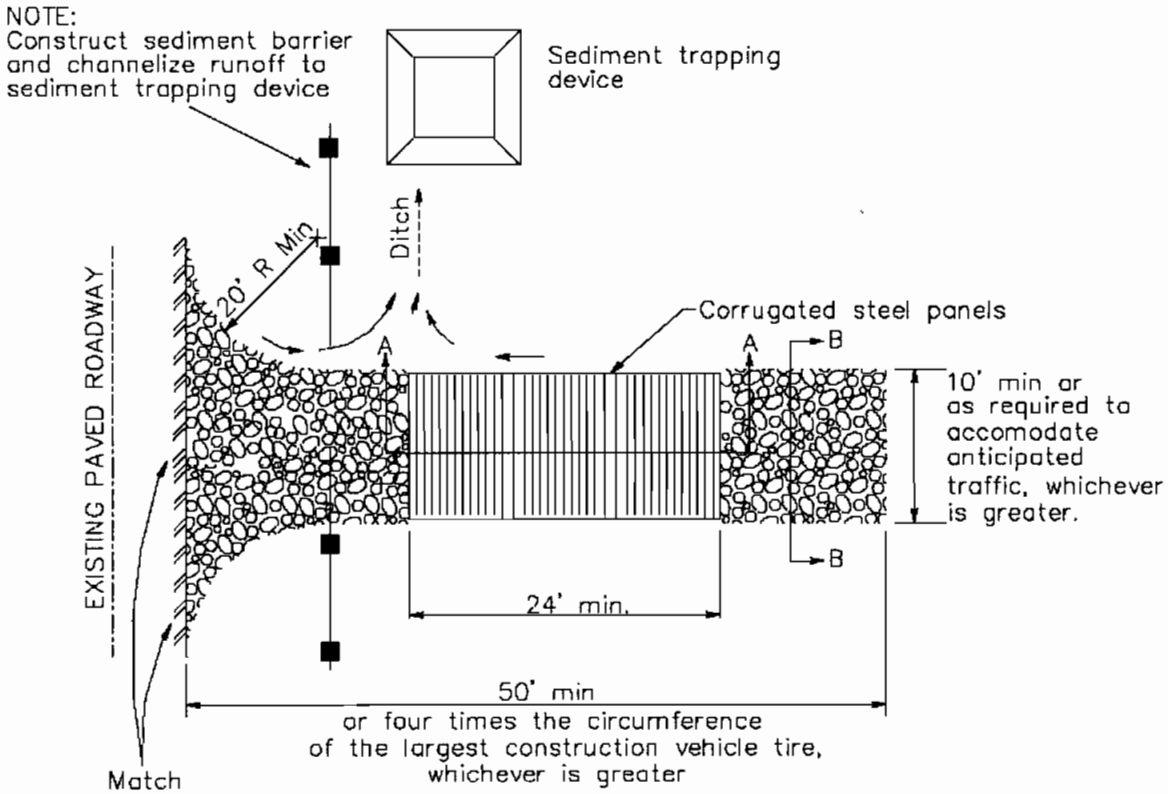
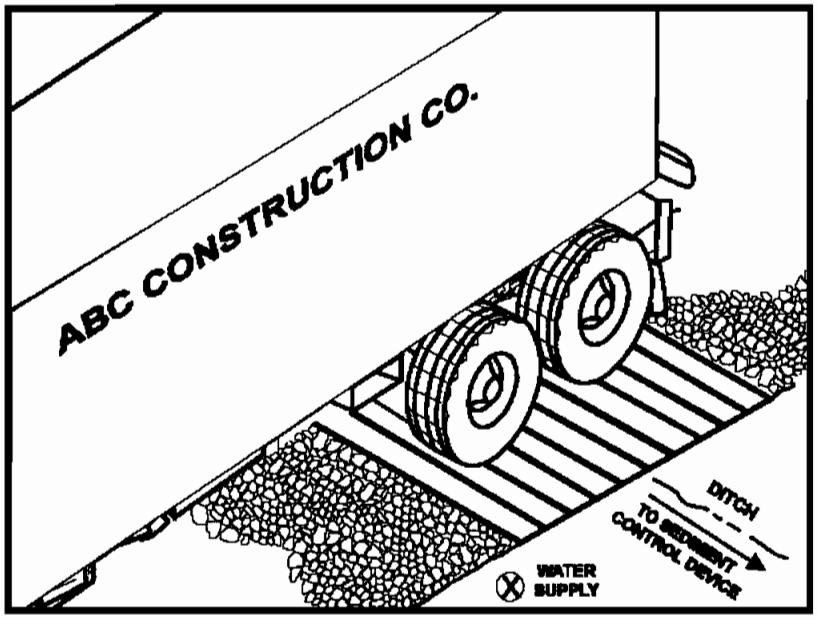


PLAN
NTS

Entrance/Outlet Tire Wash TC-3



Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

TC-1 Stabilized Construction Entrance/Exit

Description and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and under carriages and to prevent sediment from being transported onto public roadways.

Suitable Applications

Tire washes may be used on construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.

Limitations

- The tire wash requires a supply of wash water.
- A turnout or doublewide exit is required to avoid having entering vehicles drive through the wash area.
- Do not use where wet tire trucks leaving the site leave the road dangerously slick.

Implementation

- Incorporate with a stabilized construction entrance/exit. See TC-1, Stabilized Construction Entrance/Exit.
- Construct on level ground when possible, on a pad of coarse aggregate greater than 3 in. but smaller than 6 in. A geotextile fabric should be placed below the aggregate.
- Wash rack should be designed and constructed/manufactured for anticipated traffic loads.

- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device. The drainage ditch should be of sufficient grade, width, and depth to carry the wash runoff.
- Use hoses with automatic shutoff nozzles to prevent hoses from being left on.
- Require that all employees, subcontractors, and others that leave the site with mud caked tires and undercarriages to use the wash facility.
- Implement SC-7, Street Sweeping and Vacuuming, as needed.

Costs

Costs are low for installation of wash rack.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance.
- Inspect routinely for damage and repair as needed.

References

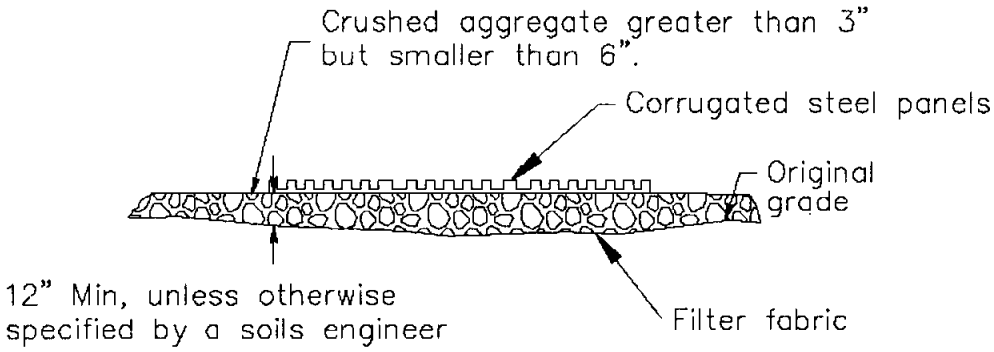
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.



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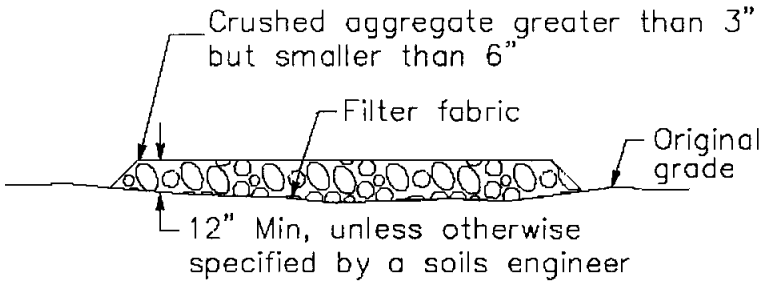

SECTION B–B
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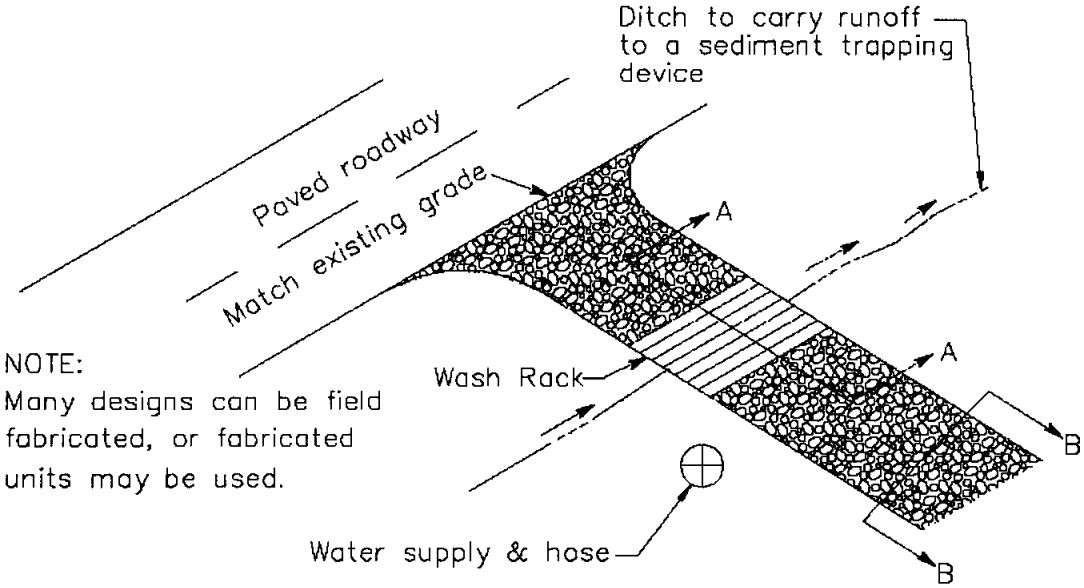
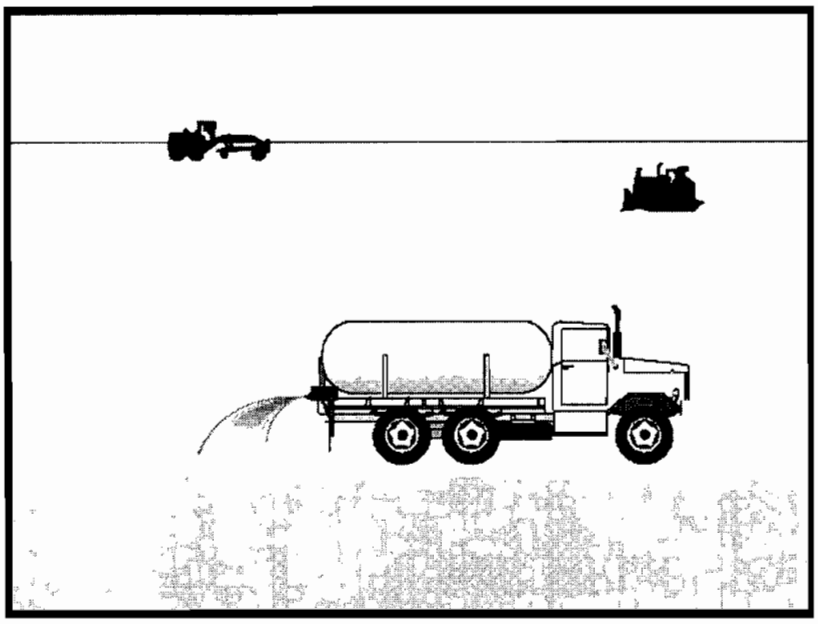


TYPICAL TIRE WASH
NOT TO SCALE

Wind Erosion Control WE-1



Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	☑
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Wind erosion or dust control consists of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

Suitable Applications

Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Sediment tracking onto paved roads
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective.
- Over watering may cause erosion.

- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Effectiveness depends on soil, temperature, humidity, and wind velocity.
- Chemically treated sub grades 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.

Implementation

General

California's Mediterranean climate, with short wet seasons and long hot dry seasons, allows the soils to thoroughly dry out. During these dry seasons, construction activities are at their peak, and disturbed 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). Approximately 90 percent of these small particles are considered to be dust. Existing dust control regulations by local agencies, municipal departments, public works department, and public health departments are in place in some regions within California.

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 and 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 BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table shows dust control practices that can be applied to site conditions that cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel 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 can be employed for areas of occasional or no construction traffic. Preventive measures would include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph, and controlling the number and activity of vehicles on a site at any given time.

SITE CONDITION	DUST CONTROL PRACTICES								
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Silt Fences	Temporary Gravel Construction Entrances/Equipment Wash Down	Haul Truck Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	X	X	X	X	X				X
Disturbed Areas Subject to Traffic			X	X	X		X		X
Material Stock Pile Stabilization			X	X		X			X
Demolition			X				X	X	
Clearing/ Excavation			X	X		X			X
Truck Traffic on Unpaved Roads			X	X	X		X	X	
Mud/Dirt Carry Out					X		X		

Additional preventive measures include:

- Schedule construction activities to minimize exposed area (EC-1, Scheduling).
- 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.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Direct most construction traffic to stabilized roadways within the project site.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.

- If reclaimed waste water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality Control Board requirements. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, "NON-POTABLE WATER - DO NOT DRINK."

- Materials applied as temporary soil stabilizers and soil binders also generally provide wind erosion control benefits.

- Pave 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 inactive 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.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater.

Costs

Installation costs for water and chemical dust suppression are low, but annual costs may be quite high since these measures are effective for only a few hours to a few days.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.

- Check areas protected to ensure coverage.

- Most dust control measures require frequent, often daily, or multiple times per day attention.

References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

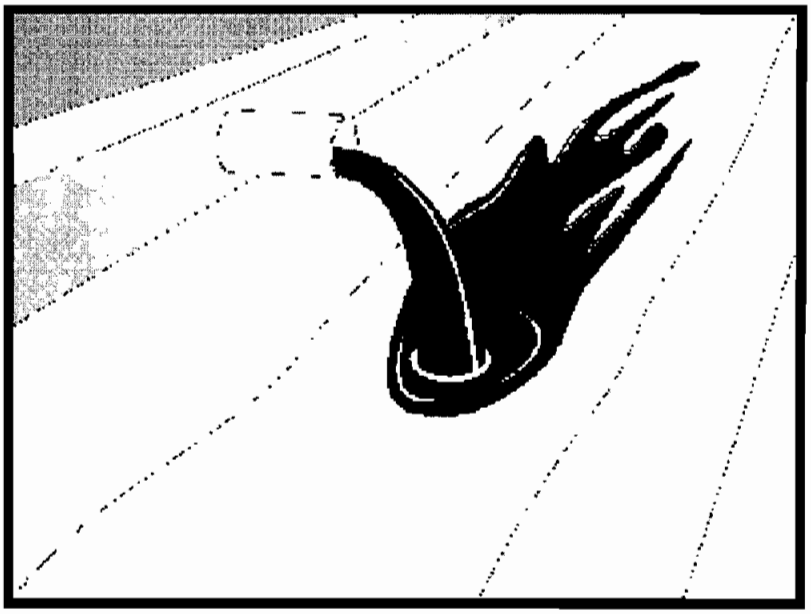
California Air Pollution Control Laws, California Air Resources Board, 1992.

Caltrans, Standard Specifications, Sections 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative".

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Illicit Connection/Discharge NS-6



Objectives		
EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Procedures and practices designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Illicit connection/discharge and reporting is applicable anytime an illicit connection or discharge is discovered or illegally dumped material is found on the construction site.

Limitations

Illicit connections and illegal discharges or dumping, for the purposes of this BMP, refer to discharges and dumping caused by parties other than the contractor. If pre-existing hazardous materials or wastes are known to exist onsite, they should be identified in the SWPPP and handled as set forth in the SWPPP.

Implementation

Planning

- Review the SWPPP. Pre-existing areas of contamination should be identified and documented in the SWPPP.
- Inspect site before beginning the job for evidence of illicit connections, illegal dumping or discharges. Document any pre-existing conditions and notify the owner.

- Inspect site regularly during project execution for evidence of illicit connections, illegal dumping or discharges.
- Observe site perimeter for evidence for potential of illicitly discharged or illegally dumped material, which may enter the job site.

Identification of Illicit Connections and Illegal Dumping or Discharges

- **General** – unlabeled and unidentifiable material should be treated as hazardous.
- **Solids** - Look for debris, or rubbish piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- **Liquids** - signs of illegal liquid dumping or discharge can include:
  - Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Abnormal water flow during the dry weather season
- **Urban Areas** - Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:
  - Abnormal water flow during the dry weather season
  - Unusual flows in sub drain systems used for dewatering
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Excessive sediment deposits, particularly adjacent to or near active offsite construction projects
- **Rural Areas** - Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:
  - Abnormal water flow during the non-irrigation season
  - Non-standard junction structures
  - Broken concrete or other disturbances at or near junction structures

Reporting

Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery. For illicit connections or discharges to the storm drain system, notify the local stormwater management agency. For illegal dumping, notify the local law enforcement agency.

Cleanup and Removal

The responsibility for cleanup and removal of illicit or illegal dumping or discharges will vary by location. Contact the local stormwater management agency for further information.

Costs

Costs to look for and report illicit connections and illegal discharges and dumping are low. The best way to avoid costs associated with illicit connections and illegal discharges and dumping is to keep the project perimeters secure to prevent access to the site, to observe the site for vehicles that should not be there, and to document any waste or hazardous materials that exist onsite before taking possession of the site.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect the site regularly to check for any illegal dumping or discharge.
- Prohibit employees and subcontractors from disposing of non-job related debris or materials at the construction site.
- Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery.

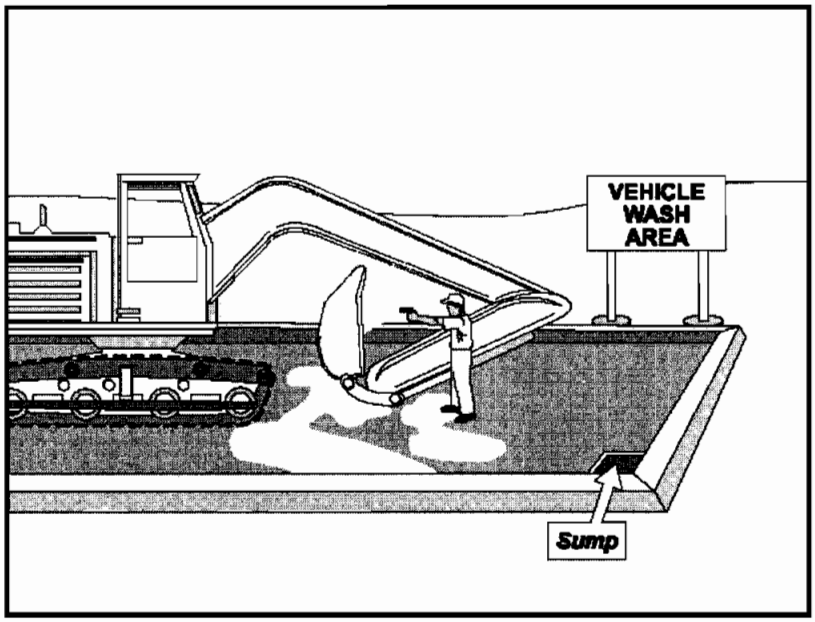
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle and Equipment Cleaning NS-8



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

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

Potential Alternatives

None

Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

If washing operations are to take place onsite, then:

- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates.
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried, and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited.
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff
  - Configured with a sump to allow collection and disposal of wash water
  - No discharge of wash waters to storm drains or watercourses
  - Used only when necessary
- When cleaning vehicles and equipment with water:
  - Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered
  - Use positive shutoff valve to minimize water usage
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater

Costs

Cleaning vehicles and equipment at an offsite facility may reduce overall costs for vehicle and equipment cleaning by eliminating the need to provide similar services onsite. When onsite cleaning is needed, the cost to establish appropriate facilities is relatively low on larger, long-duration projects, and moderate to high on small, short-duration projects.

Inspection and Maintenance

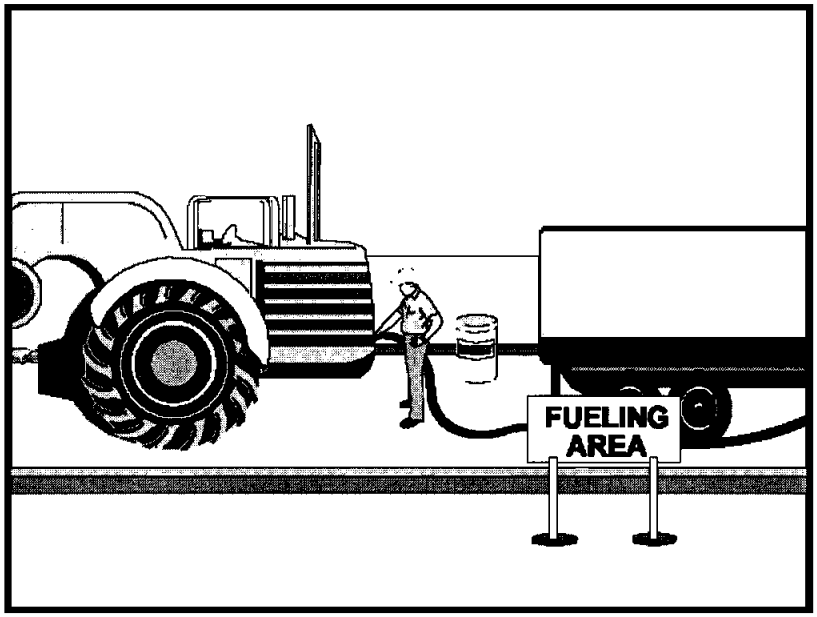
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspection and maintenance is minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Swisher, R.D. Surfactant Biodegradation, Marcel Decker Corporation, 1987.

Vehicle and Equipment Fueling NS-9



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage "topping-off" of fuel tanks.

- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should be disposed of properly after use.
- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid 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 large excavators, 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.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.
- Dedicated fueling areas should be protected from stormwater runon and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- 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.

Inspection and Maintenance

- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.
- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

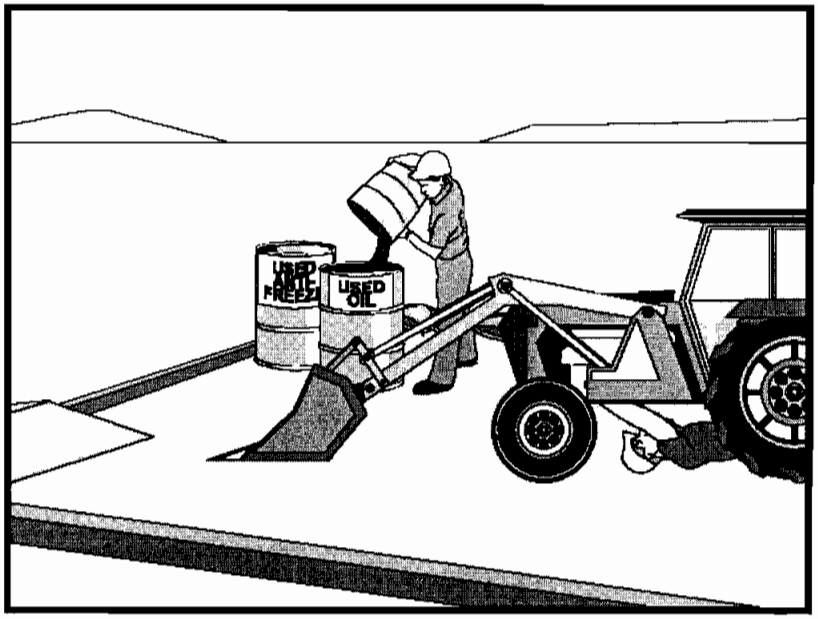
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle & Equipment Maintenance NS-10



Objectives		
EC	Erosion Control	
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Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8, Vehicle and Equipment Cleaning, and NS-9, Vehicle and Equipment Fueling.

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.
- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.
- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They 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 with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the 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 and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,-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. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can 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.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Keep ample supplies of spill cleanup materials onsite.
- Maintain waste fluid containers in leak proof condition.
- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

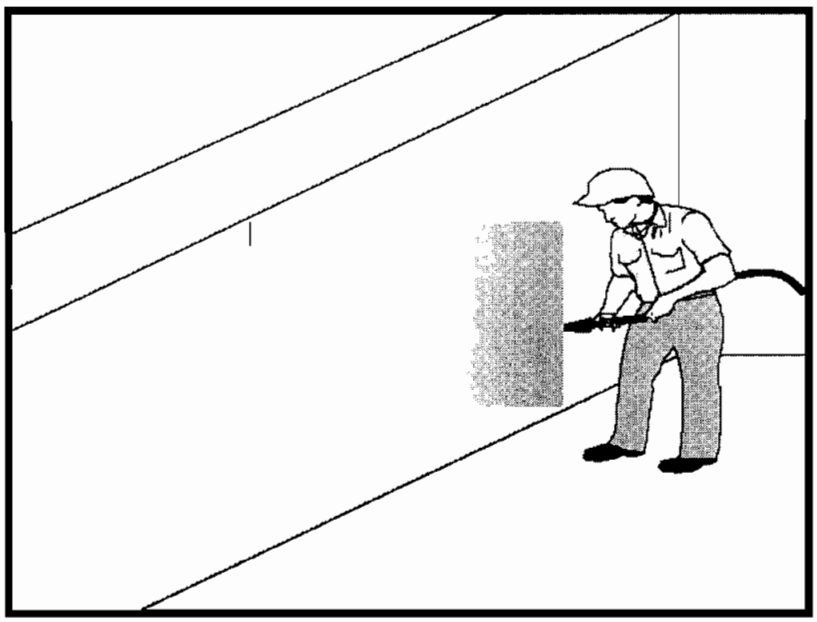
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Concrete Curing NS-12



Objectives		
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WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Concrete curing is used in the construction of structures such as bridges, retaining walls, pump houses, large slabs, and structured foundations. Concrete curing includes the use of both chemical and water methods. Discharges of stormwater and non-stormwater exposed to concrete during curing may have a high pH and may contain chemicals, metals, and fines. Proper procedures reduce or eliminate the contamination of stormwater runoff during concrete curing.

Suitable Applications

Suitable applications include all projects where Portland Cement Concrete (PCC) and concrete curing chemicals are placed where they can be exposed to rainfall, runoff from other areas, or where runoff from the PCC will leave the site.

Limitations

None identified.

Implementation

Chemical Curing

- Avoid over spray of curing compounds.
- Minimize the drift of chemical cure as much as possible by applying the curing compound close to the concrete surface. Apply an amount of compound that covers the surface, but does not allow any runoff of the compound.

- Use proper storage and handling techniques for concrete curing compounds. Refer to WM-1, Material Delivery and Storage.
- Protect drain inlets prior to the application of curing compounds.
- Refer to WM-4, Spill Prevention and Control.

Water Curing for Bridge Decks, Retaining Walls, and other Structures

- Direct cure water away from inlets and watercourses to collection areas for infiltration or other means of removal in accordance with all applicable permits.
- Collect cure water at the top of slopes and transport or dispose of water in a non-erodible manner. See EC-9 Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

Costs

All of the above measures are generally low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- Inspect cure containers and spraying equipment for leaks.

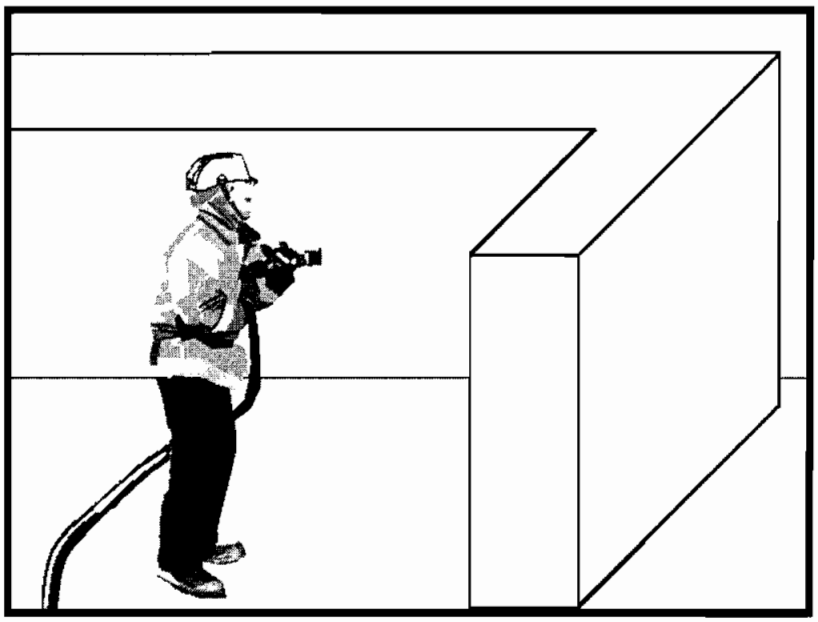
References

Blue Print for a Clean Bay-Construction-Related Industries: Best Management Practices for Stormwater Pollution Prevention; Santa Clara Valley Non Point Source Pollution Control Program, 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Concrete Finishing NS-13



Objectives		
EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances. Methods include sand blasting, shot blasting, grinding, or high pressure water blasting. Stormwater and non-stormwater exposed to concrete finishing by-products may have a high pH and may contain chemicals, metals, and fines. Proper procedures and implementation of appropriate BMPs can minimize the impact that concrete-finishing methods may have on stormwater and non-stormwater discharges.

Suitable Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

Limitations

None identified.

Implementation

- Collect and properly dispose of water from high-pressure water blasting operations.
- Collect contaminated water from blasting operations at the top of slopes. Transport or dispose of contaminated water while using BMPs such as those for erosion control. Refer to EC-9, Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.

- Direct water from blasting operations away from inlets and watercourses to collection areas for infiltration or other means of removal (dewatering). Refer to NS-2 De-Watering Operations.
- Protect inlets during sandblasting operations. Refer to SE-10, Storm Drain Inlet Protection.
- Refer to WM-8, Concrete Waste Management for disposal of concrete based debris.
- Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.
- When blast residue contains a potentially hazardous waste, refer to WM-6, Hazardous Waste Management.

Costs

These measures are generally of low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Sweep or vacuum up debris from sandblasting at the end of each shift.
- At the end of each work shift, remove and contain liquid and solid waste from containment structures, if any, and from the general work area.

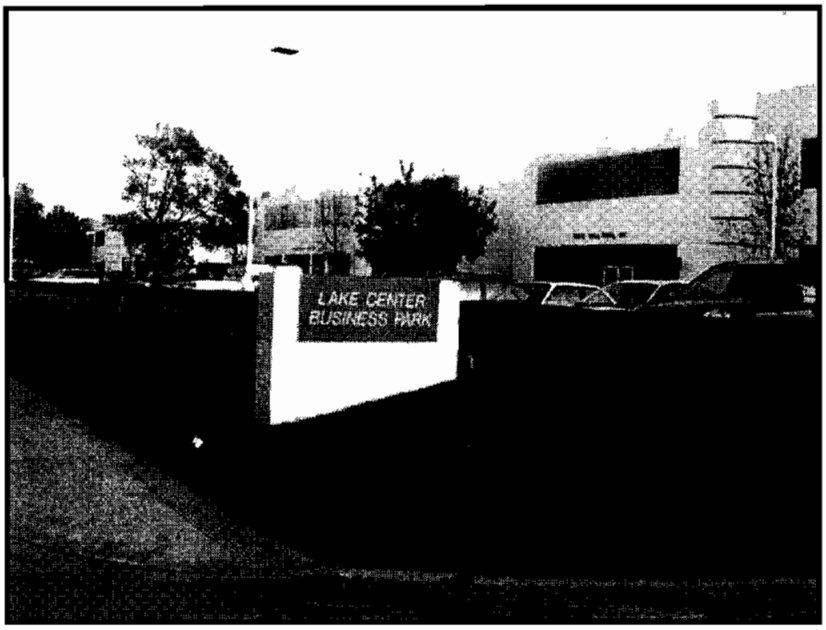
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Building & Grounds Maintenance SC-41



Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	
Organics	

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.

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- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

Suggested Protocols

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.
- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.

- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Training

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the nature of the staff.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Other Considerations

Alternative pest/weed controls may not be available, suitable, or effective in many cases.

Requirements

Costs

- Cost will vary depending on the type and size of facility.
- Overall costs should be low in comparison to other BMPs.

Maintenance

Sweep paved areas regularly to collect loose particles. Wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

Building fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

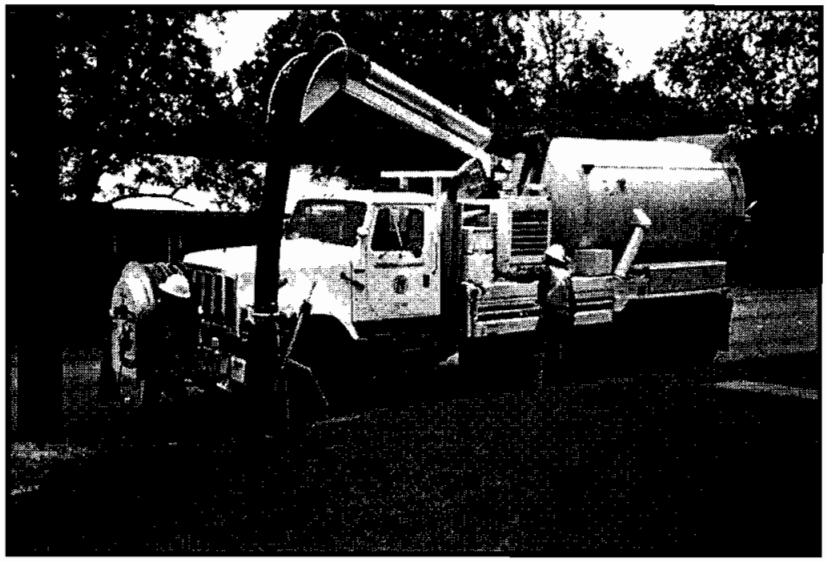
Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Drainage System Maintenance SC-44



Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	✓
Nutrients	
Trash	✓
Metals	
Bacteria	✓
Oil and Grease	
Organics	

Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff and stormwater that may contain certain pollutants. The protocols in this fact sheet are intended to reduce pollutants reaching receiving waters through proper conveyance system operation and maintenance.

Approach

Pollution Prevention

Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

Suggested Protocols

Catch Basins/Inlet Structures

- Staff should regularly inspect facilities to ensure compliance with the following:
  - Immediate repair of any deterioration threatening structural integrity.
  - Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
  - Stenciling of catch basins and inlets (see SC34 Waste Handling and Disposal).

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- Clean catch basins, storm drain inlets, and other conveyance structures before the wet season to remove sediments and debris accumulated during the summer.
- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed. Do not dewater near a storm drain or stream.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect and pump flushed effluent to the sanitary sewer for treatment whenever possible.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.
- Conduct routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

Open Channel

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural (emphasis added) state of any river, stream, or lake in California, must enter into a Steam or Lake Alteration Agreement with the Department of Fish and Game. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Federal Corps of Engineers and USFWS.

Illicit Connections and Discharges

- Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:
  - Is there evidence of spills such as paints, discoloring, etc?

- Are there any odors associated with the drainage system?
- Record locations of apparent illegal discharges/illicit connections?
- Track flows back to potential dischargers and conduct aboveground inspections. This can be done through visual inspection of upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- Eliminate the discharge once the origin of flow is established.

- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Illegal Dumping

- Inspect and clean up hot spots and other storm drainage areas regularly where illegal dumping and disposal occurs.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots
  - Types and quantities (in some cases) of wastes
  - Patterns in time of occurrence (time of day/night, month, or year)
  - Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
  - Responsible parties
- Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Training

- Train crews in proper maintenance activities, including record keeping and disposal.
- Allow only properly trained individuals to handle hazardous materials/wastes.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).

- OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
- Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Spill Response and Prevention

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.
- Refer to fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Other Considerations (Limitations and Regulations)

- Clean-up activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.
- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, liquid/sediment disposal, and prohibition against disposal of flushed effluent to sanitary sewer in some areas.
- Regulations may include adoption of substantial penalties for illegal dumping and disposal.
- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.

Requirements

Costs

- An aggressive catch basin cleaning program could require a significant capital and O&M budget.
- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The primary cost is for staff time. Cost depends on how aggressively a program is implemented. Other cost considerations for an illegal dumping program include:
  - Purchase and installation of signs.
  - Rental of vehicle(s) to haul illegally-disposed items and material to landfills.
  - Rental of heavy equipment to remove larger items (e.g., car bodies) from channels.
  - Purchase of landfill space to dispose of illegally-dumped items and material.

- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.

Supplemental Information

Further Detail of the BMP

Storm Drain Flushing

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing resuspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. Deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to recollect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75% for organics and 55-65% for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used or that fire hydrant line flushing coincide with storm sewer flushing.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

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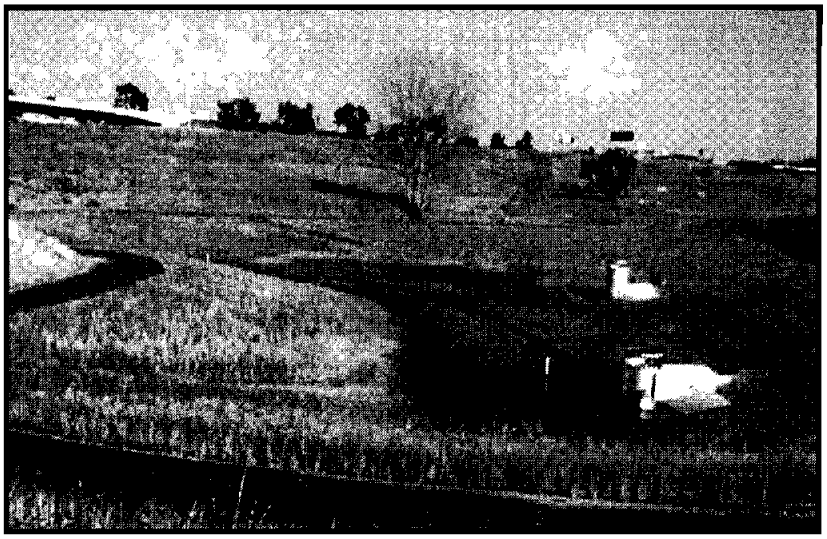
Extended Detention Basin TC-22



Maintenance Concerns, Objectives, and Goals

- Vector/Pest Control
- Sediment and Trash Removal
- Vegetation/Landscape Maintenance
- Re-suspension of settled material
- Clogging of the Outlet

General Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 72 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

Inspection/Maintenance Considerations

Inspections should be conducted semi-annually and after significant storm events to identify potential problems early. Most maintenance efforts will need to be directed toward vegetation management and vector control, which may focus on basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the basin dewaters completely (recommended 72 hour residence time or less) to prevent creating mosquito and other vector habitats.

Targeted Constituents

✓	Sediment	▲
✓	Nutrients	●
✓	Trash	■
✓	Metals	▲
✓	Bacteria	▲
✓	Oil and Grease	▲
✓	Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

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Inspection Activities	Suggested Frequency
■ Inspect after several storm events for bank stability, vegetation growth, and to determine if the desired residence time has been achieved. ■ Inspect outlet structure for evidence of clogging or outflow release velocities that are greater than design flow.	Post construction
■ Inspect for the following issues: differential settlement, cracking; erosion of pond banks or bottom, leakage, or tree growth on the embankment; the condition of the riprap in the inlet, clogging of outlet and pilot channels; standing water, slope stability, presence of burrows; sediment accumulation in the basin, forebay, and outlet structures; trash and debris, and the vigor and density of the grass turf on the basin side slopes and floor.	Semi-annual, after significant storms, or more frequent
■ Inspect for the following issues: subsidence, damage to the emergency spillway; inadequacy of the inlet/outlet channel erosion control measures; changes in the condition of the pilot channel, accumulated sediment volume, and semi-annual inspection items.	Annual
■ During inspections, changes to the extended storage pond or the contributing watershed should be noted, as these may affect basin performance.	Annual inspection
Maintenance Activities	**Suggested Frequency**
■ If necessary, modify the outlet orifice to achieve design values if inspection indicates modifications are necessary. ■ Repair undercut or eroded areas. ■ Mow side slopes. ■ Manage pesticide and nutrients. ■ Remove litter and debris. ■ Control mosquitoes as necessary.	As needed
■ Remove accumulated trash and debris from the basin, around the riser pipe, side slopes, embankment, emergency spillway, and outflow trash racks. The frequency of this activity may be altered to meet specific site conditions. ■ Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.	Semi-annual, or more frequent, as needed
■ Seed or sod to restore dead or damaged ground cover. ■ Repair erosion to banks and bottom as required.	Annual maintenance (as needed)
■ Supplement wetland plants if a significant portion have not been established (at least 50% of the surface area). ■ Remove nuisance plant species.	Annual maintenance (if needed)
■ Remove sediment from the forebay to reduce frequency of main basin cleaning.	3- to 5-year maintenance
■ Monitor sediment accumulation and remove accumulated sediment and regrade about every 10 years or when the accumulated sediment volume exceeds 10-20% of the basin volume, or when accumulation reaches 6 inches or if resuspension is observed. Clean in early spring so vegetation damaged during cleaning has time to re-establish.	Every 10-25 years

Additional Information

In most cases, sediment from extended detention basin does not contain toxins at levels posing a hazardous concern. Studies to date indicate that pond sediments are likely to meet toxicity limits and can be safely landfilled or disposed of onsite. Onsite sediment disposal is always preferable (if local authorities permit it) as long as the sediments are deposited away from the shoreline to prevent their re-entry into the pond.

Sediments should be tested for toxin in compliance with current disposal requirements if land uses in the catchment include commercial or industrial zones, or if visual or olfactory indications of pollution are noticed.

References

Metropolitan Council, Urban Small Sites Best Management Practices Manual. Available at: http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm

U.S. Environmental Protection Agency, Post-Construction Stormwater Management in New Development & Redevelopment BMP Factsheets. Available at: cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_files.cfm

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

Attachment C

BLACK & VEATCH

Calculation Record

Client Name: LS Power Page 1 of 11

Project Name: South Bay Energy Facility Project No.: 136469

Calculation Title: Drainage Calculations

Calculation No./File No.: 52.5906.01

Calculation Is: (check all that apply) ☐ Preliminary ☒ Final ☐ Nuclear Safety-Related

Objective Drainage Calculations for South Bay Energy Facility

Unverified Assumptions Requiring Subsequent Verification

No.	Assumption	Verified By	Date

See Page _____ of this calculation for additional assumptions.

This Section Used for Computer Generated Calculations

Program Name/Number: _____ Version: _____

Evidence of or reference to computer program verification, if applicable:

Bases or reference thereto supporting application of the computer program to the physical problem:

Review and Approval

Rev	Prepared By	Date	Verified By	Date	Approved By	Date
	Robert Nasset	5/15/06	MJ Tuttle	5/22/06	C. J. Schultz	5/22/06

BLACK & VEATCH

COMPUTER GENERATED CALCULATIONS

Owner: LS Power Computed By: G. V. Johnson

Plant: South Bay Energy Facility Unit: Date: May 16 20 06

Project No.: 136469 File No.: 52.5406.01

Title: Stormwater Detention Basin Analysis

PROGRAM NO.: HEC-1 VERSION: 4.1

RUN DATE: 5/16/06 RUN TIME:

CASE: NO. OF PAGES: 149

STATUS*

By: G.V. Johnson Date: 5/16 20 06

REVIEW AND APPROVAL

1. Input Data Printout

   Checked By: [signature] Date: 5/22 20 06

2. Output Data Printout

   Checked By: [signature] Date: 5/22 20 06

3. Approved: C. J. Schutty Date: 5/22 20 06

*No special indication of status is required for calculations other than those that are superseded or declared void.

BLACK & VEATCH

COMPUTER GENERATED CALCULATIONS

Owner: LS Power Computed By: G.V. Johnson

Plant: South Bay Energy Facility Unit: Date: May 16 20 06

Project No.: 136469 File No.: 52.5406.01

Title: Worksheet for Circular Channel

PROGRAM NO.: FlowMaster VERSION: 5.15

RUN DATE: 5/16/06 RUN TIME:

CASE: NO. OF PAGES: 1

STATUS*

By: G.V. Johnson Date: 5/16/05 20 06

REVIEW AND APPROVAL

1. Input Data Printout

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   Checked By: [illegible] Date: 5/22 20 06

3. Approved: C. J. Schutty Date: 5/22 20 06

*No special indication of status is required for calculations other than those that are superseded or declared void.

1.0 PURPOSE: Drainage Calculations for South Bay Energy Facility

2.0 REFERENCES:

1 B&V Drawing 136469-DS-0008 (Interim Site Arrangement) Rev. B

2 B&V Drawing 136469-SS-0001 (Pre-Construction Runoff and Drainage Plan) Rev. A

3 B&V Drawings 136469-CSTF-S3000 - S3005, S3900 (Grading and Drainage Plan Sheets) Rev. A

4 San Diego County Hydrology Manual, County of San Diego - Department of Public Works - Flood Control Section - 06/01/2003 (http://www.sdcounty.ca.gov/dpw/docs/hydrologymanual.pdf)

5 Urban Hydrology for Small Watersheds, U.S. Department of Agriculture - Natural Resources Conservation Service - Conservation Engineering Division Technical Release 55

6 Civil Engineering Reference Manual for the PE Exam, 9th edition, Michael R. Lindeburg

7 San Diego County Standard Urban Stormwater Mitigation Plan (SUSMP), County of San Diego - 02/10/2003 (http://www.sdcounty.ca.gov/dpw/watersheds/land_dev/susmp.html)

3.0 CONCLUSIONS:

3.1 See "Analysis" section of this calculation for all conclusions.

4.0 PROCEDURE/METHODOLOGY OF DESIGN:

4.1 Followed procedure outlined in Chapter 4 of Reference 4 and Chapter 3 of Reference 5. Pre-development discharge will be calculated. All developed area will be routed through a detention basin. The detention basin will be designed with sufficient capacity to maintain a maximum discharge equal to pre-development discharge.

5.0 ASSUMPTIONS:

5.1 All relevant assumptions are located within the "Analysis" section of this calculation. Those requiring verification will be listed on the cover sheet.

6.0 DEFINITIONS OF UNITS AND CONSTANTS

6.1 All required definitions of units and constants are located within the "Analysis" section of this calculation.

7.0 ANALYSIS/SOLUTION:

See attached calculation for the following sections:

	Page
7.1 Pre-Development Design Parameters	5
7.2 Pre-Development Time of Concentration Calculation	6
7.3 Post-Development Design Parameters	7
7.4 Post-Development Time of Concentration Calculation	8
7.5 Determine Ditch and Trench Drain Capacity	10
7.6 Stormwater Detention Basin Stage Discharge Relationship	11

8.0 ATTACHMENTS

Attachment A	Drawings
Attachment B	Flowmaster Output
Attachment C	Precipitation Distribution
Attachment D	HEC-1 Output Files
D.1	Pre-Development Output (8 pages)
D.2	Post-Development Output
D.2.1	50-Year Post-Development Output (52 pages)
D.2.2	100-Year Post-Development Output (40 pages)
D.2.3	85th Percentile Storm Post-Development Output (49 pages)

7.1 PRE-DEVELOPMENT DESIGN PARAMETERS

DESIGN PRECIPITATION EVENTS (Appendix B of Reference 4)

	6 Hour (inches)	24 Hour (inches)
1 year	NA	NA
2 year	1.0	1.6
5 year	1.4	2.4
10 year	1.6	3.0
25 year	2.0	3.4
50 year	2.3	3.8
100 year	2.5	4.4

COMPOSITE CURVE NUMBER - PRE-DEVELOPMENT

See Reference 2. Plant stormwater will be discharged into Sub Basin 1. The pre-development discharge of Sub Basin 1 will be calculated to determine maximum post-development discharge.

Ground Cover / Land Use	Hydrologic Condition	% of Area	Area (ac)	CN*	Area x CN
Herbaceous - Mixture of grass, weeds, and low-growing brush	Fair	75%	4.3575	90	392.175
Urban District (Industrial)	NA	25%	1.4525	93	135.0825
Total			5.81		527.2575
Composite CN (Area*CN/Area)	90.75				

* Reference 4, Table 4-2, HSB = D, Appendix B

PZN ADJUSTMENT FACTORS: (Reference 4, Table 4-6, Table 4-10, Appendix C)

Coast: PZN = 2.0 > 35-year return

Adjustment Factor = 2.0

Adjusted Curve Number = 90.75

7.2 PRE-DEVELOPMENT TIME OF CONCENTRATION

(For TC Calculation Method, see Reference 5, Chapter 3)

Sheet Flow

1. Surface Discription (table 3-1)	Smooth Surface	
2. Manning's roughness coeff., n (table 3-1)	0.011	
3. Flow length, L (total L <= 300 ft)	300	ft
4. Two-yr 24-hr rainfall, P2	1.6	in
5. Land slope, s	0.01	ft/ft
6. $Tt = 0.007*(nL)^{0.8}/(P_2^{0.5}s^{0.4})$	0.0908	hrs

Shallow Concentrated Flow

7. Surface description (paved or unpaved)	Top Unpaved		
8. Flow length, L	308	ft	
9. Watercourse slope, s	0.01		
10. Average velocity, V (figure 3-1)	1.61345	ft/s	(unpaved)
11. Tt = L/(3600 V)	0.053026	hrs	

Channel flow

12. Channel Depth	0.75	ft
13. Cross sectional flow area, a	2.5	ft^2
14. Wetted perimeter, p_w	4.6	ft
15. Hydraulic radius, r = a/Pw	0.543478	ft
16. Channel slope, s	0.005	ft/ft
17, Manning's roughness coeff., n	0.011	(concrete)
18. Velocity (V)	6.378718	ft/s
19. Flow length, L	358	ft
20. Tt = L/(3600 V)	0.01559	hrs

21. Watershed or subarea Tc	0.1594	hrs =	9.562023	min
22. Corps Lag (Tp) = 0.80Tc (Eq 4-24, Reference 4)	0.1275	hrs =	7.649618	min

7.3 POST-DEVELOPMENT DESIGN PARAMETERS

COMPOSITE CURVE NUMBER - POST-DEVELOPMENT

	Area (ac)	CN*
Undeveloped Area to Ditch (In Buffer, See Note 1)	2.7214	90

Note 1: See Reference 2. The undeveloped buffer area is area of Sub Basin 1 that discharges off site but will not be routed through the detention basin because it is in the environmental buffer. However, this area must be accounted for in the total discharge calculation. Therefore, Maximum Detention Basin Discharge = Pre-Development Discharge - Undeveloped Area Discharge.

Developed Areas	Area (ac)	CN*	Area x CN
Within Property:			
Impervious Areas (buildings)	2.5420	98	249.116
Impervious Areas (roads)	2.3177	98	227.1346
Aggregate Areas	13.0415	91	1186.7765
Utility Easement Areas:			
Impervious Areas (roads)	0.1442	98	14.1316
Aggregate Areas	2.2341	91	203.3031
Total (Developed Areas)	20.2795		1880.4618

Composite CN (Developed Area) = (Area*CN/Area)	92.73

	Area (ac)	CN
Pond Area	1.3698	95

* Reference 4, Table 4-2, HSB = D, Appendix B

PZN ADJUSTMENT FACTORS: (Reference 4, Table 4-6, Table 4-10, Appendix C)

Coast: PZN = 2.0 > 35-year return

Developed Area Adjustment Factor = 2.0

Adjusted Curve Number = 90 for Undeveloped Area
92.73 for Developed Areas (Not including pond)
95 for pond

7.4 POST-DEVELOPMENT DESIGN PARAMETERS

TIME OF CONCENTRATION (DITCH) (For TC Calculation Method, see Reference 5, Chapter 3)

Sheet Flow

1. Surface Discription (table 3-1)	Aggregate	
2. Manning's roughness coeff., n (table 3-1)	0.011	
3. Flow length, L (total L <= 300 ft)	190	ft
4. Two-yr 24-hr rainfall, P2	1.6	in
5. Land slope, s	0.0025	ft/ft
6. $Tt = 0.007*(nL)^{0.8}/(P_2^{0.5}s^{0.4})$	0.1096	hrs

Shallow Concentrated Flow

7. Surface description (paved or unpaved)	Paved	
8. Flow length, L	168	ft
9. Watercourse slope, s	0.0025	
10. Average velocity, V (figure 3-1)	1.01641	ft/s
11. Tt = L/(3600 V)	0.045913	hrs

Channel flow

12. Channel Depth	1.6	ft	
13. Cross sectional flow area, a	14.08	ft^2	(Using 3:1 ditch with 4' bottom)
14. Wetted perimeter, p_w	14.12	ft	
15. Hydraulic radius, r = a/Pw	0.997167	ft	
16. Channel slope, s	0.0025	ft/ft	
17, Manning's roughness coeff., n	0.033		gravel
18. V	2.25331	ft/s	
19. Flow length, L	745	ft	
20. Tt = L/(3600 V)	0.09184	hrs	

21. Watershed or subarea Tc	0.2474	hrs =	14.84	min
22. Corps Lag (Tp) = 0.80Tc (Eq 4-24, Reference 4)	0.1979	hrs =	11.88	min

TIME OF CONCENTRATION (BUFFER AREA) (For TC Calculation Method, see Reference 5, Chapter 3)

See Note 1 on Page 5 for definition of buffer area.

Sheet Flow

1. Surface Discription (table 3-1)	Aggregate	
2. Manning's roughness coeff., n (table 3-1)	0.011	
3. Flow length, L (total L <= 300 ft)	300	ft
4. Two-yr 24-hr rainfall, P2	1.6	in
5. Land slope, s	0.0028	ft/ft
6. $Tt = 0.007*(nL)^{0.8}/(P_2^{0.5}s^{0.4})$	0.1510	hrs

Shallow Concentrated Flow

7. Surface description (paved or unpaved)	Unpaved	
8. Flow length, L	19	ft
9. Watercourse slope, s	0.0028	
10. Average velocity, V (figure 3-1)	0.853757	ft/s
11. Tt = L/(3600 V)	0.006182	hrs

Channel flow - Grass

12. Channel Depth	0.73	ft	
13. Cross sectional flow area, a	4.52	ft^2	(Using 3:1 ditch with 4' bottom)
14. Wetted perimeter, p_w	8.61	ft	
15. Hydraulic radius, r = a/Pw	0.524971	ft	
16. Channel slope, s	0.00375	ft/ft	
17, Manning's roughness coeff., n	0.027		Grass
18. V	2.199184	ft/s	
19. Flow length, L	376	ft	
20. Tt = L/(3600 V)	0.047492	hrs	

Channel flow - Concrete

12. Channel Depth	0.56	ft	
13. Cross sectional flow area, a	1.4	ft^2	(Existing Channel)
14. Wetted perimeter, p_w	3.02	ft	
15. Hydraulic radius, r = a/Pw	0.463576	ft	
16. Channel slope, s	0.005	ft/ft	
17, Manning's roughness coeff., n	0.011		Concrete
18. V	0.478	ft/s	
19. Flow length, L	353	ft	
20. Tt = L/(3600 V)	0.205137	hrs	

21. Watershed or subarea Tc	0.4098	hrs =	24.59	min
22. Corps Lag (Tp) = 0.80Tc (Eq 4-24, Reference 4)	0.3279	hrs =	19.67	min

7.5 DETERMINE DITCH AND TRENCH DRAIN REQUIRED CAPACITY

1) DETERMINE RAINFALL INTENSITY, I (in/hr)

$I = 7.44 \times P_6 \times D^{-0.645}$		(Reference 4, Figure 3-2)
$P_6 = 2.3$	in	(50 year, 6 Hour Precipitation, Reference 4 Appendix B)
$D = 15$	min	(Post-Development Time of Concentration, See Calculation on Page 6)
$I = 2.98$	in/hr	

2) CHECK DITCH CAPACITY

Watershed	Total Area	Grass Areas		Aggregate Areas		Asphalt Areas (Road)		Foundations		Weighted C-value	Intensity, I (in/hr)	Q_{runoff} = CIA (cfs)
		Area, A_{G1} (acres)	Runoff Coefficient, C	Area, A_{G2} (acres)	Runoff Coefficient, C	Area, A_s (acres)	Runoff Coefficient, C	Area, A_f (acres)	Runoff Coefficient, C			
Ditch 1 (Plant West)	2.8896	0	0.3	1.2129	0.75	0.6931	0.85	0.9836	0.95	0.84	2.98	7.26
Ditch 2 (Plant East)	6.5352	0	0.3	4.0114	0.75	1.4685	0.85	1.0553	0.95	0.80	2.98	15.69
Ditch 3 (Combine)[3]	0.66223	0	0.3	0.30843	0.75	0.1561	0.85	0.1977	0.95	0.83	2.98	1.65
Ditch 4 (South)	6.466	0	0.3	6.466	0.75	0	0.85	0	0.95	0.75	2.98	14.47
Ditch 5 (Discharge)	The detention basin discharges into Ditch 5 at maximum of 5 cfs (See Page 9).											

	Depth	Base	A (ft^2) =	p_w (ft)	r (ft) = a/pw	s (ft/ft)	n	V (ft/s)	$Q_{capacity}$ >	Q_{runoff}	Depth Req.[2]
Ditch 1 (Plant West)	2.11	4	21.7963	17.34	1.26	0.0025	0.033	2.629	57.302	7.26	0.77
Ditch 2 (Plant East)	2.2	4	23.32	17.91	1.30	0.0025	0.033	2.692	62.766	15.69	1.08
Ditch 3 (Combine)[3]	2.28	4	24.7152	18.42	1.34	0.0025	0.033	2.746	67.877	24.60	1.42
Ditch 4 (Subs. South)	2	6	24	18.65	1.29	0.0025	0.033	2.671	64.105	14.47	0.84
Ditch 5 (Discharge)	1	4	7	10.32	0.68	0.0025	0.033	1.742	12.196	5.00	0.57

Note [1]: All Ditches have 3:1 side slopes

Note [2]: Depth Required is minimum depth needed for Q_{runoff}.

Note [3]: Ditch 3 must also contain runoff from Ditches 1 and 2

3) CHECK TRENCH DRAIN CAPACITY

Trench No.	Total Area	Grass Areas		Gravel Areas		Asphalt Areas (Road)		Foundations		Weighted C-value	Intensity, I (in/hr)	Q_{runoff} = CIA (cfs)
		Area, A_{G1} (acres)	Runoff Coefficient, C	Area, A_{G2} (acres)	Runoff Coefficient, C	Area, A_s (acres)	Runoff Coefficient, C	Area, A_f (acres)	Runoff Coefficient, C			
T-1	2.8896	0	0.3	1.2129	0.75	0.6931	0.85	0.9836	0.95	0.84	2.98	7.26
T-2	10.08703	0	0.3	5.53273	0.75	2.3177	0.85	2.2366	0.95	0.82	2.98	24.60
T-3	6.5352	0	0.3	4.0114	0.75	1.4685	0.85	1.0553	0.95	0.80	2.98	15.69
T-4	1.7398	0	0.3	1.0779	0.75	0.6619	0.85	0	0.95	0.79	2.98	4.09
T-5	1.3341	0	0.3	0.627	0.75	0.2179	0.85	0.4892	0.95	0.84	2.98	3.34

Trench No.	Depth	Base	A (ft^2) =	p_w (ft)	r (ft) = a/pw	s (ft/ft)	n	V (ft/s)	$Q_{capacity}$ >	Q_{runoff}	Depth Req.[2]
T-1	2.61	2	5.22	7.22	0.72	0.0025	0.011	5.456	28.479	7.26	0.69
T-2	2.90	2	5.8	7.80	0.74	0.0025	0.011	5.559	32.241	24.60	1.74
T-3	2.70	2	5.4	7.40	0.73	0.0025	0.011	5.490	29.644	15.69	1.23
T-4	2.15	2	4.3	6.30	0.68	0.0025	0.011	5.250	22.576	4.09	0.46
T-5	1.14	2	2.28	4.28	0.53	0.0025	0.011	4.451	10.148	3.34	0.41

4) TRENCH DRAIN TABLE

Trench No.	Length	Inlet Invert Elevation	Outlet Invert Elevation
T-1	54	20.39	20.26
T-2	40	20.10	20.00
T-3	44	20.30	20.19
T-4	40	20.85	20.75
T-5	30	21.86	21.79

5) RIP RAP TABLE

No.	V_a	$Q_{discharge}$	TW	D_{50}	T	D_0	Outlet L_a	Inlet L_a	W	
T-1	5.456	7.26	0.69	6.00	9	2.00	19	5	NA	
T-2	5.559	24.60	1.74	6.00	9	2.00	40	5	22.0	
T-3	5.490	15.69	1.23	6.00	9	2.00	31	5	NA	
T-4	5.250	4.09	0.46	6.00	9	2.00	17	5	NA	
T-5	4.451	3.34	0.41	6.00	9	2.00	16	5	NA	
Ditch Subs. South	2.671	14.47	0.84	6.00	9	2.00	23	NA	15.3	(Ditch width is greater, use ditch width)
C-1	5.240	5.00	0.91	6.00	9	1.25	19	NA	NA	

TW = tailwater depth, ft

D_0 = diamter culvert, width of trench drain, or total depth of ditch, ft

D_{50} = median stone diameter, in — D_{50} = Maximum of 6" or $[0.02*Q^{4/3}/(TW*D_0)]*12$

T = rip rap thickness (max of 9", or 1.5 * D50)

L_a = rip rap apron length, ft — Eq 1) Apron Length, La = $1.8*Q/(D_0^{3/2})+7D_0$ for $TW < D_0/2$

Eq 2) Apron Length, La = $3*Q/(D_0^{3/2})+7D_0$ for $TW > D_0/2$

W = rip rap apron width, ft (applicable only if there is no well defined channel downstream) — $W = 3D_0 + 0.4La$

7.6 STORMWATER BASIN STAGE - DISCHARGE RELATIONSHIP:

Elevation	Area		Volume below	
16	1.0606	acres	0	Cubic Yards
17	1.1371	acres	1,603.70	CY
18	1.2128	acres	3,468.10	CY
19	1.2878	acres	5,444.90	CY
20	1.3620	acres	7,535.00	CY

References: FlowMaster v5.15, Haestad Methods, Waterbury, CT.
U.S. Dept. of Transportation, FHA, Hydraulic Charts for the Selection of Highway Culverts.

Discharge Culvert:

Diameter:	15 inches
Material:	CMP
Length:	150 feet
U/S Invert:	16.00 ft, msl.
D/S Invert:	15.43 ft, msl.
Slope:	0.0038 ft/ft
Entrance Type:	manufactured entrance

Elevation	Q (cfs)
16.00	0
16.10	0.03
16.43	1.0
16.63	1.5
16.83	2.0
17.68	3.0
18.58	4.0
19.78	5.0

All Elevations are Headwater Elevations from the culvert charts with outlet control, except Elev. 16.10, which is open channel flow with 0.10 feet normal depth (see attached FlowMaster worksheet).

PRECIPITATION DISTRIBUTION:
See attached constructed distribution based on Section 6 of Reference 4.

HEC - 1 MODEL OUTPUT SUMMARY (See attached for HEC-1 Output files)

Requirement:	Post-Development Peak Discharge <	Pre-Development Peak Discharge	
	Pre-Development Peak Discharge =	11 cfs	
	50-Year Post-Development Peak Discharge =	7 cfs	**OK**
	100-Year Post-Development Peak Discharge =	9 cfs	**OK**
Requirement:	50-Year Post-Development Peak Stage <	19 [1]	
	50-Year Post-Development Peak Stage =	18.63	**OK**
Check:	100-Year Post-Development Peak Stage <	20	
	100-Year Post-Development Peak Stage =	19.28	**OK**
Requirement:	Post-Development 85th % Storm Time to Drawdown[2] =	24 < x < 72 hours	
	Post-Development 85th % Storm Time to Drawdown =	61 hours	**OK**

Note 1: Reference 7 requries 1 foot of freeboard for detention basin for the 50 year design event. Top elevation of basin is 20, therefore maximum peak stage allowable is 19. Black & Veatch standard design also checks to see if the 100 year peak stage does not exceed the top elevation of the basin.

Note 2: Appendix F of Reference 7 states Time to Drawdown for Detention Basins must be within 24 to 72 hours.