APPENDIX 5.15A

# Preliminary Stormwater Management Design

BLACK & VEATCH

## Calculation Record

Client Name: Radback Energy



Project Name: Tenaska

Project No.: 163994

Calculation Title: IMP Sizing for Laydown Area

Calculation No./File No.: 52.5406.1001

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

**Objective** To determine the minimum required size of bioswale to satisfy Stormwater C.3 requirements for treatment and flow control for the construction laydown area for the proposed Tenaska Project.

| Unverified Assumptions Requiring Subsequent Verification | | | |
|---|---|---|---|
| No. | Assumption | Verified By | Date |
| | | | |
| | | | |
| | | | |
| | | | |

See Page 2 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 |
| 0 | J Zhong *Jimmy Zhong* | March 25, 2009 | *PL Nelson* PL Nelson | 31 MAR 09 | *PL Nelson* | 31 MAR 09 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## Purpose

To determine the minimum required size of bioswale to satisfy Stormwater C.3 requirements for treatment and flow control for the construction laydown area for the proposed Tenaska Project.

## References

1. Black & Veatch Drawing:
   - 163994-SS-3002, Rev. A, "Grading & Drainage - Site Plan - Sheet 2"
   - 163994-SS-3202, Rev. A, "Surfacing/Fencing/Roadway - Site Plan - Sheet 2"
2. Contra Costa Clean Water Program; Stormwater C.3 Guidebook; Stormwater Quality Requirements for Development Applications; Fourth Edition; September 10, 2008.
3. Contra Costa County Public Works Department; Mean Seasonal Isohyets Compiled from Precipitation Records 1879-1973; Drawing No. B-166; December 1977.
4. US Department of Agriculture, Natural Resources Conservation Service; Web Soil Survey; http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.
5. US Department of Agriculture; Urban Hydrology for Small Watersheds, 2nd Edition; Technical Release 55 (TR-55); June 1986.
6. Email Communications between Black & Veatch and Contra Costa Clean Water Program; March 2009.

## Definition of Units and Constants

English units will be used.

Example of Common Unit Designations:

Rainfall amount in inches (in)

Drainage area in acres (ac)

## Attachments

1. Black & Veatch Drawings SS-3002 and SS-3202
2. Reference 2 – Select Pages
3. Reference 3 – Drawing No. B-166
4. Reference 4 – Select Pages
5. Reference 5 – Select Pages
6. Email Communications

## Summary

Based on the Stormwater C.3 requirements, the required bioswale surface area is 9,638 $ft^2$; the required bioswale volume is 7,986 $ft^3$ for the construction laydown area.

The design bioswale has a length of 1154 feet. The bioswale cross section will be trapezoidal with a bottom width of 2 feet and a side slope of 3 (h) to 1 (v). The proposed depth of the bioswale is 2 feet. The design free board is 6 inches which gives an effective depth of 1.5 feet.

The design bioswale in the construction laydown area has sufficient surface area (12,694 $ft^2$) and volume (11,252 $ft^3$) to satisfy the Stormwater C.3 requirements.

**Construction Laydown Area**

Most of the construction laydown area is covered by bare soil with little vegetation. The northeast portion of this area is covered by existing asphalt pavement. See B&V Drawing SS-3002.

The existing asphalt area will not be graded and will remain "as is". From the topography, this asphalt area slopes downward towards the north. Consequently rainfall on the asphalt pavement will flow offsite and will not enter the bioswale. Therefore, stormwater from the existing asphalt pavement area will not be included in the sizing calculations for the bioswale.

Only the bare soil area will be graded during construction. See B&V Drawing SS-3002. A gravel loop road will be built over the bare soil area. A bioswale will be constructed at the center of the bare soil area to collect and infiltrate stormwater. The bare soil area is graded in such a pattern that stormwater will flow towards the center of this area and be collected in the bioswale. The gravel road will be installed in a trench so that its surface will be even with its adjacent ground surface. In this way, stormwater will be able to flow over the gravel road and be collected in the bioswale. At the east end of the bioswale, a pump station will be installed so that if the storm water in the bioswale exceeds its volume capacity, the excess water will be pumped out to a location offsite.

Two drainage management areas (DMA) were identified based on the type of their ground covers: (1) Bare Soil; and (2) Gravel Road. See B&V Drawing SS-3202. The measured areas are:

| | | |
|---|---|---|
| DMA-1 | Bare Soil | 547,461 $ft^2$ |
| DMA-2 | Gravel Road | 72,205 $ft^2$ |

The above measurements were made by using AutoCAD.

NRCS Soil Group

Based on the soil survey information from the US Department of Agriculture Natural Resources Conservation Service (NRCS), the project site in Contra Costa County, California is covered by "Delhi Sand". See Attachment 4. From the description of "Delhi Sand" by NRCS, this soil layer is "somewhat excessively drained"; the capacity of the most limiting layer to transmit water is "high to very high (5.95 to 19.98 in/hr)". See Attachment 5. Per Ref. 5, this type of soil can be classified as Hydrologic Soil Group A soil.

Runoff Coefficients

Dense-graded aggregate (Caltran Class 2 aggregate) will be utilized to build the gravel road. After being compacted, the dense-graded aggregate is estimated to have a runoff coefficient of 0.5 to 0.7. See communications with Contra Costa County Clean Water Program (Attachment 6). Use 0.6 in this calculation.

From Table 4-2 of the Stormwater C.3 Guidebook, the "Landscape, Group A Soil" will have a runoff coefficient of 0.1 for treatment and flow control. Based on engineering experience and judgment, the "Bare soil, Group A Soil" will have a runoff coefficient of approximately 0.2.

Consequently,

$$\sum\begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} = (547{,}461 \text{x} 0.2 + 72{,}205 \text{x} 0.6) = 152{,}815 \text{ ft}^2.$$

IMP Sizing Factors

Since the project site is covered by hydrologic group A soil, the subsurface reservoir volume ($V_2$) is not needed per Stormwater C.3 Guidebook. From this guidebook, for "treatment and flow control", the IMP sizing factor for the area (A) of bioswale is 0.07. The IMP sizing factor for the surface reservoir volume ($V_1$) of bioswale is 0.058. (Ref. 2, Table 4-6).

Rain Adjustment Factor

Per the Isohyetal Map by Contra Costa County Public Works, Figure B-166 (Ref. 3), the mean annual precipitation (MAP) at the project site is 12.5 inches. Consequently, for group A soils,

$$\text{Rain Adjustment Factor} = \frac{0.0009 \times (MAP - 20.2) + 0.07}{0.07} \qquad \text{(Ref. 2, Equation 4-3)}$$

$$= \frac{0.0009 \times (12.5 - 20.2) + 0.07}{0.07}$$

$$= 0.901.$$

Minimum Area and Minimum Volume of IMP

Per Ref. 2, Equation 4-7, the required minimum area (A) of the bioswale is:

$$\text{Min. IMP Area A} = \sum \begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

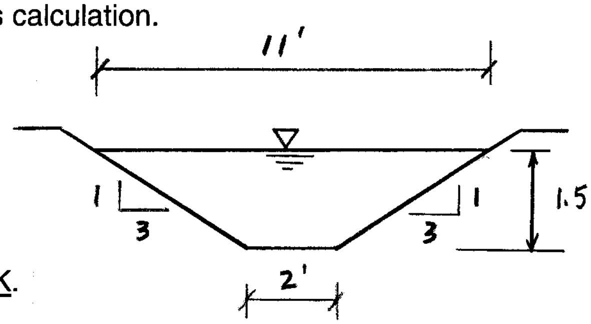
$$= 152{,}815 \times 0.07 \times 0.901 = 9{,}638 \text{ ft}^2.$$

The required minimum surface reservoir volume ($V_1$) of the bioswale is:

$$\text{Min. IMP Volume } (V_1) = \sum \begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

$$= 152{,}815 \times 0.058 \times 0.901 = 7{,}986 \text{ ft}^3.$$

The proposed bioswale in the construction laydown area will be 1154 feet long. The bioswale cross section will be trapezoidal. Bottom width = 2 feet. Side slope = 3 (h) to 1 (v). The proposed depth of the bioswale is 2 feet, but the top 6 inches is reserved as free board. Consequently, use 1.5 feet as the bioswale depth in this calculation.




The surface area of the proposed bioswale is:

$11 \times 1154 = 12{,}694 \text{ ft}^2 > 9{,}638 \text{ ft}^2$, OK.

The volume of the proposed bioswale is:

$\frac{2+11}{2} \times 1.5 \times 1154 = 11{,}252 \text{ ft}^3 > 7{,}986 \text{ ft}^3$, OK.

In summary, the proposed size of the bioswale in the construction laydown area is sufficient to meet the Stormwater C.3 requirements.

A spreadsheet was prepared for the above calculations to follow the format by Contra Costa County Clean Water Program. See next page.

| BLACK & VEATCH | | | | | |
|---|---|---|---|---|---|
| OWNER | Radback Energy | | COMP'D BY | J. Zhong | |
| PLANT | Tenaska | Unit No. | DATE | 17-Mar-2009 | |
| PROJECT NO. | 163994 | File No. 52.5406.1001 | CKD BY | PLovelace | |
| TITLE | IMP Sizing for Laydown Area | | DATE | 31 MAR 09 | |
| | | | PAGE 7 | OF 26 | |

| DMA Name | DMA Area ($ft^2$) | Post-Project Surface Type | DMA Runoff Factor | DMA Area x Runoff Factor |
|---|---|---|---|---|
| DMA-1 | 547,461 | Bare Soil, Group A Soil | 0.20 | 109,492 |
| DMA-2 | 72,205 | Gravel Road | 0.60 | 43,323 |
| | | | | |
| | | | | |
| | | | | |
| | | | Total: | 152,815 |

| Soil Type | IMP Name | | | |
|---|---|---|---|---|
| A | Bioswale (1154' long) | | | |
| **IMP Sizing Factor** | **Rain Adjustment Factor** | **Minimum Area or Volume** | **Proposed Area or Volume** | |
| 0.070 | 0.901 | 9,638 | 12,694 | **IMP Area ($ft^2$)** |
| 0.058 | 0.901 | 7,986 | 11,252 | **$V_1$ ($ft^3$)** |
| NA | 0.901 | NA | NA | **$V_2$ ($ft^3$)** |
| | | | **Orifice Size:** | NA |

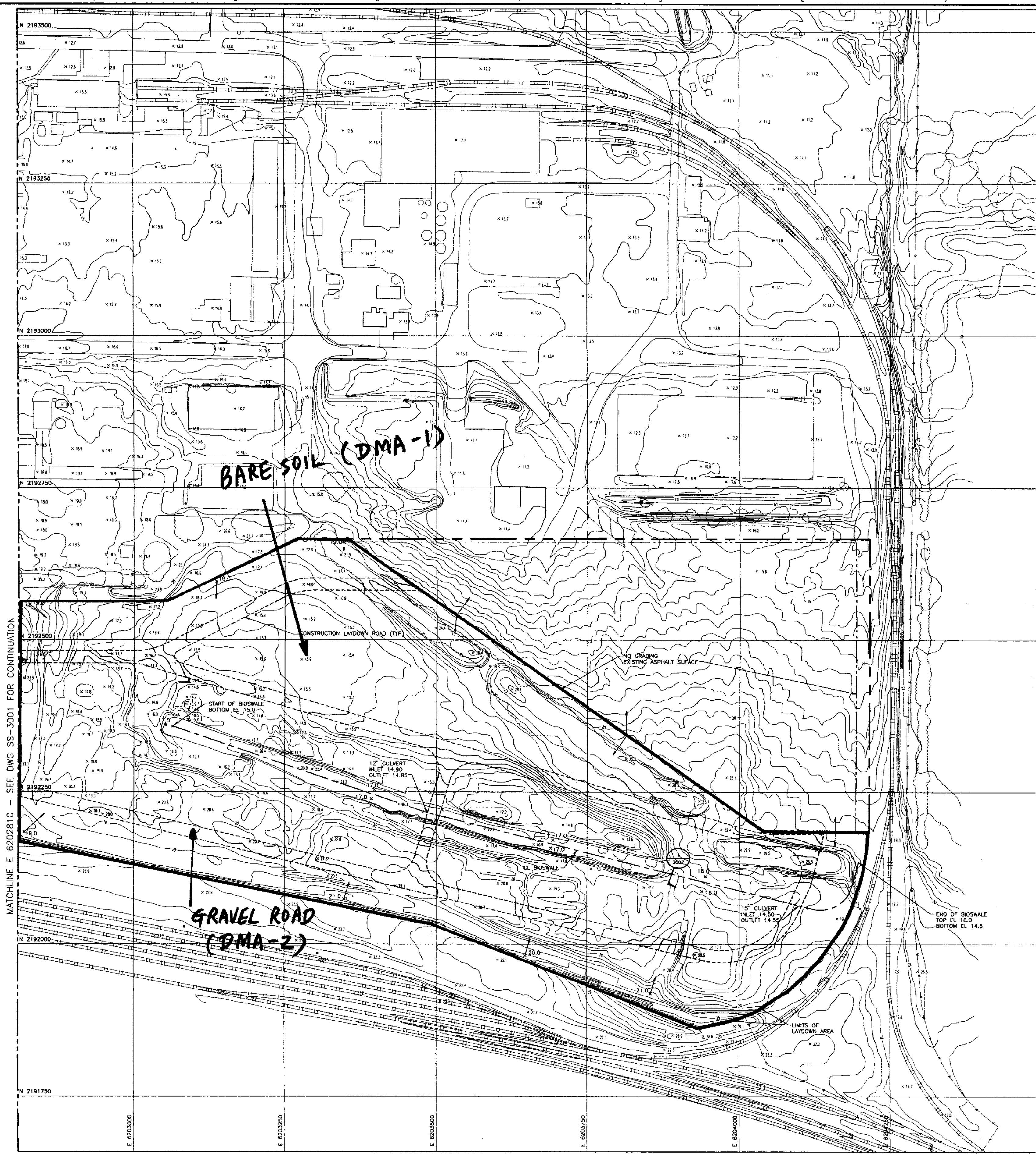
Radback Tenaska project
project # 163994 File # 52.5406.1001
IMP sizing for Laydown Area

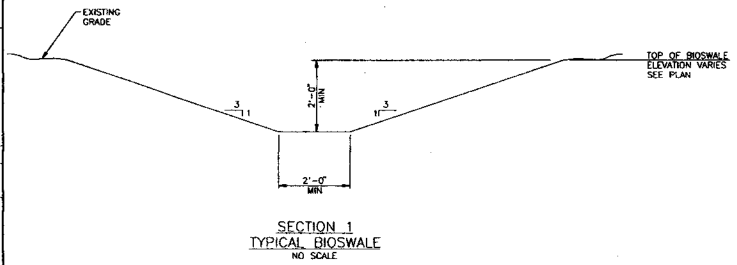
prepared by: J Zhong
Date: 3/24/09
# of pages: 3

Attachment 1

Black & Veatch Dwgs SS-3002
and SS-3202

DWG40999 24-MAR-2009 07:50:35




## NOTES

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.
2. ALL TREES WITHIN LAYDOWN AREA SHALL BE REMOVED.

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FILE FORMAT OF THIS DRAWING OUTSIDE OF BLACK & VEATCH IS UNCONTROLLED AND SHALL BE USED FOR REFERENCE PURPOSES ONLY.

| NO | DATE | REVISIONS AND RECORD OF ISSUE | DRN | DES | CHK | APP |
|---|---|---|---|---|---|---|
| A | 20/MAR/09 | ISSUED FOR CLIENT REVIEW | NAW | PLN | PLN | DVW |

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 PLN DRAWN NAW CHECKED DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

GRADING AND DRAINAGE - SITE PLAN - SHEET 2

PROJECT / DRAWING NUMBER: 163994-SS-3002 REV A

CODE
AREA

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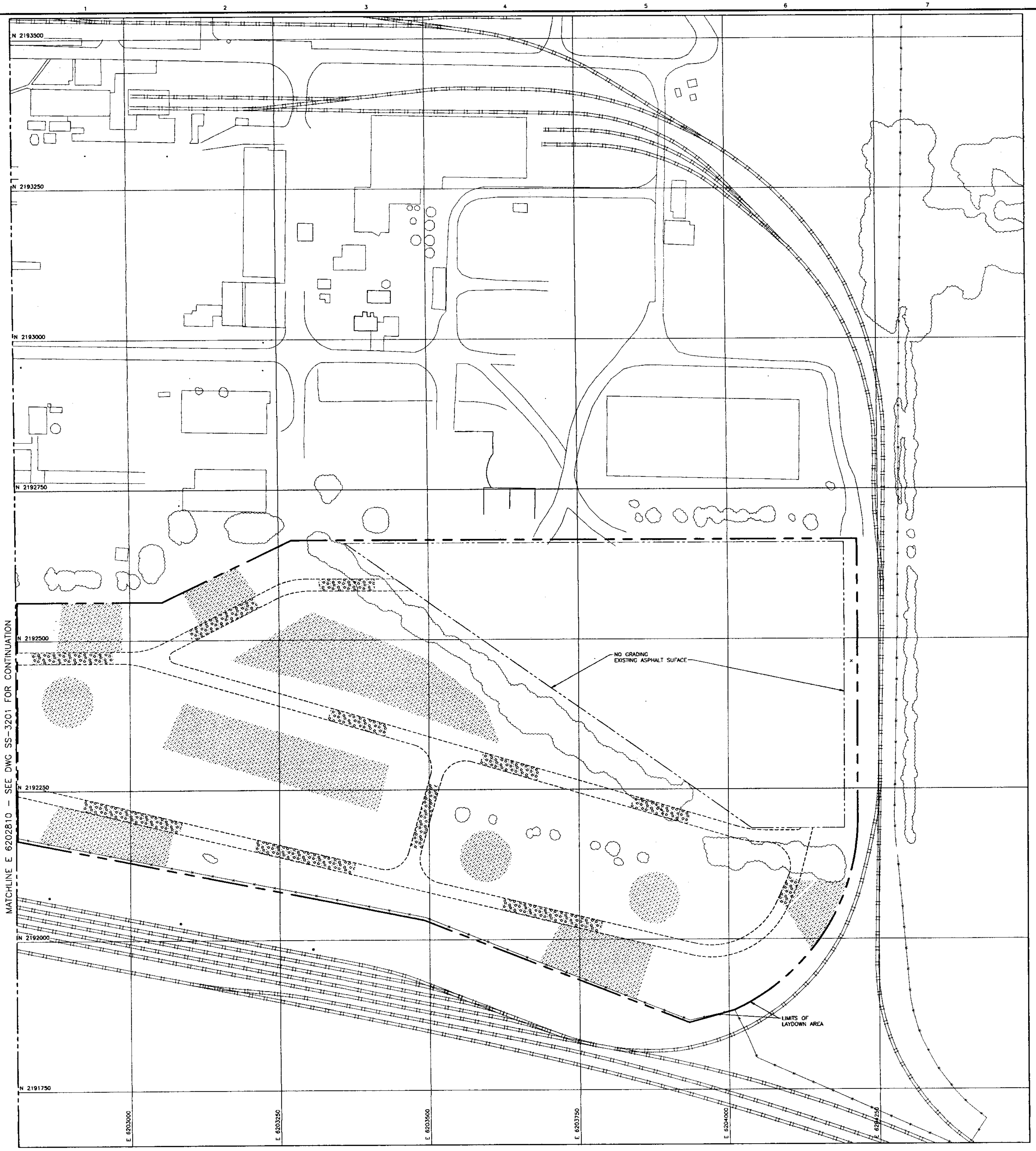


## NOTES

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.

NOT TO BE USED
FOR CONSTRUCTION

| NO | DATE | REVISIONS AND RECORD OF ISSUE | DRN | DES | CHK | PDE | APP |
|---|---|---|---|---|---|---|---|
| A | OPEN | ISSUED FOR | NAW | PLN | | PLN | DVW |

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

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SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER PLN DRAWN NAW
CHECKED DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

SURFACING/FENCING/ROADWAY – SITE PLAN – SHEET 2

PROJECT DRAWING NUMBER 163994–SS–3202 REV A
CODE
AREA

Radback Tenaska project
project # 163994 File # 52.5406.1001
IMP sizing for Laydown Area

prepared by: J Zhong
Date: 3/24/09
# of pages: 5

Attachment 2

Reference 2

select pages

(Runoff factor) x (tributary area) ≤ 2 x (self-retaining area) *Equation 4-1*

For treatment-only sites, and

(Runoff factor) x (tributary area) ≤ 1 x (self-retaining area) *Equation 4-2*

for sites subject to flow-control requirements. Use the runoff factors in Table 4-2.

Prolonged ponding is a potential problem at higher impervious/pervious ratios. In your design, ensure that the pervious area soils can handle the additional run-on and are sufficiently well-drained.

Runoff from self-treating and self-retaining areas does not require any further treatment or flow control.

TABLE 4-2. Runoff factors to be used when sizing IMPs.

| Surface | Treatment and Flow Control | Treatment only |
|---|---|---|
| Roofs | 1.0 | 1.0 |
| Concrete or Asphalt | 1.0 | 1.0 |
| Pervious Concrete | 0.1 | 0.1 |
| Porous Asphalt | 0.1 | 0.1 |
| Grouted Unit Pavers | 1.0 | 1.0 |
| Solid Unit Pavers | 0.5 | 0.2 |
| Crushed Aggregate | 0.1 | 0.1 |
| Turfblock | 0.1 | 0.1 |
| Landscape, Group A Soil | 0.1 | 0.1 |
| Landscape, Group B Soil | 0.3 | 0.1 |
| Landscape, Group C Soil | 0.5 | 0.1 |
| Landscape, Group D Soil | 0.7 | 0.1 |

**Areas draining to IMPs** are used to calculate the required size of the IMP. On most densely developed sites—such as commercial and mixed-use developments and small-lot residential subdivisions—most DMAs will drain to IMPs.

The CCCWP has developed sizing factors (ratios of IMP area to impervious DMA area). For each IMP design, factors are provided for:

TABLE 4-6. Sizing Factors

| **Treatment and Flow Control** | **NRCS Soil Group** | | | |
|---|---|---|---|---|
| **IMP** | **A** | **B** | **C** | **D** |
| Bioretention Facility | | | | |
| A | 0.07 | 0.11 | 0.06 | 0.05 |
| $V_1$ | 0.058 | 0.092 | 0.050 | 0.042 |
| $V_2$ | N/A | N/A | 0.066 | 0.055 |
| Flow-through Planter | | | | |
| A | N/A | N/A | 0.06 | 0.05 |
| $V_1$ | N/A | N/A | 0.050 | 0.042 |
| $V_2$ | N/A | N/A | 0.066 | 0.055 |
| Dry Well | | | | |
| A | 0.05 | 0.06 | N/A | N/A |
| V | 0.130 | 0.204 | N/A | N/A |
| Cistern + bioretention facility | | | | |
| A (bioretention facility) | *0.04* | *0.04* | *0.04* | *0.04* |
| V (cistern) | 0.193 | 0.228 | 0.088 | 0.060 |

* Cistern sized for flow control when used in conjunction with a treatment IMP. IMP underdrain required in B, C and D soils.

**Treatment Only**

| | | | | |
|---|---|---|---|---|
| Bioretention Facility | | | | |
| A | *0.04* | *0.04* | *0.04* | *0.04* |
| Flow-through Planter | | | | |
| A | *0.04* | *0.04* | *0.04* | *0.04* |
| Dry Well (treatment only) | | | | |
| A | 0.02 | 0.04 | N/A | N/A |
| V | 0.068 | 0.136 | N/A | N/A |

Units Notes:
A = $ft^2$ of IMP footprint per $ft^2$ of tributary impervious area (unitless)
V, $V_1$, $V_2$ = $ft^3$ per $ft^2$ of equivalent tributary impervious area (ft.)

#### STEP 5: OBTAIN SIZING AND RAIN ADJUSTMENT FACTORS FOR EACH IMP

For each of the IMPs, obtain the appropriate **area** sizing factor from Table 4-6.

Sizing factors for treatment-only IMPs (in *italics*) do not require any adjustment for differing rainfall patterns.

Both area (A) and volume ($V_1$, $V_2$) sizing factors for treatment-plus-flow-control IMPs, however, must be adjusted to account for the effects of differing rainfall patterns on pre-project and post-project runoff.

Use the equations below to compute the rainfall adjustment:

*Equation 4-3*

$$\text{For Group A soils, } \textit{Rain Adjustment} = \frac{0.0009 \times \left(MAP_{project\ site} - 20.2\right) + 0.07}{0.07}$$

*Equation 4-4*

$$\text{For Group B soils, } \textit{Rain Adjustment} = \frac{-0.0005 \times \left(MAP_{project\ site} - 20.2\right) + 0.11}{0.11}$$

*Equation 4-5*

$$\text{For Group C soils, } \textit{Rain Adjustment} = \frac{-0.0022 \times \left(MAP_{project\ site} - 20.2\right) + 0.06}{0.06}$$

*Equation 4-6*

$$\text{For Group D soils, } \textit{Rain Adjustment} = \frac{-0.0022 \times \left(MAP_{project\ site} - 20.2\right) + 0.05}{0.05}$$

where *MAP* is the mean annual precipitation at the site as shown on the isohyetal map, Contra Costa County Public Works Figure B-166, available on the CCCWP C.3 web pages.

### ► STEP 6: CALCULATE MINIMUM AREA AND VOLUME OF EACH IMP

The minimum area and storage volumes of each IMP are found by summing up the contributions of each tributary DMA and multiplying by the adjusted sizing factor for the IMP.

*Equation 4-7*

$$\textit{Min. IMP Area or Volume} = \sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

Bioretention facilities and flow-through planters have two storage volumes. $V_1$ is the floodable volume above the soil layer. $V_2$ is the storage volume below the soil layer, calculated by multiplying the volume of gravel by an assumed porosity of 0.4. See Figure 4-6. Note these volumes can be configured in a variety of practical combinations of depth and area to best fit into your landscape design.

Cisterns and dry wells have a single storage volume (V).

V is calculated using Equation 4-8:

*Equation 4-8*

$$Min.V = \sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} \times \begin{pmatrix} IMP\,Volume \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

Use the format of Table 4-7 to present the calculations of the required minimum area and volumes of the receiving IMP:

TABLE 4-7. Format for presenting calculations of minimum IMP Areas and Volumes

| *DMA Name* | *DMA Area (square feet)* | *Post-project surface type* | *DMA Runoff factor* | *DMA Area × runoff factor* |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | ***Total*** | |

| *Soil Type:* | *IMP Name* | | | |
|---|---|---|---|---|
| | | | | |
| *IMP Sizing factor* | *Rain Adjust-ment Factor* | *Minimum Area or Volume* | *Proposed Area or Volume* | |
| | | | | ***IMP Area*** |
| | | | | ***V or V1*** |
| | | | | ***V2*** |
| | | | ***Orifice Size:*** | |

### ► STEP 7: DETERMINE IF IMP AREA AND VOLUME ARE ADEQUATE

Sizing and configuring IMPs may be an iterative process. After computing the minimum IMP area using Steps 1–6, review the site plan to determine if the reserved IMP area is sufficient. If so, the planned IMPs will meet the Provision C.3 sizing requirements. If not, revise the plan accordingly. Revisions may include:

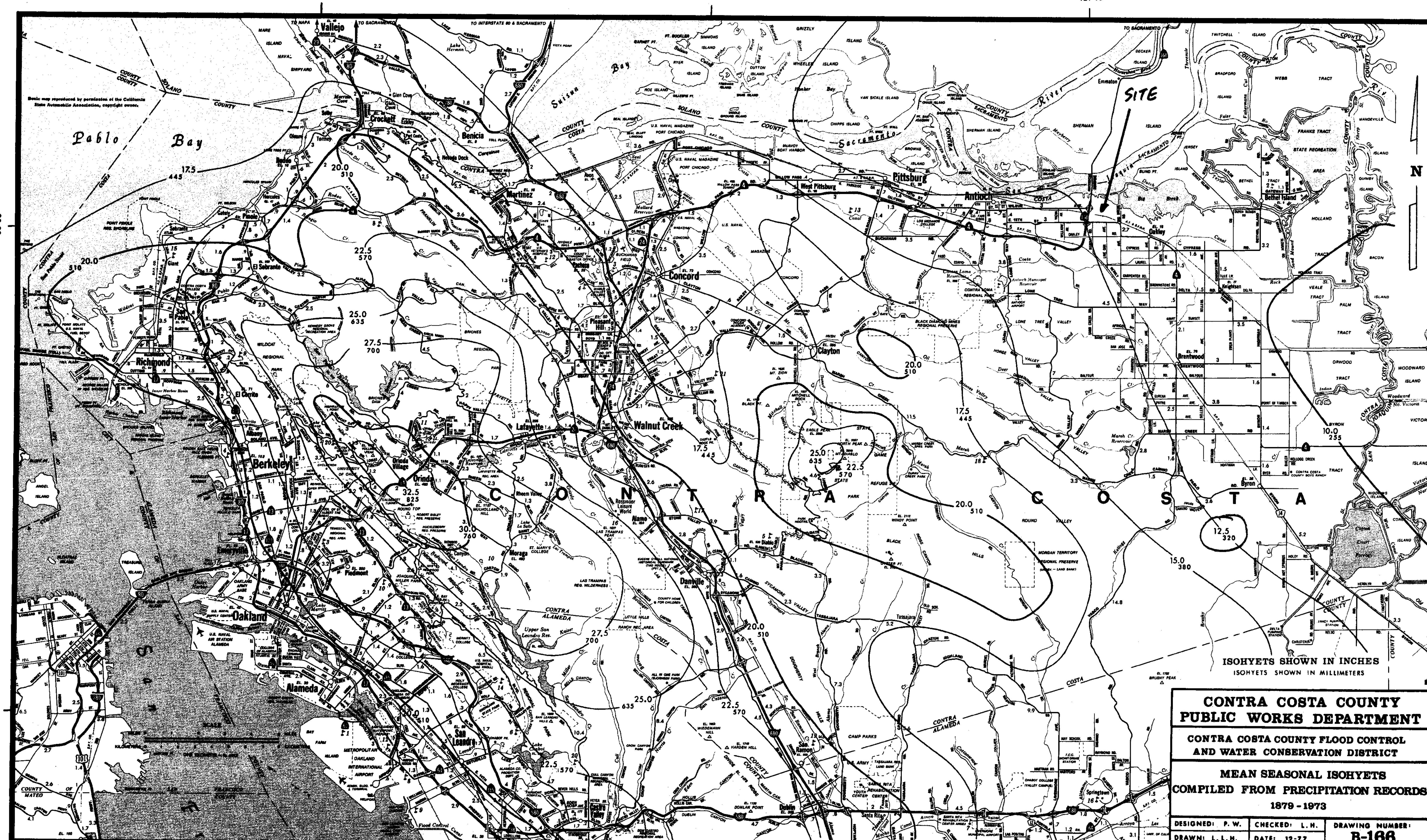
Radback Tenaska project
project # 163994 File # 52.5406.1001
IMP Sizing for Laydown Area

prepared by: JZhong
Date: 3/24/09
# of pages: 2

Attachment 3

Reference 3

Drawing No. B-166



122°15′
122°00′
121°45′
38°00′
37°45′
SITE
N
Pablo Bay
Suisun Bay
Sacramento River
San Joaquin River
CONTRA COSTA
Vallejo
Crockett
Benicia
Martinez
Pittsburg
Antioch
Oakley
Concord
Clayton
Walnut Creek
Lafayette
Orinda
Moraga
Danville
San Ramon
Dublin
Brentwood
Byron
Richmond
El Cerrito
Berkeley
Oakland
Alameda
San Leandro
Piedmont
Emeryville
Pleasant Hill
Mt. Diablo
Bethel Island
17.5 445
20.0 510
22.5 570
25.0 635
27.5 700
30.0 760
32.5 825
15.0 380
12.5 320
10.0 255
ISOHYETS SHOWN IN INCHES
ISOHYETS SHOWN IN MILLIMETERS
CONTRA COSTA COUNTY
PUBLIC WORKS DEPARTMENT
CONTRA COSTA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
MEAN SEASONAL ISOHYETS
COMPILED FROM PRECIPITATION RECORDS
1879 - 1973
DESIGNED: P. W.
CHECKED: L. H.
DRAWING NUMBER:
DRAWN: L. L. H.
DATE: 12-77
B-166

Radback Tenaska project

project # 163994   File # 52.5406.1001

IMP Sizing for Laydown Area

prepared by: JZhong

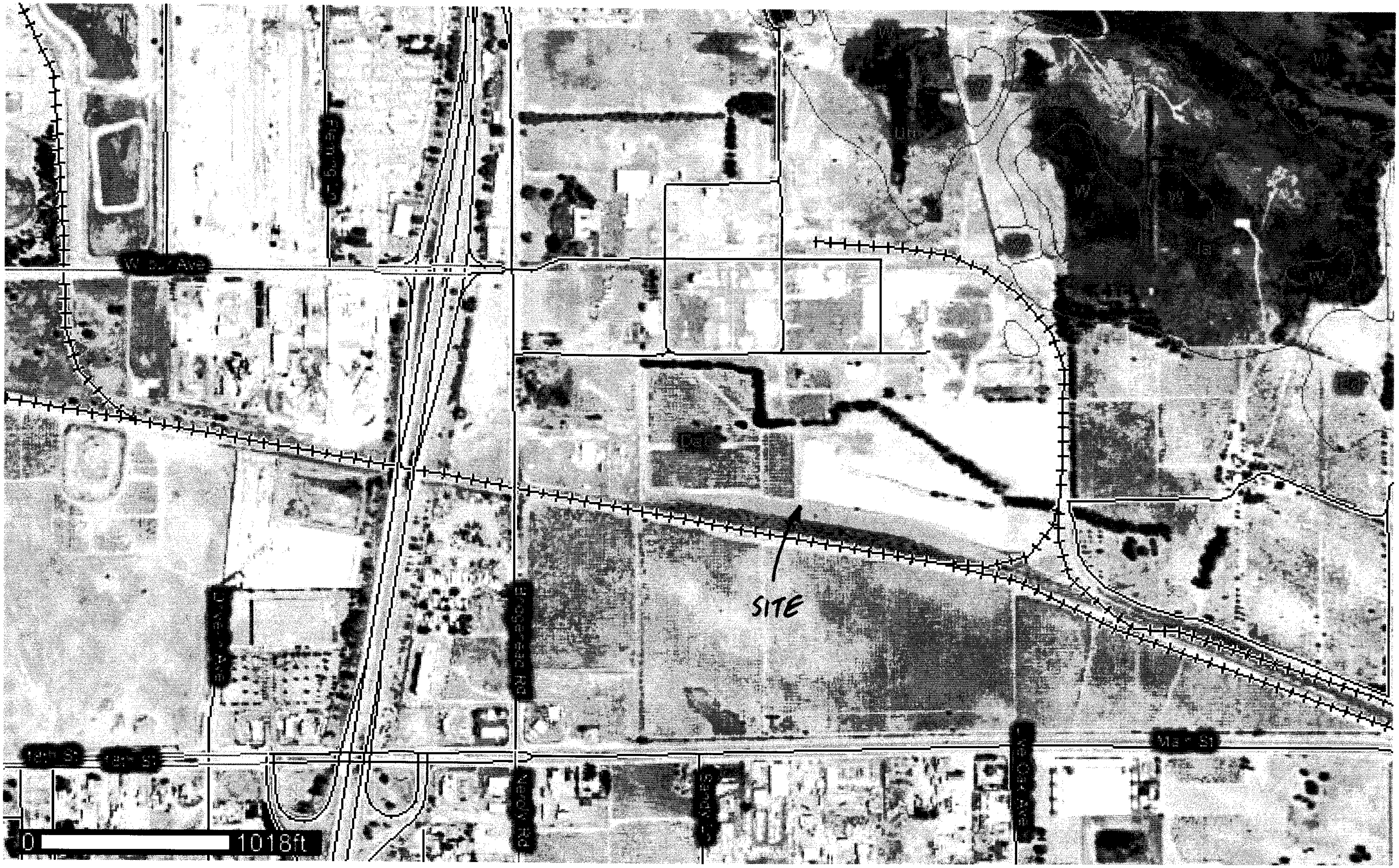
Date: 3/24/09

# of pages: 4

Attachment 4

Reference 4

Select pages


SITE
0
1018ft

# Contra Costa County, California

## DaC—DELHI SAND, 2 TO 9 PERCENT SLOPES

### Map Unit Setting

*Elevation:* 10 to 150 feet
*Mean annual precipitation:* 12 to 14 inches
*Mean annual air temperature:* 59 degrees F
*Frost-free period:* 260 to 300 days

### Map Unit Composition

*Delhi and similar soils:* 85 percent
*Minor components:* 15 percent

### Description of Delhi

#### Setting

*Landform:* Flood plains, terraces, alluvial fans
*Landform position (three-dimensional):* Tread, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Eolian deposits derived from igneous and sedimentary rock

#### Properties and qualities

*Slope:* 2 to 9 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline (0.0 to 2.0 mmhos/cm)
*Available water capacity:* Low (about 4.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3s
*Land capability (nonirrigated):* 6e

#### Typical profile

*0 to 5 inches:* Sand
*5 to 60 inches:* Sand

### Minor Components

#### Unnamed

*Percent of map unit:* 12 percent

**Laugenour**

*Percent of map unit:* 3 percent

## Data Source Information

Soil Survey Area: Contra Costa County, California
Survey Area Data: Version 8, Jul 22, 2008

Radback Tenaska project
project # 163994 File # 52.5406.1001
IMP sizing for Laydown Area

prepared by: JZhong
Date: 3/24/09
# of pages: 2

Attachment 5

Reference 5

select page

# Appendix A Hydrologic Soil Groups

Soils are classified into hydrologic soil groups (HSG's) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve numbers (see chapter 2). For the convenience of TR-55 users, exhibit A-1 lists the HSG classification of United States soils.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Approximate numerical ranges for transmission rates shown in the HSG definitions were first published by Musgrave (USDA 1955). The four groups are defined by SCS soil scientists as follows:

**Group A**soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

**Group B**soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

**Group C**soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

**Group D**soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

In exhibit A-1, some of the listed soils have an added modifier; for example, "Abrazo, gravelly." This refers to a gravelly phase of the Abrazo series that is found in SCS soil map legends.

## Disturbed soil profiles

As a result of urbanization, the soil profile may be considerably altered and the listed group classification may no longer apply. In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred (Brakensiek and Rawls 1983).

| *HSG* | *Soil textures* |
|---|---|
| A | Sand, loamy sand, or sandy loam |
| B | Silt loam or loam |
| C | Sandy clay loam |
| D | Clay loam, silty clay loam, sandy clay, silty clay, or clay |

## Drainage and group D soils

Some soils in the list are in group D because of a high water table that creates a drainage problem. Once the soils are effectively drained, they are placed in a different group. For example, Ackerman soil is classified as A/D. This indicates that the drained Ackerman soil is in group A and the undrained soil is in group D.

Radback Tenaska project
project # 163994 File # 52.5406.1001
IMP sizing for Laydown Area

prepared by: JZhong
Date: 3/24/09
# of pages: 3

Attachment 6

Email communications with contra costa county clean water program

## Zhong, Jimmy

**From:** Dan Cloak [dan@dancloak.com]
**Sent:** Monday, March 02, 2009 3:54 PM
**To:** 'Tom Dalziel'; Zhong, Jimmy
**Subject:** RE: Stormwater C.3 Question

Hi,

It is correct that dense-graded aggregates are not very pervious. Why not use an open-graded aggregate, such as ½ in. crushed rock? Be sure to use a rigid frame around the gravel area.

"Porous Pavements" by Bruce Ferguson is a good reference for porous pavement design.

If dense-graded aggregate is used, I would suggest a runoff coefficient of 0.5 to 0.7, depending on slope.

Dan

---

**From:** Tom Dalziel [mailto:tdalz@pw.cccounty.us]
**Sent:** Monday, March 02, 2009 11:04 AM
**To:** Zhong, Jimmy; Dan@dancloak.com
**Subject:** RE: Stormwater C.3 Question

Hi Dan,

Can you review and respond, as appropriate, to Jimmy on my behalf?

Thanks.

Tom Dalziel
Assistant Program Manager
Contra Costa Clean Water Program
tdalz@pw.cccounty.us
Ph. (925) 313-2392, Fax (925) 313-2301

---

**From:** Zhong, Jimmy [mailto:ZhongJ@bv.com]
**Sent:** Wednesday, February 25, 2009 1:11 PM
**To:** Tom Dalziel
**Subject:** Stormwater C.3 Question

Tom,

I talked to you and Dan this morning regarding runoff factor for Class 2 aggregates (Caltran Standard Specification Section 26). After our phone call, I had a discussion with my supervisor. He indicated that this type of material is **dense-graded** aggregate which is typically used as pavement base material. After being compacted, this type of material is not that pervious based on his experience. Dense-graded aggregates have much lower porosity than open-graded aggregates after compaction. As such, my supervisor thinks the runoff factor of 0.1 can apply to open-graded aggregate but may not be able to apply to dense-graded aggregate. Would you please forward this email to Dan and ask him again if a runoff factor of 0.1 can still be applied to Class 2 aggregates (compacted)? If not, what kind of runoff factor should be used?

I apologize if I did not communicate clearly this morning on the type of material we are using and for any confusions it caused.

Thanks again for your help.

Jimmy Zhong, P.E.
Geotechnical/Civil Engineer
Energy Division
Black & Veatch Corporation
3550 Green Court, Ann Arbor, MI 48105
P: (734) 622-8533 F: (734) 622-8700

**BLACK & VEATCH**

## Calculation Record

Client Name: Radback Energy — Page 1 of 43

Project Name: Tenaska — Project No.: 163994

Calculation Title: IMP Sizing for Plant Area

Calculation No./File No.: 52.5406.1002

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

**Objective** To determine the minimum required size of bioswales to satisfy Stormwater C.3 requirements for treatment and flow control for the plant area for the proposed Tenaska Project.

| Unverified Assumptions Requiring Subsequent Verification | | | |
|---|---|---|---|
| No. | Assumption | Verified By | Date |
| | | | |
| | | | |
| | | | |
| | | | |

See Page 2 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 |
| 0 | J Zhong Jimmy Zhong | March 31, 2009 | PLNelson | 15 APR 09 | PLNelson | 15 APR 09 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## Purpose

To determine the minimum required size of bioswales to satisfy Stormwater C.3 requirements for treatment and flow control for the plant area for proposed Tenaska Project.

## References

1. Black & Veatch Drawing:
   - 163994-SS-3001, Rev. A, "Grading & Drainage - Site Plan - Sheet 1"
   - 163994-SS-3201, Rev. A, "Surfacing/Fencing/Roadway - Site Plan - Sheet 1"
   - 163994-SS-3050, Rev. A, "Site Sections and Details"
   - 163994-SS-1002, Rev. 1, "General Arrangement – Site"
2. Contra Costa Clean Water Program; Stormwater C.3 Guidebook; Stormwater Quality Requirements for Development Applications; Fourth Edition; September 10, 2008.
3. Contra Costa County Public Works Department; Mean Seasonal Isohyets Compiled from Precipitation Records 1879-1973; Drawing No. B-166; December 1977.
4. US Department of Agriculture, Natural Resources Conservation Service; Web Soil Survey; http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.
5. US Department of Agriculture; Urban Hydrology for Small Watersheds, 2nd Edition; Technical Release 55 (TR-55); June 1986.
6. Email Communications between Black & Veatch and Contra Costa Clean Water Program; March 2009.

## Definition of Units and Constants

English units will be used.

Example of Common Unit Designations:

Rainfall amount in inches (in)

Drainage area in acres (ac)

## Attachments

1. Black & Veatch Drawings SS1002, SS-3001, SS-3201 and SS-3050
2. Reference 2 – Select Pages
3. Reference 3 – Drawing No. B-166
4. Reference 4 – Select Pages
5. Reference 5 – Select Pages
6. Email Communications

**Summary:**

Five bioswales will be constructed within the plant area to collect and infiltrate stormwater.
Based on the Stormwater C.3 requirements, the required bioswale surface area and volume for each bioswale are listed in the following table.
The design bioswale length, shape, design surface area and volume are presented in the following table. The design bioswales in the plant area have sufficient surface areas and volume to satisfy the Stormwater C.3 requirements.

| IMP ID | Shape | Length (feet) | Side Slope | Bottom Width (feet) | Design Surface Area ($ft^2$) | Design Volume ($ft^3$) | Required Surface Area ($ft^2$) | Required Volume ($ft^3$) |
|---|---|---|---|---|---|---|---|---|
| Bioswale #1 | Trapezoidal | 390 | 3 (h) to 1 (v) | 2 | 7,800 | 12,870 | 5,406 | 4,479 |
| Bioswale #2 | Trapezoidal | 933 | 3 (h) to 1 (v) | 2 | 18,660 | 30,789 | 7,635 | 6,326 |
| Bioswale #3 | Trapezoidal | 187 | 3 (h) to 1 (v) | 2 | 2,618 | 2,992 | 740 | 613 |
| Bioswale #4 | Trapezoidal | 391 | 3 (h) to 1 (v) | 2 | 7,820 | 12,903 | 7,598 | 6,296 |
| Bioswale #5 | Trapezoidal | 465 | 3 (h) to 1 (v) | 2 ft for first 265 ft long section; 8 ft for remaining 200 ft long section | 10,305 | 19,244 | 10,274 | 8,512 |

**IMP Sizing for Plant Area**

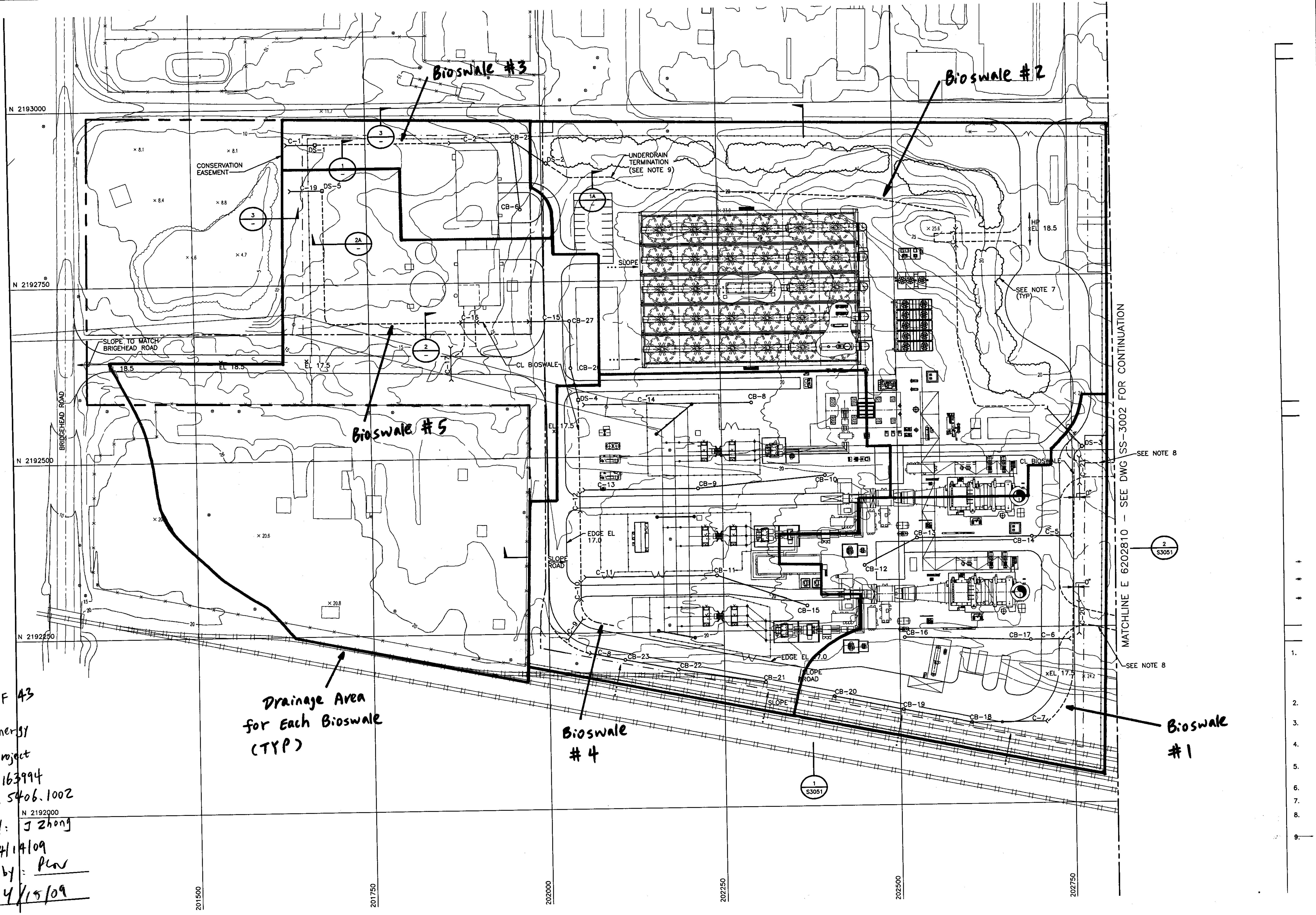
The generation area primarily consists of two combustion turbines, two heat recovery steam generators (HRSG), one air cooled condenser (ACC), three switchyards, one water treatment building, one warehouse building, two water storage tanks, one administration building, and other miscellaneous equipment/facilities. See B&V Drawing SS-1002 for plant general arrangement (Attachment 1). Plant loop road and major equipment access roads will be constructed within the plant. The areas adjacent to the buildings and equipment will have gravel surfacing. Other areas will be covered with vegetated grass. See B&V Drawing SS-3001 for proposed site surfacing of the plant (Attachment 1). The existing trees on this project site will be preserved.

Five bioswales will be constructed within the plant site to collect and infiltrate stormwater. See Page 5 for the locations of bioswales and delineated drainage area for each bioswale. Drop structures will be installed at the end of each bioswale such that sufficient depth (volume) of stormwater has to be collected in the bioswale before downstream discharge can occur.

An existing natural gas distribution facility is located west of the project and is outside the project limits. This area is generally covered by gravel surfacing. From the topography, most of the natural gas facility drains towards the wetland. After constructing the plant access road from Bridgehead Road, this area will continue to drain towards the wetland via a culvert being installed underneath the access road. The natural gas facility will be included in the IMP sizing for bioswale #5 since the stormwater from this area will flow to and accumulate in this bioswale.

NRCS Soil Group

Based on the soil survey information from the US Department of Agriculture Natural Resources Conservation Service (NRCS), the project site in Contra Costa County, California is covered by "Delhi Sand". See Attachment 4. From the description of "Delhi Sand" by NRCS, this soil layer is "somewhat excessively drained"; the capacity of the most limiting layer to transmit water is "high to very high (5.95 to 19.98 in/hr)". Per Ref. 5, this type of soil can be classified as Hydrologic Soil Group A soil.

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Radback Energy

Tenaska project

project # 163994

File # 52.5406.1002

prepared by: J Zhong

Date: 4/14/09

checked by: PLW

Date: 4/15/09

## IMP Sizing for Bioswale #1

Refer to Page 5, the total drainage area for bioswale #1 is measured to be: 153,520 $ft^2$ (3.52 ac). The bioswale #1 is measured to be 390 feet long.

Five drainage management areas (DMA) were identified based on the type of ground covers: (1) Equipment/Roofs; (2) Asphalt Pavement; (3) Gravel Surfacing; (4) Grass/Landscape; and (5) Transformer Containment.

The measured areas are shown in the following table. The measurements were made by using AutoCAD.

| DMA Name | Post-Project Surface Type | DMA Area ($ft^2$) |
|---|---|---|
| DMA-1 | Equipment/Roofs | 20,871 |
| DMA-2 | Asphalt Pavement | 27,640 |
| DMA-3 | Gravel Surfacing | 54,230 |
| DMA-4 | Grass/Landscape | 46,694 |
| DMA-5 | Transformer Containment | 4,085 |

Runoff Coefficients

Dense-graded aggregate (Caltran Class 2 aggregate) will be utilized as the materials for aggregate surfacing. After being compacted, the dense-graded aggregate is estimated to have a runoff coefficient of 0.5 to 0.7. See communications with Contra Costa County Clean Water Program (Attachment 6). Use 0.6 in this calculation.

From Table 4-2 of the Stormwater C.3 Guidebook, the "Grass/Landscape" will have a runoff coefficient of 0.1 for Group A Soil for treatment and flow control. The "Equipment/Roofs" and "Asphalt Pavement" will have a runoff coefficient of 1.0. The "Transformer Containment" will have no runoff since all the runoff will go to oil-water separator which discharges to the sanitary sewer and will not be discharged on site.

Consequently,

$$\sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} = (20{,}871 \text{x} 1.0 + 27{,}640 \text{x} 1.0 + 54{,}230 \text{x} 0.6 + 46{,}694 \text{x} 0.1 + 4{,}085 \text{x} 0)$$

$$= 85{,}718 \text{ ft}^2.$$

IMP Sizing Factors

Since the project site is covered by hydrologic group A soil, the subsurface reservoir volume ($V_2$) is not needed per Stormwater C.3 Guidebook. From this guidebook, for "treatment and flow control", the IMP sizing factor for the area (A) of bioswale is 0.07. The IMP sizing factor for the surface reservoir volume ($V_1$) of bioswale is 0.058. (Ref. 2, Table 4-6).

Rain Adjustment Factor

Per the Isohyetal Map by Contra Costa County Public Works, Figure B-166 (Ref. 3), the mean annual precipitation (MAP) at the project site is 12.5 inches. Consequently, for group A soils,

$$\text{Rain Adjustment Factor} = \frac{0.0009\times(MAP-20.2)+0.07}{0.07} \qquad \text{(Ref. 2, Equation 4-3)}$$

$$= \frac{0.0009\times(12.5-20.2)+0.07}{0.07}$$

$$= 0.901.$$

Minimum Area and Minimum Volume of IMP

Per Ref. 2, Equation 4-7, the required minimum area (A) of the bioswale is:

$$\text{Min. IMP Area A} = \sum\begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix}\times\begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix}\times\begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

$$= 85{,}718 \times 0.07 \times 0.901 = 5{,}406 \text{ ft}^2.$$

The required minimum surface reservoir volume ($V_1$) of the bioswale is:

$$\text{Min. IMP Volume } (V_1) = \sum\begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix}\times\begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix}\times\begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

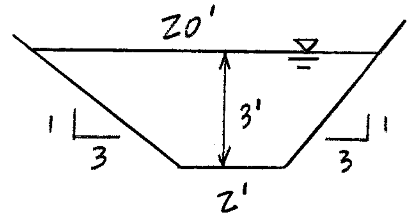
$$= 85{,}718 \times 0.058 \times 0.901 = 4{,}479 \text{ ft}^3.$$

The proposed bioswale #1 is 390 feet long. The bioswale cross section will be trapezoidal. Bottom width = 2 feet. Side slope = 3 (h) to 1 (v). The bottom of the bioswale is at EL 12.5. Drop structure DS-3 will be installed at the end of bioswale #1. See B&V Drawing SS-3001

(Attachment 1). The top of grate elevation of DS-3 will be at EL 15.5 (see Drawing SS-3050). The effective depth of the bioswale is: 15.5 – 12.5 = 3 feet.

The surface area of bioswale #1 is:

$20 \times 390 = 7{,}800\ ft^2 > 5{,}406\ ft^2$, OK.




The volume of bioswale #1 is:

$$\frac{2+20}{2} \times 3 \times 390 = 12{,}870\ ft^3 > 4{,}479\ ft^3, \quad \text{OK}.$$

Conclusion: The proposed size of bioswale #1 is sufficient to meet the Stormwater C.3 requirements.

A spreadsheet was prepared for the above calculations to follow the format by Contra Costa County Clean Water Program. See next page.

| | | | | | |
|---|---|---|---|---|---|
| BLACK & VEATCH | OWNER | Radback Energy | | COMP'D BY | J. Zhong |
| | PLANT | Tenaska | Unit No. | DATE | 20-Mar-2009 |
| | PROJECT NO. | 163994 | File No. 52.5406.1002 | CKD BY | Pcn |
| | TITLE | IMP Sizing | | DATE | 4/5/09 |
| | | | | PAGE | 9 OF 43 |

| DMA Name | DMA Area ($ft^2$) | Post-Project Surface Type | DMA Runoff Factor | DMA Area x Runoff Factor |
|---|---|---|---|---|
| DMA-1 | 20,871 | Equipment/Roofs | 1.00 | 20,871 |
| DMA-2 | 27,640 | Asphalt Pavement | 1.00 | 27,640 |
| DMA-3 | 54,230 | Gravel Surfacing | 0.60 | 32,538 |
| DMA-4 | 46,694 | Landscape, Group A Soil | 0.10 | 4,669 |
| DMA-5 | 4,085 | Transformer Containment | 0.00 | 0 |
| | | | **Total:** | 85,718 |

| Soil Type | IMP Name | | | |
|---|---|---|---|---|
| A | Bioswale #1 | | | |
| **IMP Sizing Factor** | **Rain Adjustment Factor** | **Minimum Area or Volume** | **Proposed Area or Volume** | |
| 0.070 | 0.901 | 5,406 | 7,800 | **IMP Area ($ft^2$)** |
| 0.058 | 0.901 | 4,479 | 12,870 | **$V_1$ ($ft^3$)** |
| NA | 0.901 | NA | NA | **$V_2$ ($ft^3$)** |
| | | | **Orifice Size:** | NA |

## IMP Sizing for Bioswale #2

Refer to Page 5, the total drainage area for bioswale #2 is measured to be: 337,648 $ft^2$ (7.75 ac). The bioswale #2 is measured to be 933 feet long.

Six drainage management areas (DMA) were identified based on the type of ground covers: (1) Equipment/Roofs; (2) Asphalt Pavement; (3) Gravel Surfacing; (4) Grass/Landscape; (5) Transformer Containment; and (6) Open Graded Aggregates (ACC Area).

The measured areas are shown in the following table. The measurements were made by using AutoCAD.

| DMA Name | Post-Project Surface Type | DMA Area ($ft^2$) |
|---|---|---|
| DMA-1 | Equipment/Roofs | 34,029 |
| DMA-2 | Asphalt Pavement | 37,473 |
| DMA-3 | Gravel Surfacing | 45,970 |
| DMA-4 | Grass/Landscape | 151,570 |
| DMA-5 | Transformer Containment | 406 |
| DMA-6 | Open Graded Aggregates | 68,200 |

### Runoff Coefficients

From Table 4-2 of the Stormwater C.3 Guidebook, the "Grass/Landscape" will have a runoff coefficient of 0.1 for Group A Soil for treatment and flow control. The "Equipment/Roofs" and "Asphalt Pavement" will have a runoff coefficient of 1.0. The "Open Graded Aggregates" will have a runoff coefficient of 0.1. The "Transformer Containment" will have no runoff since all the runoff will go to oil-water separator which discharges to the sanitary sewer and will not be discharged on site.

Use 0.6 for dense-graded aggregate surfacing (see Page 6).

Consequently,

$$\sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} = (34{,}029 \times 1.0 + 37{,}473 \times 1.0 + 45{,}970 \times 0.6 + 151{,}570 \times 0.1 + 406 \times 0 + 68{,}200 \times 0.1) = 121{,}061 \text{ ft}^2.$$

IMP sizing factor = 0.07 for the area (A) of bioswale; IMP sizing factor = 0.058 for the surface reservoir volume ($V_1$). See Page 7.

Rain adjustment factor = 0.901. See Page 7.

Minimum Area and Minimum Volume of IMP

Per Ref. 2, Equation 4-7, the required minimum area (A) of the bioswale is:

$$\text{Min. IMP Area A} = \sum \begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

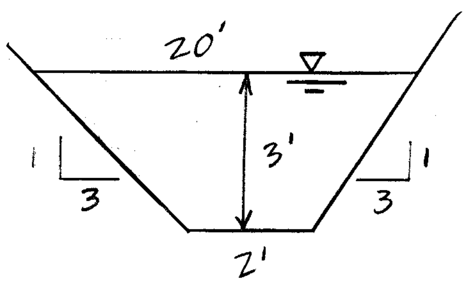
$$= 121{,}061 \times 0.07 \times 0.901 = 7{,}635 \text{ ft}^2.$$

The required minimum surface reservoir volume ($V_1$) of the bioswale is:

$$\text{Min. IMP Volume } (V_1) = \sum \begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

$$= 121{,}061 \times 0.058 \times 0.901 = 6{,}326 \text{ ft}^3.$$

The proposed bioswale #2 is 933 feet long. The bioswale cross section will be trapezoidal. Bottom width = 2 feet. Side slope = 3 (h) to 1 (v). The bottom of the bioswale is at EL 12.5. Drop structure DS-2 will be installed at the end of bioswale #2. See B&V Drawing SS-3001. The top of grate elevation of DS-2 will be at EL 15.5 (see Drawing SS-3050). The effective depth of the bioswale is: 15.5 – 12.5 = 3 feet.




The surface area of bioswale #2 is:

$20 \times 933 = 18{,}660 \text{ ft}^2 > 7{,}635 \text{ ft}^2$, OK.

The volume of bioswale #2 is:

$\frac{2+20}{2} \times 3 \times 933 = 30{,}789 \text{ ft}^3 > 6{,}326 \text{ ft}^3$, OK.

Conclusion: The proposed size of bioswale #2 is sufficient to meet the Stormwater C.3 requirements.

A spreadsheet was prepared for the above calculations to follow the format by Contra Costa County Clean Water Program. See next page.

| BLACK & VEATCH | | | | |
|---|---|---|---|---|
| OWNER | Radback Energy | | COMP'D BY | J. Zhong |
| PLANT | Tenaska | Unit No. | DATE | 20-Mar-2009 |
| PROJECT NO. | 163994 | File No. 52.5406.1002 | CKD BY | Pm |
| TITLE | IMP Sizing | | DATE | 4/15/09 |
| | | | PAGE | 12 OF 43 |

| Soil Type | IMP Name |
|---|---|
| A | Bioswale #2 |

| DMA Name | DMA Area ($ft^2$) | Post-Project Surface Type | DMA Runoff Factor | DMA Area x Runoff Factor |
|---|---|---|---|---|
| DMA-1 | 34,029 | Equipment / Roofs | 1.00 | 34,029 |
| DMA-2 | 37,473 | Asphalt Pavement | 1.00 | 37,473 |
| DMA-3 | 45,970 | Gravel Surfacing | 0.60 | 27,582 |
| DMA-4 | 151,570 | Landscape, Group A Soil | 0.10 | 15,157 |
| DMA-5 | 406 | Transformer Containment | 0.00 | 0 |
| DMA-6 | 68,200 | Open Graded Aggregates | 0.10 | 6,820 |
| | | | Total: | 121,061 |

| IMP Sizing Factor | Rain Adjustment Factor | Minimum Area or Volume | Proposed Area or Volume | |
|---|---|---|---|---|
| 0.070 | 0.901 | 7,635 | 18,660 | IMP Area ($ft^2$) |
| 0.058 | 0.901 | 6,326 | 30,789 | $V_1$ ($ft^3$) |
| NA | 0.901 | NA | NA | $V_2$ ($ft^3$) |
| | | | Orifice Size: | NA |

**IMP Sizing for Bioswale #3**

Refer to Page 5, the total drainage area for bioswale #3 is measured to be: 40,711 $ft^2$ (0.93 ac). The bioswale #3 is measured to be 187 feet long.

Three drainage management areas (DMA) were identified based on the type of ground covers: (1) Equipment/Roofs; (2) Asphalt Pavement; and (3) Grass/Landscape.

The measured areas are shown in the following table. The measurements were made by using AutoCAD.

| DMA Name | Post-Project Surface Type | DMA Area ($ft^2$) |
|---|---|---|
| DMA-1 | Equipment/Roofs | 6,423 |
| DMA-2 | Asphalt Pavement | 2,086 |
| DMA-3 | Grass/Landscape | 32,202 |

Runoff Coefficients

From Table 4-2 of the Stormwater C.3 Guidebook, the "Grass/Landscape" will have a runoff coefficient of 0.1 for Group A Soil for treatment and flow control. The "Equipment/Roofs" and "Asphalt Pavement" will have a runoff coefficient of 1.0.

Consequently,

$$\sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} = (6{,}423\text{x}1.0+2{,}086\text{x}1.0+32{,}202\text{x}0.1)$$

$$= 11{,}729 \text{ ft}^2.$$

IMP sizing factor = 0.07 for the area (A) of bioswale; IMP sizing factor = 0.058 for the surface reservoir volume ($V_1$). See Page 7.

Rain adjustment factor = 0.901. See Page 7.

Minimum Area and Minimum Volume of IMP

Per Ref. 2, Equation 4-7, the required minimum area (A) of the bioswale is:

$$\text{Min. IMP Area A} = \sum \begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

$$= 11{,}729 \times 0.07 \times 0.901 = 740 \text{ ft}^2.$$

The required minimum surface reservoir volume ($V_1$) of the bioswale is:

$$\text{Min. IMP Volume } (V_1) = \sum \begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

$$= 11{,}729 \times 0.058 \times 0.901 = 613 \text{ ft}^3.$$

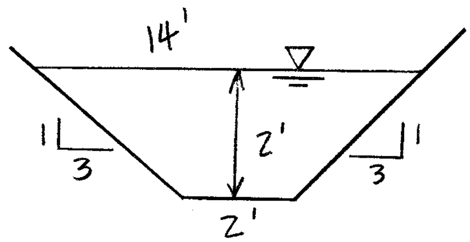
The proposed bioswale #3 is 187 feet long. The bioswale cross section will be trapezoidal. Bottom width = 2 feet. Side slope = 3 (h) to 1 (v). The bottom of the bioswale is at EL 11.0. Drop structure DS-1 will be installed at the end of bioswale #3. See B&V Drawing SS-3001. The top of grate elevation of DS-1 will be at EL 13.0 (see Drawing SS-3050). The effective depth of the bioswale is: 13.0 – 11.0 = 2 feet.

The surface area of bioswale #3 is:

$14 \times 187 = 2{,}618 \text{ ft}^2 > 740 \text{ ft}^2$, <u>OK</u>.

The volume of bioswale #3 is:

$\frac{2+14}{2} \times 2 \times 187 = 2992 \text{ ft}^3 > 613 \text{ ft}^3$, <u>OK</u>.




A 6" perforated underdrain will be installed in bioswale #3 and a portion of bioswale #2 to discharge stormwater runoff from less intensive storm events to the wetland to allow the wetland to continue to have water. See Dwg SS-3001 (Attachment 1).

<u>Conclusion</u>: The proposed size of bioswale #3 is sufficient to meet the Stormwater C.3 requirements.

A spreadsheet was prepared for the above calculations to follow the format by Contra Costa County Clean Water Program. See next page.

| | | | | |
|---|---|---|---|---|
| BLACK & VEATCH | OWNER | Radback Energy | COMP'D BY | J. Zhong |
| | PLANT | Tenaska | Unit No. | DATE | 20-Mar-2009 |
| | PROJECT NO. | 163994 | File No. 52.5406.1002 | CKD BY | PLN |
| | TITLE | IMP Sizing | | DATE | 4/15/09 |
| | | | | PAGE | 15 OF 43 |

| Soil Type | IMP Name |
|---|---|
| A | Bioswale #3 |

| DMA Name | DMA Area ($ft^2$) | Post-Project Surface Type | DMA Runoff Factor | DMA Area x Runoff Factor |
|---|---|---|---|---|
| DMA-1 | 6,423 | Equipment / Roofs | 1.00 | 6,423 |
| DMA-2 | 2,086 | Asphalt Pavement | 1.00 | 2,086 |
| DMA-3 | 32,202 | Landscape, Group A Soil | 0.10 | 3,220 |
| | | | | |
| | | | | |
| | | | Total: | 11,729 |

| IMP Sizing Factor | Rain Adjustment Factor | Minimum Area or Volume | Proposed Area or Volume | |
|---|---|---|---|---|
| 0.070 | 0.901 | 740 | 2,618 | IMP Area ($ft^2$) |
| 0.058 | 0.901 | 613 | 2,992 | $V_1$ ($ft^3$) |
| NA | 0.901 | NA | NA | $V_2$ ($ft^3$) |
| | | | Orifice Size: | NA |

**IMP Sizing for Bioswale #4**

Refer to Page 5, the total drainage area for bioswale #4 is measured to be: 190,955 ft$^2$ (4.38 ac). The bioswale #4 is measured to be 391 feet long.

Five drainage management areas (DMA) were identified based on the type of ground covers: (1) Equipment/Roofs; (2) Asphalt Pavement; (3) Gravel Surfacing; (4) Grass/Landscape; and (5) Transformer Containment.

The measured areas are shown in the following table. The measurements were made by using AutoCAD.

| DMA Name | Post-Project Surface Type | DMA Area (ft$^2$) |
|---|---|---|
| DMA-1 | Equipment/Roofs | 19,314 |
| DMA-2 | Asphalt Pavement | 33,262 |
| DMA-3 | Gravel Surfacing | 109,208 |
| DMA-4 | Grass/Landscape | 23,692 |
| DMA-5 | Transformer Containment | 5,479 |

Runoff Coefficients

From Table 4-2 of the Stormwater C.3 Guidebook, the "Grass/Landscape" will have a runoff coefficient of 0.1 for Group A Soil for treatment and flow control. The "Equipment/Roofs" and "Asphalt Pavement" will have a runoff coefficient of 1.0. The "Transformer Containment" will have no runoff since all the runoff will go to oil-water separator which discharges to the sanitary sewer and will not be discharged on site.

Use 0.6 for dense-graded aggregate surfacing (see Page 6).

Consequently,

$$\sum\begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} = (19{,}314\text{x}1.0+33{,}262\text{x}1.0+109{,}208\text{x}0.6+23{,}692\text{x}0.1+5{,}479\text{x}0)$$

$$= 120{,}470 \text{ ft}^2.$$

IMP sizing factor = 0.07 for the area (A) of bioswale; IMP sizing factor = 0.058 for the surface reservoir volume ($V_1$). See Page 7.

Rain adjustment factor = 0.901. See Page 7.

Minimum Area and Minimum Volume of IMP

Per Ref. 2, Equation 4-7, the required minimum area (A) of the bioswale is:

$$\text{Min. IMP Area A} = \sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

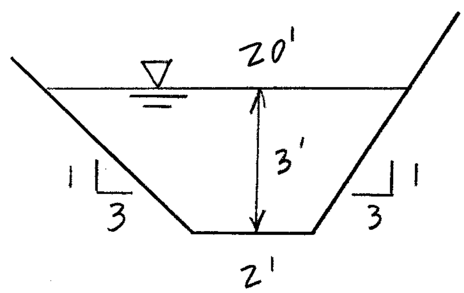
$$= 120{,}470 \times 0.07 \times 0.901 = 7{,}598 \text{ ft}^2.$$

The required minimum surface reservoir volume ($V_1$) of the bioswale is:

$$\text{Min. IMP Volume } (V_1) = \sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

$$= 120{,}470 \times 0.058 \times 0.901 = 6{,}296 \text{ ft}^3.$$

The proposed bioswale #4 is 391 feet long. The bioswale cross section will be trapezoidal. Bottom width = 2 feet. Side slope = 3 (h) to 1 (v). The bottom of the bioswale is at EL 12.5. Drop structure DS-4 will be installed at the end of bioswale #4. See B&V Drawing SS-3001. The top of grate elevation of DS-4 will be at EL 15.5 (see Drawing SS-3050). The effective depth of the bioswale is: 15.5 – 12.5 = 3 feet.




The surface area of bioswale #4 is:

$20 \times 391 = 7{,}820 \text{ ft}^2 > 7{,}598 \text{ ft}^2$, OK.

The volume of bioswale #4 is:

$\frac{2+20}{2} \times 3 \times 391 = 12{,}903 \text{ ft}^3 > 6{,}296 \text{ ft}^3$, OK.

Conclusion: The proposed size of bioswale #4 is sufficient to meet the Stormwater C.3 requirements.

A spreadsheet was prepared for the above calculations to follow the format by Contra Costa County Clean Water Program. See next page.

| BLACK & VEATCH | | | |
|---|---|---|---|
| OWNER | Radback Energy | COMP'D BY | J. Zhong |
| PLANT | Tenaska, Unit No. | DATE | 20-Mar-2009 |
| PROJECT NO. | 163994, File No. 52.5406.1002 | CKD BY | PLN |
| TITLE | IMP Sizing | DATE | 4/15/09 |
| | | PAGE | 18 OF 43 |

| Soil Type | IMP Name |
|---|---|
| A | Bioswale #4 |

| DMA Name | DMA Area ($ft^2$) | Post-Project Surface Type | DMA Runoff Factor | DMA Area x Runoff Factor |
|---|---|---|---|---|
| DMA-1 | 19,314 | Equipment / Roofs | 1.00 | 19,314 |
| DMA-2 | 33,262 | Asphalt Pavement | 1.00 | 33,262 |
| DMA-3 | 109,208 | Gravel Surfacing | 0.60 | 65,525 |
| DMA-4 | 23,692 | Landscape, Group A Soil | 0.10 | 2,369 |
| DMA-5 | 5,479 | Transformer Containment | 0.00 | 0 |
| | | | | |
| | | | Total: | 120,470 |

| IMP Sizing Factor | Rain Adjustment Factor | Minimum Area or Volume | Proposed Area or Volume | |
|---|---|---|---|---|
| 0.070 | 0.901 | 7,598 | 7,820 | IMP Area ($ft^2$) |
| 0.058 | 0.901 | 6,296 | 12,903 | $V_1$ ($ft^3$) |
| NA | 0.901 | NA | NA | $V_2$ ($ft^3$) |
| | | | Orifice Size: | NA |

**IMP Sizing for Bioswale #5**

Refer to Page 5, the total drainage area for bioswale #5 is measured to be: 318,309 $ft^2$ (7.31 ac) (natural gas facility included). The bioswale #5 is measured to be 465 feet long total.

Four drainage management areas (DMA) were identified based on the type of ground covers: (1) Equipment/Roofs; (2) Asphalt Pavement; (3) Gravel Surfacing; and (4) Grass/Landscape.

The measured areas are shown in the following table. The measurements were made by using AutoCAD.

| DMA Name | Post-Project Surface Type | DMA Area ($ft^2$) |
|---|---|---|
| DMA-1 | Equipment/Roofs | 15,984 |
| DMA-2 | Asphalt Pavement | 25,905 |
| DMA-3 | Gravel Surfacing | 186,725 |
| DMA-4 | Grass/Landscape | 89,695 |

Runoff Coefficients

From Table 4-2 of the Stormwater C.3 Guidebook, the "Grass/Landscape" will have a runoff coefficient of 0.1 for Group A Soil for treatment and flow control. The "Equipment/Roofs" and "Asphalt Pavement" will have a runoff coefficient of 1.0.

Use 0.6 for dense-graded aggregate surfacing (see Page 6).

Consequently,

$$\sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} = (15{,}984 \text{x} 1.0 + 25{,}905 \text{x} 1.0 + 186{,}725 \text{x} 0.6 + 89{,}695 \text{x} 0.1)$$

$$= 162{,}894 \text{ ft}^2.$$

IMP sizing factor = 0.07 for the area (A) of bioswale; IMP sizing factor = 0.058 for the surface reservoir volume ($V_1$). See Page 7.

Rain adjustment factor = 0.901. See Page 7.

**Owner**: Radback Energy **Computed By**: J. Zhong
**Plant**: Tenaska **Unit**: **Date**: March 30, 2009
**Project No.**: 163994 **File No.** 52.5406.1002 **Verified By**: PLN
**Title**: IMP Sizing for Plant Area **Date**: 4/15/09


Minimum Area and Minimum Volume of IMP

Per Ref. 2, Equation 4-7, the required minimum area (A) of the bioswale is:

$$\text{Min. IMP Area A} = \sum \begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

$$= 162{,}894 \times 0.07 \times 0.901 = 10{,}274 \text{ ft}^2.$$

The required minimum surface reservoir volume ($V_1$) of the bioswale is:

$$\text{Min. IMP Volume } (V_1) = \sum \begin{pmatrix} DMA & DMA \\ Square & \times Runoff \\ Footage & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

$$= 162{,}894 \times 0.058 \times 0.901 = 8{,}512 \text{ ft}^3.$$

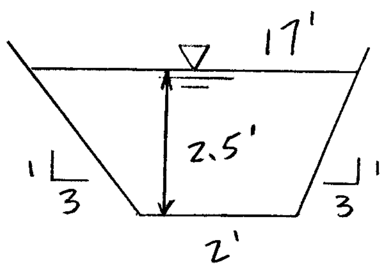
The proposed bioswale #5 is 465 feet long total. The bioswale cross section will be trapezoidal. Bottom width = 2 feet for the first 265 feet long section (Section 2 on SS-3001) and 8 feet for the remaining 200 feet long section (Section 2A on SS-3001). Side slope = 3 (h) to 1 (v). The bottom of the bioswale is at EL 12.0 for Section 2 and EL 11.0 for Section 2A. Drop structure DS-5 will be installed at the end of bioswale #5. See B&V Drawing SS-3001. The top of grate elevation of DS-5 will be at EL 15.0 (see Drawing SS-3050). The effective depth of the bioswale is: 14.5 – 11.0 = 3.5 feet for Section 2A and 14.5 – 12.0 = 2.5 feet for Section 2. See Dwg SS-3001 in Attachment 1.

The surface area of bioswale #5 is:

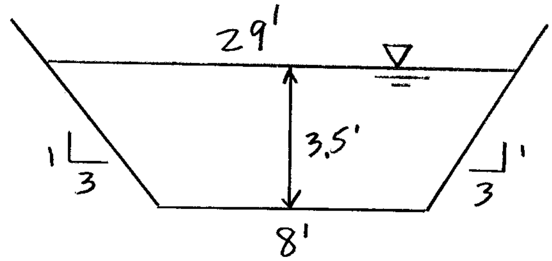
$17 \times 265 + 29 \times 200 = 10{,}305 \text{ ft}^2 > 10{,}274 \text{ ft}^2$, OK.

The volume of bioswale #5 is:

$\frac{2+17}{2} \times 2.5 \times 265 + \frac{8+29}{2} \times 3.5 \times 200 = 19{,}244 \text{ ft}^3 > 8{,}512 \text{ ft}^3$, OK.




Section 2
DWG SS-3001




Section 2A
DWG SS-3001

Conclusion: The proposed size of bioswale #5 is sufficient to meet the Stormwater C.3 requirements.

A spreadsheet was prepared for the above calculations to follow the format by Contra Costa County Clean Water Program. See next page.

| BLACK & VEATCH | | | | | |
|---|---|---|---|---|---|
| OWNER | Radback Energy | | COMP'D BY | J. Zhong | |
| PLANT | Tenaska | Unit No. | DATE | 20-Mar-2009 | |
| PROJECT NO. | 163994 | File No. 52.5406.1002 | CKD BY | PLW | |
| TITLE | IMP Sizing | | DATE | 4/15/09 | |
| | | | PAGE | 22 | OF 43 |

| Soil Type | IMP Name |
|---|---|
| A | Bioswale #5 |

| DMA Name | DMA Area ($ft^2$) | Post-Project Surface Type | DMA Runoff Factor | DMA Area x Runoff Factor |
|---|---|---|---|---|
| DMA-1 | 15,984 | Equipment / Roofs | 1.00 | 15,984 |
| DMA-2 | 25,905 | Asphalt Pavement | 1.00 | 25,905 |
| DMA-3 | 186,725 | Gravel Surfacing | 0.60 | 112,035 |
| DMA-4 | 89,695 | Landscape, Group A Soil | 0.10 | 8,970 |
| | | | | |
| | | | Total: | 162,894 |

| IMP Sizing Factor | Rain Adjustment Factor | Minimum Area or Volume | Proposed Area or Volume | |
|---|---|---|---|---|
| 0.070 | 0.901 | 10,274 | 10,305 | IMP Area ($ft^2$) |
| 0.058 | 0.901 | 8,512 | 19,244 | $V_1$ ($ft^3$) |
| NA | 0.901 | NA | NA | $V_2$ ($ft^3$) |
| | | | Orifice Size: | NA |

Radback Tenaska project

project # 163994 File # 52.5406.1002

IMP sizing for plant Area

prepared by: J Zhong

Date: 3/30/09

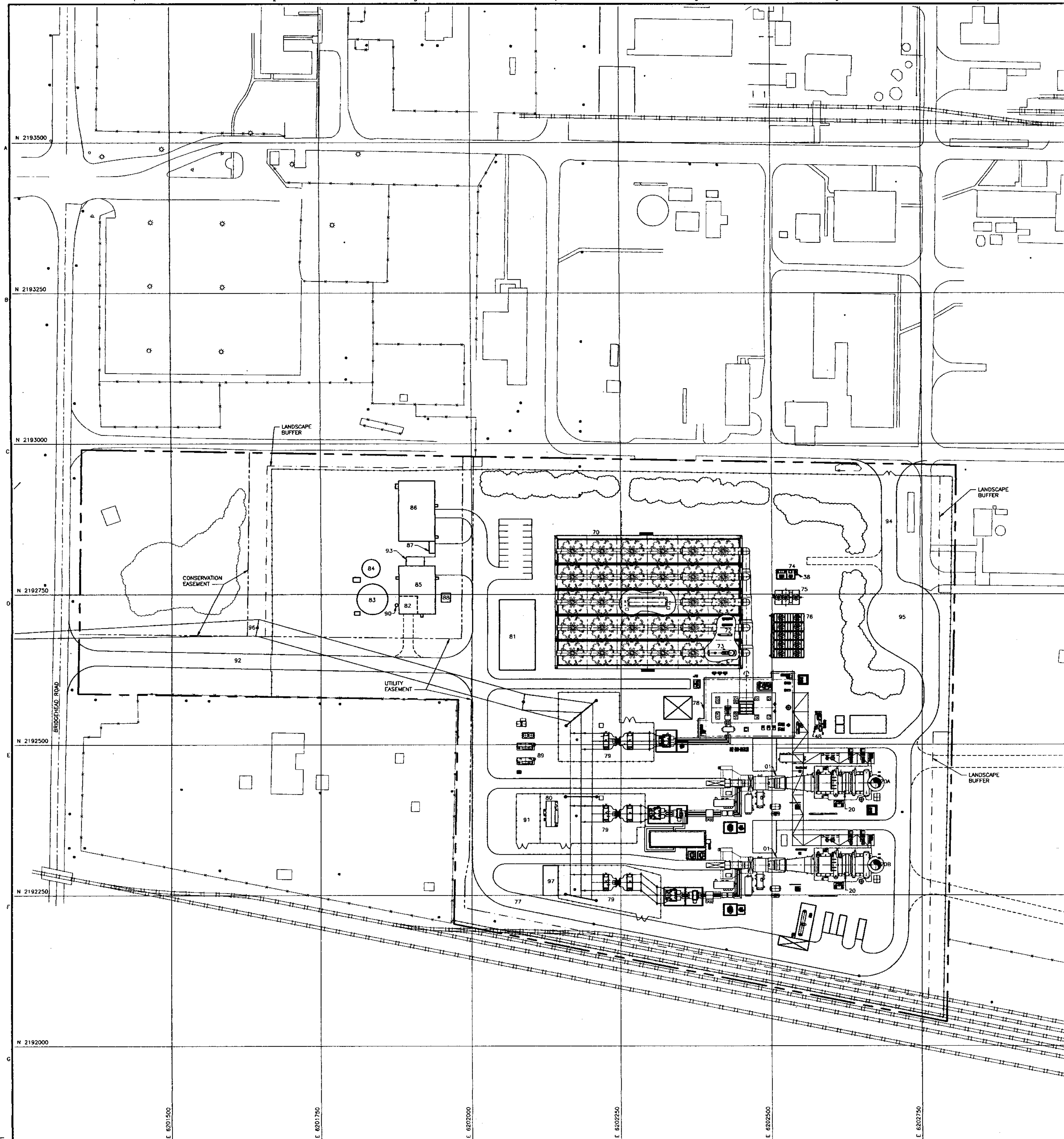
# of pages: 5

Attachment 1

Black & Veatch Dwgs

SS-1002, SS-3001, SS-3201, SS-3050

DWG40999 31-MAR-2009 09:29:37




## FACILITIES LEGEND

| ID | FACILITY | STRUCTURE HEIGHT | TIEDOWN LOCATION NORTH | TIEDOWN LOCATION EAST | REMARKS |
|---|---|---|---|---|---|
| 01 | COMBUSTION TURBINE | 70' | – | – | – |
| 20 | HEAT RECOVERY STEAM GENERATOR (HRSG) | 103' | – | – | – |
| 20A | HRSG EXHAUST STACK A | 155' | 2192436.00 | 6202665.00 | CL EXHAUST STACK |
| 20B | HRSG EXHAUST STACK B | 155' | 2192300.00 | 6202665.00 | CL EXHAUST STACK |
| 38 | SAFETY SHOWER EYEWASH STATION | – | – | – | – |
| 48 | AUXILIARY BOILER | 50' | 2192527.61 | 6202572.26 | CL EXHAUST STACK |
| 70 | AIR COOLED CONDENSER (ACC) | 124' | – | – | – |
| 71 | ACC ELECTRICAL ENCLOSURE | 14' | – | – | – |
| 72 | CONDENSER AIR EXTRACTION SKIDS | 6' | – | – | – |
| 73 | ACC CONDENSATE COLLECTION TANK | 28' | – | – | – |
| 74 | WET SURFACE AIR COOLER CHEMICAL FEED SKIDS | 8' | – | – | – |
| 75 | WET SURFACE AIR COOLER | 23' | 2192744.67 | 6202523.00 | CL COOLER |
| 76 | CLOSED CYCLE COOLING WATER HEAT EXCHANGER | 19' | – | – | – |
| 77 | LOOP ROAD | – | – | – | – |
| 78 | STEAM TURBINE FOUNDATION | – | – | – | – |
| 79 | SWITCHYARD | 18' & 45' | – | – | – |
| 80 | SWITCHYARD CONTROL ENCLOSURE | 12' | – | – | – |
| 81 | CONTROL & ADMIN BUILDING | 14' | – | – | – |
| 82 | FIRE WATER PUMP ROOM | 20' | – | – | – |
| 83 | FIRE/SERVICE WATER STORAGE TANK | 32' | – | – | – |
| 84 | DEMIN WATER STORAGE TANK | 24' | – | – | – |
| 85 | WATER TREATMENT BUILDING | 20' | – | – | – |
| 86 | WAREHOUSE/MAINTENANCE BUILDING | 16' | – | – | – |
| 87 | LUBRICANT STORAGE SHED | 10' | – | – | – |
| 88 | WASTE WATER LIFT STATION (IF REQUIRED) | – | – | – | – |
| 89 | GAS COMPRESSORS & GAS CONDITIONING | 13' | – | – | – |
| 90 | DIESEL FIRE PUMP EXHAUST | 16' | 2192732.52 | 6201874.72 | CL EXHAUST STACK |
| 91 | GAS METERING STATION | – | – | – | – |
| 92 | ACCESS ROAD | – | – | – | – |
| 93 | LEASED MIX BED EXCHANGER CONCRETE SLAB | – | – | – | – |
| 94 | EMERGENCY ACCESS ROAD | – | – | – | – |
| 95 | CUL DA SAC (TURNAROUND) | – | – | – | – |
| 96 | 230KV POWER POLE | 106' | – | – | – |
| 97 | OUTAGE MAINTENANCE TRAILERS AREA | – | – | – | – |

## NOTES

1. COORDINATES ARE BASED ON CALIFORNIA COORDINATE SYSTEM CCS83, ZONE 3. ELEVATION ARE BASED ON, NGVD 29 DATUM. BENCHMARK IS NATIONAL GEODETIC SURVEY BENCH MARK "W 563", LOCATED ADJACENT TO THE FLAGPOLE AT THE DUPONT PLANT ENTRANCE, ELEVATION = 11.168 FEET. TO OBTAIN DUPONT PLANT DATUM ELEVATION, ADD 0.70 FEET TO THE ELEVATIONS SHOWN. TOPOGRAPHIC DATA IS BASED ON AERIAL PHOTOGRAPH DATED JUNE 11, 2001. AERIAL SURVEY INFORMATION WAS OBTAINED BY RONALD GREENWELL & ASSOCIATES, INC.
2. SEE PLANT ARRANGEMENT DRAWING SM-2001, FOR LEGEND OF MAIN POWER BLOCK.
3. PROPERTY AND EASEMENT BOUNDARY INFORMATION IS BASED UPON DRAWING EXHIBIT D, BY RONALD GREENWELL & ASSOCIATES, INC. REVISION DATED 05/FEB/09.

## GENERAL LEGEND

NEW FENCE

EXISTING FENCE

PROPERTY BOUNDRY (SEE NOTE 3)

EASEMENT BOUNDARY (SEE NOTE 3)

LANDSCAPE BUFFER

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|---|---|---|---|---|---|---|---|
| 1 | 30/MAR/09 | ISSUED PER ECN-N-S-0001 | NAW | PLN | | PLN | DVW |
| 0 | 13/MAR/09 | ISSUED FOR PERMITTING | NAW | PLN | | PLN | DVW |

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

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SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER PLN DRAWN NAW
CHECKED DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

GENERAL ARRANGEMENT
SITE

PROJECT DRAWING NUMBER 163994-SS-1002 REV 1
CODE
AREA

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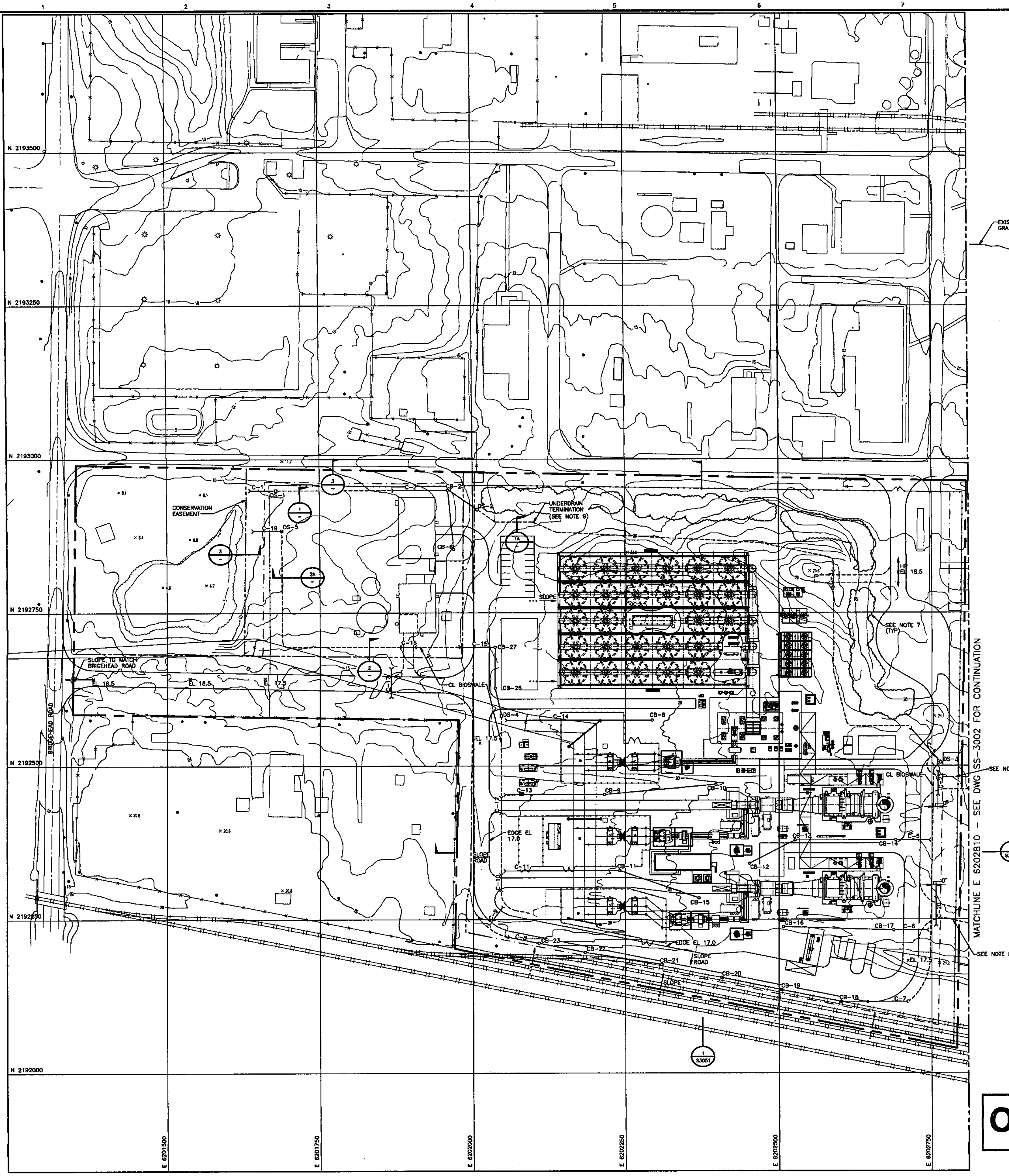


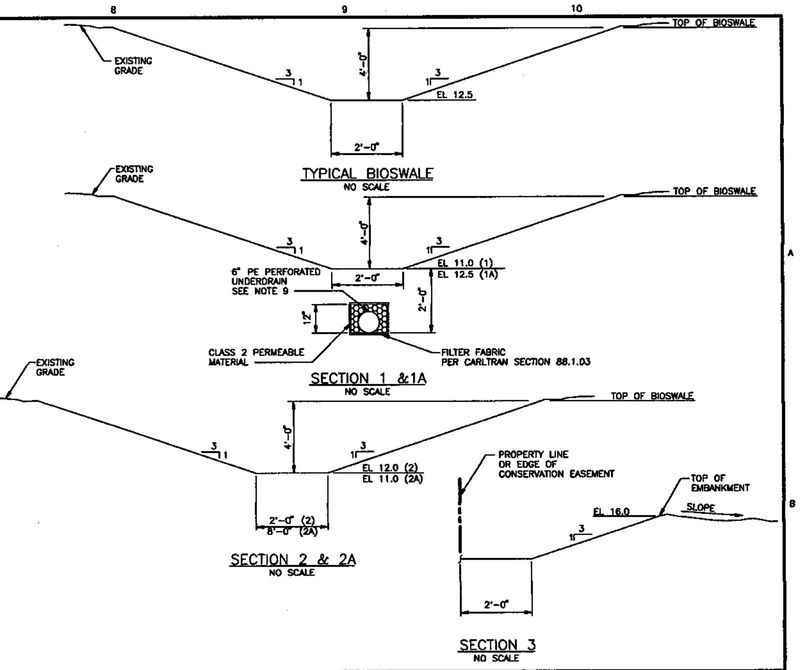


## ABBREVIATIONS APPLICABLE TO ALL SS-3000 SERIES DRAWINGS

| | | | |
|---|---|---|---|
| APPROX | APPROXIMATE | LTR | LATER |
| ASPH | ASPHALT | MAX | MAXIMUM |
| AVG | AVERAGE | MH | MANHOLE |
| BND | BEND | MIN | MINIMUM |
| BLDG | BUILDING | MJ | MECHANICAL JOINT |
| B/MH | BOTTOM OF MANHOLE ELEVATION | MSL | MEAN SEA LEVEL |
| BOC | BOTTOM OF CONDUIT ELEVATION | NO. | NUMBER |
| BOD | BOTTOM OF DUCTBANK ELEVATION | NTS | NOT TO SCALE |
| BOP | BOTTOM OF PIPE ELEVATION | OD | OUTSIDE DIAMETER |
| BU | BELL-UP | OWS | OIL WATER SEPARATOR |
| C | CULVERT | OWMH | OILYWASTE MANHOLE |
| CB | CATCH BASIN | PC | POINT OF CURVATURE |
| CD | CABLE DUCT | PE | PLAIN END |
| CHDPE | CORRUGATED HIGH DENSITY POLYETHYLENE PIPE | PI | POINT OF INTERSECTION |
| CL | CENTERLINE | PLCS | PLACES |
| CLR | CLEAR | PM | PLANT MANHOLE |
| CMH | CHEMICAL MANHOLE | POT | POINT OF TANGENT |
| CND | CONDUIT | PT | PIPE TERMINATION |
| CONC | CONCRETE | PVC | POLYVINYL CHLORIDE PIPE |
| CO | CLEAN OUT | QTY | QUANITY |
| CS | CARBON STEEL | R | RADIUS |
| CW | CIRCULATING WATER | RCP | REINFORCED CONCRETE PIPE |
| DB | DUCTBANK | RD | ROOF DRAIN |
| DBC | DIRECT BURIED CABLE | REV | REVISION |
| DET | DETAIL | RGS | RIGID GALVANIZED STEEL |
| DIA | DIAMETER | RR | RAILROAD |
| DIP | DUCTILE IRON PIPE | SECT | SECTION |
| DWG | DRAWING | SIM | SIMILAR |
| DWP | DOUBLE WALL PIPE | SLS | SANITARY LIFT STATION |
| EC | ELECTRICAL CONDUIT | SMH | SANITARY MANHOLE |
| ECC | ECCENTRIC | STMH | STORM MANHOLE |
| EF | EACH FACE | STRL | STRUCTURAL |
| EHH | ELECTRICAL HANDHOLE | T/C | TOP OF CONCRETE ELEVATION |
| EL | ELEVATION | T/G | TOP OF GRADE ELEVATION |
| EMH | ELECTRICAL MANHOLE | THH | TELEPHONE SERVICE HANDHOLE |
| EW | EACH WAY | T/MH | TOP OF MANHOLE ELEVATION |
| FC | FIELD CHECK | T/P | TOP OF PAVEMENT ELEVATION |
| FDN | FOUNDATION | TP | MECH PIPE TERMINAL POINT |
| FF | FLAT FACE | TYP | TYPICAL |
| FRP | FIBERGLASS REINFORCED PIPE | UGL | UNDERGROUND LIGHTING CONDUIT |
| GR | GRADE | UNO | UNLESS NOTED OTHERWISE |
| HDM | HOT DRAIN MANHOLE | VERT | VERTICAL |
| HDPE | HIGH DENSITY POLYETHYLENE PIPE | WGT | WEIGHT |
| HP | HIGH POINT | WTR | WATER |
| HYD | HYDRANT | W/ | WITH |
| ID | INSIDE DIAMETER | W/O | WITHOUT |
| INV | INVERT | WP | WORK POINT |
| JBX | JUNCTION BOX | XFMR | TRANSFORMER |
| L | LENGTH | | |
| LP | LOW POINT | | |

## LEGEND APPLICABLE TO ALL S3000 DRAWINGS

| | |
|---|---|
| NEW CULVERT | NEW SLIDE GATE |
| CL BIOSWALE | NEW SWING GATE |
| SECTION OR DETAIL NUMBER / DRAWING DESIGNATION NUMBER | EXISTING POWER POLE |
| 326.5 FINISHED SPOT ELEVATIONS | CB-101 NEW CATCH BASIN |
| | NEW DROP STRUCTURE |
| BM-1 SURVEY MONUMENT/CONTROL POINT | PROPERTY LINE |
| EXISTING FENCE | BOUNDARY LINE |
| NEW SECURITY FENCE | 126 EXISTING CONTOURS |
| TEMPORARY CONSTRUCTION FENCE | GRADE TO DRAIN (DIRECTION OF ARROW) |
| TR-1 EROSION CONTROL METHOD | |

## NOTES APPLICABLE TO ALL SS-3000 SERIES DRAWINGS

1. COORDINATES ARE BASED ON CALIFORNIA COORDINATE SYSTEM CCS83, ZONE 3. ELEVATION ARE BASED ON, NGVD 29 DATUM. BENCHMARK IS NATIONAL GEODETIC SURVEY BENCH MARK "W 563", LOCATED ADJACENT TO THE FLAGPOLE AT THE DUPONT PLANT ENTRANCE, ELEVATION = 11.168 FEET. TO OBTAIN DUPONT PLANT DATUM ELEVATION, ADD 0.70 FEET TO THE ELEVATIONS SHOWN. TOPOGRAPHIC DATA IS BASED ON AERIAL PHOTOGRAPH DATED JUNE 11, 2001. AERIAL SURVEY INFORMATION WAS OBTAINED BY RONALD GREENWELL & ASSOCIATES, INC.
2. NEW GRADE ELEVATIONS SHOWN ON THE SITE GRADING AND DRAINAGE PLANS INDICATE FINISH GRADE UNLESS NOTED OTHERWISE.
3. ALL CUT AND FILL SLOPES SHALL BE 3 HORIZONTAL TO 1 VERTICAL OR FLATTER, UNLESS NOTED OTHERWISE.
4. SEE DWG SS-3050 FOR GRADING AND DRAINAGE DETAILS INCLUDING CULVERT, CATCH BASIN AND DROP STRUCTURE CHARTS.
5. TOP OF CONCRETE ELEVATIONS AND FINISH FLOOR ELEVATIONS FOR ALL EQUIPMENT AND BUILDINGS IS EL 18.0. FINISH GRADE ADJACENT TO ALL FOUNDATIONS IS EL 17.5.
6. CL OF ALL PAVED ROADS IS EL 17.5 UNO.
7. TREES TO REMAIN. GRADE TO REMAIN UNCHANGED WITHIN 20' OF TREE BASE.
8. TEMPORARY ROAD FROM LAYDOWN AREA. ROAD AND CULVERT UNDER ROAD TO BE REMOVED AT END OF CONSTRUCTION.
9. UNDERDRAIN CONTINUOUS UNDER BIOSWALE FROM UNDERDRAIN TERMINATION TO CONSERVATION EASEMENT. UTILIZE UNPERFORATED PIPE BETWEEN DS-2 TO C-2 OUTLET AND DS-1 TO C-1 OUTLET.

**OPEN**
04/01/09

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|---|---|---|---|---|---|---|
| 0 | 15/APR/09 | ISSUED FOR PERMITTING | NAW | PLN | PLN | DW |

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
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BLACK & VEATCH CORPORATION
ENGINEER PLN | DRAWN NAW
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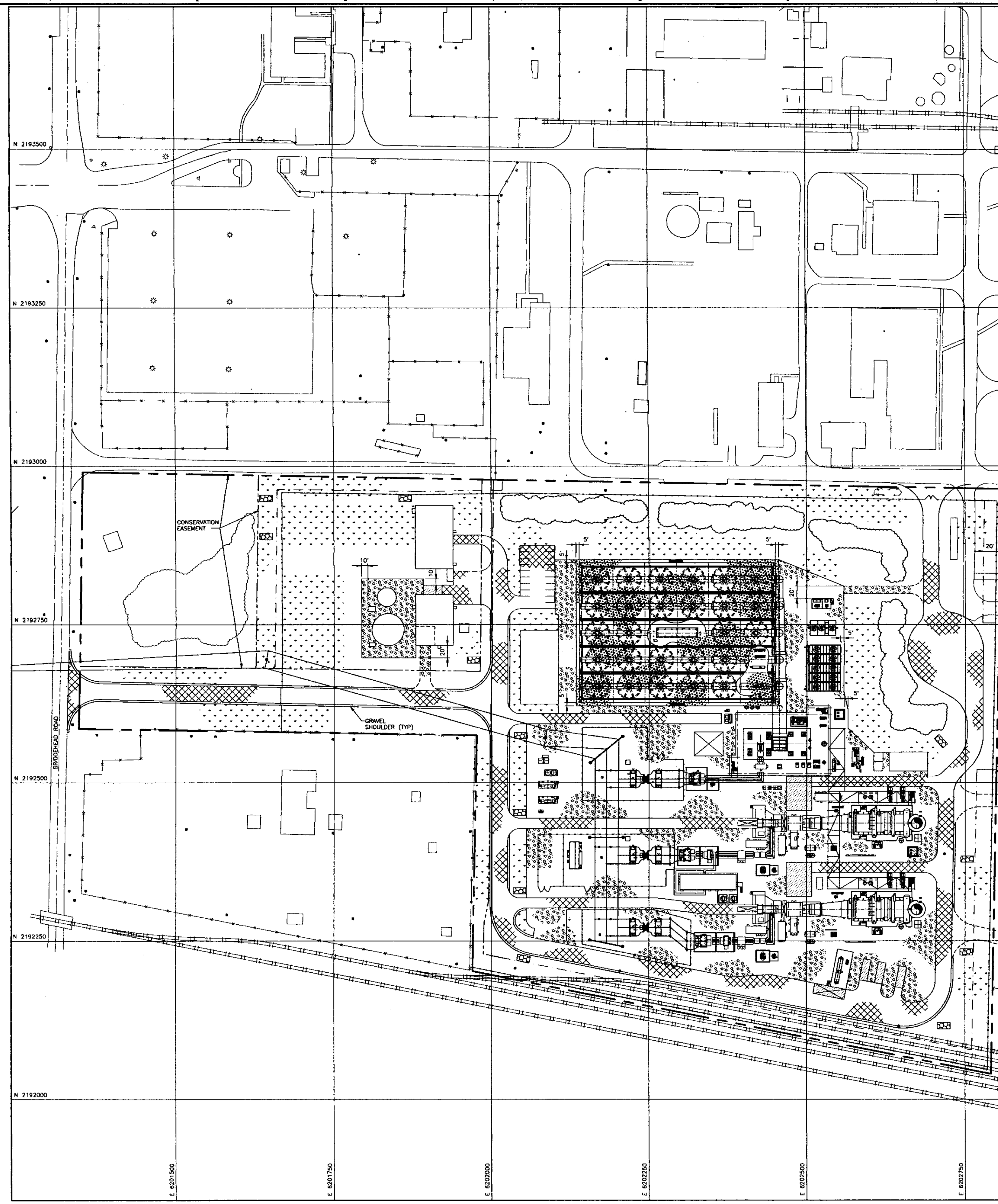
CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

GRADING AND DRAINAGE - SITE PLAN - SHEET 1

PROJECT / DRAWING NUMBER: 163994-SS-3001 | REV 0
CODE
AREA

DWG40999 31-MAR-2009 09:31:01




## SITE SURFACING LEGEND

- ASPHALT SURFACING
- AGGREGATE SURFACING
- CONCRETE
- GRASS
- OPEN GRADED STONE SURFACING
- RIPRAP
- EXISTING FACILITY
- NEW FACILITY
- NATURAL SOIL

## NOTES

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.

NOT TO BE USED
FOR CONSTRUCTION

| NO | DATE | REVISIONS AND RECORD OF ISSUE | DRN | DES | CHK | PDE | APP |
|---|---|---|---|---|---|---|---|
| A | 27/MAR/09 | ISSUED FOR CLIENT REVIEW | NAW | PLN | | PLN | DVW |

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

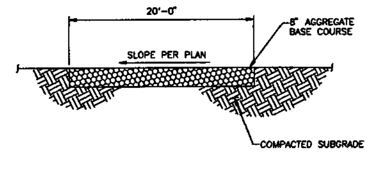
I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF CALIFORNIA
SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER PLN DRAWN NAW
CHECKED DATE

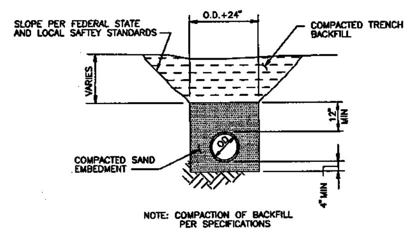
CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY
SURFACING/FENCING/ROADWAY - SITE PLAN - SHEET 1

PROJECT DRAWING NUMBER: 163994-SS-3201
REV: A
CODE
AREA

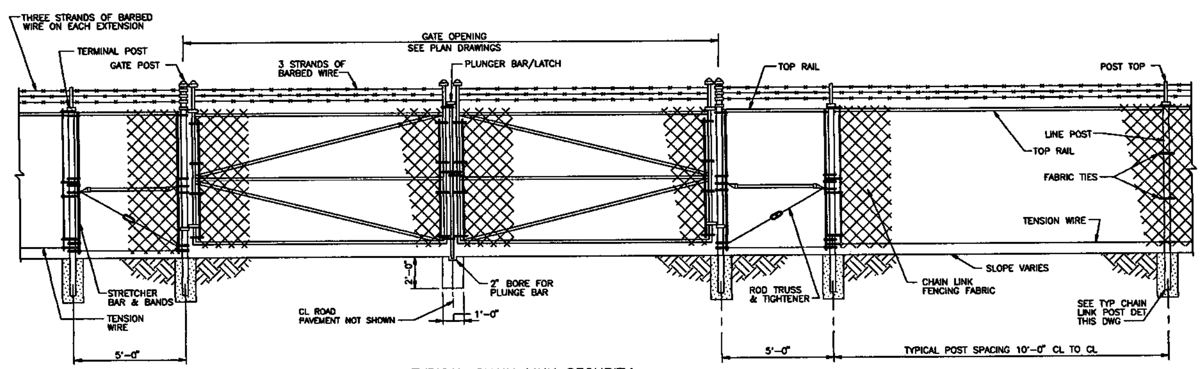
DWG40999 14-APR-2009 15:07:20



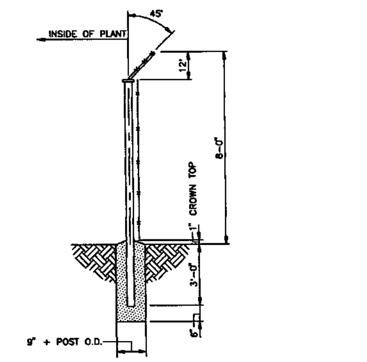
TYPICAL CONSTRUCTION LAYDOWN ROAD
NO SCALE



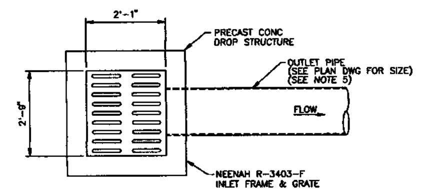
TYPICAL PIPE EMBEDMENT
NO SCALE



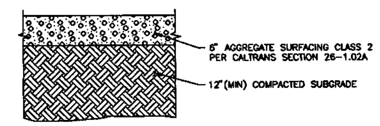
TYPICAL CHAIN LINK SECURITY FENCE AND GATE DETAIL
NO SCALE



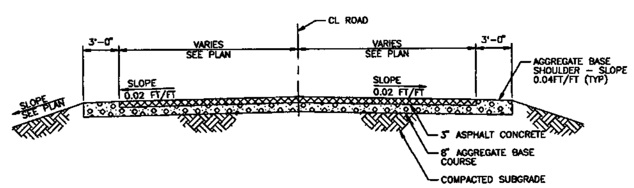
TYPICAL SECURITY FENCE POST DETAIL
NO SCALE



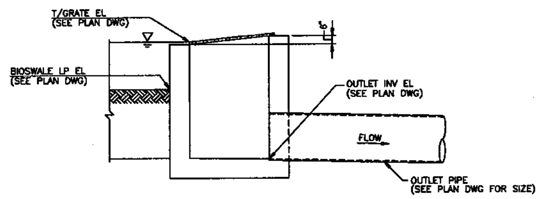
PLAN



TYPICAL AGGREGATE SURFACING SECTION
NO SCALE

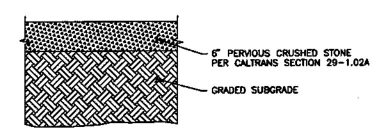


TYPICAL PAVED ROAD
NO SCALE
SEE DWG SS-3201



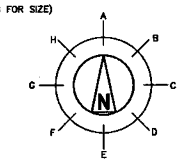
SECTION

TYPICAL BIOSWALE DROP STRUCTURE DETAIL
NO SCALE



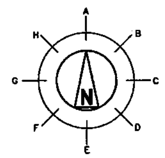
TYPICAL PERVIOUS CRUSHED STONE SURFACING SECTION
NO SCALE

| CULVERT TABLE | | | | | | |
|---|---|---|---|---|---|---|
| CULVERT NO. | INLET INV ELEVATION | OUTLET INV ELEVATION | LENGTH | PIPE DIAMETER | PIPE MATERIAL | REMARKS |
| C-1 | 8.2 | 8.0 | – | 18" | – | |
| C-2 | 11.8 | 11.5 | – | 18" | – | |
| C-3 | 13.0 | 13.0 | – | 18" | – | |
| C-4 | 13.2 | 13.0 | – | 18" | – | |
| C-5 | 13.1 | 13.0 | – | 12" | – | |
| C-6 | 13.1 | 13.0 | – | 12" | – | |
| C-7 | 13.3 | 13.0 | – | 12" | – | |
| C-8 | 13.2 | 13.0 | – | 12" | – | |
| C-9 | 13.0 | 13.0 | – | 12" | – | |
| C-10 | 13.0 | 13.0 | – | 15" | – | |
| C-11 | 13.4 | 13.0 | – | 12" | – | |
| C-12 | 13.0 | 13.0 | – | 18" | – | |
| C-13 | 13.4 | 13.0 | – | 12" | – | |
| C-14 | 13.5 | 13.0 | – | 12" | – | |
| C-15 | 12.8 | 12.5 | – | 18" | – | |
| C-16 | 12.5 | 12.5 | – | 18" | – | |
| C-17 | 14.7 | 14.4 | – | 12" | – | |
| | | | | | | |
| C-19 | 8.7 | 8.5 | – | 18" | – | |
| C-20 | – | – | – | 18" | – | |
| C-21 | – | – | – | 18" | – | |



| CATCH BASIN TABLE | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURE NO. | CENTERLINE COORDINATES | | TOP OF GRATE ELEVATION | INLET & OUTLET PIPE INFORMATION | | | | | | | | | | | | | | | | REMARKS |
| | | | | A | | B | | C | | D | | E | | F | | G | | H | | |
| | NORTH | EAST | | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | |
| CB-6 | – | – | 16.0 | – | – | 13.2 | 12" | – | – | – | – | 13.2 | 12" | – | – | – | – | – | – | |
| CB-7 | NOT USED | | | | | | | | | | | | | | | | | | | |
| CB-8 | – | – | 17.0 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 13.5 | 12" | |
| CB-9 | – | – | 17.0 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | 13.4 | 12" | – | – | |
| CB-10 | – | – | 17.0 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | – | – | – | – | |
| CB-11 | – | – | 17.0 | – | – | – | – | – | – | 13.4 | 12" | – | – | – | – | 13.4 | 12" | – | – | |
| CB-12 | – | – | 17.0 | – | – | 13.6 | 12" | – | – | – | – | – | – | – | – | – | – | – | – | |
| CB-13 | – | – | 17.0 | – | – | – | – | 13.4 | 12" | – | – | – | – | 13.4 | 12" | – | – | – | – | |
| CB-14 | – | – | 17.0 | – | – | – | – | 13.1 | 12" | – | – | – | – | – | – | 13.1 | 12" | – | – | |
| CB-15 | – | – | 17.0 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 13.6 | 12" | |
| CB-16 | – | – | 17.0 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | – | – | – | – | |
| CB-17 | – | – | 17.0 | – | – | – | – | 13.1 | 12" | – | – | – | – | – | – | 13.1 | 12" | – | – | |
| CB-18 | – | – | 16.5 | – | – | 13.2 | 12" | – | – | – | – | – | – | – | – | 13.2 | 12" | – | – | |
| CB-19 | – | – | 16.5 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | 13.4 | 12" | – | – | |
| CB-20 | – | – | 16.5 | – | – | – | – | 13.6 | 12" | – | – | – | – | – | – | – | – | – | – | |
| CB-21 | – | – | 16.5 | – | – | – | – | – | – | – | – | – | – | – | – | 13.6 | 12" | – | – | |
| CB-22 | – | – | 16.5 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | 13.4 | 12" | – | – | |
| CB-23 | – | – | 16.5 | – | – | – | – | 13.2 | 12" | – | – | – | – | – | – | 13.2 | 12" | – | – | |
| CB-24 | NOT USED | | | | | | | | | | | | | | | | | | | |
| CB-25 | – | – | 15.0 | – | – | – | – | – | – | 11.8 | 18" | 12.3 | 12" | – | – | 11.8 | 18" | – | – | |
| CB-26 | – | – | 16.0 | 13.2 | 18" | – | – | – | – | – | – | 13.2 | 18" | – | – | – | – | – | – | |
| CB-27 | – | – | 16.5 | – | – | – | – | – | – | – | – | 12.8 | 18" | – | – | 12.8 | 18" | – | – | |

ALL DIMENSIONS ARE IN FEET, EXCEPT DIAMETER, WHICH IS IN INCHES
FOR PIPELINE MATERIAL SEE PIPELINE LIST



| DROP STRUCTURE (DS) TABLE | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURE NO. | CENTERLINE COORDINATES | | TOP OF GRATE ELEVATION | INLET & OUTLET PIPE INFORMATION | | | | | | | | | | | | | | | | REMARKS |
| | | | | A | | B | | C | | D | | E | | F | | G | | H | | |
| | NORTH | EAST | | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | |
| DS-1 | – | – | 13.0 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 12.1 | 18" | |
| DS-2 | – | – | 15.5 | – | – | – | – | – | – | – | – | – | – | – | – | 11.8 | 18" | – | – | |
| DS-3 | – | – | 15.5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 13.2 | 18" | |
| DS-4 | – | – | 15.5 | 13.5 | 18" | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| DS-5 | – | – | 14.5 | 8.7 | 18" | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |

ALL DIMENSIONS ARE IN FEET, EXCEPT DIAMETER, WHICH IS IN INCHES
FOR PIPELINE MATERIAL SEE PIPELINE LIST

## NOTES

1. FILTER FABRIC SHALL BE UV-STABILIZED NONWOVEN GEOTEXTILE HAVING A MINIMUM WEIGHT OF 135 $g/M^2$ PER CALTRANS SS 88-1.03.
2. SEE DWG SS-3001 FOR GENERAL NOTES AND LEGEND.

**OPEN**
04/01/09

NOT TO BE USED FOR CONSTRUCTION



| NO | DATE | REVISIONS AND RECORD OF ISSUE | DRN | DES | CHK | PDE | APP |
|---|---|---|---|---|---|---|---|
| 0 | 16/APR/09 | ISSUED FOR PERMITTING | NAW | PLN | | PLN | DVW |

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 PLN | DRAWN NAW | CHECKED | DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

SITE
SECTIONS AND DETAILS

PROJECT / DRAWING NUMBER: 163994-SS-3050
REV: 0
CODE
AREA

Radback Tenaska project
project # 163994 File # 52.5406.1002
IMP sizing for Plant Area

prepared by: J zhong
Date: 3/30/09
# of pages: 5

Attachment 2

Reference 2

Select Pages

(Runoff factor) x (tributary area) ≤ 2 x (self-retaining area) *Equation 4-1*

For treatment-only sites, and

(Runoff factor) x (tributary area) ≤ 1 x (self-retaining area) *Equation 4-2*

for sites subject to flow-control requirements. Use the runoff factors in Table 4-2.

Prolonged ponding is a potential problem at higher impervious/pervious ratios. In your design, ensure that the pervious area soils can handle the additional run-on and are sufficiently well-drained.

Runoff from self-treating and self-retaining areas does not require any further treatment or flow control.

TABLE 4-2. Runoff factors to be used when sizing IMPs.

| Surface | Treatment and Flow Control | Treatment only |
|---|---|---|
| Roofs | 1.0 | 1.0 |
| Concrete or Asphalt | 1.0 | 1.0 |
| Pervious Concrete | 0.1 | 0.1 |
| Porous Asphalt | 0.1 | 0.1 |
| Grouted Unit Pavers | 1.0 | 1.0 |
| Solid Unit Pavers | 0.5 | 0.2 |
| Crushed Aggregate | 0.1 | 0.1 |
| Turfblock | 0.1 | 0.1 |
| Landscape, Group A Soil | 0.1 | 0.1 |
| Landscape, Group B Soil | 0.3 | 0.1 |
| Landscape, Group C Soil | 0.5 | 0.1 |
| Landscape, Group D Soil | 0.7 | 0.1 |

**Areas draining to IMPs** are used to calculate the required size of the IMP. On most densely developed sites—such as commercial and mixed-use developments and small-lot residential subdivisions—most DMAs will drain to IMPs.

The CCCWP has developed sizing factors (ratios of IMP area to impervious DMA area). For each IMP design, factors are provided for:

TABLE 4-6. Sizing Factors

| **Treatment and Flow Control** | **NRCS Soil Group** | | | |
|---|---|---|---|---|
| **IMP** | **A** | **B** | **C** | **D** |
| Bioretention Facility | | | | |
| A | 0.07 | 0.11 | 0.06 | 0.05 |
| $V_1$ | 0.058 | 0.092 | 0.050 | 0.042 |
| $V_2$ | N/A | N/A | 0.066 | 0.055 |
| Flow-through Planter | | | | |
| A | N/A | N/A | 0.06 | 0.05 |
| $V_1$ | N/A | N/A | 0.050 | 0.042 |
| $V_2$ | N/A | N/A | 0.066 | 0.055 |
| Dry Well | | | | |
| A | 0.05 | 0.06 | N/A | N/A |
| V | 0.130 | 0.204 | N/A | N/A |
| Cistern + bioretention facility | | | | |
| A (bioretention facility) | *0.04* | *0.04* | *0.04* | *0.04* |
| V (cistern) | 0.193 | 0.228 | 0.088 | 0.060 |

* Cistern sized for flow control when used in conjunction with a treatment IMP. IMP underdrain required in B, C and D soils.

**Treatment Only**

| | | | | |
|---|---|---|---|---|
| Bioretention Facility | | | | |
| A | *0.04* | *0.04* | *0.04* | *0.04* |
| Flow-through Planter | | | | |
| A | *0.04* | *0.04* | *0.04* | *0.04* |
| Dry Well (treatment only) | | | | |
| A | 0.02 | 0.04 | N/A | N/A |
| V | 0.068 | 0.136 | N/A | N/A |

Units Notes:
A = $ft^2$ of IMP footprint per $ft^2$ of tributary impervious area (unitless)
V, $V_1$, $V_2$ = $ft^3$ per $ft^2$ of equivalent tributary impervious area (ft.)

#### STEP 5: OBTAIN SIZING AND RAIN ADJUSTMENT FACTORS FOR EACH IMP

For each of the IMPs, obtain the appropriate **area** sizing factor from Table 4-6.

Sizing factors for treatment-only IMPs (in *italics*) do not require any adjustment for differing rainfall patterns.

Both area (A) and volume ($V_1$, $V_2$) sizing factors for treatment-plus-flow-control IMPs, however, must be adjusted to account for the effects of differing rainfall patterns on pre-project and post-project runoff.

Use the equations below to compute the rainfall adjustment:

*Equation 4-3*

$$\text{For Group A soils, } Rain\ \ Adjustment = \frac{0.0009 \times (MAP_{project\ site} - 20.2) + 0.07}{0.07}$$

*Equation 4-4*

$$\text{For Group B soils, } Rain\ \ Adjustment = \frac{-0.0005 \times (MAP_{project\ site} - 20.2) + 0.11}{0.11}$$

*Equation 4-5*

$$\text{For Group C soils, } Rain\ \ Adjustment = \frac{-0.0022 \times (MAP_{project\ site} - 20.2) + 0.06}{0.06}$$

*Equation 4-6*

$$\text{For Group D soils, } Rain\ \ Adjustment = \frac{-0.0022 \times (MAP_{project\ site} - 20.2) + 0.05}{0.05}$$

where *MAP* is the mean annual precipitation at the site as shown on the isohyetal map, Contra Costa County Public Works Figure B-166, available on the CCCWP C.3 web pages.

#### ► STEP 6: CALCULATE MINIMUM AREA AND VOLUME OF EACH IMP

The minimum area and storage volumes of each IMP are found by summing up the contributions of each tributary DMA and multiplying by the adjusted sizing factor for the IMP.

*Equation 4-7*

$$Min.IMP\,Area\ or\ Volume = \sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

Bioretention facilities and flow-through planters have two storage volumes. $V_1$ is the floodable volume above the soil layer. $V_2$ is the storage volume below the soil layer, calculated by multiplying the volume of gravel by an assumed porosity of 0.4. See Figure 4-6. Note these volumes can be configured in a variety of practical combinations of depth and area to best fit into your landscape design.

Cisterns and dry wells have a single storage volume (V).

V is calculated using Equation 4-8:

*Equation 4-8*

$$Min.V = \sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} \times \begin{pmatrix} IMP\,Volume \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

Use the format of Table 4-7 to present the calculations of the required minimum area and volumes of the receiving IMP:

TABLE 4-7. Format for presenting calculations of minimum IMP Areas and Volumes

| *DMA Name* | *DMA Area (square feet)* | *Post-project surface type* | *DMA Runoff factor* | *DMA Area × runoff factor* |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | ***Total*** | |

| *Soil Type:* | *IMP Name* | | | |
|---|---|---|---|---|
| | | | | |
| *IMP Sizing factor* | *Rain Adjust-ment Factor* | *Minimum Area or Volume* | *Proposed Area or Volume* | |
| | | | | ***IMP Area*** |
| | | | | ***V or V1*** |
| | | | | ***V2*** |
| | | | ***Orifice Size:*** | |

► **STEP 7: DETERMINE IF IMP AREA AND VOLUME ARE ADEQUATE**

Sizing and configuring IMPs may be an iterative process. After computing the minimum IMP area using Steps 1–6, review the site plan to determine if the reserved IMP area is sufficient. If so, the planned IMPs will meet the Provision C.3 sizing requirements. If not, revise the plan accordingly. Revisions may include:

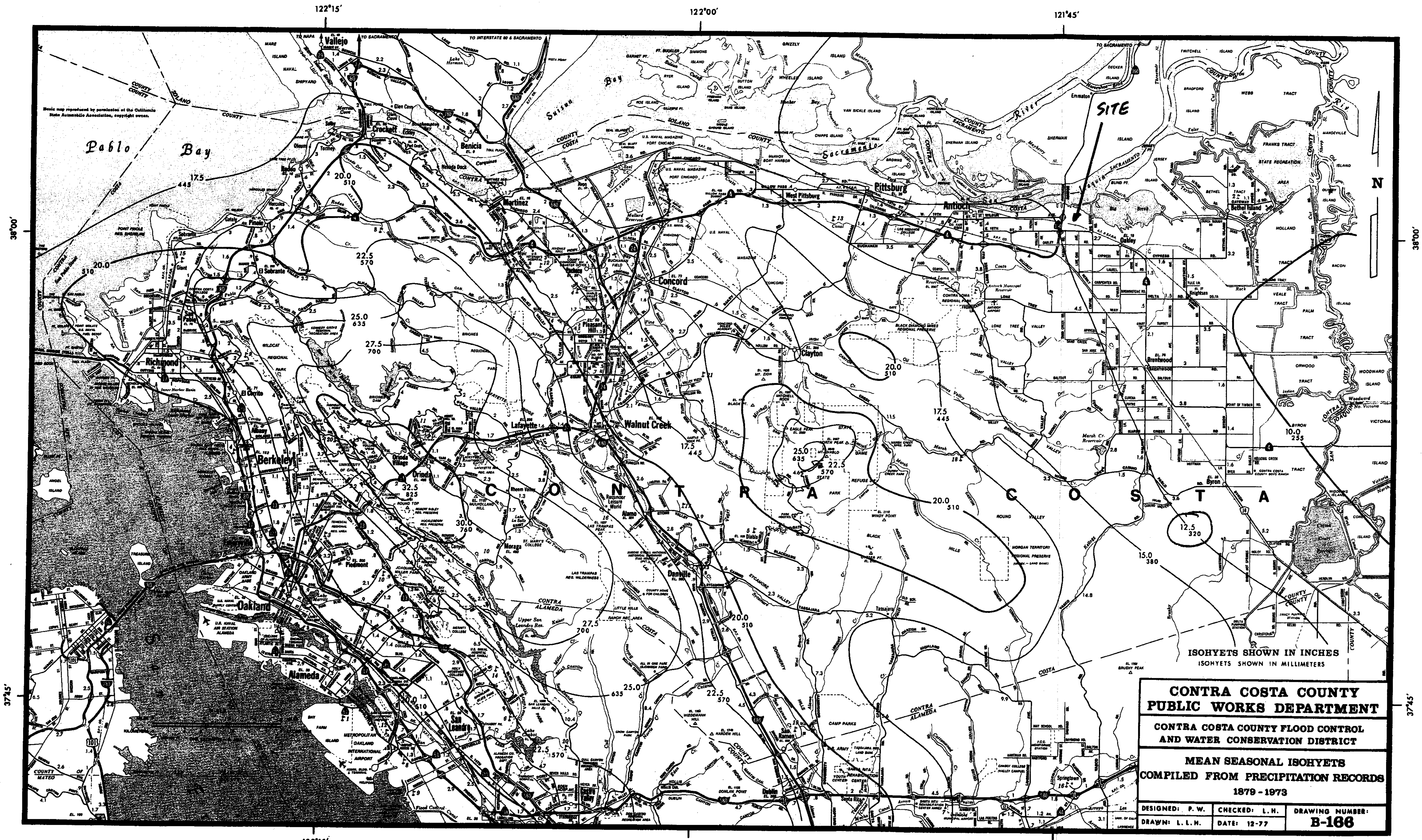
Radback Tenaska project
project # 163994 File # 52.5406.1002
IMP sizing for ~~[illegible]~~ plant Area

prepared by: JZhong
Date: 3/24/09
# of pages: 2

Attachment 3

Reference 3

Drawing No. B-166


CONTRA COSTA COUNTY
PUBLIC WORKS DEPARTMENT
CONTRA COSTA COUNTY FLOOD CONTROL
AND WATER CONSERVATION DISTRICT
MEAN SEASONAL ISOHYETS
COMPILED FROM PRECIPITATION RECORDS
1879 - 1973
DESIGNED: P. W.
CHECKED: L. H.
DRAWING NUMBER:
B-166
DRAWN: L. L. H.
DATE: 12-77
ISOHYETS SHOWN IN INCHES
ISOHYETS SHOWN IN MILLIMETERS
SITE
N
C O N T R A C O S T A
122°15′
122°00′
121°45′
38°00′
37°45′
Pablo Bay
Suisun Bay
Basic map reproduced by permission of the California State Automobile Association, copyright owner.
Vallejo
Crockett
Benicia
Martinez
Pittsburg
West Pittsburg
Antioch
Oakley
Concord
Clayton
Walnut Creek
Lafayette
Orinda
Moraga
Danville
Richmond
El Cerrito
Berkeley
Oakland
Alameda
San Leandro
Brentwood
Byron
Dublin
Piedmont
Pinole
Hercules
Rodeo
El Sobrante
Pleasant Hill
Alamo
Knightsen
Bethel Island
17.5 445
20.0 510
22.5 570
25.0 635
27.5 700
30.0 760
32.5 825
15.0 380
12.5 320
10.0 255

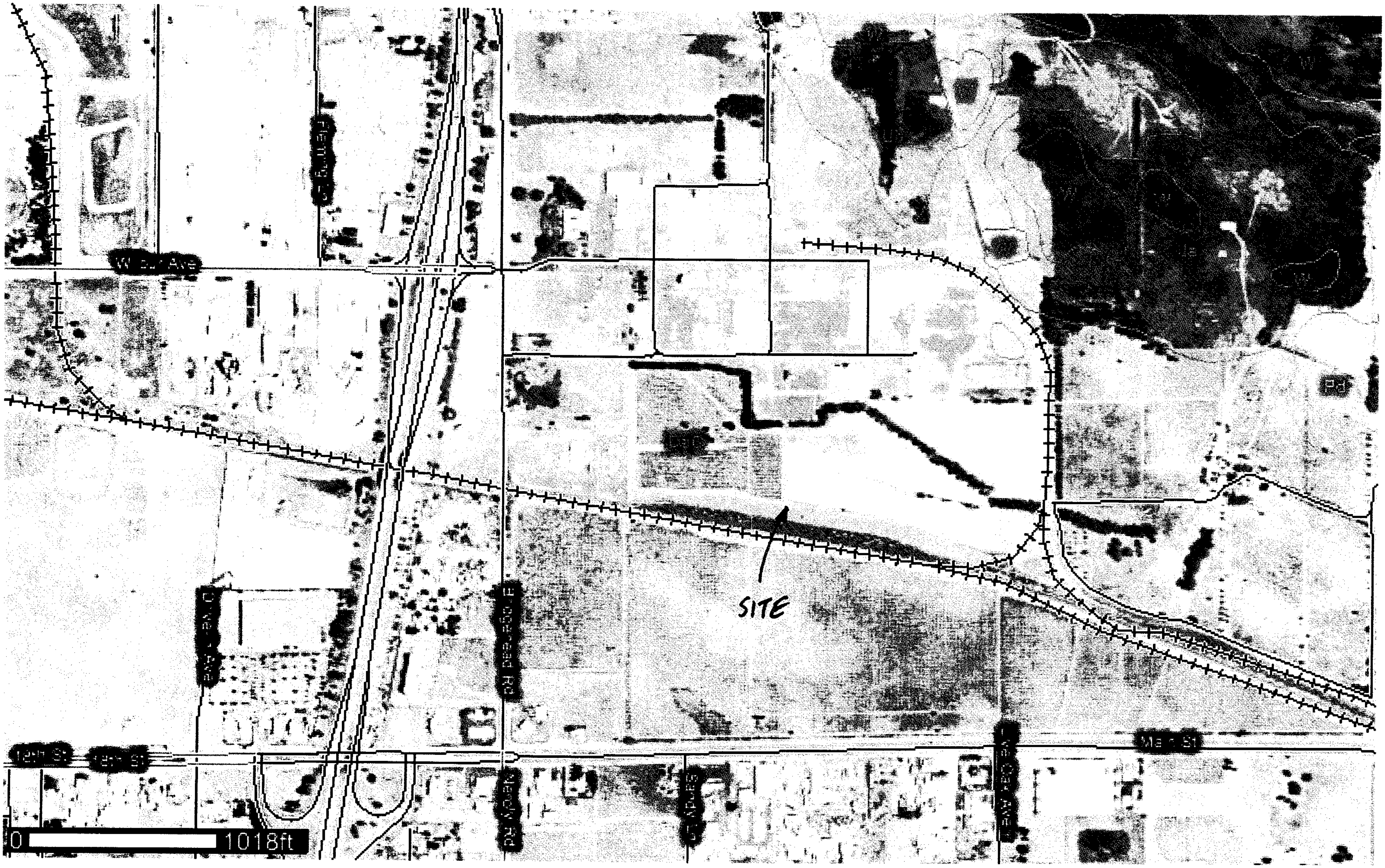
Radback Tenaska project
project # 163994 File # 52.5406.1002
IMP sizing for ~~Laydown~~ plant Area

prepared by: JZhong
Date: 3/24/09
# of pages: 4

Attachment 4

Reference 4

select pages



SITE
Main St
0
1018ft

# Contra Costa County, California

## DaC—DELHI SAND, 2 TO 9 PERCENT SLOPES

### Map Unit Setting

*Elevation:* 10 to 150 feet
*Mean annual precipitation:* 12 to 14 inches
*Mean annual air temperature:* 59 degrees F
*Frost-free period:* 260 to 300 days

### Map Unit Composition

*Delhi and similar soils:* 85 percent
*Minor components:* 15 percent

### Description of Delhi

#### Setting

*Landform:* Flood plains, terraces, alluvial fans
*Landform position (three-dimensional):* Tread, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Eolian deposits derived from igneous and sedimentary rock

#### Properties and qualities

*Slope:* 2 to 9 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline (0.0 to 2.0 mmhos/cm)
*Available water capacity:* Low (about 4.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3s
*Land capability (nonirrigated):* 6e

#### Typical profile

*0 to 5 inches:* Sand
*5 to 60 inches:* Sand

### Minor Components

#### Unnamed

*Percent of map unit:* 12 percent

**Laugenour**

*Percent of map unit:* 3 percent

## Data Source Information

Soil Survey Area: Contra Costa County, California
Survey Area Data: Version 8, Jul 22, 2008

Radback Tenaska project

project # 163994 File # 52.5406.1002

IMP sizing for ~~Laydown~~ plant Area

prepared by: JZhong

Date: 3/24/09

# of pages: 2

Attachment 5

Reference 5

select page

# Appendix A Hydrologic Soil Groups

Soils are classified into hydrologic soil groups (HSG's) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve numbers (see chapter 2). For the convenience of TR-55 users, exhibit A-1 lists the HSG classification of United States soils.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Approximate numerical ranges for transmission rates shown in the HSG definitions were first published by Musgrave (USDA 1955). The four groups are defined by SCS soil scientists as follows:

**Group A** soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

**Group B** soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

**Group C** soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

**Group D** soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

In exhibit A-1, some of the listed soils have an added modifier; for example, "Abrazo, gravelly." This refers to a gravelly phase of the Abrazo series that is found in SCS soil map legends.

## Disturbed soil profiles

As a result of urbanization, the soil profile may be con-siderably altered and the listed group classification ma no longer apply. In these circumstances, use the follov ing to determine HSG according to the texture of the new surface soil, provided that significant compactior has not occurred (Brakensiek and Rawls 1983).

| *HSG* | *Soil textures* |
|---|---|
| A | Sand, loamy sand, or sandy loam |
| B | Silt loam or loam |
| C | Sandy clay loam |
| D | Clay loam, silty clay loam, sandy clay, silty clay, or clay |

## Drainage and group D soils

Some soils in the list are in group D because of a higl water table that creates a drainage problem. Once th soils are effectively drained, they are placed in a diff ent group. For example, Ackerman soil is classified a A/D. This indicates that the drained Ackerman soil is group A and the undrained soil is in group D.

Radback Tenaska project
project # 163994 File # 52.5406.1002
IMP sizing for ~~Lagoon~~ Plant Area

Prepared by: JZhong
Date: 3/24/09
# of pages: 3

# Attachment 6

Email communications with contra costa county clean water program

**From:** Dan Cloak [dan@dancloak.com]
**Sent:** Monday, March 02, 2009 3:54 PM
**To:** 'Tom Dalziel'; Zhong, Jimmy
**Subject:** RE: Stormwater C.3 Question

Hi,

It is correct that dense-graded aggregates are not very pervious. Why not use an open-graded aggregate, such as ½ in. crushed rock? Be sure to use a rigid frame around the gravel area.

"Porous Pavements" by Bruce Ferguson is a good reference for porous pavement design.

If dense-graded aggregate is used, I would suggest a runoff coefficient of 0.5 to 0.7, depending on slope.

Dan

---

**From:** Tom Dalziel [mailto:tdalz@pw.cccounty.us]
**Sent:** Monday, March 02, 2009 11:04 AM
**To:** Zhong, Jimmy; Dan@dancloak.com
**Subject:** RE: Stormwater C.3 Question

Hi Dan,

Can you review and respond, as appropriate, to Jimmy on my behalf?

Thanks.

Tom Dalziel
Assistant Program Manager
Contra Costa Clean Water Program
tdalz@pw.cccounty.us
Ph. (925) 313-2392, Fax (925) 313-2301

---

**From:** Zhong, Jimmy [mailto:ZhongJ@bv.com]
**Sent:** Wednesday, February 25, 2009 1:11 PM
**To:** Tom Dalziel
**Subject:** Stormwater C.3 Question

Tom,

I talked to you and Dan this morning regarding runoff factor for Class 2 aggregates (Caltran Standard Specification Section 26). After our phone call, I had a discussion with my supervisor. He indicated that this type of material is **dense-graded** aggregate which is typically used as pavement base material. After being compacted, this type of material is not that pervious based on his experience. Dense-graded aggregates have much lower porosity than open-graded aggregates after compaction. As such, my supervisor thinks the runoff factor of 0.1 can apply to open-graded aggregate but may not be able to apply to dense-graded aggregate. Would you please forward this email to Dan and ask him again if a runoff factor of 0.1 can still be applied to Class 2 aggregates (compacted)? If not, what kind of runoff factor should be used?

I apologize if I did not communicate clearly this morning on the type of material we are using and for any confusions it caused.

Thanks again for your help.

Jimmy Zhong, P.E.
Geotechnical/Civil Engineer
Energy Division
Black & Veatch Corporation
3550 Green Court, Ann Arbor, MI 48105
P: (734) 622-8533    F: (734) 622-8700

**BLACK & VEATCH**

## Calculation Record

Client Name: Radback Energy — Page 1 of 53

Project Name: Tenaska — Project No.: 163994

Calculation Title: Stormwater Analysis for Wetland

Calculation No./File No.: 52, 5406, 1003

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

**Objective** To determine if the existing wetland at the Tenaska project site can retain the runoff of a 100-yr 24-hr storm without overflowing to other properties. The analysis is performed for pre-construction ground conditions at the site.

| Unverified Assumptions Requiring Subsequent Verification | | | |
|---|---|---|---|
| No. | Assumption | Verified By | Date |
| | | | |
| | | | |
| | | | |
| | | | |

See Page 2 of this calculation for additional assumptions.

**This Section Used for Computer Generated Calculations**

Program Name/Number: HEC-HMS — Version: 3.3

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 |
| 0 | J Zhong Jimmy Zhong | March 5, 2009 | [signature] | 6 MAR 09 | [signature] | 6 MAR 09 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## Purpose

To determine if the existing wetland at the Tenaska project site can retain the runoff of a 100-year 24-hour storm without overflowing to other properties. The analysis is performed for pre-construction ground conditions at the project site. The existing wetland has no outlet structure.

## References

1. Black & Veatch Drawings:
   - 163994-SS-3001, Rev. A, "Grading & Drainage - Site"
   - 163994-SS-3002, Rev. A, "Grading & Drainage - Site"
2. US Department of Agriculture; Urban Hydrology for Small Watersheds, 2nd Edition; Technical Release 55 (TR-55); June 1986.
3. US Army Corps of Engineers; Hydrologic Modeling System HEC-HMS, User's Manual, Version 3.3; September 2008.
4. US Army Corps of Engineers; Hydrologic Modeling System HEC-HMS, Technical Reference Manual; March 2000.
5. US Department of Commerce; Technical Paper No. 40; Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years; May 1961.
6. US Department of Agriculture, Natural Resources Conservation Service; Web Soil Survey; http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.
7. Mays, L. W.; Stormwater Collection Systems Design Handbook, McGraw-Hill; 2001.

## Definition of Units and Constants

English units will be used.

Example of Common Unit Designations:

Rainfall amount in inches (in)

Drainage area in acres (ac)

## Attachments

1. HEC-HMS Input
2. HEC-HMS Output
3. Reference 2 – Select Pages
4. Reference 6 – Select Pages

| | | |
|---|---|---|
| **Owner:** Radback | | **Computed By:** J. Zhong |
| **Plant:** Tenaska | **Unit:** 4 | **Date:** March 4, 2009 |
| **Project No.:** 163994 | **File No.** 52.5466.1003 | **Verified By:** PL |
| **Title:** Stormwater Analysis | | **Date:** 3/6/09 |
| | | **Page:** 3 of 53 |


**Summary**

Based on the HEC-HMS analysis, the maximum water elevation in the wetland is determined to be EL 9.1 feet. The lowest elevation where the stormwater in the wetland can overflow to other properties is EL 11.5 feet. Based on the HEC-HMS analysis with current ground cover conditions, the stormwater runoff to the wetland will not overflow to other properties for a 100-year 24-hour storm.

**Hydrology Modeling – HEC-HMS**

There is one drainage area that will drain to the wetland. See Page 5 for the boundary delineation of this area. This drainage area generally has four types of ground cover: (1) Vineyard, 19.85 acres; (2) Gravel Pavement, 3.96 acres; (3) Railroad Yard, 0.94 acres; and (4) Wetland, 0.40 acres. The total area of this drainage area is 25.15 acres (0.0393 mile$^2$). The measurements of the above areas were made by using AutoCAD.

The stormwater runoff to the wetland for a 100-year 24-hour storm event was modeled by using a computer program, HEC-HMS version 3.3, developed by the US Army Corps of Engineers (Ref. 3).

<u>Section 1.0 Determine the Time of Concentration</u>

Time of concentration ($T_c$) can be calculated as:

$$T_c = T_{sheet} + T_{shallow} + T_{channel} \qquad \text{(Ref. 4, Eq. 6-11)}$$

Where:

$T_{sheet}$ = travel time in sheet flow;

$T_{shallow}$ = travel time in shallow concentrated flow;

$T_{channel}$ = travel time in open channels.

There is no open channel flow on this site. Thus $T_{channel} = 0$.

The flow path from the hydraulically most distant point of this drainage area to the wetland is identified as shown on Page 5.

The total flow length is measured to 1490 feet.

(1) Sheet Flow

Sheet flow travel time can be calculated as:

$$T_{sheet} = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{(Ref. 2, Eq. 3-3)}$$

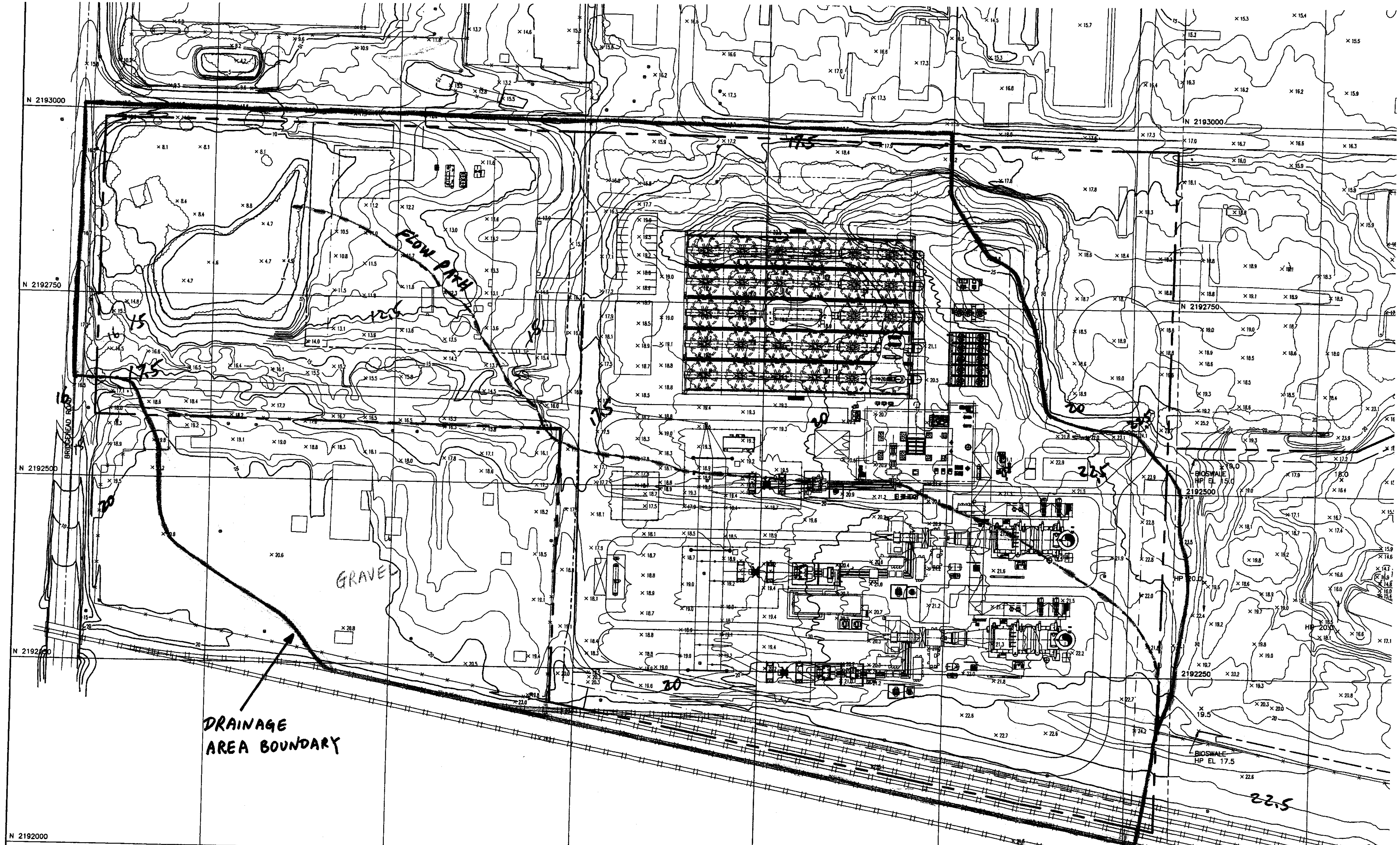
Where:

n = roughness coefficient;

L = flow length (ft);

$P_2$ = 2-year, 24-hour rainfall (in);

s = land slope (ft/ft).




Radback Tenaska project
project # 163994
52.5466.1003

stormwater Analysis
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prepared by: J Zhong
Date: 3/4/09
checked by: [signature]
Date: 3/6/09

NOTE: THIS PAGE IS A PORTION OF B&V Drawing 163994-SS-3001 Rev A.

ACAD 16.1s (LMS Tech) 1=1 09:17:10 E1

Roughness coefficient n = 0.17 for "cultivated soils, residue cover > 20%". (Ref. 2, Table 3-1)

Per Ref. 2, "After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow". Use sheet flow length L = 300 feet.

2-year, 24-hour rainfall $P_2$ = 2 inch for this site per Ref. 5 (see Page 8).

The land slope for the first 300 feet = (24.2-21.5)/300 = 0.009 ft/ft. (Refer to Page 5)

Thus, $T_{sheet} = \frac{0.007 \times (0.17 \times 300)^{0.8}}{2^{0.5} \times 0.009^{0.4}}$ = 0.76 hour.

(2) Shallow Concentrated Flow

The flow length for shallow concentrated flow L = 1490-300 = 1190 feet.

The average watercourse slope = (21.5-5) / 1190 = 0.014 ft/ft. (Refer to Page 5)

Based on a slope of 0.014 ft/ft, from Ref. 2, Figure 3-1, the average velocity (V) for "unpaved" surface is found to be:

V = 1.9 ft/sec.

Thus the travel time for shallow concentrated flow is calculated to be:

$$T_{shallow} = \frac{L}{3600 \times V} = \frac{1190}{3600 \times 1.9} = 0.17 \text{ hour.}$$

In summary, the time of concentration is calculated to be:

$T_c = T_{sheet} + T_{shallow} + T_{channel}$

= 0.76 + 0.17 + 0

= 0.93 hour.

Per Ref. 4, "For ungaged watersheds, the SCS suggests that the UH (unit hydrograph) lag time may be related to the time of concentration, $T_c$, as: $T_{lag} = 0.6\ T_c$". See Page 7.

The SCS UH lag time ($T_{lag}$) is an input parameter into the HEC-HMS computer program. Thus

$T_{lag}$ = 0.6 x 0.93 = 0.56 hour = 33.6 minutes.

UH can be found from the dimensionless form, which is included in HEC-HMS, by multiplication.

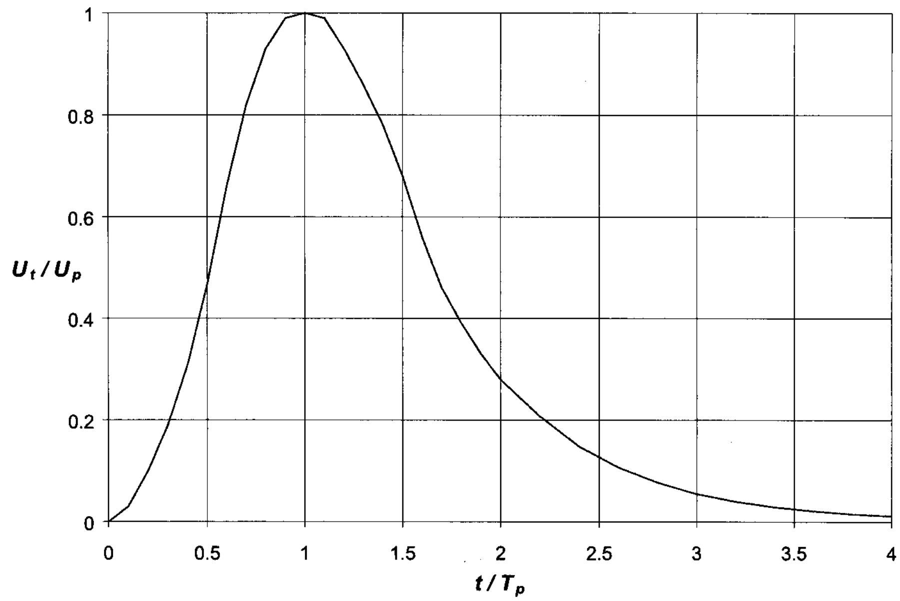



*Figure 6-2. SCS unit hydrograph*

## Estimating the SCS UH Model Parameters

The SCS UH lag can be estimated via calibration, using procedures described in Chapter 9, for gaged headwater subwatersheds.

For ungaged watersheds, the SCS suggests that the UH lag time may be related to time of concentration, $t_c$, as:

$$t_{lag} = 0.6\, t_c \qquad (6\text{-}10)$$

Time of concentration is a quasi-physically based parameter that can be estimated as

$$t_c = t_{sheet} + t_{shallow} + t_{channel} \qquad (6\text{-}11)$$

where $t_{sheet}$ = sum of travel time in sheet flow segments over the watershed land surface; $t_{shallow}$ = sum of travel time in shallow flow segments, down streets, in gutters, or in shallow rills and rivulets; and $t_{channel}$ = sum of travel time in channel segments.

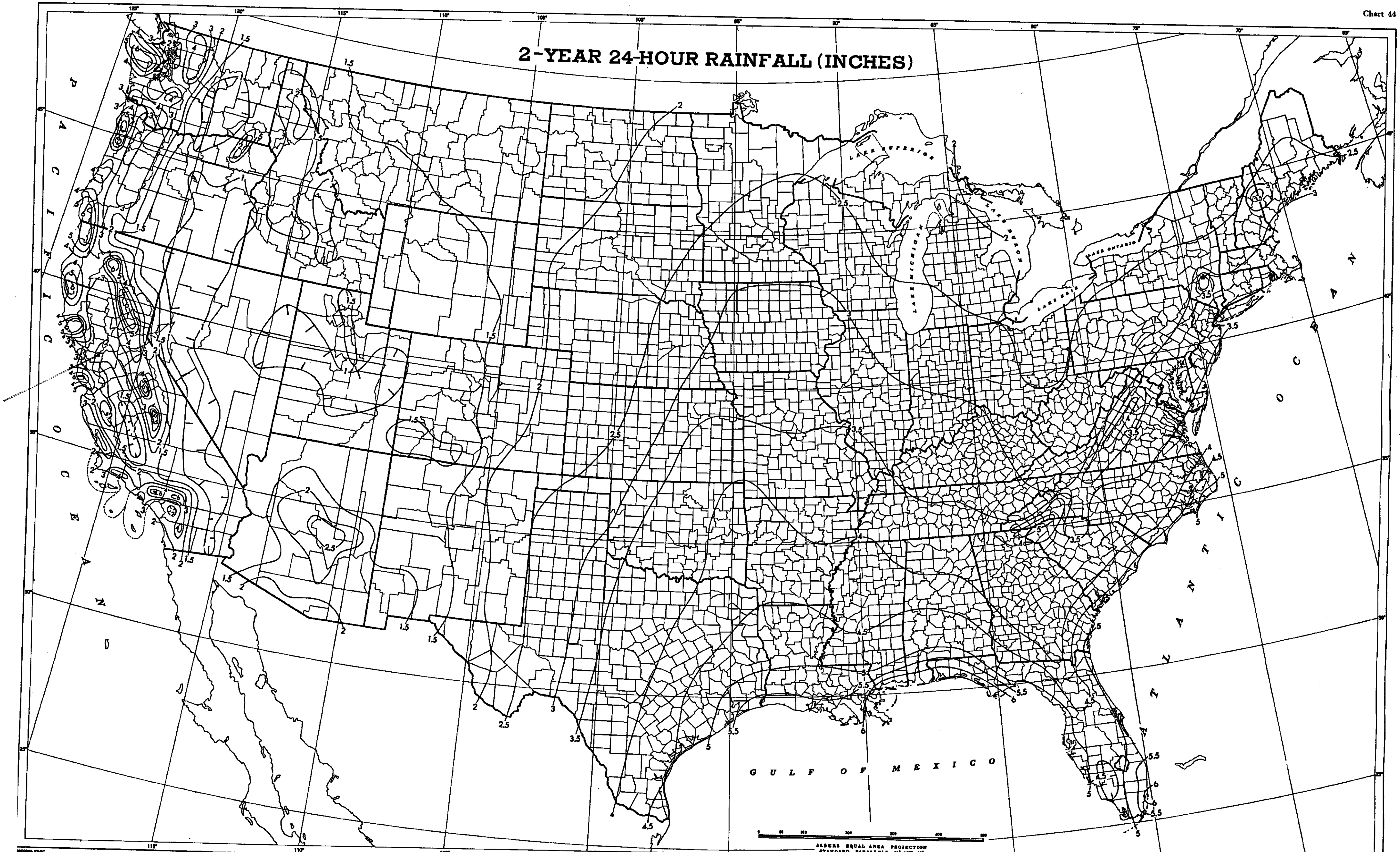
NOTE: THIS PAGE IS FROM REF. 4.

Identify open channels where cross section information is available. Obtain cross sections from field surveys, maps, or aerial photographs. For these channels, estimate velocity by Manning's equation:

$$V = \frac{CR^{2/3}S^{1/2}}{n} \qquad (6\text{-}12)$$

where $V$ = average velocity; $R$ = the hydraulic radius (defined as the ratio of channel cross-section area to wetted perimeter); $S$ = slope of the energy grade

Chart 44

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stormwater Analysis

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52.5406.1003

NOTE: THIS PAGE IS
FROM REF. 5.

Section 2.0 Rainfall Distribution

From Ref. 2, Figure B-2, the rainfall distribution for the site in Contra Costa County, California should be Type I distribution.

From Ref. 5, the 100-year 24-hour rainfall amount for the site is 4 inches. (See Page 10)

Section 3.0 Determine the Composite SCS Curve Number

"SCS Curve Number" method was used in the HEC-HMS computer program to calculate the loss rate for the drainage area.

The drainage area generally has four types of ground cover: (1) Vineyard, 19.85 acres; (2) Gravel Pavement, 3.96 acres; (3) Railroad Yard, 0.94 acres; and (4) Wetland, 0.40 acres. The total area of this drainage area is 25.15 acres (0.0393 mile$^2$). The measurements of the above areas were made by using AutoCAD.

Based on the soil survey information from the US Department of Agriculture Natural Resources Conservation Service (NRCS), the site in Contra Costa County, California is covered by "Delhi Sand". See Attachment 4. From the description of "Delhi Sand" by NRCS, this soil layer is "somewhat excessively drained"; the capacity of the most limiting layer to transmit water is "high to very high (5.95 to 19.98 in/hr)". See Attachment 4. Per Ref. 2, this type of soil can be classified as Hydrologic Soil Group A soil.

Per Ref. 2, Table 2-2b, the curve number (CN) for "Row Crops, straight row (SR) with crop residue cover (CR)" for Group A soil is between 64 (good condition) and 71 (poor condition). Use the average curve number 68 for the vineyard area.

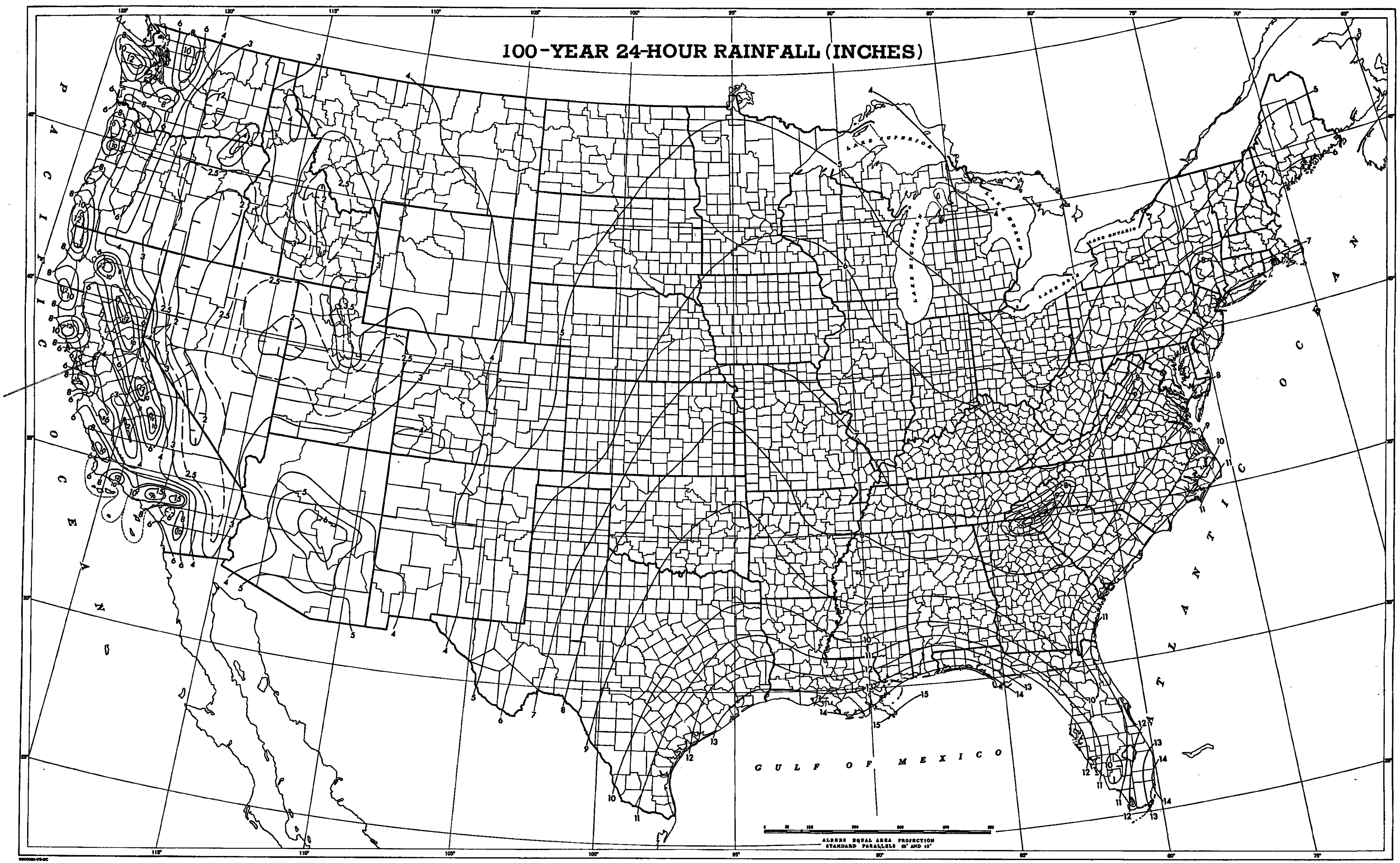
Per Ref. 2, Table 2-2a, the curve number for gravel area for Group A soil is 76. The ground cover in railroad yard is similar to the gravel area. Use the same curve number (76) for the railroad yard.

Treat the wetland as an impervious area since it may have standing water in it. Per Ref. 2, Table 2-2a, a curve number of 98 can be used for this area.

Thus the composite curve number (CN) for the drainage area is calculated as:

$$CN = (19.85 \times 68 + 3.96 \times 76 + 0.94 \times 76 + 0.40 \times 98) / 25.15 = 70.$$

The "SCS Curve Number" method also requires the input of initial abstraction (initial loss) in the computer program. The initial abstraction accounts for all losses before runoff begins. It




SITE
4"



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NOTE: THIS PAGE IS FROM
REF. 5.

includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration (Ref. 2).

The initial abstraction ($I_a$) can be estimated to be:

$I_a = 0.2\ S$ (Ref. 2, Eq. 2-2)

Where: $S = \frac{1000}{CN} - 10$ (Ref. 2, Eq. 2-4)

Based on a composite CN of 70, the initial abstraction is calculated to be:

$$I_a = 0.2 \times (1000/70 - 10) = 0.857 \text{ inch.}$$

The "SCS Curve Number" method also requires the input of "% impervious" in the computer program. The impervious area consists of the roofs of a few small buildings in the southwest portion of the drainage area. By using AutoCAD, the total roof area is measured to be 0.17 acre. Thus,

% impervious = 0.17 / 25.15 = 0.68%, say 1%.

## Section 4.0 Wetland Area versus Elevation

The bottom of the wetland is at an approximate elevation of 5 feet. See B&V Drawing SS-3001 (Page 5). The relationship of Area versus Elevation for the wetland area was presented in the table below. The wetland area was measured by using AutoCAD. It should be noted that a small portion of the wetland at the east side within the project property will be filled at a later time. This area will be graded at a 4 (H) to 1 (V) slope towards the wetland. The area in the table below at Elevation 10 (1.44 acres) has already had the future fill area been deducted to accurately model the wetland storage capacity.

| Elevation (ft) | Wetland Area (acre) |
|---|---|
| 5.0 | 0.40 |
| 7.5 | 0.62 |
| 10.0 | 1.44 |

## Section 5.0 HEC-HMS Output

The parameters determined in Sections 1.0 through 4.0 were input into the HEC-HMS computer program. The outflow from the wetland is specified in the HEC-HMS program to be 0 at all times (no outflow). The initial water elevation in the wetland is specified to be at

EL 5 assuming that standing water in the wetland is not higher than EL 5 before the 100-year 24-hour storm begins.

The maximum water elevation in the wetland was calculated by running the HEC-HMS program.

The output results are included in Attachment 2 and are summarized below.

| | |
|---|---|
| Peak Inflow: | 9.0 $ft^3$/sec. |
| Peak Storage: | 2.8 acre-feet |
| Peak Elevation: | 9.1 feet. |

**Conclusion:**

Based on the HEC-HMS analysis, the existing wetland will be able to contain all the runoff from its drainage area at current ground cover conditions for a 100-year 24-hour storm.

From B&V Drawing SS-3001, the lowest elevation where the stormwater in the wetland can overflow to other properties is EL 11.5 feet. Based on the HEC-HMS analysis, the stormwater runoff to the wetland will not overflow to other properties for a 100-year 24-hour storm.

Radback Tenaska project Stormwater Analysis JZ 3/4/09

project # 163994

\# of pages : 12

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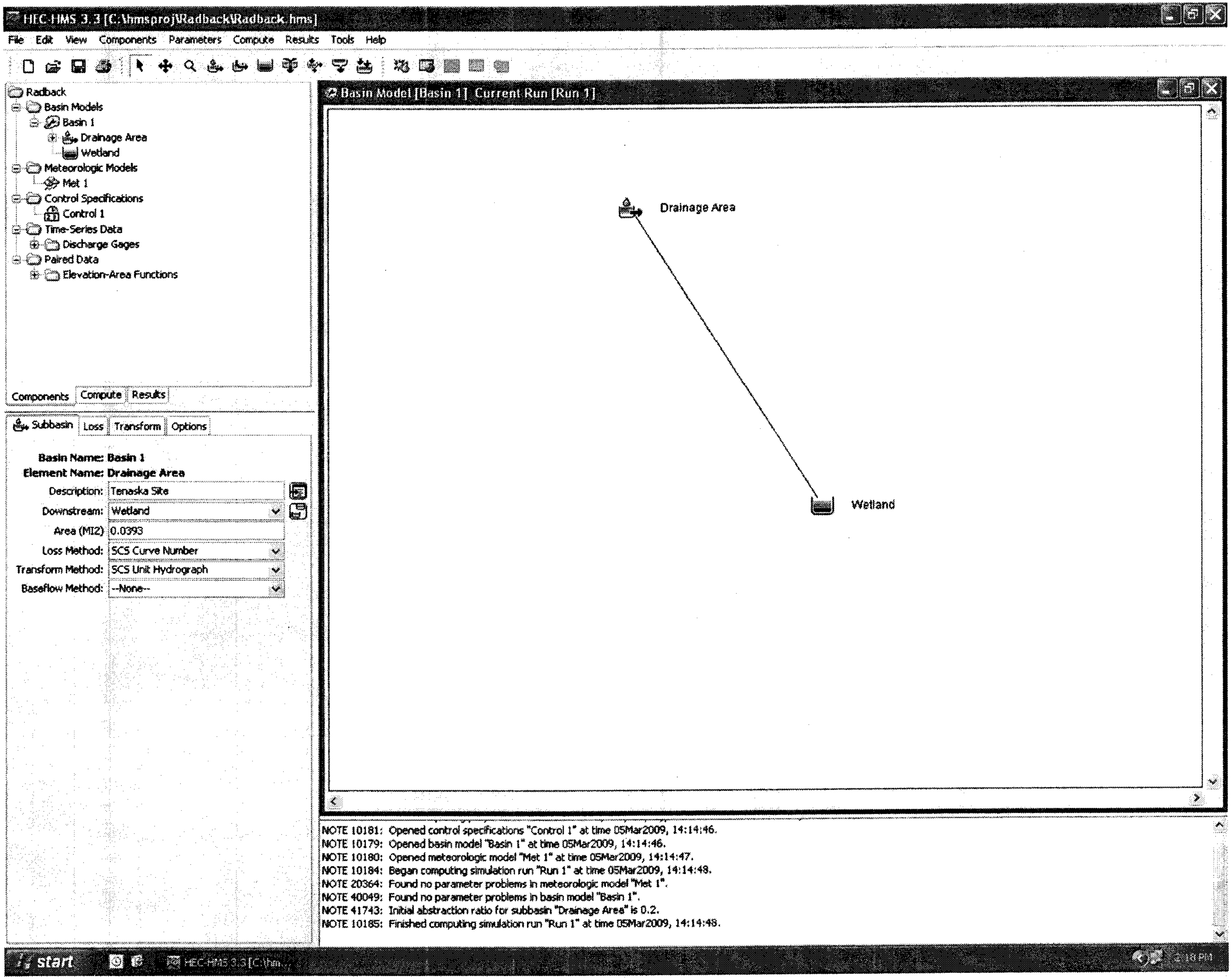
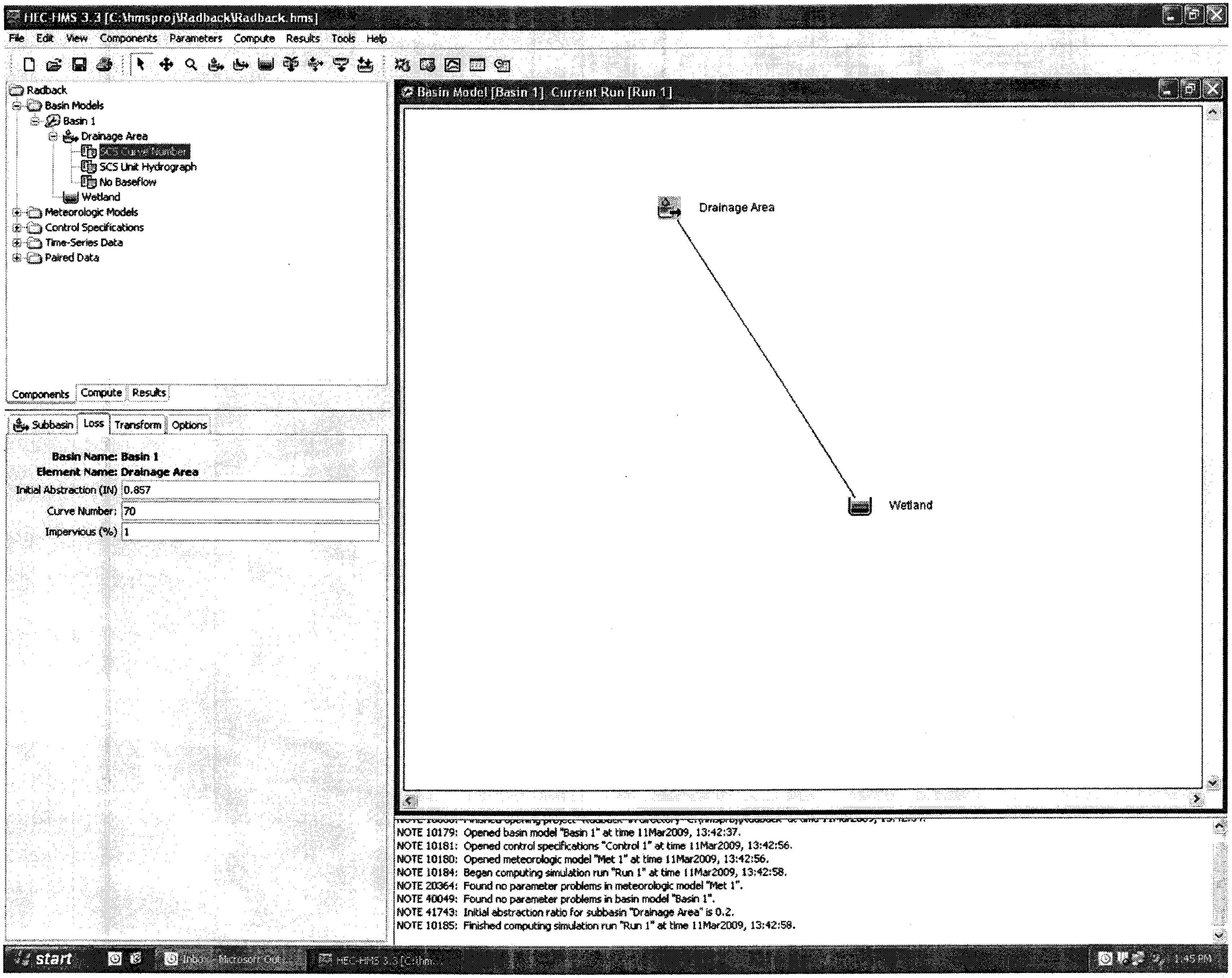
Attachment 1

HEC - HMS Input


HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
Wetland
Meteorologic Models
Met 1
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Paired Data
Elevation-Area Functions
Components Compute Results
Subbasin Loss Transform Options
Basin Name: Basin 1
Element Name: Drainage Area
Description: Tenaska Site
Downstream: Wetland
Area (MI2) 0.0393
Loss Method: SCS Curve Number
Transform Method: SCS Unit Hydrograph
Baseflow Method: --None--
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
NOTE 20364: Found no parameter problems in meteorologic model "Met 1".
NOTE 40049: Found no parameter problems in basin model "Basin 1".
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start


HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
Wetland
Meteorologic Models
Control Specifications
Time-Series Data
Paired Data
Components Compute Results
Subbasin Loss Transform Options
Basin Name: Basin 1
Element Name: Drainage Area
Initial Abstraction (IN) 0.857
Curve Number: 70
Impervious (%) 1
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
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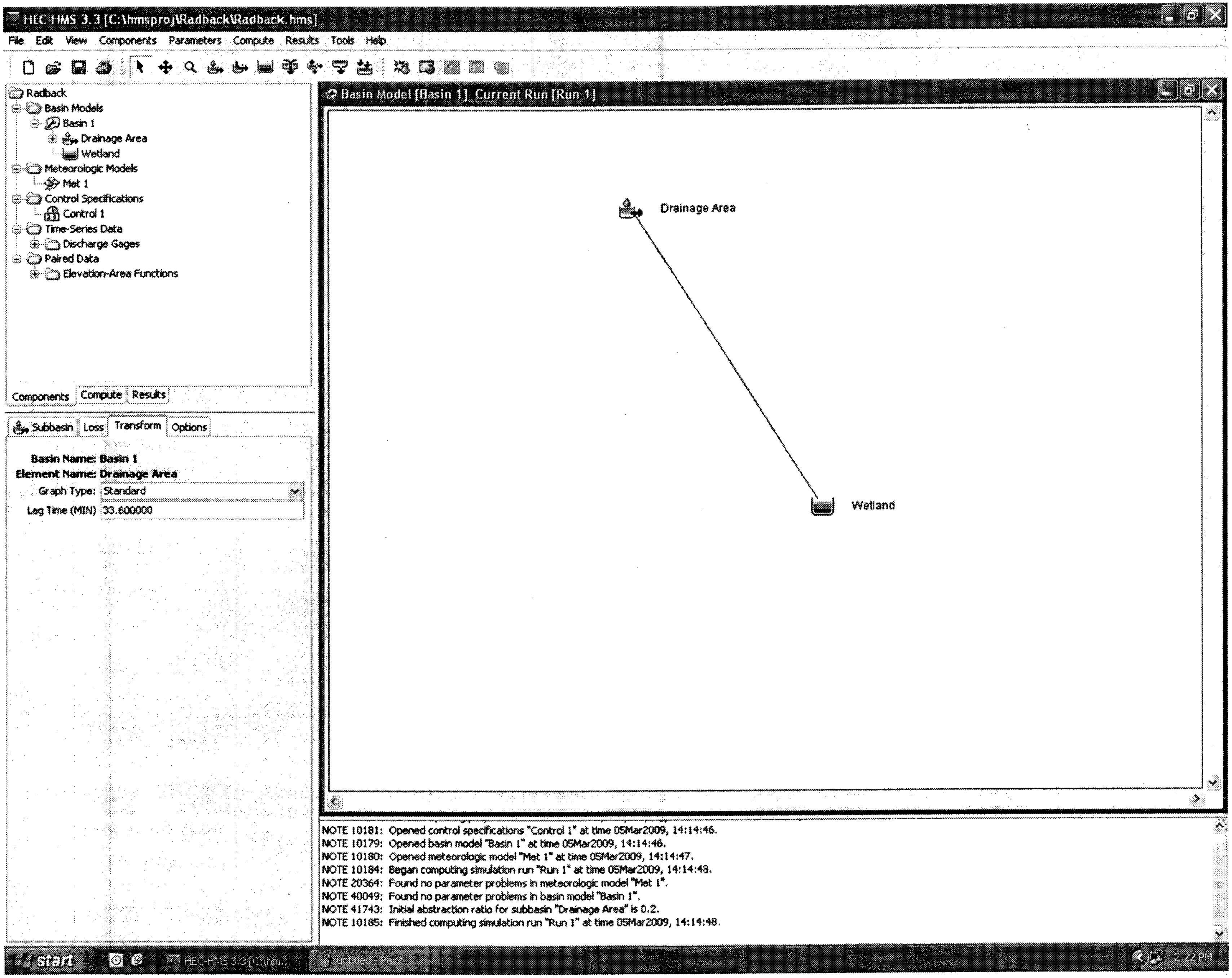
NOTE 10180: Opened meteorologic model "Met 1" at time 11Mar2009, 13:42:56.
NOTE 10184: Began computing simulation run "Run 1" at time 11Mar2009, 13:42:58.
NOTE 20364: Found no parameter problems in meteorologic model "Met 1".
NOTE 40049: Found no parameter problems in basin model "Basin 1".
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 11Mar2009, 13:42:58.
start


HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
Wetland
Meteorologic Models
Met 1
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Paired Data
Elevation-Area Functions
Components Compute Results
Subbasin Loss Transform Options
Basin Name: Basin 1
Element Name: Drainage Area
Graph Type: Standard
Lag Time (MIN) 33.600000
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
NOTE 20364: Found no parameter problems in meteorologic model "Met 1".
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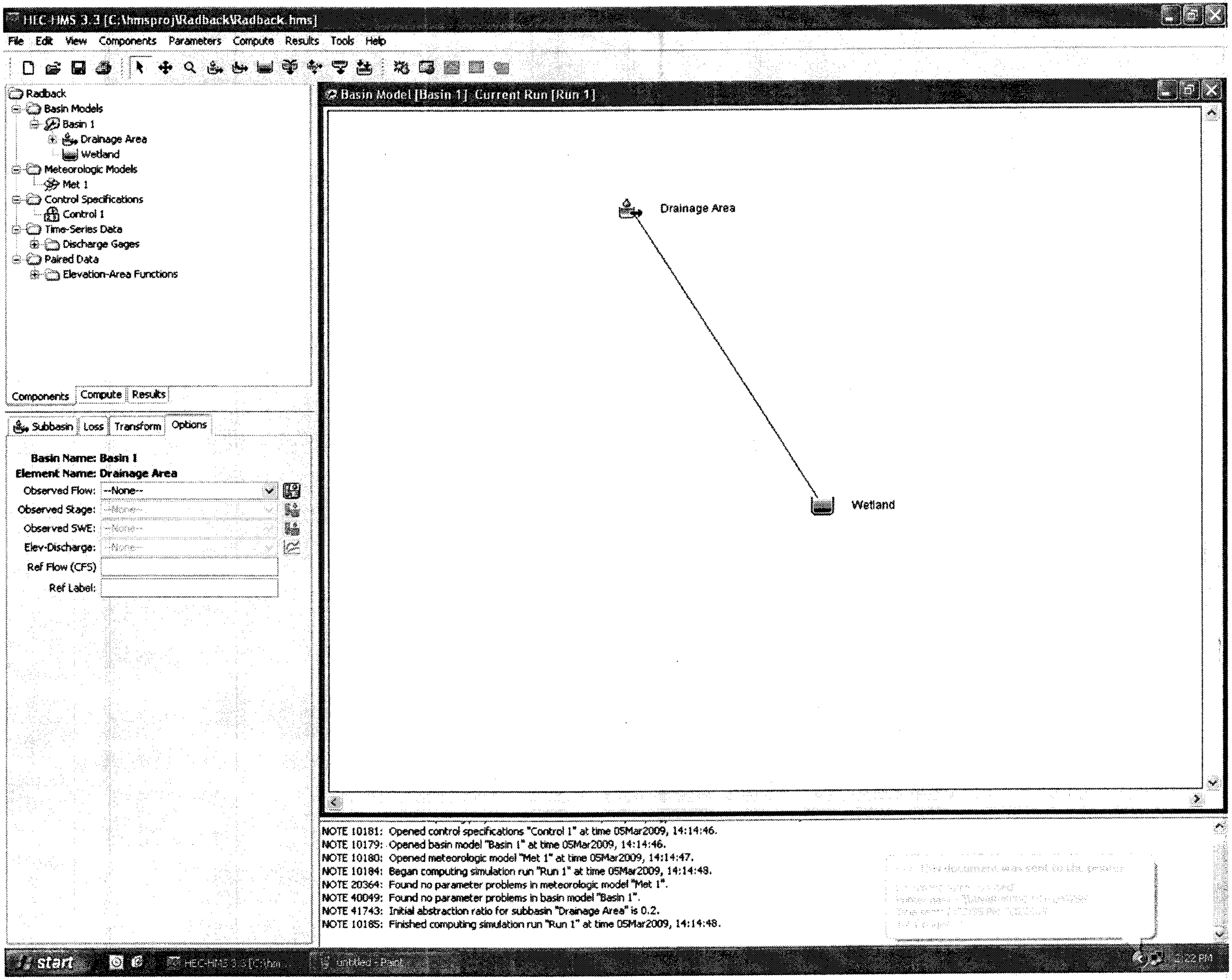
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start


HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
Wetland
Meteorologic Models
Met 1
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Paired Data
Elevation-Area Functions
Components Compute Results
Subbasin Loss Transform Options
Basin Name: Basin 1
Element Name: Drainage Area
Observed Flow: --None--
Observed Stage:
Observed SWE:
Elev-Discharge:
Ref Flow (CFS)
Ref Label:
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
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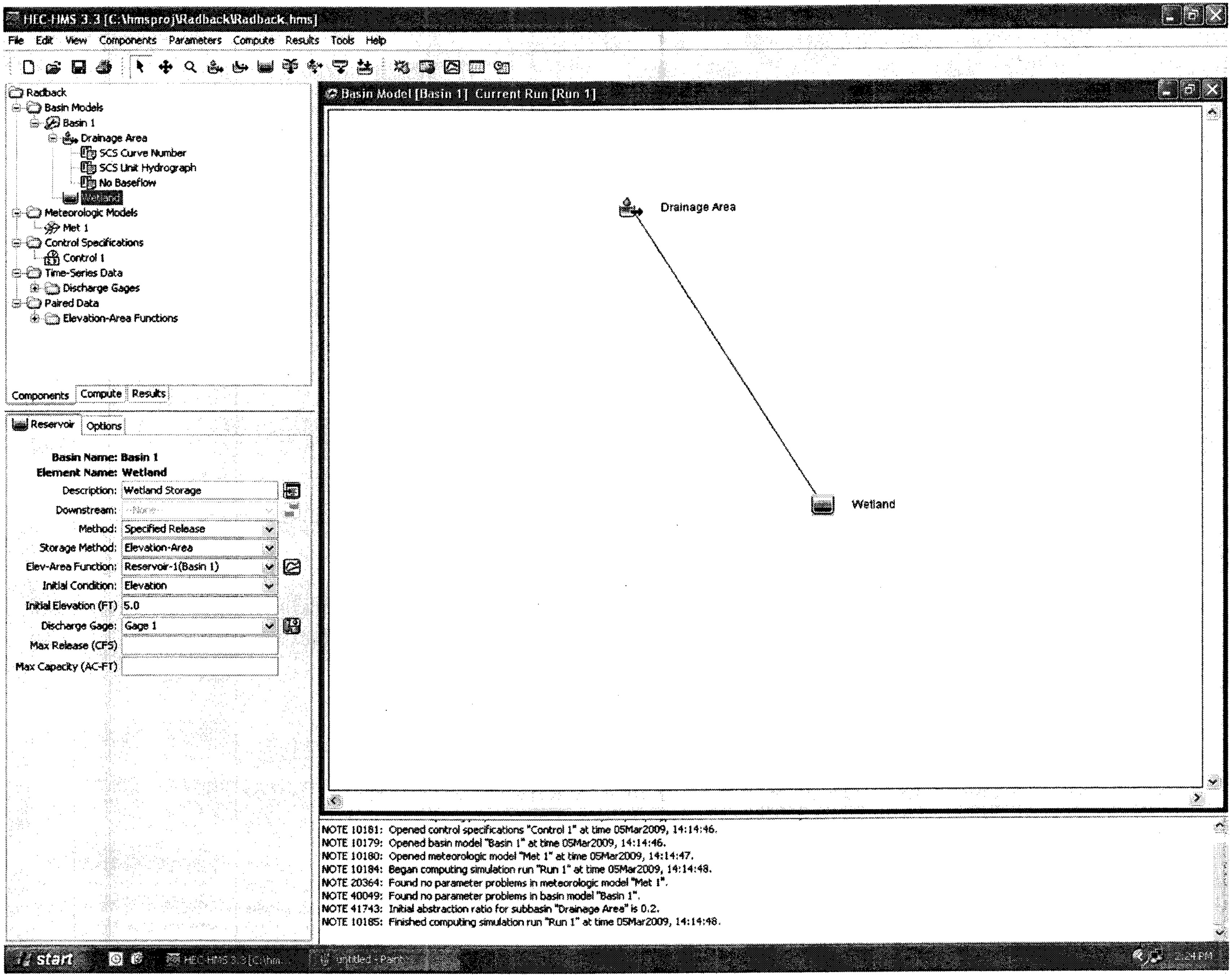
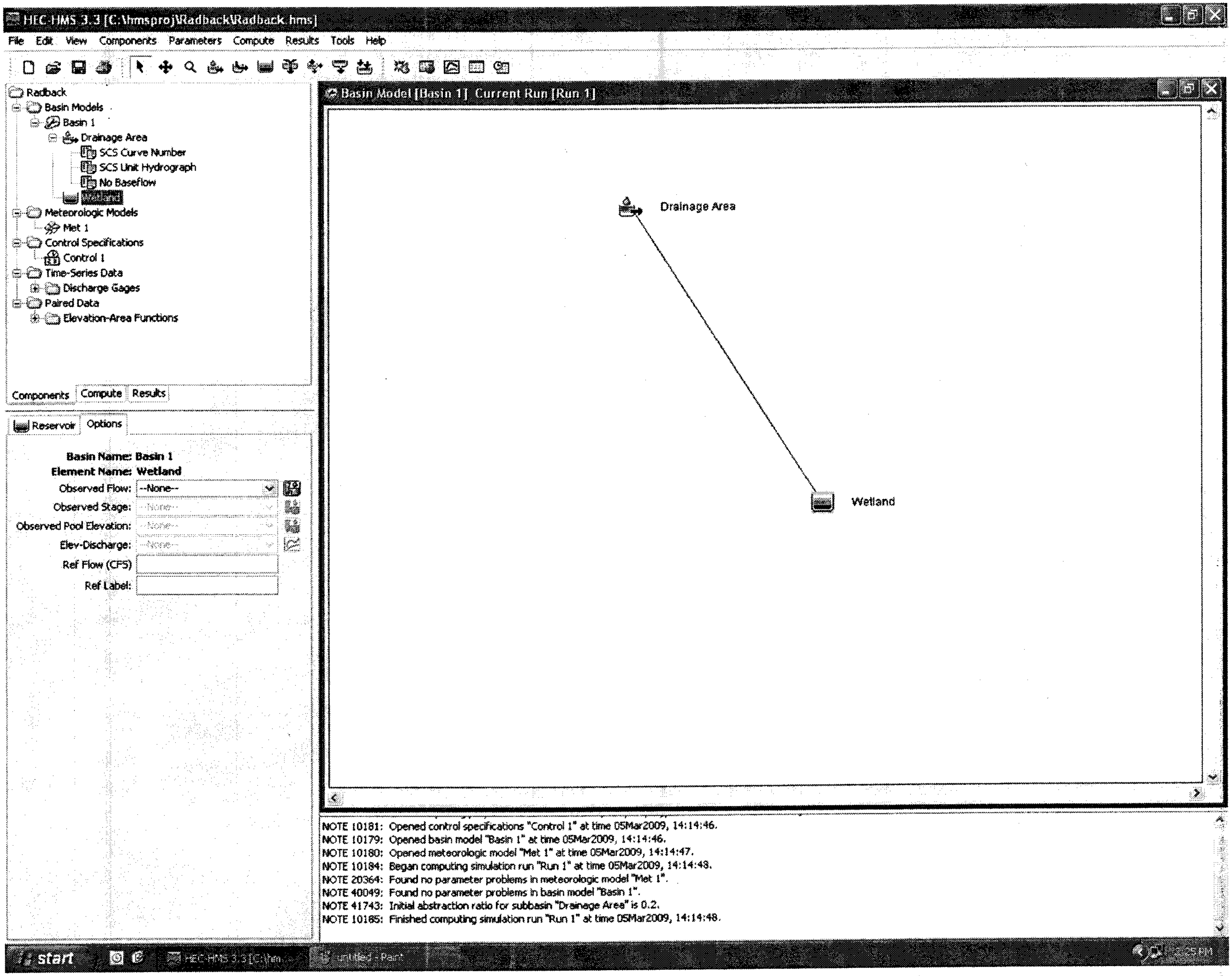
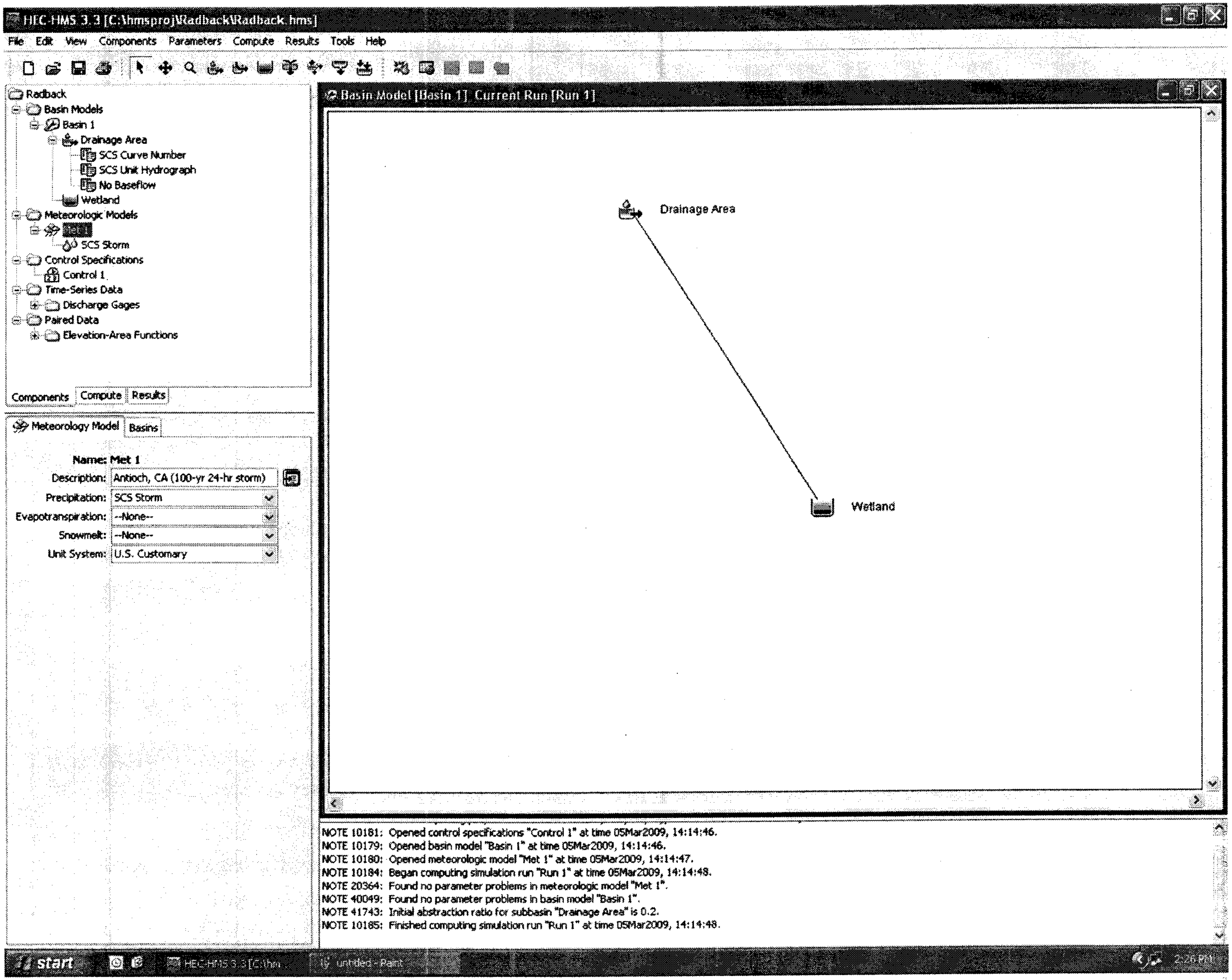
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start
untitled - Paint

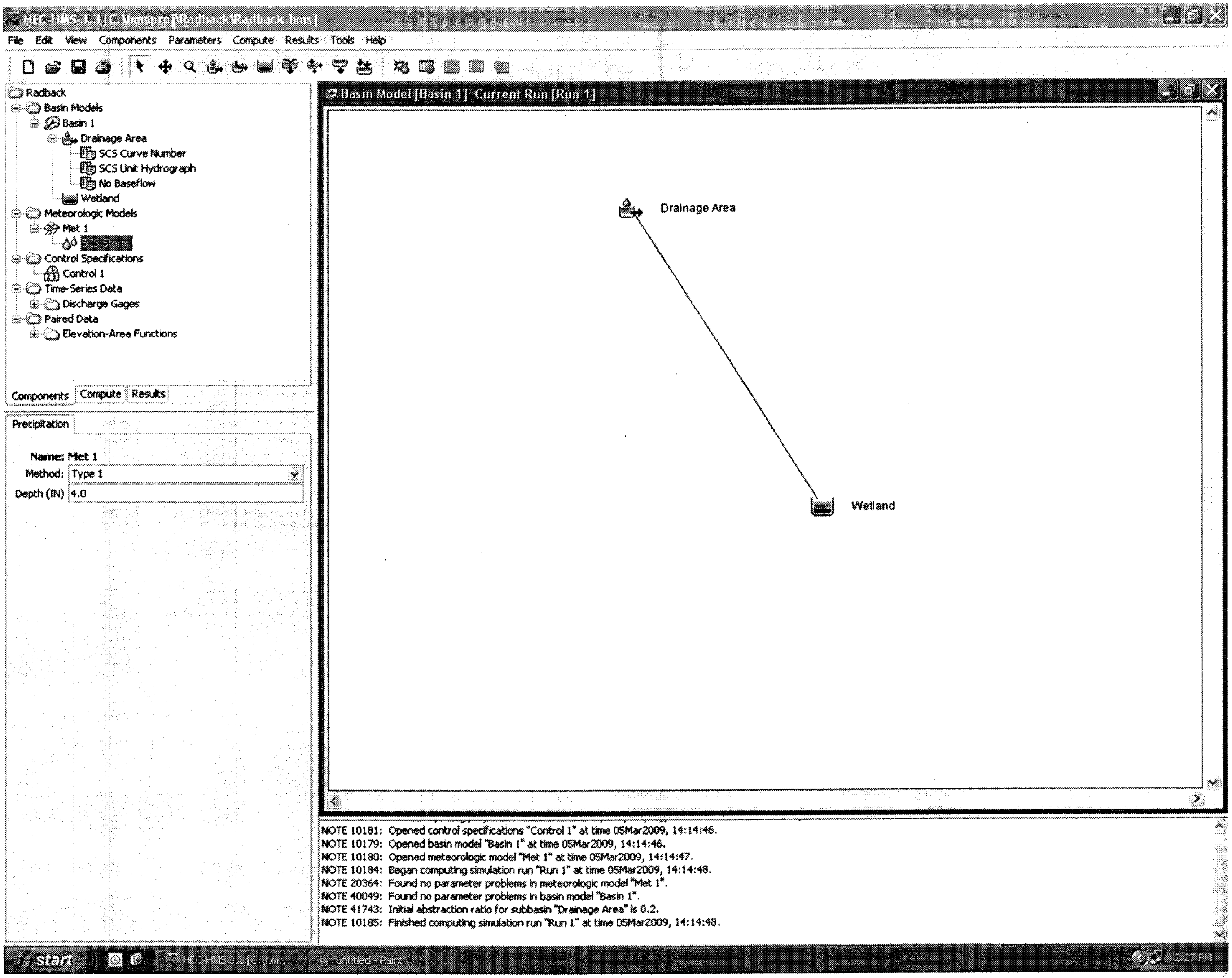


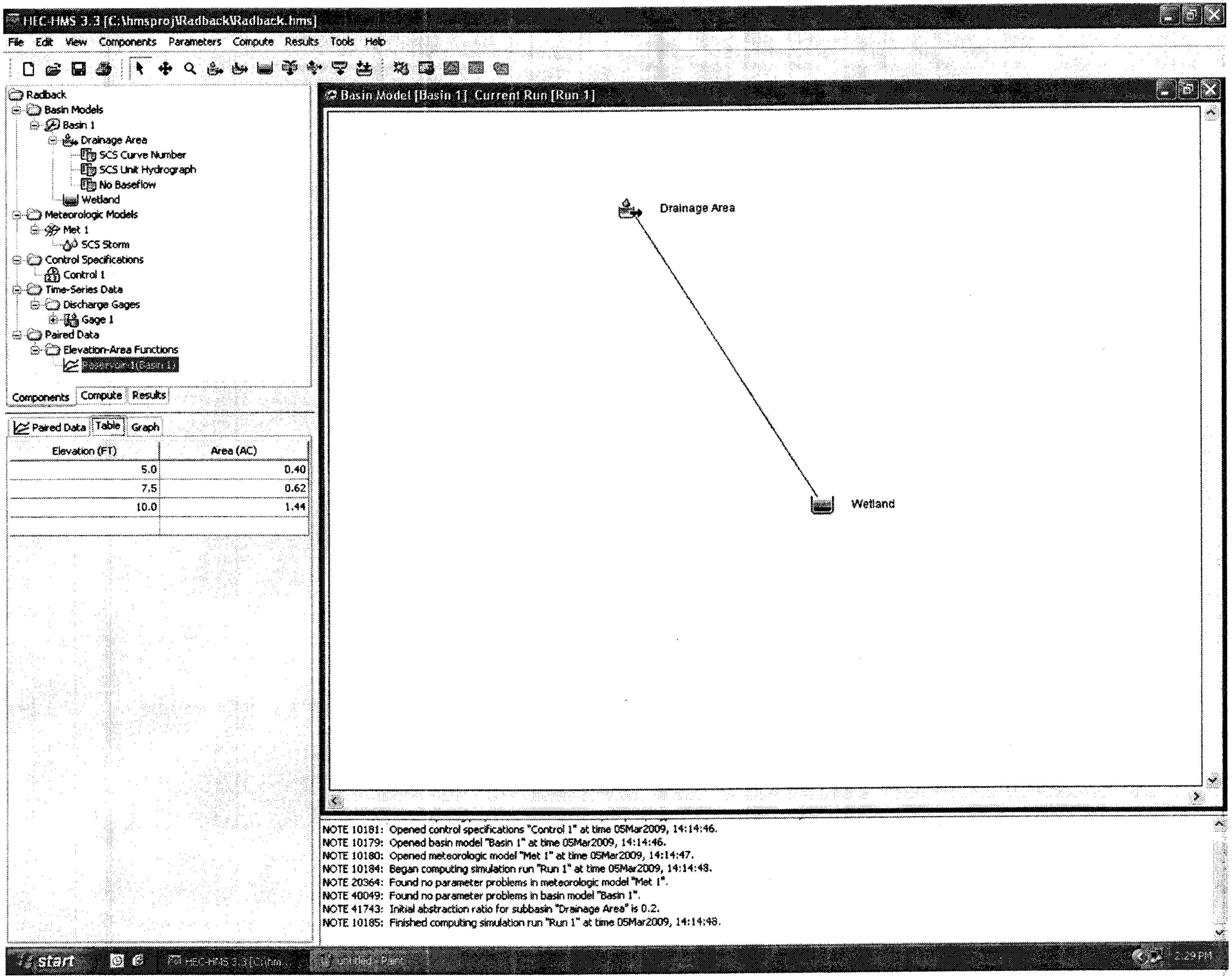
HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
Wetland
Meteorologic Models
Met 1
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Paired Data
Elevation-Area Functions
Components Compute Results
Reservoir Options
Basin Name: Basin 1
Element Name: Wetland
Description: Wetland Storage
Downstream: --None--
Method: Specified Release
Storage Method: Elevation-Area
Elev-Area Function: Reservoir-1(Basin 1)
Initial Condition: Elevation
Initial Elevation (FT) 5.0
Discharge Gage: Gage 1
Max Release (CFS)
Max Capacity (AC-FT)
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
NOTE 20364: Found no parameter problems in meteorologic model "Met 1".
NOTE 40049: Found no parameter problems in basin model "Basin 1".
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start

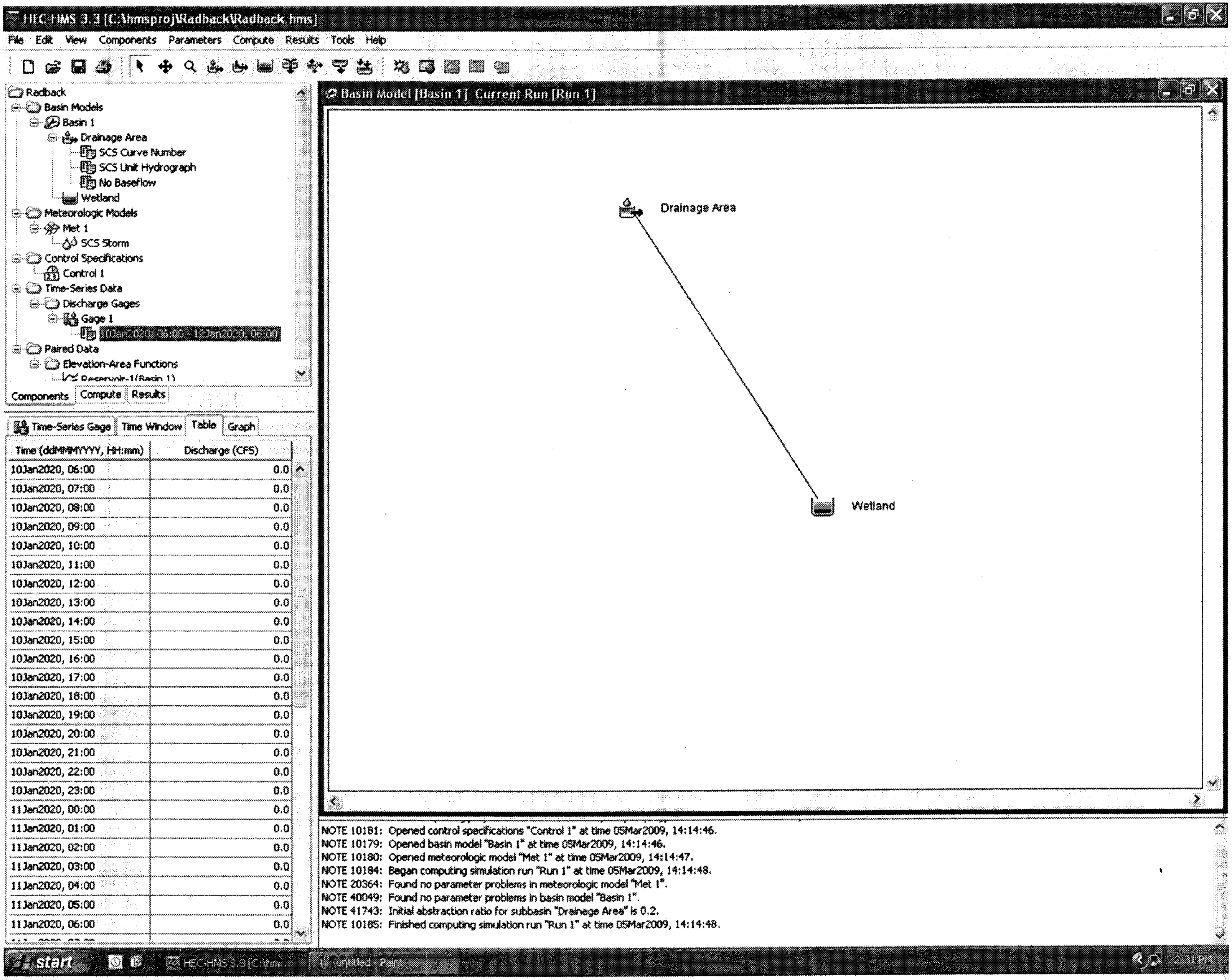

HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
Wetland
Meteorologic Models
Met 1
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Paired Data
Elevation-Area Functions
Components Compute Results
Reservoir Options
Basin Name: Basin 1
Element Name: Wetland
Observed Flow: --None--
Observed Stage:
Observed Pool Elevation:
Elev-Discharge:
Ref Flow (CFS)
Ref Label:
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
NOTE 20364: Found no parameter problems in meteorologic model "Met 1".
NOTE 40049: Found no parameter problems in basin model "Basin 1".
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start



HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
Wetland
Meteorologic Models
SCS Storm
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Paired Data
Elevation-Area Functions
Components Compute Results
Meteorology Model Basins
Name: Met 1
Description: Antioch, CA (100-yr 24-hr storm)
Precipitation: SCS Storm
Evapotranspiration: --None--
Snowmelt: --None--
Unit System: U.S. Customary
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
NOTE 20364: Found no parameter problems in meteorologic model "Met 1".
NOTE 40049: Found no parameter problems in basin model "Basin 1".
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start
untitled - Paint


HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
Wetland
Meteorologic Models
Met 1
SCS Storm
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Paired Data
Elevation-Area Functions
Components Compute Results
Precipitation
Name: Met 1
Method: Type 1
Depth (IN) 4.0
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
NOTE 20364: Found no parameter problems in meteorologic model "Met 1".
NOTE 40049: Found no parameter problems in basin model "Basin 1".
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start


HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
Wetland
Meteorologic Models
Met 1
SCS Storm
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Gage 1
Paired Data
Elevation-Area Functions
Components Compute Results
Paired Data Table Graph
Elevation (FT) Area (AC)
5.0 0.40
7.5 0.62
10.0 1.44
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
NOTE 20364: Found no parameter problems in meteorologic model "Met 1".
NOTE 40049: Found no parameter problems in basin model "Basin 1".
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start


HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
Wetland
Meteorologic Models
Met 1
SCS Storm
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Gage 1
10Jan2020, 06:00 - 12Jan2020, 06:00
Paired Data
Elevation-Area Functions
Components Compute Results
Time-Series Gage Time Window Table Graph
Time (ddMMMYYYY, HH:mm) Discharge (CFS)
10Jan2020, 06:00 0.0
10Jan2020, 07:00 0.0
10Jan2020, 08:00 0.0
10Jan2020, 09:00 0.0
10Jan2020, 10:00 0.0
10Jan2020, 11:00 0.0
10Jan2020, 12:00 0.0
10Jan2020, 13:00 0.0
10Jan2020, 14:00 0.0
10Jan2020, 15:00 0.0
10Jan2020, 16:00 0.0
10Jan2020, 17:00 0.0
10Jan2020, 18:00 0.0
10Jan2020, 19:00 0.0
10Jan2020, 20:00 0.0
10Jan2020, 21:00 0.0
10Jan2020, 22:00 0.0
10Jan2020, 23:00 0.0
11Jan2020, 00:00 0.0
11Jan2020, 01:00 0.0
11Jan2020, 02:00 0.0
11Jan2020, 03:00 0.0
11Jan2020, 04:00 0.0
11Jan2020, 05:00 0.0
11Jan2020, 06:00 0.0
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
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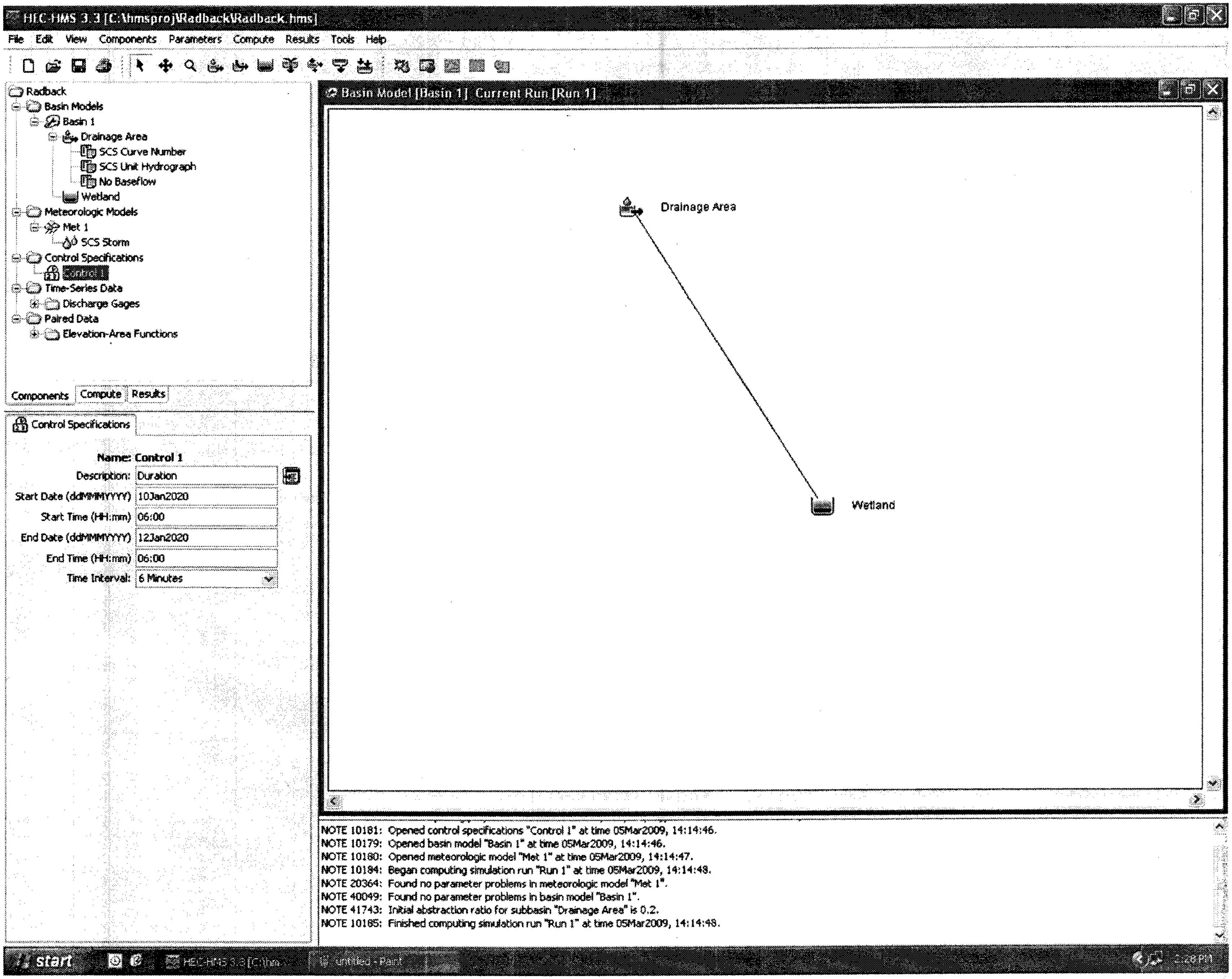
NOTE 40049: Found no parameter problems in basin model "Basin 1".
NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start
untitled - Paint


HEC-HMS 3.3 [C:\hmsproj\Radback\Radback.hms]
File Edit View Components Parameters Compute Results Tools Help
Radback
Basin Models
Basin 1
Drainage Area
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
Wetland
Meteorologic Models
Met 1
SCS Storm
Control Specifications
Control 1
Time-Series Data
Discharge Gages
Paired Data
Elevation-Area Functions
Components Compute Results
Control Specifications
Name: Control 1
Description: Duration
Start Date (ddMMMYYYY) 10Jan2020
Start Time (HH:mm) 06:00
End Date (ddMMMYYYY) 12Jan2020
End Time (HH:mm) 06:00
Time Interval: 6 Minutes
Basin Model [Basin 1] Current Run [Run 1]
Drainage Area
Wetland
NOTE 10181: Opened control specifications "Control 1" at time 05Mar2009, 14:14:46.
NOTE 10179: Opened basin model "Basin 1" at time 05Mar2009, 14:14:46.
NOTE 10180: Opened meteorologic model "Met 1" at time 05Mar2009, 14:14:47.
NOTE 10184: Began computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
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NOTE 41743: Initial abstraction ratio for subbasin "Drainage Area" is 0.2.
NOTE 10185: Finished computing simulation run "Run 1" at time 05Mar2009, 14:14:48.
start
untitled - Paint

Radback Tenaska Project    Stormwater Analysis    JZ 3/4/09

project # 163994    # of pages: 15

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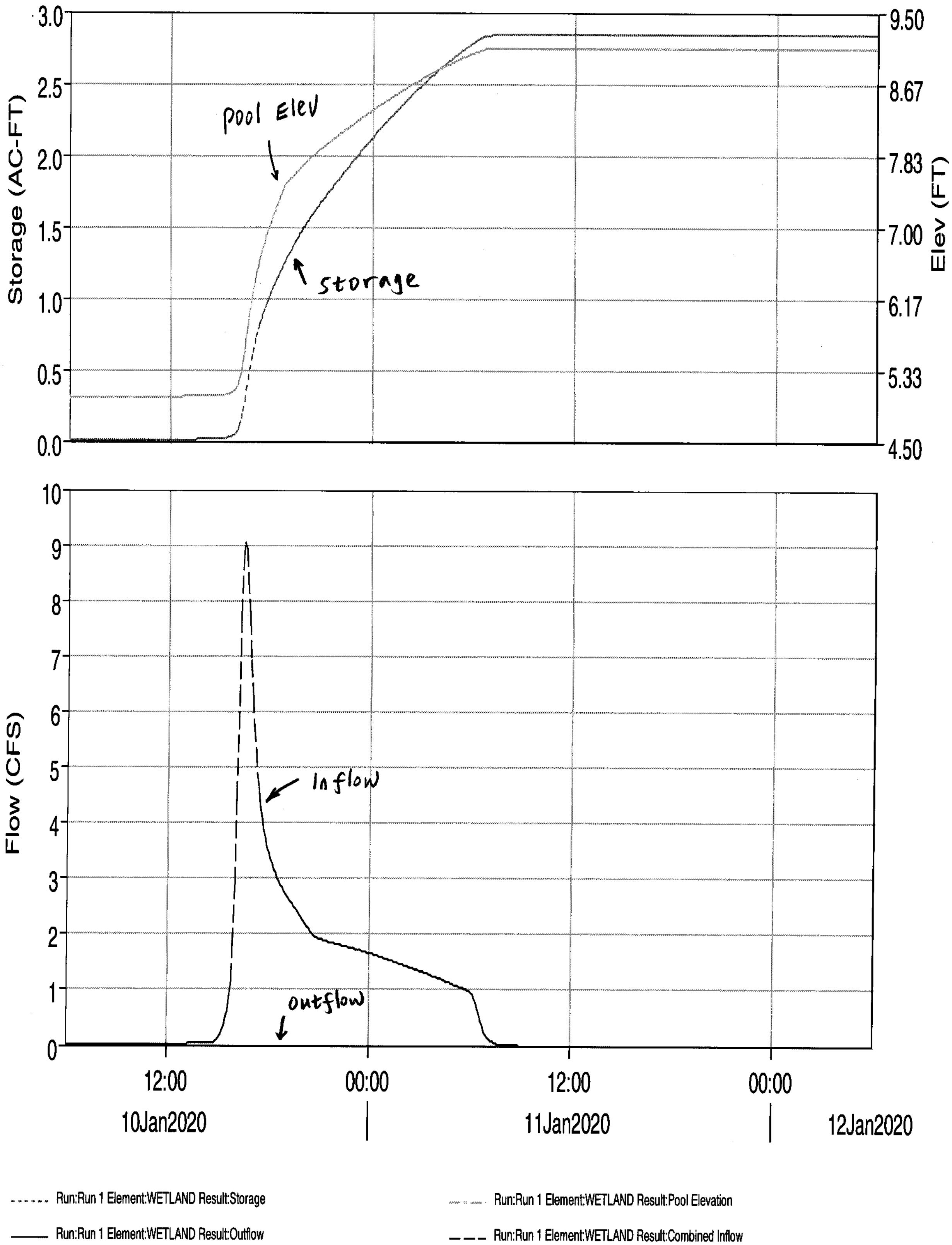
Attachment 2

HEC-HMS Output

Reservoir "Wetland" Results for Run "Run 1"



Project: Radback
Simulation Run: Run 1 Reservo

Start of Run: 10Jan2020, 06:00 Basin
End of Run: 12Jan2020, 06:00 M
Compute Time: 11Mar2009, 13:42:58

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 10Jan2020 | 06:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:24 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:30 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:36 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:42 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:48 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 06:54 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:24 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:30 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:36 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:42 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:48 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 07:54 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:24 | 0.0 | 0.0 | 5.0 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 10Jan2020 | 08:30 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:36 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:42 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:48 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 08:54 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:24 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:30 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:36 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:42 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:48 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 09:54 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:24 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:30 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:36 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:42 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:48 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 10:54 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:24 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:30 | 0.0 | 0.0 | 5.0 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 10Jan2020 | 11:36 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:42 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:48 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 11:54 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:24 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:30 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:36 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:42 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:48 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 12:54 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:24 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:30 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:36 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:42 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:48 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 13:54 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:00 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:06 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:12 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:18 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:24 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:30 | 0.0 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:36 | 0.0 | 0.0 | 5.0 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 10Jan2020 | 14:42 | 0.1 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:48 | 0.1 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 14:54 | 0.1 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 15:00 | 0.1 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 15:06 | 0.2 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 15:12 | 0.2 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 15:18 | 0.3 | 0.0 | 5.0 | 0.0 |
| 10Jan2020 | 15:24 | 0.4 | 0.0 | 5.1 | 0.0 |
| 10Jan2020 | 15:30 | 0.5 | 0.0 | 5.1 | 0.0 |
| 10Jan2020 | 15:36 | 0.6 | 0.0 | 5.1 | 0.0 |
| 10Jan2020 | 15:42 | 0.8 | 0.0 | 5.1 | 0.0 |
| 10Jan2020 | 15:48 | 1.1 | 0.0 | 5.1 | 0.0 |
| 10Jan2020 | 15:54 | 1.8 | 0.1 | 5.1 | 0.0 |
| 10Jan2020 | 16:00 | 2.9 | 0.1 | 5.2 | 0.0 |
| 10Jan2020 | 16:06 | 4.4 | 0.1 | 5.2 | 0.0 |
| 10Jan2020 | 16:12 | 6.2 | 0.2 | 5.3 | 0.0 |
| 10Jan2020 | 16:18 | 7.7 | 0.2 | 5.4 | 0.0 |
| 10Jan2020 | 16:24 | 8.7 | 0.3 | 5.6 | 0.0 |
| 10Jan2020 | 16:30 | 9.0 | 0.4 | 5.7 | 0.0 |
| 10Jan2020 | 16:36 | 8.9 | 0.4 | 5.8 | 0.0 |
| 10Jan2020 | 16:42 | 8.4 | 0.5 | 6.0 | 0.0 |
| 10Jan2020 | 16:48 | 7.7 | 0.6 | 6.1 | 0.0 |
| 10Jan2020 | 16:54 | 6.9 | 0.6 | 6.2 | 0.0 |
| 10Jan2020 | 17:00 | 6.3 | 0.7 | 6.3 | 0.0 |
| 10Jan2020 | 17:06 | 5.8 | 0.7 | 6.4 | 0.0 |
| 10Jan2020 | 17:12 | 5.3 | 0.8 | 6.5 | 0.0 |
| 10Jan2020 | 17:18 | 4.9 | 0.8 | 6.6 | 0.0 |
| 10Jan2020 | 17:24 | 4.6 | 0.9 | 6.7 | 0.0 |
| 10Jan2020 | 17:30 | 4.3 | 0.9 | 6.8 | 0.0 |
| 10Jan2020 | 17:36 | 4.1 | 0.9 | 6.8 | 0.0 |
| 10Jan2020 | 17:42 | 3.9 | 1.0 | 6.9 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 10Jan2020 | 17:48 | 3.7 | 1.0 | 7.0 | 0.0 |
| 10Jan2020 | 17:54 | 3.6 | 1.0 | 7.0 | 0.0 |
| 10Jan2020 | 18:00 | 3.5 | 1.1 | 7.1 | 0.0 |
| 10Jan2020 | 18:06 | 3.3 | 1.1 | 7.1 | 0.0 |
| 10Jan2020 | 18:12 | 3.3 | 1.1 | 7.2 | 0.0 |
| 10Jan2020 | 18:18 | 3.2 | 1.1 | 7.2 | 0.0 |
| 10Jan2020 | 18:24 | 3.1 | 1.2 | 7.3 | 0.0 |
| 10Jan2020 | 18:30 | 3.0 | 1.2 | 7.3 | 0.0 |
| 10Jan2020 | 18:36 | 3.0 | 1.2 | 7.4 | 0.0 |
| 10Jan2020 | 18:42 | 2.9 | 1.2 | 7.4 | 0.0 |
| 10Jan2020 | 18:48 | 2.8 | 1.3 | 7.5 | 0.0 |
| 10Jan2020 | 18:54 | 2.8 | 1.3 | 7.5 | 0.0 |
| 10Jan2020 | 19:00 | 2.7 | 1.3 | 7.5 | 0.0 |
| 10Jan2020 | 19:06 | 2.7 | 1.3 | 7.6 | 0.0 |
| 10Jan2020 | 19:12 | 2.6 | 1.3 | 7.6 | 0.0 |
| 10Jan2020 | 19:18 | 2.6 | 1.4 | 7.6 | 0.0 |
| 10Jan2020 | 19:24 | 2.5 | 1.4 | 7.6 | 0.0 |
| 10Jan2020 | 19:30 | 2.5 | 1.4 | 7.6 | 0.0 |
| 10Jan2020 | 19:36 | 2.5 | 1.4 | 7.7 | 0.0 |
| 10Jan2020 | 19:42 | 2.4 | 1.5 | 7.7 | 0.0 |
| 10Jan2020 | 19:48 | 2.4 | 1.5 | 7.7 | 0.0 |
| 10Jan2020 | 19:54 | 2.3 | 1.5 | 7.7 | 0.0 |
| 10Jan2020 | 20:00 | 2.3 | 1.5 | 7.7 | 0.0 |
| 10Jan2020 | 20:06 | 2.2 | 1.5 | 7.8 | 0.0 |
| 10Jan2020 | 20:12 | 2.2 | 1.5 | 7.8 | 0.0 |
| 10Jan2020 | 20:18 | 2.1 | 1.6 | 7.8 | 0.0 |
| 10Jan2020 | 20:24 | 2.1 | 1.6 | 7.8 | 0.0 |
| 10Jan2020 | 20:30 | 2.1 | 1.6 | 7.8 | 0.0 |
| 10Jan2020 | 20:36 | 2.0 | 1.6 | 7.8 | 0.0 |
| 10Jan2020 | 20:42 | 2.0 | 1.6 | 7.9 | 0.0 |
| 10Jan2020 | 20:48 | 2.0 | 1.6 | 7.9 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 10Jan2020 | 20:54 | 1.9 | 1.7 | 7.9 | 0.0 |
| 10Jan2020 | 21:00 | 1.9 | 1.7 | 7.9 | 0.0 |
| 10Jan2020 | 21:06 | 1.9 | 1.7 | 7.9 | 0.0 |
| 10Jan2020 | 21:12 | 1.9 | 1.7 | 7.9 | 0.0 |
| 10Jan2020 | 21:18 | 1.9 | 1.7 | 8.0 | 0.0 |
| 10Jan2020 | 21:24 | 1.9 | 1.7 | 8.0 | 0.0 |
| 10Jan2020 | 21:30 | 1.9 | 1.8 | 8.0 | 0.0 |
| 10Jan2020 | 21:36 | 1.9 | 1.8 | 8.0 | 0.0 |
| 10Jan2020 | 21:42 | 1.9 | 1.8 | 8.0 | 0.0 |
| 10Jan2020 | 21:48 | 1.8 | 1.8 | 8.0 | 0.0 |
| 10Jan2020 | 21:54 | 1.8 | 1.8 | 8.1 | 0.0 |
| 10Jan2020 | 22:00 | 1.8 | 1.8 | 8.1 | 0.0 |
| 10Jan2020 | 22:06 | 1.8 | 1.8 | 8.1 | 0.0 |
| 10Jan2020 | 22:12 | 1.8 | 1.9 | 8.1 | 0.0 |
| 10Jan2020 | 22:18 | 1.8 | 1.9 | 8.1 | 0.0 |
| 10Jan2020 | 22:24 | 1.8 | 1.9 | 8.1 | 0.0 |
| 10Jan2020 | 22:30 | 1.8 | 1.9 | 8.1 | 0.0 |
| 10Jan2020 | 22:36 | 1.8 | 1.9 | 8.2 | 0.0 |
| 10Jan2020 | 22:42 | 1.8 | 1.9 | 8.2 | 0.0 |
| 10Jan2020 | 22:48 | 1.8 | 2.0 | 8.2 | 0.0 |
| 10Jan2020 | 22:54 | 1.8 | 2.0 | 8.2 | 0.0 |
| 10Jan2020 | 23:00 | 1.7 | 2.0 | 8.2 | 0.0 |
| 10Jan2020 | 23:06 | 1.7 | 2.0 | 8.2 | 0.0 |
| 10Jan2020 | 23:12 | 1.7 | 2.0 | 8.2 | 0.0 |
| 10Jan2020 | 23:18 | 1.7 | 2.0 | 8.3 | 0.0 |
| 10Jan2020 | 23:24 | 1.7 | 2.0 | 8.3 | 0.0 |
| 10Jan2020 | 23:30 | 1.7 | 2.1 | 8.3 | 0.0 |
| 10Jan2020 | 23:36 | 1.7 | 2.1 | 8.3 | 0.0 |
| 10Jan2020 | 23:42 | 1.7 | 2.1 | 8.3 | 0.0 |
| 10Jan2020 | 23:48 | 1.7 | 2.1 | 8.3 | 0.0 |
| 10Jan2020 | 23:54 | 1.7 | 2.1 | 8.3 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 11Jan2020 | 00:00 | 1.7 | 2.1 | 8.4 | 0.0 |
| 11Jan2020 | 00:06 | 1.6 | 2.1 | 8.4 | 0.0 |
| 11Jan2020 | 00:12 | 1.6 | 2.2 | 8.4 | 0.0 |
| 11Jan2020 | 00:18 | 1.6 | 2.2 | 8.4 | 0.0 |
| 11Jan2020 | 00:24 | 1.6 | 2.2 | 8.4 | 0.0 |
| 11Jan2020 | 00:30 | 1.6 | 2.2 | 8.4 | 0.0 |
| 11Jan2020 | 00:36 | 1.6 | 2.2 | 8.4 | 0.0 |
| 11Jan2020 | 00:42 | 1.6 | 2.2 | 8.5 | 0.0 |
| 11Jan2020 | 00:48 | 1.6 | 2.2 | 8.5 | 0.0 |
| 11Jan2020 | 00:54 | 1.6 | 2.2 | 8.5 | 0.0 |
| 11Jan2020 | 01:00 | 1.6 | 2.3 | 8.5 | 0.0 |
| 11Jan2020 | 01:06 | 1.6 | 2.3 | 8.5 | 0.0 |
| 11Jan2020 | 01:12 | 1.5 | 2.3 | 8.5 | 0.0 |
| 11Jan2020 | 01:18 | 1.5 | 2.3 | 8.5 | 0.0 |
| 11Jan2020 | 01:24 | 1.5 | 2.3 | 8.5 | 0.0 |
| 11Jan2020 | 01:30 | 1.5 | 2.3 | 8.6 | 0.0 |
| 11Jan2020 | 01:36 | 1.5 | 2.3 | 8.6 | 0.0 |
| 11Jan2020 | 01:42 | 1.5 | 2.3 | 8.6 | 0.0 |
| 11Jan2020 | 01:48 | 1.5 | 2.4 | 8.6 | 0.0 |
| 11Jan2020 | 01:54 | 1.5 | 2.4 | 8.6 | 0.0 |
| 11Jan2020 | 02:00 | 1.5 | 2.4 | 8.6 | 0.0 |
| 11Jan2020 | 02:06 | 1.4 | 2.4 | 8.6 | 0.0 |
| 11Jan2020 | 02:12 | 1.4 | 2.4 | 8.6 | 0.0 |
| 11Jan2020 | 02:18 | 1.4 | 2.4 | 8.6 | 0.0 |
| 11Jan2020 | 02:24 | 1.4 | 2.4 | 8.7 | 0.0 |
| 11Jan2020 | 02:30 | 1.4 | 2.4 | 8.7 | 0.0 |
| 11Jan2020 | 02:36 | 1.4 | 2.5 | 8.7 | 0.0 |
| 11Jan2020 | 02:42 | 1.4 | 2.5 | 8.7 | 0.0 |
| 11Jan2020 | 02:48 | 1.4 | 2.5 | 8.7 | 0.0 |
| 11Jan2020 | 02:54 | 1.4 | 2.5 | 8.7 | 0.0 |
| 11Jan2020 | 03:00 | 1.3 | 2.5 | 8.7 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 11Jan2020 | 03:06 | 1.3 | 2.5 | 8.7 | 0.0 |
| 11Jan2020 | 03:12 | 1.3 | 2.5 | 8.8 | 0.0 |
| 11Jan2020 | 03:18 | 1.3 | 2.5 | 8.8 | 0.0 |
| 11Jan2020 | 03:24 | 1.3 | 2.5 | 8.8 | 0.0 |
| 11Jan2020 | 03:30 | 1.3 | 2.6 | 8.8 | 0.0 |
| 11Jan2020 | 03:36 | 1.3 | 2.6 | 8.8 | 0.0 |
| 11Jan2020 | 03:42 | 1.3 | 2.6 | 8.8 | 0.0 |
| 11Jan2020 | 03:48 | 1.2 | 2.6 | 8.8 | 0.0 |
| 11Jan2020 | 03:54 | 1.2 | 2.6 | 8.8 | 0.0 |
| 11Jan2020 | 04:00 | 1.2 | 2.6 | 8.8 | 0.0 |
| 11Jan2020 | 04:06 | 1.2 | 2.6 | 8.8 | 0.0 |
| 11Jan2020 | 04:12 | 1.2 | 2.6 | 8.9 | 0.0 |
| 11Jan2020 | 04:18 | 1.2 | 2.6 | 8.9 | 0.0 |
| 11Jan2020 | 04:24 | 1.2 | 2.6 | 8.9 | 0.0 |
| 11Jan2020 | 04:30 | 1.2 | 2.7 | 8.9 | 0.0 |
| 11Jan2020 | 04:36 | 1.2 | 2.7 | 8.9 | 0.0 |
| 11Jan2020 | 04:42 | 1.1 | 2.7 | 8.9 | 0.0 |
| 11Jan2020 | 04:48 | 1.1 | 2.7 | 8.9 | 0.0 |
| 11Jan2020 | 04:54 | 1.1 | 2.7 | 8.9 | 0.0 |
| 11Jan2020 | 05:00 | 1.1 | 2.7 | 8.9 | 0.0 |
| 11Jan2020 | 05:06 | 1.1 | 2.7 | 8.9 | 0.0 |
| 11Jan2020 | 05:12 | 1.1 | 2.7 | 8.9 | 0.0 |
| 11Jan2020 | 05:18 | 1.1 | 2.7 | 9.0 | 0.0 |
| 11Jan2020 | 05:24 | 1.1 | 2.7 | 9.0 | 0.0 |
| 11Jan2020 | 05:30 | 1.0 | 2.7 | 9.0 | 0.0 |
| 11Jan2020 | 05:36 | 1.0 | 2.8 | 9.0 | 0.0 |
| 11Jan2020 | 05:42 | 1.0 | 2.8 | 9.0 | 0.0 |
| 11Jan2020 | 05:48 | 1.0 | 2.8 | 9.0 | 0.0 |
| 11Jan2020 | 05:54 | 1.0 | 2.8 | 9.0 | 0.0 |
| 11Jan2020 | 06:00 | 1.0 | 2.8 | 9.0 | 0.0 |
| 11Jan2020 | 06:06 | 1.0 | 2.8 | 9.0 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
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| 11Jan2020 | 06:18 | 0.9 | 2.8 | 9.0 | 0.0 |
| 11Jan2020 | 06:24 | 0.8 | 2.8 | 9.0 | 0.0 |
| 11Jan2020 | 06:30 | 0.7 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 06:36 | 0.5 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 06:42 | 0.4 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 06:48 | 0.3 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 06:54 | 0.2 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:00 | 0.2 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:06 | 0.1 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:12 | 0.1 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:18 | 0.1 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:24 | 0.1 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 07:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 08:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:12 | 0.0 | 2.8 | 9.1 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 11Jan2020 | 09:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 09:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 10:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 11:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:18 | 0.0 | 2.8 | 9.1 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 11Jan2020 | 12:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 12:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 13:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 14:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:24 | 0.0 | 2.8 | 9.1 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 11Jan2020 | 15:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 15:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 16:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 17:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:30 | 0.0 | 2.8 | 9.1 | 0.0 |

| Date | Time | Inflow (CFS) | Storage (AC-FT) | Elevation (FT) | Outflow (CFS) |
|---|---|---|---|---|---|
| 11Jan2020 | 18:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 18:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 19:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:36 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:42 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:48 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 20:54 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 21:00 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 21:06 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 21:12 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 21:18 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 21:24 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 21:30 | 0.0 | 2.8 | 9.1 | 0.0 |
| 11Jan2020 | 21:36 | 0.0 | 2.8 | 9.1 | 0.0 |

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Attachment 3

Reference 2

Select pages

# Chapter 2 Estimating Runoff

## SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \quad \text{[eq. 2-1]}$$

where

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
$I_a$ = initial abstraction (in)

Initial abstraction ($I_a$) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. $I_a$ is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, $I_a$ was found to be approximated by the following empirical equation:

$$I_a = 0.2S \quad \text{[eq. 2-2]}$$

By removing $I_a$ as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \quad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \quad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

## Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Figure 2-2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (*a* to *d*) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify them for urban conditions.

### Hydrologic soil groups

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates.

Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced. Therefore, a method based on soil texture is given in appendix A for determining the HSG classification for disturbed soils.

**Table 2-2a** Runoff curve numbers for urban areas [1]

| Cover description: Cover type and hydrologic condition | Average percent impervious area [2] | Curve numbers for hydrologic soil group: A | B | C | D |
|---|---|---|---|---|---|
| *Fully developed urban areas (vegetation established)* | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.) [3]: | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (pervious areas only) [4] | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| *Developing urban areas* | | | | | |
| Newly graded areas (pervious areas only, no vegetation) [5] | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c). | | | | | |

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

**Table 2-2b** Runoff curve numbers for cultivated agricultural lands [1]

| Cover description | | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|---|
| Cover type | Treatment [2] | Hydrologic condition [3] | A | B | C | D |
| Fallow | Bare soil | — | 77 | 86 | 91 | 94 |
| | Crop residue cover (CR) | Poor | 76 | 85 | 90 | 93 |
| | | Good | 74 | 83 | 88 | 90 |
| Row crops | Straight row (SR) | Poor | 72 | 81 | 88 | 91 |
| | | Good | 67 | 78 | 85 | 89 |
| | SR + CR | Poor | 71 | 80 | 87 | 90 |
| | | Good | 64 | 75 | 82 | 85 |
| | Contoured (C) | Poor | 70 | 79 | 84 | 88 |
| | | Good | 65 | 75 | 82 | 86 |
| | C + CR | Poor | 69 | 78 | 83 | 87 |
| | | Good | 64 | 74 | 81 | 85 |
| | Contoured & terraced (C&T) | Poor | 66 | 74 | 80 | 82 |
| | | Good | 62 | 71 | 78 | 81 |
| | C&T+ CR | Poor | 65 | 73 | 79 | 81 |
| | | Good | 61 | 70 | 77 | 80 |
| Small grain | SR | Poor | 65 | 76 | 84 | 88 |
| | | Good | 63 | 75 | 83 | 87 |
| | SR + CR | Poor | 64 | 75 | 83 | 86 |
| | | Good | 60 | 72 | 80 | 84 |
| | C | Poor | 63 | 74 | 82 | 85 |
| | | Good | 61 | 73 | 81 | 84 |
| | C + CR | Poor | 62 | 73 | 81 | 84 |
| | | Good | 60 | 72 | 80 | 83 |
| | C&T | Poor | 61 | 72 | 79 | 82 |
| | | Good | 59 | 70 | 78 | 81 |
| | C&T+ CR | Poor | 60 | 71 | 78 | 81 |
| | | Good | 58 | 69 | 77 | 80 |
| Close-seeded or broadcast legumes or rotation meadow | SR | Poor | 66 | 77 | 85 | 89 |
| | | Good | 58 | 72 | 81 | 85 |
| | C | Poor | 64 | 75 | 83 | 85 |
| | | Good | 55 | 69 | 78 | 83 |
| | C&T | Poor | 63 | 73 | 80 | 83 |
| | | Good | 51 | 67 | 76 | 80 |

1 Average runoff condition, and $I_a$=0.2S

2 Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

3 Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

## Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

**Table 3-1** Roughness coefficients (Manning's n) for sheet flow

| Surface description | n [1] |
|---|---|
| Smooth surfaces (concrete, asphalt, gravel, or bare soil) | 0.011 |
| Fallow (no residue) | 0.05 |
| Cultivated soils: | |
| Residue cover ≤20% | 0.06 |
| Residue cover >20% | 0.17 |
| Grass: | |
| Short grass prairie | 0.15 |
| Dense grasses [2] | 0.24 |
| Bermudagrass | 0.41 |
| Range (natural) | 0.13 |
| Woods: [3] | |
| Light underbrush | 0.40 |
| Dense underbrush | 0.80 |

1 The n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute $T_t$:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \quad \text{[eq. 3-3]}$$

where:

$T_t$ = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
$P_2$ = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

### Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

### Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

# Chapter 3 Time of Concentration and Travel Time

Travel time ( $T_t$ ) is the time it takes water to travel from one location to another in a watershed. $T_t$ is a component of time of concentration ( $T_c$ ), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. $T_c$ is computed by summing all the travel times for consecutive components of the drainage conveyance system.

$T_c$ influences the shape and peak of the runoff hydrograph. Urbanization usually decreases $T_c$, thereby increasing the peak discharge. But $T_c$ can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

## Factors affecting time of concentration and travel time

### Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

### Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

### Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

## Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time ( $T_t$ ) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[eq. 3-1]}$$

where:

$T_t$ = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

Time of concentration ( $T_c$ ) is the sum of $T_t$ values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \dots T_{t_m} \qquad \text{[eq. 3-2]}$$

where:

$T_c$ = time of concentration (hr)
m = number of flow segments

**Figure 3-1** Average velocities for estimating travel time for shallow concentrated flow

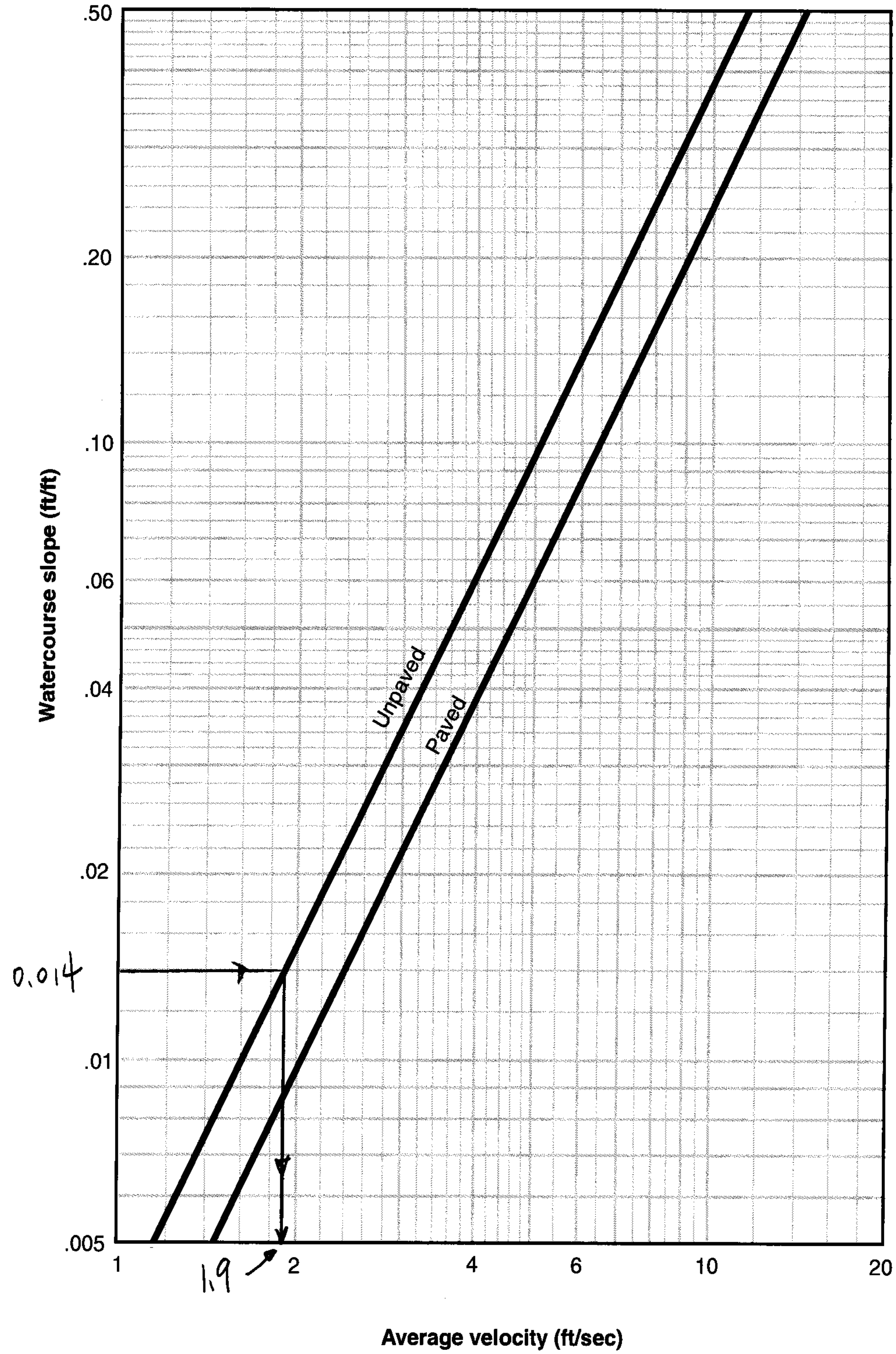
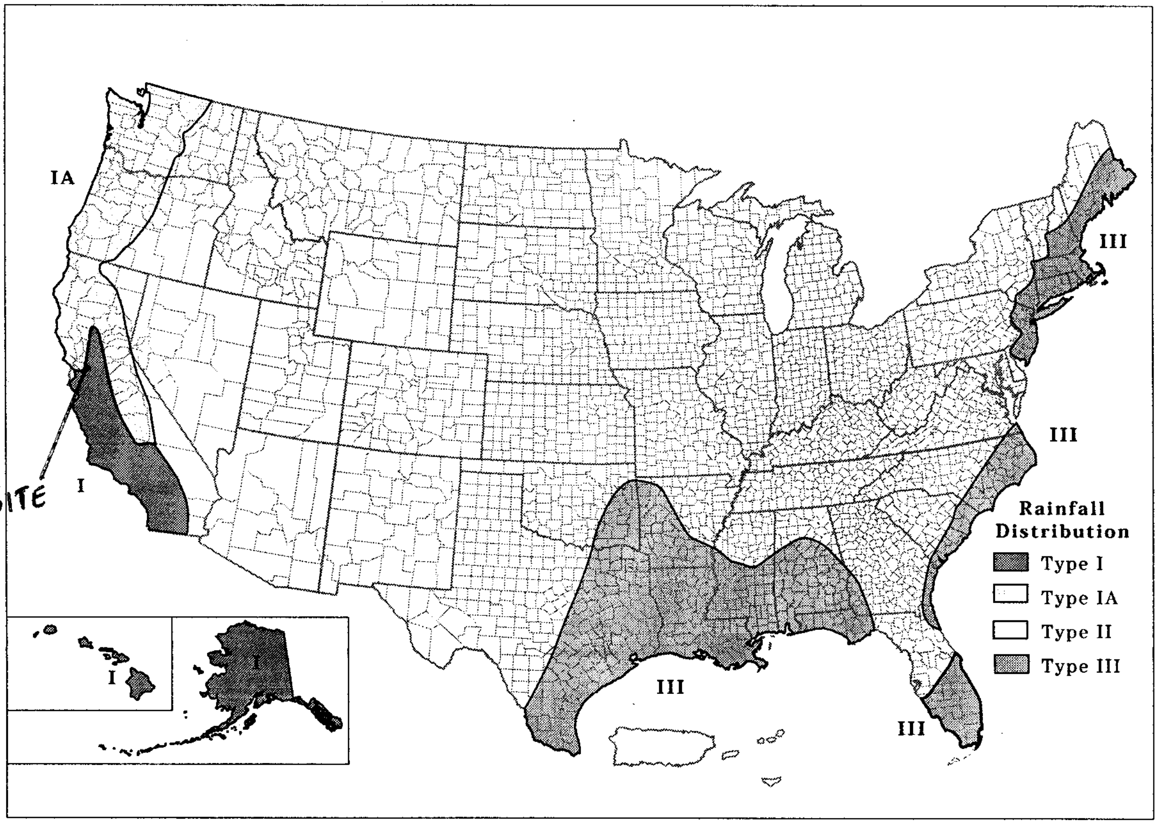


**Figure B-2** Approximate geographic boundaries for NRCS (SCS) rainfall distributions




## Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

### East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

### West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

### Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

### Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

### Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

# Appendix A Hydrologic Soil Groups

Soils are classified into hydrologic soil groups (HSG's) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve numbers (see chapter 2). For the convenience of TR-55 users, exhibit A-1 lists the HSG classification of United States soils.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Approximate numerical ranges for transmission rates shown in the HSG definitions were first published by Musgrave (USDA 1955). The four groups are defined by SCS soil scientists as follows:

**Group A** soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

**Group B** soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

**Group C** soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

**Group D** soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

In exhibit A-1, some of the listed soils have an added modifier; for example, "Abrazo, gravelly." This refers to a gravelly phase of the Abrazo series that is found in SCS soil map legends.

## Disturbed soil profiles

As a result of urbanization, the soil profile may be considerably altered and the listed group classification may no longer apply. In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred (Brakensiek and Rawls 1983).

| *HSG* | *Soil textures* |
|---|---|
| A | Sand, loamy sand, or sandy loam |
| B | Silt loam or loam |
| C | Sandy clay loam |
| D | Clay loam, silty clay loam, sandy clay, silty clay, or clay |

## Drainage and group D soils

Some soils in the list are in group D because of a high water table that creates a drainage problem. Once these soils are effectively drained, they are placed in a different group. For example, Ackerman soil is classified as A/D. This indicates that the drained Ackerman soil is in group A and the undrained soil is in group D.

Radback Tenaska project Stormwater Analysis JT 3/4/09

project # 163994

# of pages : 5

52, 5406, 1003

# Attachment 4

Reference 6

Select pages

( printed out from the Online Web soil survey )


Project site

# Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series.* All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

# Contra Costa County, California

## DaC—DELHI SAND, 2 TO 9 PERCENT SLOPES

**Map Unit Setting**

*Elevation:* 10 to 150 feet
*Mean annual precipitation:* 12 to 14 inches
*Mean annual air temperature:* 59 degrees F
*Frost-free period:* 260 to 300 days

**Map Unit Composition**

*Delhi and similar soils:* 85 percent
*Minor components:* 15 percent

**Description of Delhi**

**Setting**

*Landform:* Flood plains, terraces, alluvial fans
*Landform position (three-dimensional):* Tread, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Eolian deposits derived from igneous and sedimentary rock

**Properties and qualities**

*Slope:* 2 to 9 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline (0.0 to 2.0 mmhos/cm)
*Available water capacity:* Low (about 4.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3s
*Land capability (nonirrigated):* 6e

**Typical profile**

*0 to 5 inches:* Sand
*5 to 60 inches:* Sand

**Minor Components**

**Unnamed**

*Percent of map unit:* 12 percent

**Laugenour**

*Percent of map unit:* 3 percent

# Data Source Information

Soil Survey Area: Contra Costa County, California
Survey Area Data: Version 8, Jul 22, 2008

BLACK & VEATCH

## Calculation Record

Client Name: Radback Energy



Project Name: Tenaska Contra Costa Generating Station

Project No.: 163994

Calculation Title: Soil Erosion Control

Calculation No./File No.: 52.5406.1004

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

**Objective** To design the site's Best Management Practices (BMP) for soil erosion and sediment control.

| 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 |
| 0 | P. L. Nelson | 3 Apr 2009 | Jimmy Zhong | 4/3/09 | P. L. Nelson | 4/3/09 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## Purpose

To design the site's Best Management Practices (BMP) for soil erosion and sediment control.

## References

1. US Dept of Agriculture, Natural Resources Conservation Services (NRCS), Web Soil Survey.
2. Black & Veatch Drawing:
   - 163994-SS-3101, Rev. A, "Soil Erosion Control Site, Plan Sheet 1"
   - 163994-SS-3102, Rev. A, "Soil Erosion Control Site, Plan Sheet 2"
   - 163994-SS-3150, Rev. A, "Soil Erosion Control Site, Sections and Details"
3. California Stormwater Quality Association, California Stormwater Best Management Practice (BMP) Construction Handbook, January 2003.

## Definition of Units and Constants

English units will be used.

Example of Common Unit Designations:

Rainfall amount in inches (in)

Drainage area in acres (ac)

## Assumptions

Contained in the body of the calculation.

## Attachments

1. NRCS Soil Survey
2. Black & Veatch Drawings SS-3101, SS-3102 and SS-3150
3. Reference 2 – Select Pages

## Summary

As noted on the drawings and in this calculation, the project site meets the requirements of the California Stormwater Quality Association (CSQA), California Stormwater Best Management Practice (BMP) Construction Handbook.

## Site Location

The site is located on the border of Antioch and Oakley California at a former industrial facility. The site previously had no buildings, process equipment or other facilities when the industrial facility was in operation. The main site is currently a vineyard with a row of eucalyptus trees along the north east corner. The site appears to be tilled once or twice a year. Soil is Delhi sand (dune sand) and has a high to very high water transmission rate (Ref 1 and attachment 1). The laydown area was disturbed by industrial facility activities in the form of asphalt paving in the northeast portion. The paved area will be used as-is for temporary storage of materials and equipment. The remainder of the laydown area is currently sparse vegetation to bare soil very similar in nature to the main plant area. ✓

## Main Plant Site Design (Dwg SS-3101)

The site drainage design is required to meet Contra Costa Clean Water Program's Stormwater C.3 Guidebook, Stormwater Quality Requirements for Development Applications, Fourth Edition. The vast majority of stormwater runoff will be directed to bioswales for both runoff rate control and water quality improvement. The main plant site will utilize hydraulic mulch, hydroseeding, geotextiles & mats, velocity dissipation devices, silt fence, fiber rolls, storm drain inlet protection and stabilized construction roadway. General details and facts about each BMP are noted in attachment 3. Project specific details are shown in attachment 2 along with plan drawing SS-3101. ✓

## Laydown Area Design (Dwg SS-3101)

The laydown area drainage design will meet the same requirements as the main plant site. The stormwater drainage from the asphalt paved area will not be modified. Silt fence wil be placed along the edge to capture any soil from construction traffic deposited on the asphalt. The soil area will be graded to drain to a bioswale down the middle of the laydown area. The bioswale will be pumped as needed to prevent over topping of the bioswale due to a lack of a gravity outlet. BMPs will include hydraulic mulch, hydroseeding, geotextiles & mats, soil binder, silt fence, fiber rolls and stabilized construction roadway. See plan drawing SS-3102 (attachment 2) for further details.

## General Construction Sequence

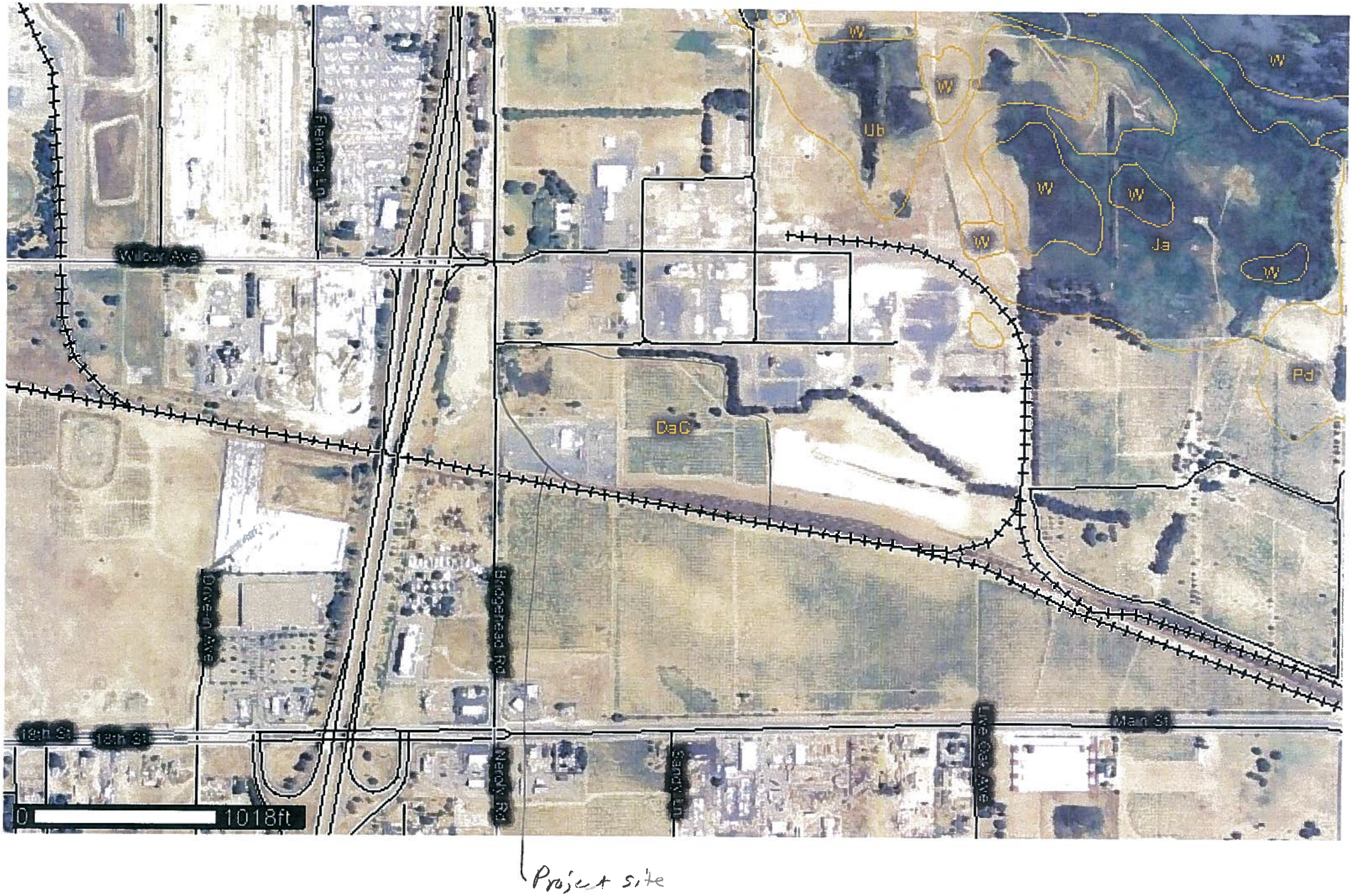
1. Install silt fence and stabilized construction entrances/exits as indicated on the drawings. Construction contractor may temporarily install an additional construction entrance/exit based on the details of the site grading equipment/methods utilized.

2. Install bioswales starting at the lowest elevations and working toward higher elevations. No more soil shall be disturbed than is required to building the facilities lowest in elevation first. Stabilize bioswales and slopes adjacent to conservation easement area as soon as practical in the grading process. Install fiber rolls along top of bioswales at the same time as installing hydroseeding and geotextiles/mats. Fiber rolls may be removed once vegetation obtains 70% coverage within the bioswales. ✓
3. Install storm sewer and catch basin in conjunction with other underground utilities. Place inlet protection on each catch basin and velocity dissipation devices on sewer outlets as each item is installed.
4. Install aggregate roads and maintain construction entrances/exits as required.
5. Install aggregate area surfacing and remaining vegetation/landscaping as project construction permits.

Attachment 1

NRCS Web Soil Survey

4 pages



Fleming Ln
Wilbur Ave
Drive-in Ave
Bridgehead Rd
Neroly Rd
18th St
Sandy Ln
Live Oak Ave
Main St
DaC
Ub
Ja
Pd
W
0
1018ft
Project site

# Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

# Contra Costa County, California

## DaC—DELHI SAND, 2 TO 9 PERCENT SLOPES

### Map Unit Setting

*Elevation:* 10 to 150 feet
*Mean annual precipitation:* 12 to 14 inches
*Mean annual air temperature:* 59 degrees F
*Frost-free period:* 260 to 300 days

### Map Unit Composition

*Delhi and similar soils:* 85 percent
*Minor components:* 15 percent

### Description of Delhi

#### Setting

*Landform:* Flood plains, terraces, alluvial fans
*Landform position (three-dimensional):* Tread, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Eolian deposits derived from igneous and sedimentary rock

#### Properties and qualities

*Slope:* 2 to 9 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline (0.0 to 2.0 mmhos/cm)
*Available water capacity:* Low (about 4.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3s
*Land capability (nonirrigated):* 6e

#### Typical profile

*0 to 5 inches:* Sand
*5 to 60 inches:* Sand

### Minor Components

#### Unnamed

*Percent of map unit:* 12 percent

#### Laugenour

*Percent of map unit:* 3 percent

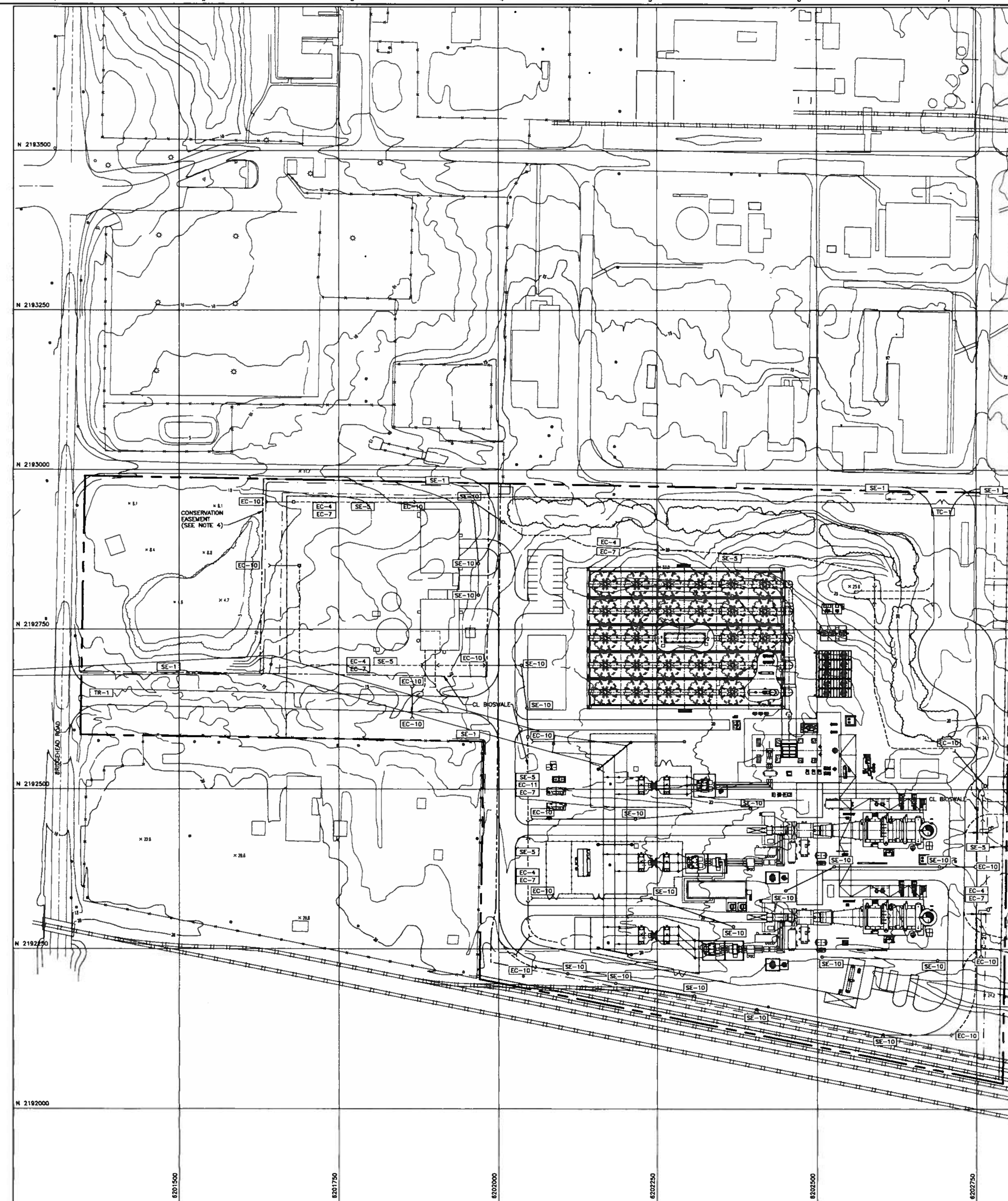
## Data Source Information

Soil Survey Area: Contra Costa County, California
Survey Area Data: Version 8, Jul 22, 2008

Attachment 2

B+V Design Dwgs

3 pages




**OPEN**
04/01/09

## NOTES APPLICABLE TO ALL SS-3000 SERIES DRAWINGS

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.
2. SEE DWG SS-3001 FOR GRADING & DRAINAGE PLAN
3. SEE DWG SS-3150 FOR SOIL EROSION CONTROL SECTIONS AND DETAILS.
4. NO CONSTRUCTION ACTIVITY SHALL OCCUR WITHIN CONSERVATION EASEMENT.
5. SE-5 MAY BE REMOVED AFTER BIOSWALE GRASS OBTAINS 70% COVERAGE.
6. SEE DWG SS-3201 FOR SITE SURFACING PLAN. ALL GRASS OR LANDSCAPE AREAS SHALL BE SEEDED AND FERTILIZED EC-4 AND COVERED WITH HYDRAULIC MULCH EC-3

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FILE FORMAT OF THIS DRAWING OUTSIDE OF BLACK & VEATCH IS UNCONTROLLED AND SHALL BE USED FOR REFERENCE PURPOSES ONLY.

| NO | DATE | REVISIONS AND RECORD OF ISSUE | DRN | DES | CHK | PDE | APP |
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| A | OPEN | | NAW | PLN | | | |

SCALE: 1"=60'

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SIGNED ______
DATE ______ REG NO. ______

BLACK & VEATCH CORPORATION
ENGINEER PLN DRAWN NAW
CHECKED DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

SOIL EROSION CONTROL – SITE PLAN – SHEET 1

PROJECT DRAWING NUMBER 163994-SS-3101 REV A
CODE
AREA


**OPEN**
04/02/09

## NOTES

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.
2. SEE DWG SS-3002 FOR GRADING & DRAINAGE PLAN
3. SEE DWG SS-3150 FOR SOIL EROSION CONTROL SECTIONS AND DETAILS.
4. SEE DWG SS-3202 FOR SITE SURFACING PLAN.
5. A TEMPORARY 2000 GPM PUMP SHALL BE INSTALLED AND STARTED WHEN WATER LEVEL REACHES EL 16.5. PUMP SHALL DISCHARGGE TO NATURAL DRAINAGE EAST OF RAILROAD TRACKS.
6. SE-5 MAY BE REMOVED AFTER BIOSWALE GRASS OBTAINS 70% COVERAGE.
7. SOIL BINDER EC-5 SHOULD BE APPLIED PRIOR TO STORAGE OF MATERIAL OR EQUIPMENT.

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FILE FORMAT OF THIS DRAWING OUTSIDE OF BLACK & VEATCH IS UNCONTROLLED AND SHALL BE USED FOR REFERENCE PURPOSES ONLY.

| NO | DATE | REVISIONS AND RECORD OF ISSUE | DRN | DES | CHK | PDE | APP |
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| A | OPEN | | NAW | PLN | | PLN | DVW |

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

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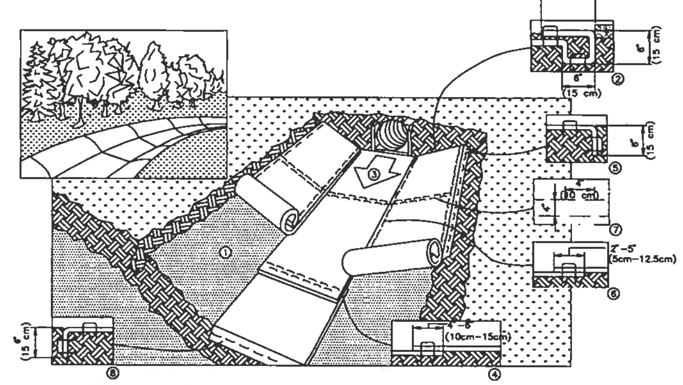
DATE ______ REG NO. ______

BLACK & VEATCH CORPORATION
ENGINEER PLN | DRAWN NAW
CHECKED | DATE

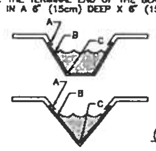
CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

SOIL EROSION CONTROL – SITE PLAN – SHEET 2

PROJECT / DRAWING NUMBER: 163994-SS-3102
REV: A
CODE
AREA




1. PREPARE SOIL BEFORE INSTALLING BLANKETS, INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED. NOTE: WHEN USING CELL-O-SEED DO NOT SEED PREPARED AREA. CELL-O-SEED MUST BE INSTALLED WITH PAPER SIDE DOWN.
2. BEGIN AT THE TOP OF THE CHANNEL BY ANCHORING THE BLANKET IN A 6" (15cm) DEEP X 6" (15cm) WIDE TRENCH WITH APPROXIMATELY 12" (30cm) OF BLANKET EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE BLANKET WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30cm) APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" (30cm) PORTION OF BLANKET BACK OVER SEED AND COMPACTED SOIL. SECURE BLANKET OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" (30cm) APART ACROSS THE WIDTH OF THE BLANKET.
3. ROLL CENTER BLANKET IN DIRECTION OF WATER FLOW IN BOTTOM OF CHANNEL. BLANKETS WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL BLANKETS MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING OPTIONAL DOT SYSTEM™, STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. PLACE CONSECUTIVE BLANKETS END OVER END (SHINGLE STYLE) WITH A 4"-6" (10cm-15cm) OVERLAP. USE A DOUBLE ROW OF STAPLES STAGGERED 4" (10cm) APART AND 4" (10cm) ON CENTER TO SECURE BLANKETS.
5. FULL LENGTH EDGE OF BLANKETS AT TOP OF SIDE SLOPES MUST BE ANCHORED WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30cm) APART IN A 6" (15cm) DEEP X 6" (15cm) WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.
6. ADJACENT BLANKETS MUST BE OVERLAPPED APPROXIMATELY 2"-5" (5cm-12.5cm) (DEPENDING ON BLANKET TYPE) AND STAPLED. TO ENSURE PROPER SEAM ALIGNMENT, PLACE THE EDGE OF THE OVERLAPPING BLANKET (BLANKET BEING INSTALLED ON TOP) EVEN WITH THE COLORED SEAM STITCH ON THE BLANKET BEING OVERLAPPED.
7. IN HIGH FLOW CHANNEL APPLICATIONS, A STAPLE CHECK SLOT IS RECOMMENDED AT 30 TO 40 FOOT (9m-12m) INTERVALS. USE A DOUBLE ROW OF STAPLES STAGGERED 4" (10cm) APART AND 4" (10cm) ON CENTER OVER ENTIRE WIDTH OF THE CHANNEL.
8. THE TERMINAL END OF THE BLANKETS MUST BE ANCHORED WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30cm) APART IN A 6" (15cm) DEEP X 6" (15cm) WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.



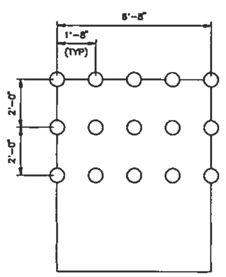

CRITICAL POINTS

A. OVERLAPS AND SEAMS
B. PROJECTED WATER LINE
C. CHANNEL BOTTOM/SIDE SLOPE VERTICES

NOTE:
* HORIZONTAL STAPLE SPACING SHOULD BE ALTERED IF NECESSARY TO ALLOW STAPLES TO SECURE THE CRITICAL POINTS ALONG THE CHANNEL SURFACE.

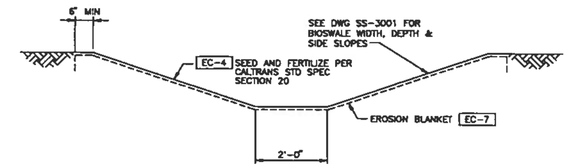
** IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" (15 cm) MAY BE NECESSARY TO PROPERLY ANCHOR THE BLANKETS.

EC-7 EROSION BLANKET INSTALLATION (NORTH AMERICAN GREEN SC150BN OR S150 BN)
NO SCALE
SEE THIS DWG

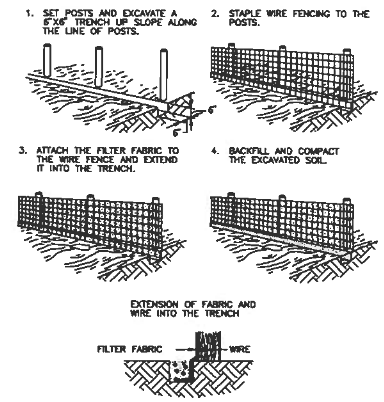



NOTE:
USE 3.4 STAPLES PER SQ YD WITH 6", 11 GA WIRE "U" STAPLES.
FOR LOOSE SOILS USE STAPLES 8" AND LONGER.
FOR HARD OR ROCKY SOILS USE 9 GA STAPLES OR HEAVIER.
SECURE BLANKETS TO SOIL BY PLACING A STAPLE/STAKE THROUGH EACH WHITE COLORED CIRCLE.

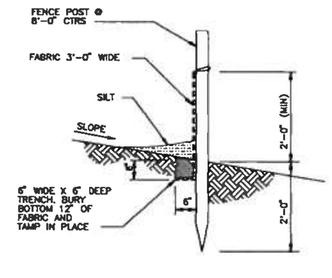
STAPLE PATTERN "D" FOR EROSION BLANKET
NO SCALE
SEE THIS DWG




TYPICAL BIOSWALE EROSION PROTECTION
NO SCALE

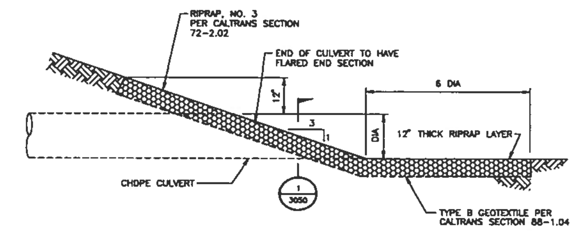



PLANS

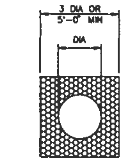



ELEVATION

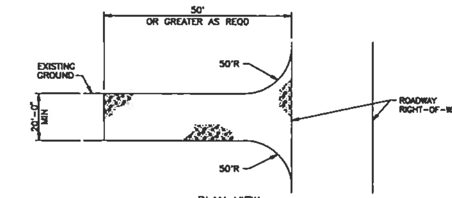
SE-1 SILT FENCE DETAIL
NO SCALE



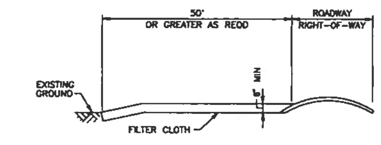

EC-10 TYPICAL STORM DRAIN PIPING INLET/OUTLET PROTECTION
NO SCALE




SECTION 1
NO SCALE

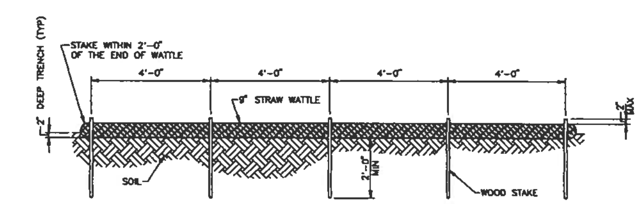



PLAN VIEW

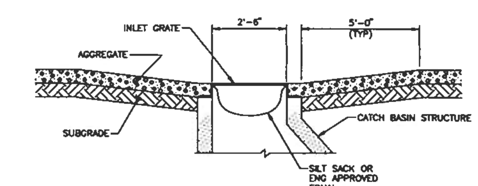



PROFILE

TC-1 TYPICAL STABILIZED CONSTRUCTION ENTRANCE
NO SCALE
SEE NOTE 2




SE-5 STRAW WATTLE DETAIL
NOT TO SCALE




SE-10 TYPICAL CATCH BASIN SEDIMENT FILTER
NOT TO SCALE

## NOTES

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.
2. PROVIDE APPROPRIATE TRANSITION BETWEEN STABILIZED CONSTRUCTION ENTRANCE AND ROADWAY 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 – 50 FEET MINIMUM WHERE THE SOILS ARE SANDS OR GRAVEL OR 100 FEET MINIMUM WHERE SOILS ARE CLAYS OR SILTS, EXCEPT WHERE THE TRAVELED LENGTH IS LESS THAN 50 OR 100 FEET RESPECTIVELY. THESE LENGTHS 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.

NOT TO BE USED FOR CONSTRUCTION

| NO | DATE | REVISIONS AND RECORD OF ISSUE | DRN | CHK | APP |
|---|---|---|---|---|---|
| A | OPEN | ISSUED FOR | NAW | PLN | PLN |

SCALE: 1"=60'

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SIGNED ______
DATE ______ REG NO. ______

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ENGINEER PLN | DRAWN NAW | CHECKED | DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

SOIL EROSION CONTROL – SITE SECTIONS AND DETAILS

PROJECT / DRAWING NUMBER: 163994-SS-3150 REV A

**BLACK & VEATCH**

## Calculation Record

Client Name: Radback Energy



Project Name: Tenaska

Project No.: 163994

Calculation Title: Storm Sewer Pipe Design

Calculation No./File No.: 52.5406.1005

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

**Objective** To verify the storm sewer pipes have sufficient capacity to convey the stormwater runoff for the design storm event for proposed Tenaska Contra Costa Generation Project.

| Unverified Assumptions Requiring Subsequent Verification | | | |
|---|---|---|---|
| No. | Assumption | Verified By | Date |
| | | | |
| | | | |
| | | | |
| | | | |

See Page 2 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 |
| 0 | J Zhong *Jimmy Zhong* | April 15, 2009 | *[signature]* | 4/15/09 | *[signature]* | 4/15/09 |
| | | | | | | |
| | | | | | | |
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| | | | | | | |

## Purpose

The design of storm sewer pipes for this project generally consist of two sizes - 12" diameter and 18" diameter. All the sewer pipes will be installed at a minimum of 0.4% slope. The purpose of this calculation is to verify the storm sewer pipes have sufficient capacity to convey the stormwater for a 10-year storm event. The two 18" diameter pipes which discharge directly to the wetland at the most downstream of bioswales will be sized based on a 50-year storm event due to bioswale sizing being based on a 30-year design event.

## References

1. Black & Veatch Drawing:
   - 163994-SS-3001, Rev. 0, "Grading & Drainage - Site Plan - Sheet 1"
   - 163994-SS-3201, Rev. A, "Surfacing/Fencing/Roadway - Site Plan - Sheet 1"
   - 163994-SS-3050, Rev. 0, "Site Sections and Details"
   - 163994-SS-1002, Rev. 1, "General Arrangement – Site"
2. Roberson, Cassidy and Chaudhry; Hydraulic Engineering; John Wiley & Sons, Inc.; Second Edition; 1997.
3. US Department of Commerce; Rainfall Intensity-Duration-Frequency Curves; Technical Paper No. 25; December 1955.
4. US Department of Agriculture; Urban Hydrology for Small Watersheds, 2nd Edition; Technical Release 55 (TR-55); June 1986.
5. Contra Costa Clean Water Program; Stormwater C.3 Guidebook; Stormwater Quality Requirements for Development Applications; Fourth Edition; September 10, 2008.
6. Mays, L. W.; Stormwater Collection Systems Design Handbook; McGraw-Hill; 2001.
7. Black & Veatch Calculation; Stormwater Analysis for Wetland; File No. 52.5406.1003; Same Project; March 2009.
8. Black & Veatch Calculation; IMP Sizing for Plant Area; File No. 52.5406.1002; Same Project; March 2009.

## Definition of Units and Constants

English units will be used.

Example of Common Unit Designations:

Rainfall intensity in inches per hour (inch/hr)

Drainage area in acres (ac)

## B&V General Design Criteria

The following design items are based on standard practices used at B&V and engineering experience:

1. Use the Rational Method to determine the peak rate of run-off.

$$Q = CIA \quad (cfs) \qquad \text{(Ref. 2, Eq. 2-1)}$$

C = runoff coefficient
I = rainfall intensity (inch/hr)
A = drainage area (acres)

2. Per Ref. 4, Page 3-4, 0.1 hour (6 minutes) is the minimum time of concentration ($T_c$) used in TR-55 for a drainage basin. Per Ref. 6, Table 4.2, standard time of concentrations can be used for small, impervious areas. The recommended time of concentration is 5 minutes for "roof and property drainage", 5 minutes for "road inlet pits", and 10 minutes for "small areas less than 1 acre". Based on the above information, the minimum travel time to a yard catch basin within each drainage basin is set to be 6 minutes (0.1 hour).

3. Assume the project site is graded with slopes of approximately 0.5% for effective drainage of stormwater.

4. Slope storm sewer piping with a diameter of 12-inch and greater at a minimum of 0.4% which is typical for storm sewer design.

5. Design the storm sewer piping such that the full flow velocity through the piping will be greater than 2 ft/s and less than 8 ft/s.

6. Use corrugated high-density polyethylene (CHDPE) pipes for typical storm sewer piping. Use Manning's "n" of 0.011 based on the product specification of HANCOR SURE-LOK® F477 (see Page 4).

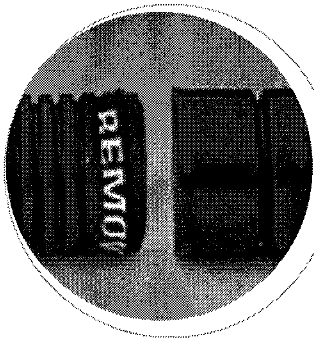
Radback Tenaska project 163994
File # 52.5406.1005



Hancor®
Technology · Innovation · Solutions™

## HANCOR SURE-LOK® WT PIPE SPECIFICATIONS

Diameter: 4" - 10" (100 - 250mm)
Length: 20' (6.1m)
Specifications: AASHTO M252, Type S
Joints: Bell-and-spigot
Gasket: Rubber, meeting ASTM F477




## SCOPE

This specification describes 4" - 10" (100 - 250 mm) Hancor Sure-Lok WT pipe for use in non-pressure drainage applications.

## PIPE REQUIREMENTS

Sure-Lok WT pipe shall have a smooth interior and annular exterior corrugations.

- 4" - 10" (100 - 250 mm) shall meet AASHTO M252, Type S.
- Manning's "n" value for use in design shall be 0.010 to 0.012.

USE n = 0.011

## JOINT PERFORMANCE

Pipe shall be joined with the Sure-Lok joint meeting the requirements of AASHTO M252. The joint shall be watertight according to the laboratory requirements of ASTM D3212. Joints shall remain watertight when subjected to a 1.5 degree axial misalignment.

Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477 with the addition that the gaskets shall not have any visible cracking when tested according to ASTM D1149 after 72 hour exposure in 50 PPHM ozone at 104° F (40° C).

Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

## FITTINGS

4" - 10" (100 - 250 mm) fittings shall conform to AASHTO M252.

## MATERIAL PROPERTIES

Virgin material for pipe and fitting production shall be high density polyethylene meeting ASTM D3350 minimum cell classification 324420C for 4" - 10" (100 - 250 mm) diameters.

## INSTALLATION

Installation shall be in accordance with ASTM D2321 and Hancor's published installation guidelines; with the exception that minimum cover in trafficked areas shall be one-foot (0.3 m). Contact your local Hancor representative or visit our website at www.hancor.com for a copy of the latest installation guidelines.

## PIPE DIMENSIONS

| Nominal Pipe I.D., in. (mm) | 4 (100) | 6 (150) | 8 (200) | 10* (250) |
|---|---|---|---|---|
| Approx. Pipe O.D., in. (mm) | 4.7 (119) | 6.9 (175) | 9.4 (239) | 11.9 (303) |
| Approx. Pitch in. (mm) | 0.6 (16) | 0.7 (19) | 1.0 (26) | 13.1 (333) |
| Approx. Weight lb/ft. (kg/m) | 0.33 (0.49) | 1.0 (1.5) | 1.5 (2.2) | 3.0 (4.47) |

*Check with sales representative for availability.

OFFICIAL PARTNER
DUCKS UNLIMITED

Hancor is an Official Partner of Ducks Unlimited, the world's leading wetland conservation organization.

All sales of Hancor product are subject to a limited warranty and purchasers are solely responsible for installation and use of Hancor products and determining whether a product is suited for any specific needs. Please consult a full copy of Hancor's Terms and Conditions for Sale for further details.

## Direct Contact

**Customer Service**
888-FOR PIPE (367-7473)
Fax 888-FAX PIPE (329-7473) 24 hours a day

**Application Engineering**
For technical questions, call
800-2HANCOR (242-6267), ext. 809

## Electronic Media

**Web Site**
For further details on product specifications, visit the Design Aids section of our On-Line Pipeline:
www.hancor.com



Hancor 401 Olive St., Findlay, OH 45840

## Project Specific Design Criteria

The following design items are specific to the project site:

1. Subdivide the individual drainage basins based on the following runoff categories:
   - Equipment/Roofs
   - Asphalt/Concrete Pavement
   - Gravel Surfacing (dense-graded aggregates)
   - Landscape/Grass
   - Transformer Containment
   - Open Graded Aggregates (ACC Area)

2. Use the following runoff coefficients (C) for the Rational Method (Ref. 5 and Ref. 8):
   - Equipment/Roofs = 1.00
   - Asphalt/Concrete Pavement = 1.00
   - Gravel Surfacing = 0.60
   - Landscape/Grass, Type A Soil = 0.10 (See Ref. 8 for Soil Classification)
   - Transformer Containment = 0.00
   - Open Graded Aggregates = 0.10

3. Use the rainfall intensity curves for Sacramento, California (Ref. 3) to determine the intensity for the project site as this project site is close to and has similar climate conditions as Sacramento, California.

## Attachments

1. Black & Veatch Drawings SS-1002, SS-3001, SS-3201 and SS-3050
2. Reference 3 – Select Pages
3. Reference 4 – Select Pages
4. Reference 5 – Select Pages
5. Reference 6 – Select Pages

## Summary

The 12" diameter storm sewer pipes were verified to have sufficient capacity to carry the peak runoff for a 10-year storm event. The 18" diameter storm sewer pipes at the end of the bioswales which discharge directly to the wetland (these pipes have the maximum flow rates among 18" diameter pipes) were verified to have sufficient capacity to carry the peak runoff for a 50-year storm event.

## General

The design storm sewer pipes for this project generally consist of two sizes - 12" diameter and 18" diameter. All the sewer pipes will be installed at approximately 0.5% slope. The 12" diameter sewer pipes will drain to bioswales constructed near the perimeter of the plant. Two bioswale routes will be constructed to convey stormwater runoff to the wetland, one route along the north boundary of the plant site and the other one along the south boundary. See Drawing SS-3001 (Attachment 1). The bioswales will collect and infiltrate stormwater on site. Drop structures will be installed at the end of each bioswale such that sufficient depth (volume) of stormwater has to be collected in the bioswales before downstream discharge can happen.

18" diameter storm sewer pipes will be installed at the most downstream of bioswales along with drop structures to discharge any overflow to the wetland. The wetland is located on the west side of the conservation easement. 18" diameter pipes acting as culverts will be used to connect adjacent bioswales. See Drawing SS-3001 (Attachment 1).

## Pipe Sizing - 12" Diameter

By examining individual drainage basins and their ground cover conditions, the storm sewer pipes C-5, C-6 and C-11 are considered to have the maximum flow rates among 12" diameter sewer pipes. The drainage areas for these three sewer pipes are delineated as shown on Page 10. These three areas will be utilized to verify that the 12" diameter storm sewer pipes have sufficient capacity to carry the peak flow.

Slope of Pipes C-5 and C-6: From SS-3050 (Attachment 1), the inlet invert EL is at 13.1; the outlet invert EL is at 12.9. The pipe is measured to be 52 feet long. Thus the slope = (13.1-12.9)/52 = 0.4%.

Slope of Pipe C-11: From SS-3050 (Attachment 1), the inlet invert EL is at 13.4; the outlet invert EL is at 12.6. The pipe is measured to be 185 feet long. Thus the slope = (13.4-12.6)/185 = 0.4%.

Use 0.4% as the slope of the pipes in the calculations.

**(1) Travel Time**

The minimum time of concentration ($T_c$) used in TR-55 is 0.1 hour.

The drainage areas for storm sewer pipes C-5, C-6 and C-11 predominantly consist of equipment, asphalt pavement and aggregate surfacing. These areas are relatively small in size. It is expected that the time of concentration for these areas are very low. Use the minimum time of concentration $T_c$ = 0.1 hr (6 minutes) for all these drainage areas.

**(2) Rainfall Intensity**

Based on the "Rainfall Intensity – Duration – Frequency" curve for Sacramento, California, the rainfall intensity for a 10-year storm event for 6-minute duration is:

I = 2.9 inch/hr. (see Ref. 3)

**(3) Maximum Allowable Flow Rate**

The maximum allowable flow rate for a 12" diameter pipe with a 0.4% slope was determined using the FlowMaster 2005 computer program. From the computer output shown on Page 11, the results are as follows:

Maximum allowable flow rate = 2.66 cfs. (full pipe flow)

Flow velocity = 3.39 ft/s, between 2 ft/s and 8 ft/s, OK.

The peak runoff rate by Rational Method is: Q = C x I x A, where: I in inch/hr, A in acres, and Q in cfs.

For I = 2.9 inch/hr and maximum Q = 2.66 cfs, the maximum (C x A) is calculated to be:

$$(C \times A)_{\max imum} = 2.66 / 2.9 = 0.92 \text{ acres.}$$

The $C \times A$ values were calculated for each drainage basin for the storm sewer pipes C-5, C-6 and C-11. See below. All the areas were measured by using AutoCAD.

**Drainage Basin for C-5**

| | Area, A ($ft^2$) | Runoff Coefficient, C | C X A ($ft^2$) |
|---|---|---|---|
| Equipment/Roofs | 14,071 | 1.0 | 14,071 |
| Asphalt Pavement | 6,678 | 1.0 | 6,678 |
| Gravel Surfacing | 22,232 | 0.6 | 13,339 |
| Transformer Containment | 1,142 | 0.0 | 0 |
| Total | -- | -- | 34,088 |

$$\sum(C \times A) = 34{,}088 \text{ ft}^2 = 0.783 \text{ acres} < (C \times A)_{\max imum} = 0.92 \text{ acres, OK.}$$

**Drainage Basin for C-6**

| | Area, A ($ft^2$) | Runoff Coefficient, C | C X A ($ft^2$) |
|---|---|---|---|
| Equipment/Roofs | 6,800 | 1.0 | 6,800 |
| Asphalt Pavement | 2,290 | 1.0 | 2,290 |
| Gravel Surfacing | 18,317 | 0.6 | 10,990 |
| Transformer Containment | 2,943 | 0.0 | 0 |
| Total | -- | -- | 20,080 |

$$\sum(C \times A) = 20{,}080 \text{ ft}^2 = 0.461 \text{ acres} < (C \times A)_{\max imum} = 0.92 \text{ acres, OK.}$$

**Drainage Basin for C-11**

| | Area, A ($ft^2$) | Runoff Coefficient, C | C X A ($ft^2$) |
|---|---|---|---|
| Equipment/Roofs | 5,862 | 1.0 | 5,862 |
| Asphalt Pavement | 4,138 | 1.0 | 4,138 |
| Gravel Surfacing | 19,291 | 0.6 | 11,575 |
| Transformer Containment | 1,874 | 0.0 | 0 |
| Total | -- | -- | 21,575 |

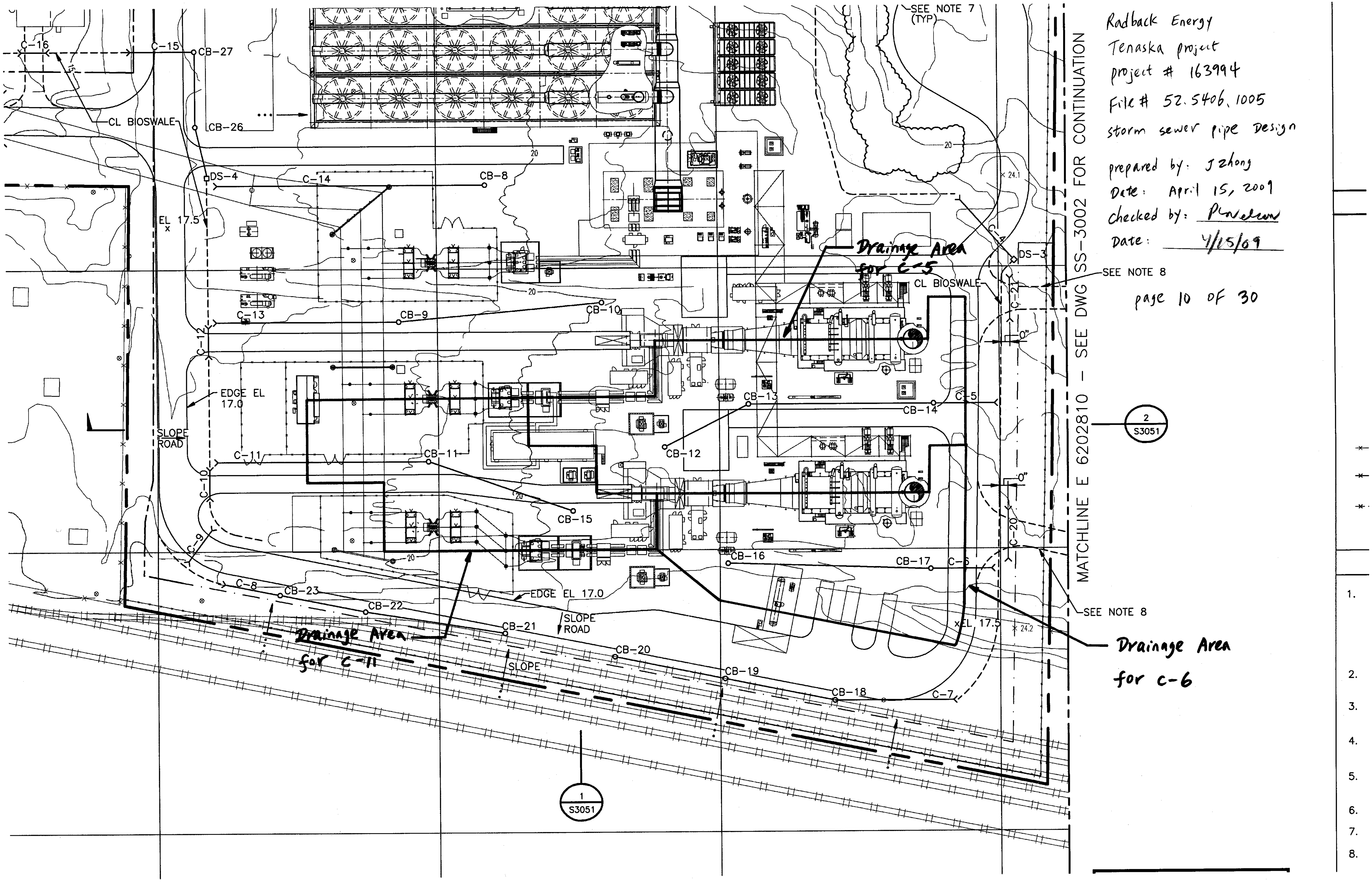
$$\sum(C \times A) = 21{,}575 \text{ ft}^2 = 0.495 \text{ acres} < (C \times A)_{\max imum} = 0.92 \text{ acres, OK.}$$

**Conclusion:** The 12" diameter storm sewer pipes have sufficient capacity to carry the flows.

Radback Energy
Tenaska project
project # 163994
File # 52.5406.1005
storm sewer pipe Design

prepared by: J Zhong
Date: April 15, 2009
Checked by: [signature]
Date: 4/15/09





Radback Tenaska project
project # 163994
File # 52.5406.1005



# Worksheet for Circular Pipe - 1

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Full Flow Capacity |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.011 | |
| Channel Slope | 0.00400 | ft/ft |
| Normal Depth | 1.00 | ft |
| Diameter | 1.00 | ft |
| Discharge | 2.66 | ft³/s |

## Results

| | | |
|---|---|---|
| Discharge | 2.66 | ft³/s |
| Normal Depth | 1.00 | ft |
| Flow Area | 0.79 | ft² |
| Wetted Perimeter | 3.14 | ft |
| Top Width | 0.00 | ft |
| Critical Depth | 0.70 | ft |
| Percent Full | 100.0 | % |
| Critical Slope | 0.00572 | ft/ft |
| Velocity | 3.39 | ft/s |
| Velocity Head | 0.18 | ft |
| Specific Energy | 1.18 | ft |
| Froude Number | 0.00 | |
| Maximum Discharge | 2.86 | ft³/s |
| Discharge Full | 2.66 | ft³/s |
| Slope Full | 0.00400 | ft/ft |
| Flow Type | SubCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 100.00 | % |

## Pipe Sizing - 18" Diameter

18" diameter storm sewer pipes (C-1 and C-19) will be installed at the most downstream of bioswales along with drop structures to discharge any overflow to the wetland. There are two bioswale routes to convey stormwater runoff to the wetland. The first route is along the north boundary of the plant site while the second route is along the south boundary. The drainage areas for the first route and second route are delineated as shown on Page 15.

Slope of Pipe C-1: From SS-3050 (Attachment 1), the inlet invert EL is at 8.2; the outlet invert EL is at 8.0. The pipe is measured to be 38 feet long. Thus the slope = (8.2-8.0)/38 = 0.5%.

Slope of Pipe C-19: From SS-3050 (Attachment 1), the inlet invert EL is at 8.7; the outlet invert EL is at 8.4. The pipe is measured to be 45 feet long. Thus the slope = (8.7-8.4)/45 = 0.7%.

Use 0.5% as the slope of the pipes in the calculations to be conservative.

**(1) Travel Time**

Per calculation "Stormwater Analysis for Wetland" for the same project (Ref. 7), the time of concentration for this project site is 0.93 hour (56 minutes) for pre-development condition. For post-development condition, IMPs (bioswales) will be installed to retain and infiltrate stormwater on site. The Stormwater C.3 Guidebook (Ref. 5) indicates that post-project runoff does not exceed pre-project runoff rates or durations if the IMPs are sized based on the C.3 Guidebook. Based on this, it is estimated that the post-development time of concentration will not exceed the pre-development time of concentration. Therefore, use the time of concentration $T_c$ = 56 minutes for both bioswale routes.

**(2) Rainfall Intensity**

Based on the "Rainfall Intensity – Duration – Frequency" curve for Sacramento, California, the rainfall intensity for a 50-year storm event for 56-minute duration is:

I = 1.2 inch/hr. (see Ref. 3)

**(3) Maximum Allowable Flow Rate**

The maximum allowable flow rate for an 18" diameter pipe with a 0.5% slope was determined using the FlowMaster 2005 computer program. From the computer output on Page 16, the results are as follows:

Maximum allowable flow rate = 8.78 cfs. (full pipe flow)
Flow velocity = 4.97 ft/s, between 2 ft/s and 8 ft/s, OK.

The peak runoff rate by Rational Method is: Q = C x I x A, where: I in inch/hr, A in acres, and Q in cfs.

For I = 1.2 inch/hr and maximum Q = 8.78 cfs, the maximum (C x A) is calculated to be:
$(C \times A)_{\max imum}$ = 8.78 / 1.2 = 7.32 acres.

The $C \times A$ values were calculated for each drainage area of the two bioswale routes. See below. All the areas were measured by using AutoCAD.

**Drainage Area for North Bioswale Route**

| | Area, A ($ft^2$) | Runoff Coefficient, C | C X A ($ft^2$) |
|---|---|---|---|
| Equipment/Roofs | 61,323 | 1.0 | 61,323 |
| Asphalt Pavement | 67,199 | 1.0 | 67,199 |
| Gravel Surfacing | 100,200 | 0.6 | 60,120 |
| Open Graded Aggregates (ACC Area) | 68,200 | 0.1 | 6,820 |
| Landscape, Group A Soil | 230,466 | 0.1 | 23,047 |
| Transformer Containment | 4,491 | 0.0 | 0 |
| Total | -- | -- | 218,509 |

$\sum(C \times A)$ = 218,509 $ft^2$ = 5.02 acres < $(C \times A)_{\max imum}$ = 7.32 acres, OK.

**Drainage Area for South Bioswale Route**

| | Area, A ($ft^2$) | Runoff Coefficient, C | C X A ($ft^2$) |
|---|---|---|---|
| Equipment/Roofs | 35,298 | 1.0 | 35,298 |
| Asphalt Pavement | 59,167 | 1.0 | 59,167 |
| Gravel Surfacing | 295,933 | 0.6 | 177,560 |

| | Area, A ($ft^2$) | Runoff Coefficient, C | C X A ($ft^2$) |
|---|---|---|---|
| Landscape, Group A Soil | 113,387 | 0.1 | 11,339 |
| Transformer Containment | 5,479 | 0.0 | 0 |
| Total | -- | -- | 283,364 |

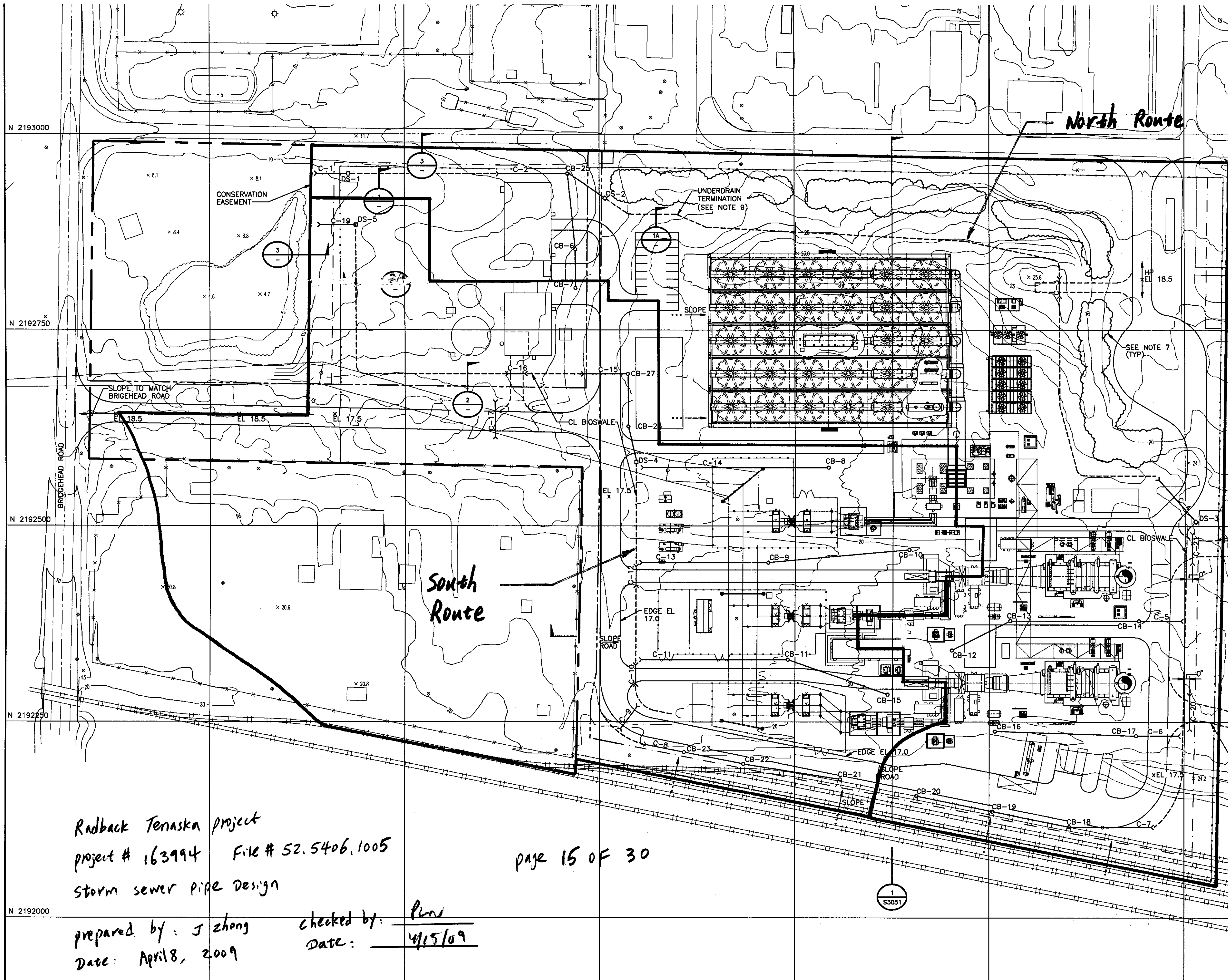
$$\sum(C \times A) = 283{,}364 \text{ ft}^2 = 6.51 \text{ acres} < (C \times A)_{maximum} = 7.32 \text{ acres, OK.}$$

The combined peak flow rate of pipes C-1 and C-19 is:

$$\sum(C \times A) \text{x I} = (5.02 + 6.51) \text{ x } 1.2 = 13.8 \text{ cfs.}$$

The peak flow rate from Ref. 7 was estimated at 9.0 cfs. Rational Method used in this calculation is known to over-estimate flow rate, especially for ~~large~~ larger areas (normal limit is 20 acres).

**Conclusion:** The 18" diameter storm sewer pipes have sufficient capacity to carry the flows.




Radback Tenaska project
project # 163994 File # 52.5406.1005
storm sewer pipe Design
page 15 of 30
prepared by: J zhong
Date: April 8, 2009
checked by: [illegible]
Date: 4/15/09

## ABBREVIATION

| | | |
|---|---|---|
| APPROX | – | APPR |
| ASPH | – | ASPH |
| AVG | – | AVER |
| BND | – | BEND |
| BLDG | – | BUILD |
| B/MH | – | BOTTC |
| BOC | – | BOTTC |
| BOD | – | BOTTC |
| BOP | – | BOTTC |
| BU | – | BELL- |
| C | – | CULVI |
| CB | – | CATCH |
| CD | – | CABLE |
| CHDPE | – | CORR DENSI |
| CL | – | CENTI |
| CLR | – | CLEAF |
| CMH | – | CHEM |
| CND | – | COND |
| CONC | – | CONC |
| CO | – | CLEAN |
| CS | – | CARB |
| CW | – | CIRCU |
| DB | – | DUCTI |
| DBC | – | DIREC |
| DET | – | DETAIL |
| DIA | – | DIAME |
| DIP | – | DUCTI |
| DWG | – | DRAW |
| DWP | – | DOUB |
| EC | – | ELECT |
| ECC | – | ECCE |
| EF | – | EACH |
| EHH | – | ELECT |
| EL | – | ELEVA |
| EMH | – | ELECT |
| EW | – | EACH |
| FC | – | FIELD |
| FDN | – | FOUN |
| FF | – | FLAT |
| FRP | – | FIBER |
| GR | – | GRADI |
| HDM | – | HOT I |
| HDPE | – | HIGH |
| HP | – | HIGH |
| HYD | – | HYDRA |
| ID | – | INSIDE |
| INV | – | INVER |
| JBX | – | JUNC |
| L | – | LENGT |
| LP | – | LOW I |

## LEGI

1 S3000

326.5

BM-1

TR-1

## NOTES A

1. COORDINATES ARE BASI NGVD 29 DATUM. BENC THE FLAGPOLE AT THE DATUM ELEVATION, ADD PHOTOGRAPH DATED JU ASSOCIATES, INC.
2. NEW GRADE ELEVATIONS INDICATE FINISH GRADE
3. ALL CUT AND FILL SLOI NOTED OTHERWISE.
4. SEE DWG SS-3050 FOI STRUCTURE CHARTS.
5. TOP OF CONCRETE ELE EL 18.0. FINISH GRADE
6. CL OF ALL PAVED ROAI
7. TREES TO REMAIN. GRA
8. TEMPORARY ROAD FROI CONSTRUCTION.
9. UNDERDRAIN CONTINUOI EASEMENT. UTILIZE UNP

Radback Tenaska project
project # 163994
File # 52.5406.1005



# Worksheet for Circular Pipe - 1

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Full Flow Capacity |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.011 | |
| Channel Slope | 0.00500 | ft/ft |
| Normal Depth | 1.50 | ft |
| Diameter | 1.50 | ft |
| Discharge | 8.78 | ft³/s |

## Results

| | | |
|---|---|---|
| Discharge | 8.78 | ft³/s |
| Normal Depth | 1.50 | ft |
| Flow Area | 1.77 | ft² |
| Wetted Perimeter | 4.71 | ft |
| Top Width | 0.00 | ft |
| Critical Depth | 1.15 | ft |
| Percent Full | 100.0 | % |
| Critical Slope | 0.00575 | ft/ft |
| Velocity | 4.97 | ft/s |
| Velocity Head | 0.38 | ft |
| Specific Energy | 1.88 | ft |
| Froude Number | 0.00 | |
| Maximum Discharge | 9.44 | ft³/s |
| Discharge Full | 8.78 | ft³/s |
| Slope Full | 0.00500 | ft/ft |
| Flow Type | SubCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

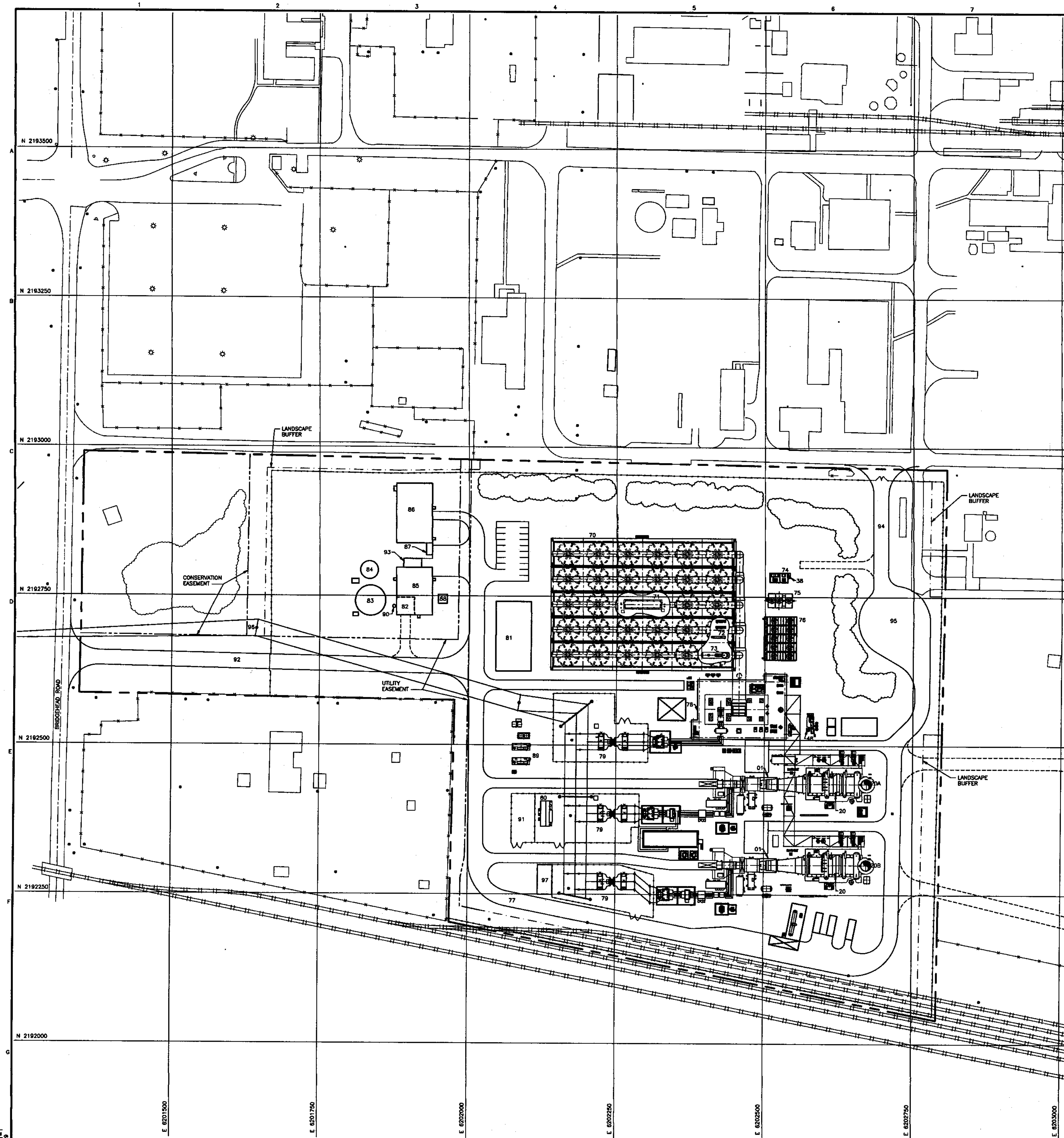
## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 100.00 | % |

# Attachment 1

**Black & Veatch Dwgs SS-1002, SS-3001, SS-3201 and SS-3050**

DWG40999 08-APR-2009 10:05:34




## FACILITIES LEGEND

| ID | FACILITY | STRUCTURE HEIGHT | TIEDOWN LOCATION NORTH | TIEDOWN LOCATION EAST | REMARKS |
|---|---|---|---|---|---|
| 01 | COMBUSTION TURBINE | 70' | – | – | – |
| 20 | HEAT RECOVERY STEAM GENERATOR (HRSG) | 103' | – | – | – |
| 20A | HRSG EXHAUST STACK A | 155' | 2192436.00 | 6202665.00 | CL EXHAUST STACK |
| 20B | HRSG EXHAUST STACK B | 155' | 2192300.00 | 6202665.00 | CL EXHAUST STACK |
| 38 | SAFETY SHOWER EYEWASH STATION | – | – | – | – |
| 48 | AUXILIARY BOILER | 50' | 2192527.61 | 6202572.26 | CL EXHAUST STACK |
| 70 | AIR COOLED CONDENSER (ACC) | 124' | – | – | – |
| 71 | ACC ELECTRICAL ENCLOSURE | 14' | – | – | – |
| 72 | CONDENSER AIR EXTRACTION SKIDS | 6' | – | – | – |
| 73 | ACC CONDENSATE COLLECTION TANK | 28' | – | – | – |
| 74 | WET SURFACE AIR COOLER CHEMICAL FEED SKIDS | 8' | – | – | – |
| 75 | WET SURFACE AIR COOLER | 23' | 2192744.67 | 6202523.00 | CL COOLER |
| 76 | CLOSED CYCLE COOLING WATER HEAT EXCHANGER | 19' | – | – | – |
| 77 | LOOP ROAD | – | – | – | – |
| 78 | STEAM TURBINE FOUNDATION | – | – | – | – |
| 79 | SWITCHYARD | 18' & 45' | – | – | – |
| 80 | SWITCHYARD CONTROL ENCLOSURE | 12' | – | – | – |
| 81 | CONTROL & ADMIN BUILDING | 14' | – | – | – |
| 82 | FIRE WATER PUMP ROOM | 20' | – | – | – |
| 83 | FIRE/SERVICE WATER STORAGE TANK | 32' | – | – | – |
| 84 | DEMIN WATER STORAGE TANK | 24' | – | – | – |
| 85 | WATER TREATMENT BUILDING | 20' | – | – | – |
| 86 | WAREHOUSE/MAINTENANCE BUILDING | 16' | – | – | – |
| 87 | LUBRICANT STORAGE SHED | 10' | – | – | – |
| 88 | WASTE WATER LIFT STATION (IF REQUIRED) | – | – | – | – |
| 89 | GAS COMPRESSORS & GAS CONDITIONING | 13' | – | – | – |
| 90 | DIESEL FIRE PUMP EXHAUST | 16' | 2192732.52 | 6201874.72 | CL EXHAUST STACK |
| 91 | GAS METERING STATION | – | – | – | – |
| 92 | ACCESS ROAD | – | – | – | – |
| 93 | LEASED MIX BED EXCHANGER CONCRETE SLAB | – | – | – | – |
| 94 | EMERGENCY ACCESS ROAD | – | – | – | – |
| 95 | CUL DA SAC (TURNAROUND) | – | – | – | – |
| 96 | 230KV POWER POLE | 106' | – | – | – |
| 97 | OUTAGE MAINTENANCE TRAILERS AREA | – | – | – | – |

## NOTES

1. COORDINATES ARE BASED ON CALIFORNIA COORDINATE SYSTEM CCS83, ZONE 3. ELEVATION ARE BASED ON, NGVD 29 DATUM. BENCHMARK IS NATIONAL GEODETIC SURVEY BENCH MARK "W 563", LOCATED ADJACENT TO THE FLAGPOLE AT THE DUPONT PLANT ENTRANCE, ELEVATION = 11.168 FEET. TO OBTAIN DUPONT PLANT DATUM ELEVATION, ADD 0.70 FEET TO THE ELEVATIONS SHOWN. TOPOGRAPHIC DATA IS BASED ON AERIAL PHOTOGRAPH DATED JUNE 11, 2001. AERIAL SURVEY INFORMATION WAS OBTAINED BY RONALD GREENWELL & ASSOCIATES, INC.
2. SEE PLANT ARRANGEMENT DRAWING SM-2001, FOR LEGEND OF MAIN POWER BLOCK.
3. PROPERTY AND EASEMENT BOUNDARY INFORMATION IS BASED UPON DRAWING EXHIBIT D, BY RONALD GREENWELL & ASSOCIATES, INC. REVISION DATED 05/FEB/09.

## GENERAL LEGEND

NEW FENCE

EXISTING FENCE

PROPERTY BOUNDRY (SEE NOTE 3)

EASEMENT BOUNDARY (SEE NOTE 3)

LANDSCAPE BUFFER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FILE FORMAT OF THIS DRAWING OUTSIDE OF BLACK & VEATCH IS UNCONTROLLED AND SHALL BE USED FOR REFERENCE PURPOSES ONLY.

| NO | DATE | REVISIONS AND RECORD OF ISSUE | DRN | DES | CHK | PDE | APP |
|---|---|---|---|---|---|---|---|
| 1 | 30/MAR/09 | ISSUED PER ECN-N-S-0001 | NAW | PLN | | PLN | DVW |
| 0 | 13/MAR/09 | ISSUED FOR PERMITTING | NAW | PLN | | PLN | DVW |

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 PLN DRAWN NAW

CHECKED DATE

CONTRA COSTA GENERATING STATION LLC

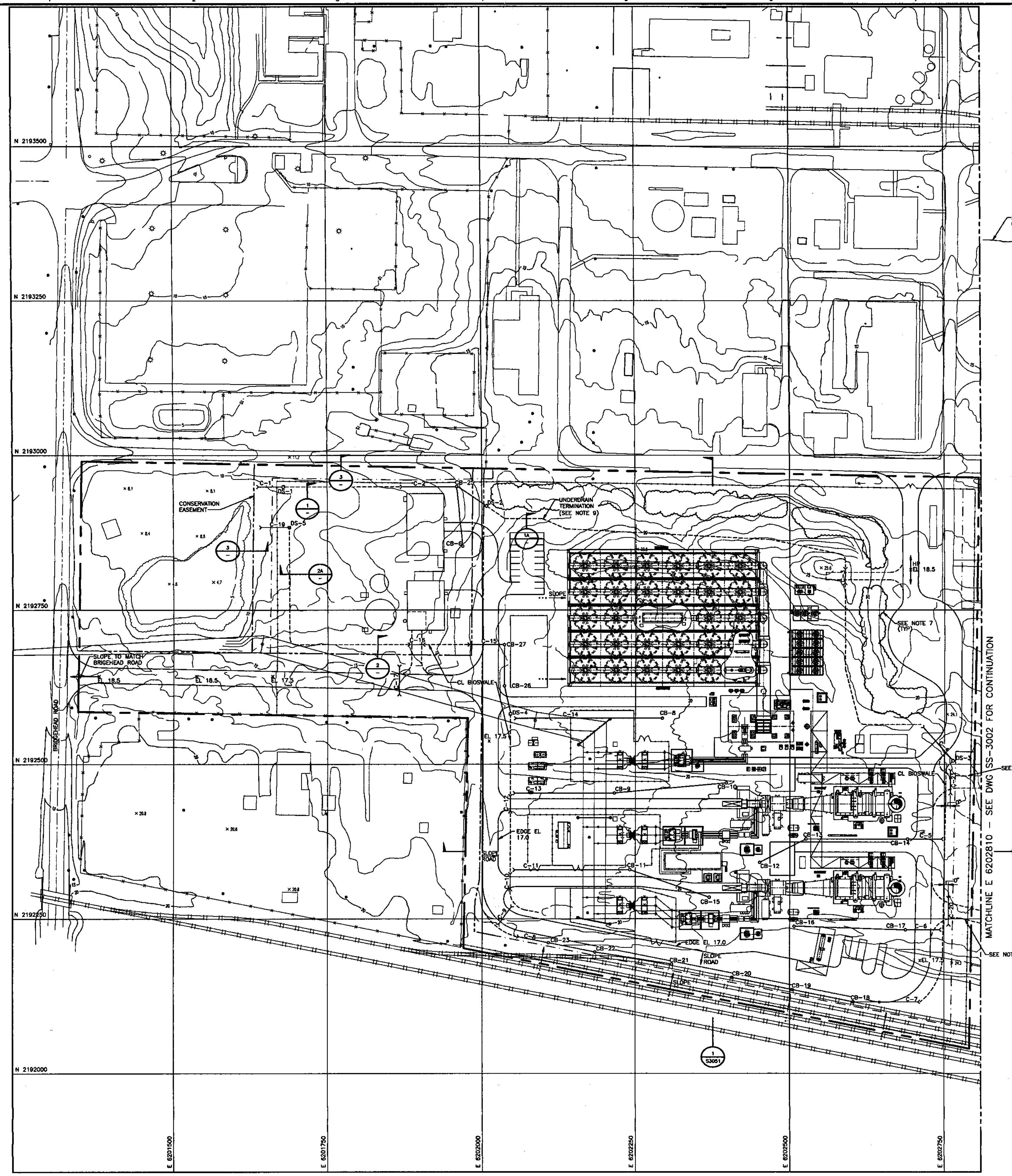
CONTRA COSTA COMBINED CYCLE FACILITY

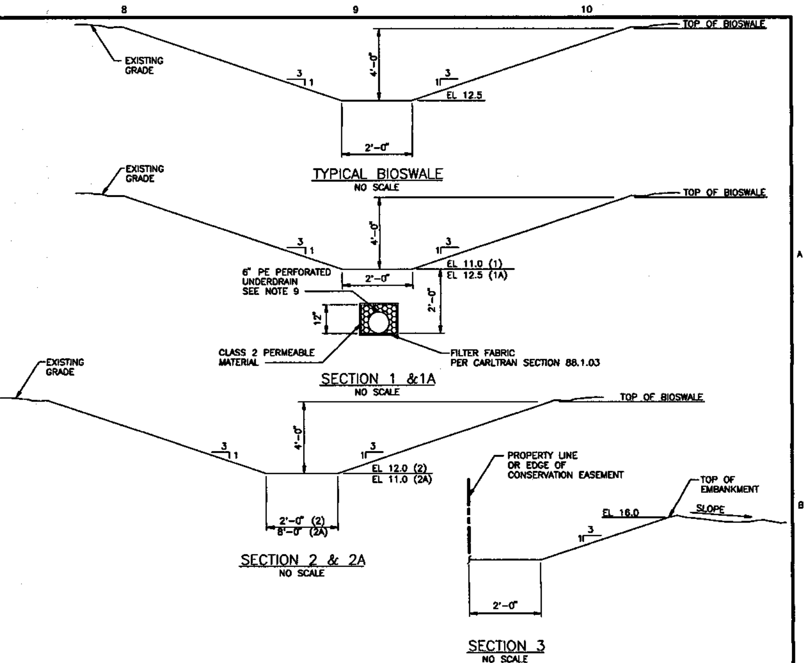
GENERAL ARRANGEMENT SITE

PROJECT DRAWING NUMBER 163994-SS-1002 REV 1

CODE

AREA




## ABBREVIATIONS APPLICABLE TO ALL SS-3000 SERIES DRAWINGS

| | | | |
|---|---|---|---|
| APPROX | APPROXIMATE | LTR | LATER |
| ASPH | ASPHALT | MAX | MAXIMUM |
| AVG | AVERAGE | MH | MANHOLE |
| BND | BEND | MIN | MINIMUM |
| BLDG | BUILDING | MJ | MECHANICAL JOINT |
| B/MH | BOTTOM OF MANHOLE ELEVATION | MSL | MEAN SEA LEVEL |
| BOC | BOTTOM OF CONDUIT ELEVATION | NO. | NUMBER |
| BOD | BOTTOM OF DUCTBANK ELEVATION | NTS | NOT TO SCALE |
| BOP | BOTTOM OF PIPE ELEVATION | OD | OUTSIDE DIAMETER |
| BU | BELL-UP | OWS | OIL WATER SEPARATOR |
| C | CULVERT | OWMH | OILYWASTE MANHOLE |
| CB | CATCH BASIN | PC | POINT OF CURVATURE |
| CD | CABLE DUCT | PE | PLAIN END |
| CHDPE | CORRUGATED HIGH DENSITY POLYETHYLENE PIPE | PI | POINT OF INTERSECTION |
| CL | CENTERLINE | PLCS | PLACES |
| CLR | CLEAR | PM | PLANT MANHOLE |
| CMH | CHEMICAL MANHOLE | POT | POINT OF TANGENT |
| CND | CONDUIT | PT | PIPE TERMINATION |
| CONC | CONCRETE | PVC | POLYVINYL CHLORIDE PIPE |
| CO | CLEAN OUT | QTY | QUANITY |
| CS | CARBON STEEL | R | RADIUS |
| CW | CIRCULATING WATER | RCP | REINFORCED CONCRETE PIPE |
| DB | DUCTBANK | RD | ROOF DRAIN |
| DBC | DIRECT BURIED CABLE | REV | REVISION |
| DET | DETAIL | RGS | RIGID GALVANIZED STEEL |
| DIA | DIAMETER | RR | RAILROAD |
| DIP | DUCTILE IRON PIPE | SECT | SECTION |
| DWG | DRAWING | SIM | SIMILAR |
| DWP | DOUBLE WALL PIPE | SLS | SANITARY LIFT STATION |
| EC | ELECTRICAL CONDUIT | SMH | SANITARY MANHOLE |
| ECC | ECCENTRIC | STMH | STORM MANHOLE |
| EF | EACH FACE | STRL | STRUCTURAL |
| EHH | ELECTRICAL HANDHOLE | T/C | TOP OF CONCRETE ELEVATION |
| EL | ELEVATION | T/G | TOP OF GRADE ELEVATION |
| EMH | ELECTRICAL MANHOLE | THH | TELEPHONE SERVICE HANDHOLE |
| EW | EACH WAY | T/MH | TOP OF MANHOLE ELEVATION |
| FC | FIELD CHECK | T/P | TOP OF PAVEMENT ELEVATION |
| FDN | FOUNDATION | TP | MECH PIPE TERMINAL POINT |
| FF | FLAT FACE | TYP | TYPICAL |
| FRP | FIBERGLASS REINFORCED PIPE | UGL | UNDERGROUND LIGHTING CONDUIT |
| GR | GRADE | UNO | UNLESS NOTED OTHERWISE |
| HDM | HOT DRAIN MANHOLE | VERT | VERTICAL |
| HDPE | HIGH DENSITY POLYETHYLENE PIPE | WGT | WEIGHT |
| HP | HIGH POINT | WTR | WATER |
| HYD | HYDRANT | W/ | WITH |
| ID | INSIDE DIAMETER | W/O | WITHOUT |
| INV | INVERT | WP | WORK POINT |
| JBX | JUNCTION BOX | XFMR | TRANSFORMER |
| L | LENGTH | | |
| LP | LOW POINT | | |

## LEGEND APPLICABLE TO ALL S3000 DRAWINGS

| | |
|---|---|
| NEW CULVERT | NEW SLIDE GATE |
| CL BIOSWALE | NEW SWING GATE |
| SECTION OR DETAIL NUMBER / DRAWING DESIGNATION NUMBER (1 / S3000) | EXISTING POWER POLE |
| FINISHED SPOT ELEVATIONS (326.5) | NEW CATCH BASIN (CB-101) |
| SURVEY MONUMENT/CONTROL POINT (BM-1) | NEW DROP STRUCTURE |
| EXISTING FENCE | PROPERTY LINE |
| NEW SECURITY FENCE | BOUNDARY LINE |
| TEMPORARY CONSTRUCTION FENCE | EXISTING CONTOURS (126) |
| EROSION CONTROL METHOD (TR-1) | GRADE TO DRAIN (DIRECTION OF ARROW) |

## NOTES APPLICABLE TO ALL SS-3000 SERIES DRAWINGS

1. COORDINATES ARE BASED ON CALIFORNIA COORDINATE SYSTEM CCS83, ZONE 3. ELEVATION ARE BASED ON, NGVD 29 DATUM. BENCHMARK IS NATIONAL GEODETIC SURVEY BENCH MARK "W 563", LOCATED ADJACENT TO THE FLAGPOLE AT THE DUPONT PLANT ENTRANCE, ELEVATION = 11.168 FEET. TO OBTAIN DUPONT PLANT DATUM ELEVATION, ADD 0.70 FEET TO THE ELEVATIONS SHOWN. TOPOGRAPHIC DATA IS BASED ON AERIAL PHOTOGRAPH DATED JUNE 11, 2001. AERIAL SURVEY INFORMATION WAS OBTAINED BY RONALD GREENWELL & ASSOCIATES, INC.
2. NEW GRADE ELEVATIONS SHOWN ON THE SITE GRADING AND DRAINAGE PLANS INDICATE FINISH GRADE UNLESS NOTED OTHERWISE.
3. ALL CUT AND FILL SLOPES SHALL BE 3 HORIZONTAL TO 1 VERTICAL OR FLATTER, UNLESS NOTED OTHERWISE.
4. SEE DWG SS-3050 FOR GRADING AND DRAINAGE DETAILS INCLUDING CULVERT, CATCH BASIN AND DROP STRUCTURE CHARTS.
5. TOP OF CONCRETE ELEVATIONS AND FINISH FLOOR ELEVATIONS FOR ALL EQUIPMENT AND BUILDINGS IS EL 18.0. FINISH GRADE ADJACENT TO ALL FOUNDATIONS IS EL 17.5.
6. CL OF ALL PAVED ROADS IS EL 17.5 UNO.
7. TREES TO REMAIN. GRADE TO REMAIN UNCHANGED WITHIN 20' OF TREE BASE.
8. TEMPORARY ROAD FROM LAYDOWN AREA. ROAD AND CULVERT UNDER ROAD TO BE REMOVED AT END OF CONSTRUCTION.
9. UNDERDRAIN CONTINUOUS UNDER BIOSWALE FROM UNDERDRAIN TERMINATION TO CONSERVATION EASEMENT. UTILIZE UNPERFORATED PIPE BETWEEN DS-2 TO C-2 OUTLET AND DS-1 TO C-1 OUTLET.

# NOT TO BE USED FOR CONSTRUCTION

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| 0 | 16/APR/09 | ISSUED FOR PERMITTING | NAW | PLN | | PLN | DVW |

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

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SIGNED ________

DATE ________ REG NO. ________

BLACK & VEATCH CORPORATION

ENGINEER PLN | DRAWN NAW | CHECKED | DATE

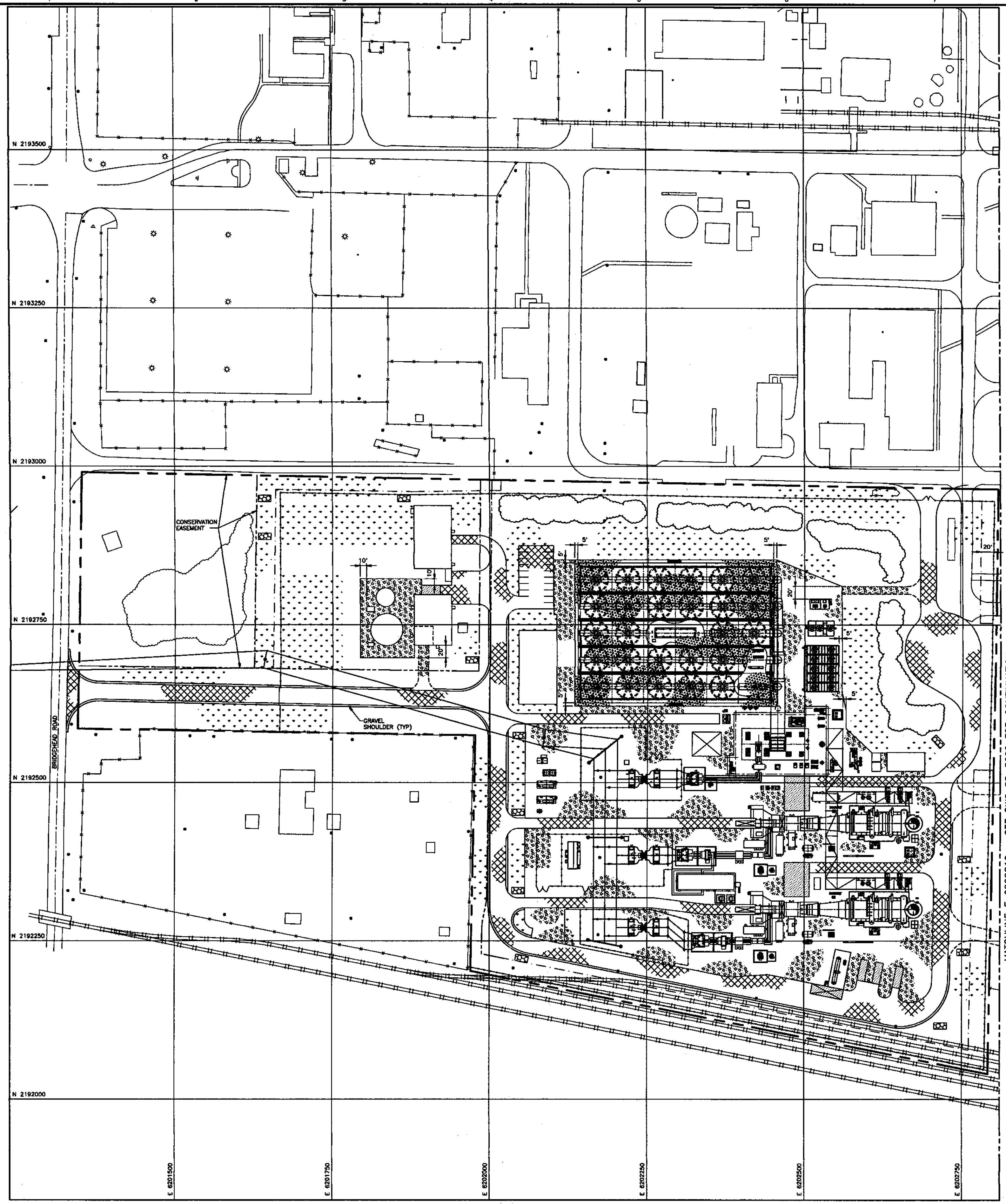
**CONTRA COSTA GENERATING STATION LLC**
CONTRA COSTA COMBINED CYCLE FACILITY

GRADING AND DRAINAGE – SITE PLAN – SHEET 1

PROJECT / DRAWING NUMBER: 163994–SS–3001 | REV: 0

CODE | AREA

DWG40999 08-APR-2009 10:05:50




## SITE SURFACING LEGEND

- ASPHALT SURFACING
- AGGREGATE SURFACING
- CONCRETE
- GRASS
- OPEN GRADED STONE SURFACING
- RIPRAP
- EXISTING FACILITY
- NEW FACILITY
- NATURAL SOIL

## NOTES

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.

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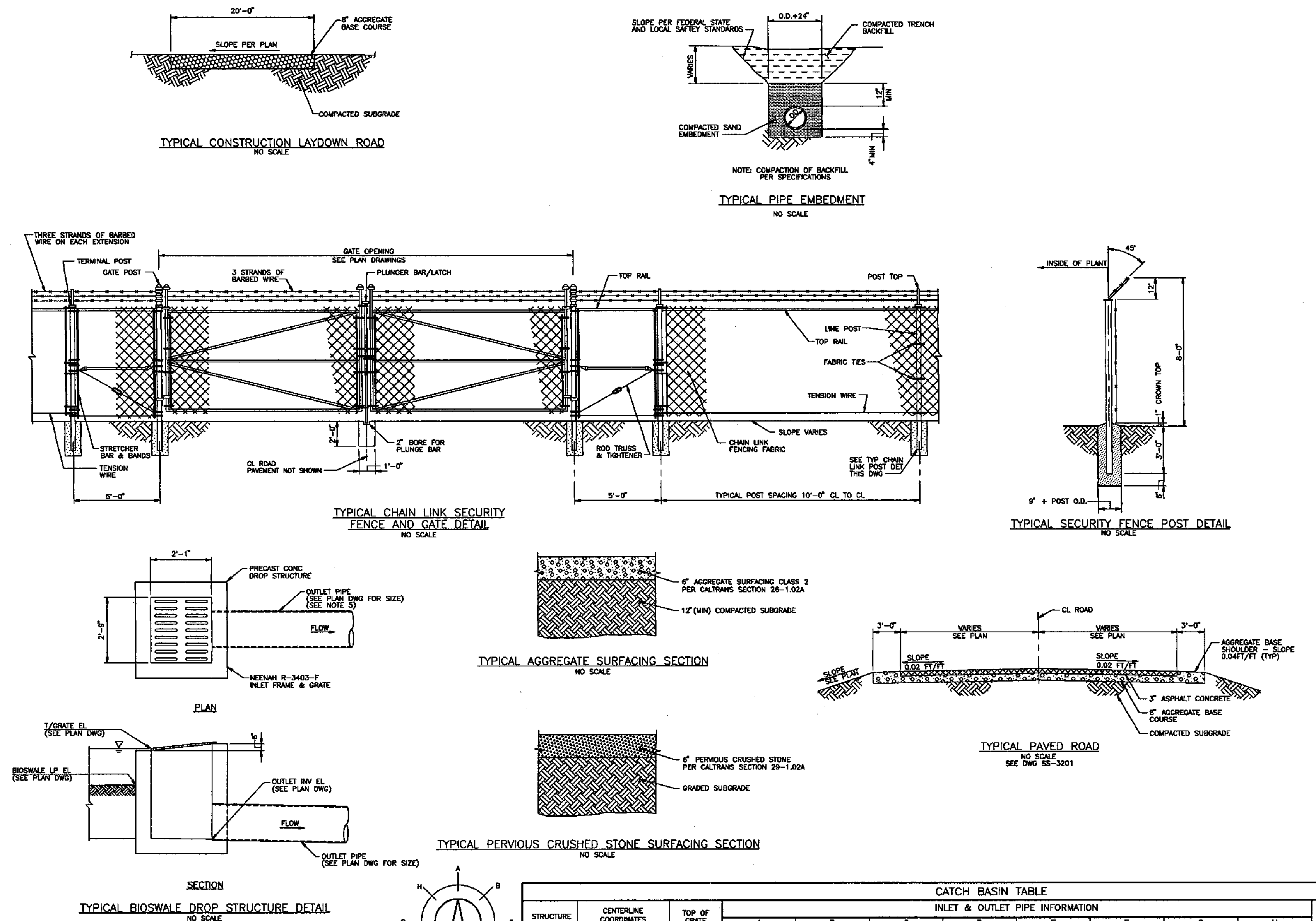
BLACK & VEATCH CORPORATION
ENGINEER PLN DRAWN NAW
CHECKED DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

SURFACING/FENCING/ROADWAY - SITE PLAN - SHEET 1

PROJECT / DRAWING NUMBER: 163994-SS-3201
REV: A
CODE
AREA

DWG40999 15-APR-2009 07:52:10




**CULVERT TABLE**

| CULVERT NO. | INLET INV ELEVATION | OUTLET INV ELEVATION | LENGTH | PIPE DIAMETER | PIPE MATERIAL | REMARKS |
|---|---|---|---|---|---|---|
| C-1 | 8.2 | 8.0 | – | 18" | – | |
| C-2 | 11.8 | 11.5 | – | 18" | – | |
| C-3 | 13.0 | 13.0 | – | 18" | – | |
| C-4 | 13.2 | 13.0 | – | 18" | – | |
| C-5 | 13.1 | 12.9 | – | 12" | – | |
| C-6 | 13.1 | 12.9 | – | 12" | – | |
| C-7 | 13.3 | 13.0 | – | 12" | – | |
| C-8 | 13.2 | 13.0 | – | 12" | – | |
| C-9 | 13.0 | 13.0 | – | 12" | – | |
| C-10 | 13.0 | 13.0 | – | 15" | – | |
| C-11 | 13.4 | 12.6 | – | 12" | – | |
| C-12 | 13.0 | 13.0 | – | 18" | – | |
| C-13 | 13.4 | 12.6 | – | 12" | – | |
| C-14 | 13.5 | 12.5 | – | 12" | – | |
| C-15 | 12.8 | 12.5 | – | 18" | – | |
| C-16 | 12.5 | 12.5 | – | 18" | – | |
| C-17 | 14.7 | 14.4 | – | 12" | – | |
| | | | | | | |
| C-19 | 8.7 | 8.4 | – | 18" | – | |
| C-20 | – | – | – | 18" | – | |
| C-21 | – | – | – | 18" | – | |

**CATCH BASIN TABLE**

| STRUCTURE NO. | CENTERLINE COORDINATES | | TOP OF GRATE ELEVATION | INLET & OUTLET PIPE INFORMATION | | | | | | | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | | B | | C | | D | | E | | F | | G | | H | | |
| | NORTH | EAST | | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | |
| CB-6 | – | – | 16.0 | – | – | 13.2 | 12" | – | – | – | – | 13.2 | 12" | – | – | – | – | – | – | |
| CB-7 | NOT USED | | | | | | | | | | | | | | | | | | | |
| CB-8 | – | – | 17.0 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 13.5 | 12" | |
| CB-9 | – | – | 17.0 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | 13.4 | 12" | – | – | |
| CB-10 | – | – | 17.0 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | – | – | – | – | |
| CB-11 | – | – | 17.0 | – | – | – | – | – | – | 13.4 | 12" | – | – | – | – | 13.4 | 12" | – | – | |
| CB-12 | – | – | 17.0 | – | – | 13.6 | 12" | – | – | – | – | – | – | – | – | – | – | – | – | |
| CB-13 | – | – | 17.0 | – | – | – | – | 13.4 | 12" | – | – | – | – | 13.4 | 12" | – | – | – | – | |
| CB-14 | – | – | 17.0 | – | – | – | – | 13.1 | 12" | – | – | – | – | – | – | 13.1 | 12" | – | – | |
| CB-15 | – | – | 17.0 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 13.6 | 12" | |
| CB-16 | – | – | 17.0 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | – | – | – | – | |
| CB-17 | – | – | 17.0 | – | – | – | – | 13.1 | 12" | – | – | – | – | – | – | 13.1 | 12" | – | – | |
| CB-18 | – | – | 16.5 | – | – | 13.2 | 12" | – | – | – | – | – | – | – | – | 13.2 | 12" | – | – | |
| CB-19 | – | – | 16.5 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | 13.4 | 12" | – | – | |
| CB-20 | – | – | 16.5 | – | – | – | – | 13.6 | 12" | – | – | – | – | – | – | – | – | – | – | |
| CB-21 | – | – | 16.5 | – | – | – | – | – | – | – | – | – | – | – | – | 13.6 | 12" | – | – | |
| CB-22 | – | – | 16.5 | – | – | – | – | 13.4 | 12" | – | – | – | – | – | – | 13.4 | 12" | – | – | |
| CB-23 | – | – | 16.5 | – | – | – | – | 13.2 | 12" | – | – | – | – | – | – | 13.2 | 12" | – | – | |
| CB-24 | NOT USED | | | | | | | | | | | | | | | | | | | |
| CB-25 | – | – | 15.0 | – | – | – | – | – | – | 11.8 | 18" | 12.3 | 12" | – | – | 11.8 | 18" | – | – | |
| CB-26 | – | – | 16.0 | 13.2 | 18" | – | – | – | – | – | – | 13.2 | 18" | – | – | – | – | – | – | |
| CB-27 | – | – | 16.5 | – | – | – | – | – | – | – | – | 12.8 | 18" | – | – | 12.8 | 18" | – | – | |

ALL DIMENSIONS ARE IN FEET, EXCEPT DIAMETER, WHICH IS IN INCHES
FOR PIPELINE MATERIAL SEE PIPELINE LIST

**DROP STRUCTURE (DS) TABLE**

| STRUCTURE NO. | CENTERLINE COORDINATES | | TOP OF GRATE ELEVATION | INLET & OUTLET PIPE INFORMATION | | | | | | | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | | B | | C | | D | | E | | F | | G | | H | | |
| | NORTH | EAST | | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | INV EL | DIA | |
| DS-1 | – | – | 13.0 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 12.1 | 18" | |
| DS-2 | – | – | 15.5 | – | – | – | – | – | – | – | – | – | – | – | – | 11.8 | 18" | – | – | |
| DS-3 | – | – | 15.5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 13.2 | 18" | |
| DS-4 | – | – | 15.5 | 13.5 | 18" | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| DS-5 | – | – | 14.5 | 8.7 | 18" | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | | | | | | | | | | | | | | | | | | | | |

ALL DIMENSIONS ARE IN FEET, EXCEPT DIAMETER, WHICH IS IN INCHES
FOR PIPELINE MATERIAL SEE PIPELINE LIST

**NOTES**

1. FILTER FABRIC SHALL BE UV-STABILIZED NONWOVEN GEOTEXTILE HAVING A MINIMUM WEIGHT OF 135 $g/M^2$ PER CALTRANS SS 88-1.03.
2. SEE DWG SS-3001 FOR GENERAL NOTES AND LEGEND.

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

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DATE ______ REG NO. ______

BLACK & VEATCH CORPORATION
ENGINEER PLN DRAWN NAW
CHECKED DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

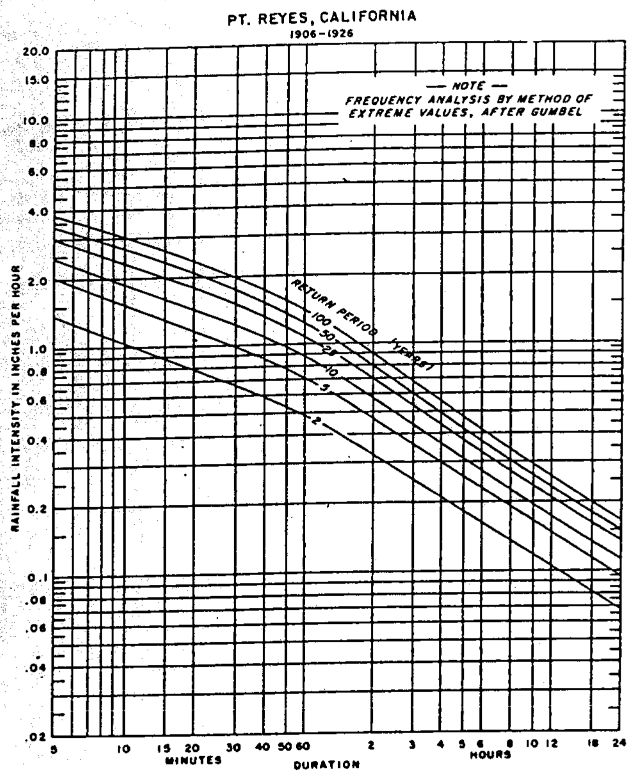
SITE
SECTIONS AND DETAILS

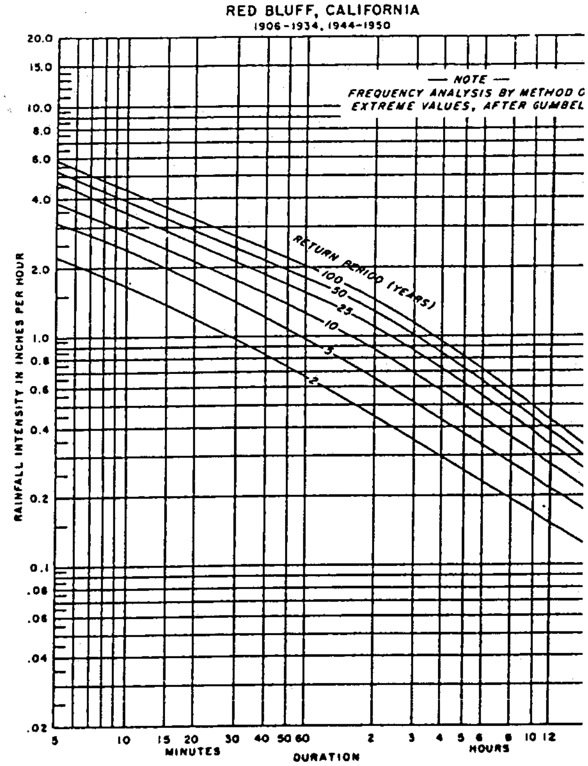
PROJECT / DRAWING NUMBER: 163994-SS-3050 REV 0
CODE
AREA

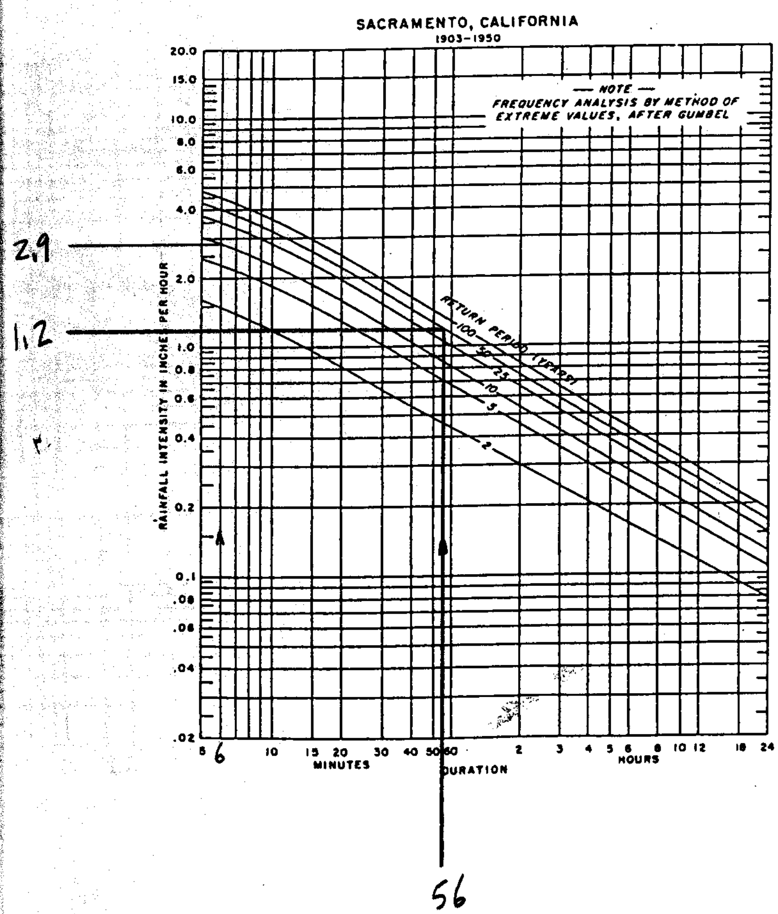
# Attachment 2

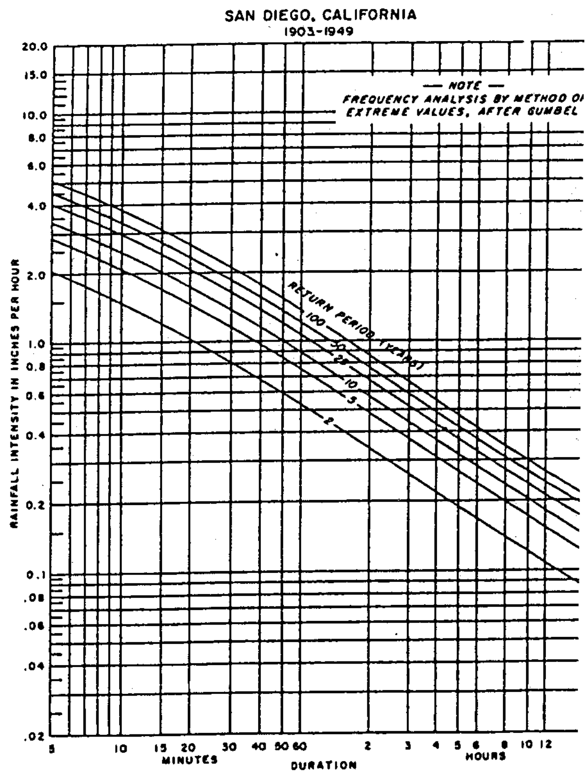
**Reference 3 – Select Pages**

# RAINFALL INTENSITY– DURATION–FREQUENCY CURVES



# Attachment 3

**Reference 4 – Select Pages**

Manning's equation is:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \quad \text{[eq. 3-4]}$$

where:

V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to $a/p_w$
  a = cross sectional flow area ($ft^2$)
  $p_w$ = wetted perimeter (ft)
s = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, $T_t$ for the channel segment can be estimated using equation 3-1.

### Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

## Limitations

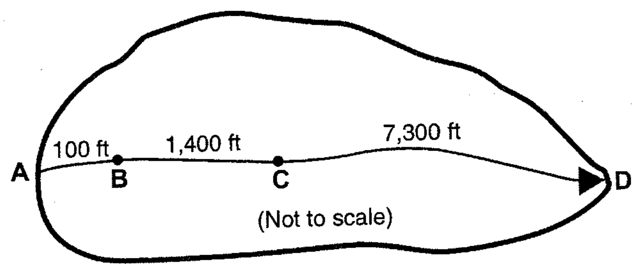
- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.
- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate $T_c$. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.
- The minimum $T_c$ used in TR-55 is 0.1 hour.
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

## Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute $T_c$ at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute $T_c$, first determine $T_t$ for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft. Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1,400 ft. Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 $ft^2$; wetted perimeter ($p_w$) = 28.2 ft; s = 0.005 ft/ft; and L = 7,300 ft.

See figure 3-2 for the computations made on worksheet 3.



# Attachment 4

**Reference 5 – Select Pages**

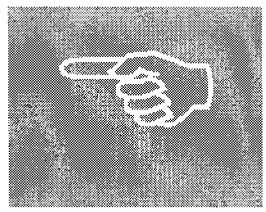
(Runoff factor) x (tributary area) ≤ 2 x (self-retaining area) *Equation 4-1*

For treatment-only sites, and

(Runoff factor) x (tributary area) ≤ 1 x (self-retaining area) *Equation 4-2*

for sites subject to flow-control requirements. Use the runoff factors in Table 4-2.

Prolonged ponding is a potential problem at higher impervious/pervious ratios. In your design, ensure that the pervious area soils can handle the additional run-on and are sufficiently well-drained.



Runoff from self-treating and self-retaining areas does not require any further treatment or flow control.

TABLE 4-2. Runoff factors to be used when sizing IMPs.

| Surface | Treatment and Flow Control | Treatment only |
|---|---|---|
| Roofs | 1.0 | 1.0 |
| Concrete or Asphalt | 1.0 | 1.0 |
| Pervious Concrete | 0.1 | 0.1 |
| Porous Asphalt | 0.1 | 0.1 |
| Grouted Unit Pavers | 1.0 | 1.0 |
| Solid Unit Pavers | 0.5 | 0.2 |
| Crushed Aggregate | 0.1 | 0.1 |
| Turfblock | 0.1 | 0.1 |
| Landscape, Group A Soil | 0.1 | 0.1 |
| Landscape, Group B Soil | 0.3 | 0.1 |
| Landscape, Group C Soil | 0.5 | 0.1 |
| Landscape, Group D Soil | 0.7 | 0.1 |

**Areas draining to IMPs** are used to calculate the required size of the IMP. On most densely developed sites—such as commercial and mixed-use developments and small-lot residential subdivisions—most DMAs will drain to IMPs.

The CCCWP has developed sizing factors (ratios of IMP area to impervious DMA area). For each IMP design, factors are provided for:

1. the intensity-duration-frequency method, with a hydrograph corresponding to a 50-year storm,
2. the 85th percentile rainfall intensity times two, and
3. 0.2 inches per hour.

An analysis conducted for the CCCWP determined all three methods yielded similar results. The 0.2 inches per hour rainfall intensity is used for sizing flow-based treatment facilities in Contra Costa County. This intensity corresponds to a storm depth of approximately 0.6 inches.

The CCCWP used the 0.2 inches per hour criterion to develop a **consistent countywide sizing factor** for bioretention facilities when used for stormwater treatment only (i.e., not for flow control). The factor is based on maintaining a minimum percolation rate of 5 inches per hour through an engineered soil mix. The sizing factor is the ratio of the design intensity of rainfall on tributary impervious surfaces (0.2 inches/hour) to the design percolation rate in the facility (5 inches/hour), or **0.04** (dimensionless).

### ► FLOW-CONTROL (HYDROGRAPH MODIFICATION MANAGEMENT)

The NPDES permit specifies for applicable projects:

> ...estimated post-project runoff peaks and durations do not exceed estimated pre-project peaks and durations if increased stormwater runoff peaks or durations could cause erosion or other significant effects on beneficial uses.

Applicants may select among **four options** for compliance. See Table 1-2. The first three options demonstrate runoff will not exceed pre-project durations by showing there will be no net increase in impervious area, by using Integrated Management Practice designs and sizing factors developed by the Program, or by constructing a site-specific hydrologic model. The fourth option is to demonstrate that, even though runoff will increase, it will not cause erosion or other significant effects on beneficial uses. This may be done by showing downstream channels are not susceptible to erosion (Option 4a) or that a restoration project will mitigate any impacts from increased flows (Options 4b and 4c).

Details on compliance requirements are in Appendix C. Technical background is in the Hydrograph Modification Management Plan, which is available on the Program's website.

# Attachment 5

**Reference 6 – Select Pages**

**TABLE 4.2** Time of Concentration for Small, Impervious Areas

| Location | Standard $t_c$ (minutes) |
|---|---|
| Roof and property drainage | 5 |
| Road inlet pits | 5 |
| Small areas <1 acre | 10 |

Rather than attempting more detailed analysis, for areas up to one acre, values in Table 4.2 (taken from Urban Storm Water Management Manual for Malaysia, 2000) can be used.

To obtain an estimate of the time of concentration for the basin, the component values should be added. However, the addition must be done only for those components of flow in series along the principal path of flow from the hydraulically most remote point to the design point. Do not add travel time in intermediate tributaries. In the case of residential areas, consider only the interconnected impervious area.

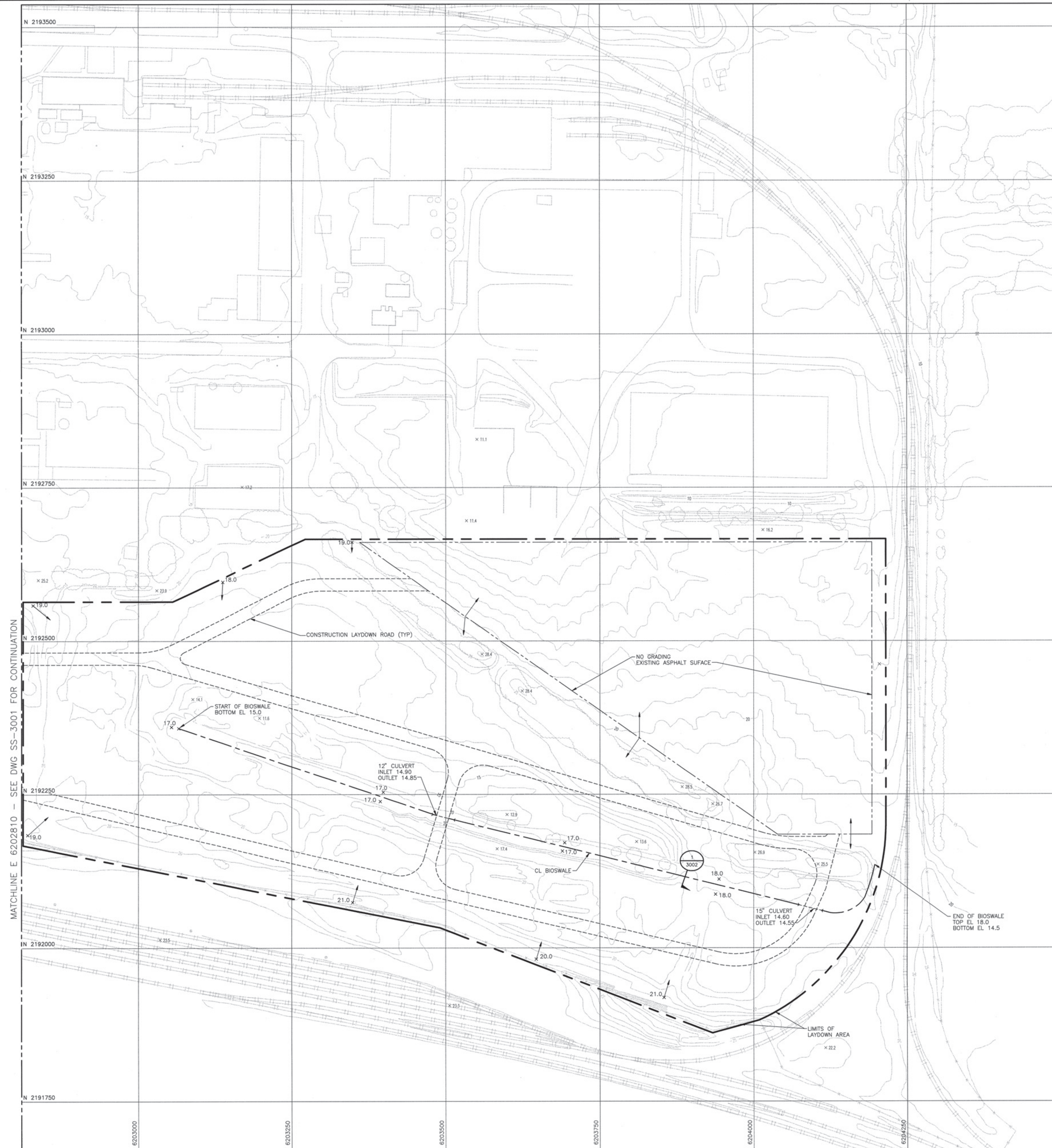
In the selection of a time of concentration for any individual component, the engineer should probably use two or three of the methods with which he or she is familiar and for which the necessary independent variables and parameters exist or can be economically determined. The procedure that gives a reasonable value and is conservative (shorter times will result in higher peak flow rates) with respect to the design objective should be the value that is selected.

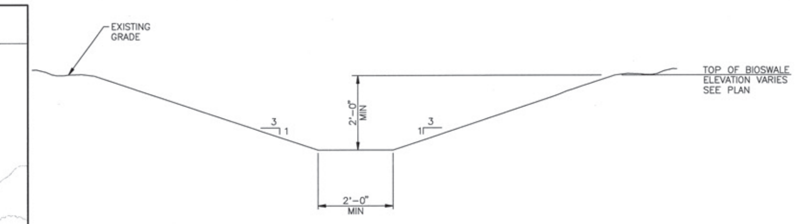
Remember, the equations are based on average velocities, not point velocities. Therefore, in many, if not most cases, you can walk faster than water flows. For overland flow and for concentrated flow in swales or natural channels, velocities will normally be less than 5 ft/sec or 6 ft/sec, and in larger, lined channels and closed conduits, they will usually be less than 10 ft/sec to 12 ft/sec.

Typically, rainfall intensities are determined from *Intensity-Duration-Frequency curves* (*IDF curves*) or *Depth-Duration-Frequency curves* (*DDF curves*). These are plots of rainfall intensity (or depth) versus duration of event rainfall. Usually, there are several curves on a single graph, one for each of several different rainfall frequencies (e.g. the 10-year event, the 25-year event, the 50-year event and the 100-year event). Figure 4.1 is a set of IDF curves for Rolla, MO.

Often, one or both of these graphs (or a tabular form thereof) are supplied by the local governmental authority under whose auspices the work is being done. First, the time of concentration is determined. Then, in the case of the IDF curve, the graph is entered with time of concentration and the rainfall intensity or depth is read at the intersection of the time coordinate and the corresponding design frequency. In the case of DDF data, the design depth is divided by the time of concentration so as to obtain the desired rainfall intensity, $I$.

In the absence of preexisting IDF or DDF curves, the engineer must develop the information that is required. In the best of all worlds, an engineer should develop IDF or DDF curves from local or nearby rainfall data. However, for all practical purposes, the necessary rainfall data are seldom available, and if they are available, the cost of developing the rainfall frequency relations is seldom justifiable in terms of any design project where the Rational method is applicable (e.g. drainage design for a subdivision, an industrial park, a shopping center, etc.). In this case, IDF or DDF curves can be developed from rainfall data contained in published rainfall frequency atlases (e.g. Hershfield, 1961; Miller et al., 1973; Frederick et al., 1977; Huff and Angel, 1992). For a given frequency, rainfall depths are interpolated from isohyets in the atlas at the published durations. Each rainfall depth is divided by the corresponding duration to obtain an average rainfall intensity for that particular duration. The computed intensities for the given frequency are then plotted on either logarithmic or on semilogarithmic coordinates (time on the logarithmic scale in both cases). Use of loga-




SECTION 1
TYPICAL BIOSWALE
NO SCALE

## NOTES

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.
2. ALL TREES WITHIN LAYDOWN AREA SHALL BE REMOVED.

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

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SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER PLN DRAWN NAW
CHECKED DATE

CONTRA COSTA GENERATING STATION LLC
CONTRA COSTA COMBINED CYCLE FACILITY

GRADING AND DRAINAGE – SITE
PLAN – SHEET 2

PROJECT DRAWING NUMBER 163994–SS–3002
REV 0
CODE
AREA

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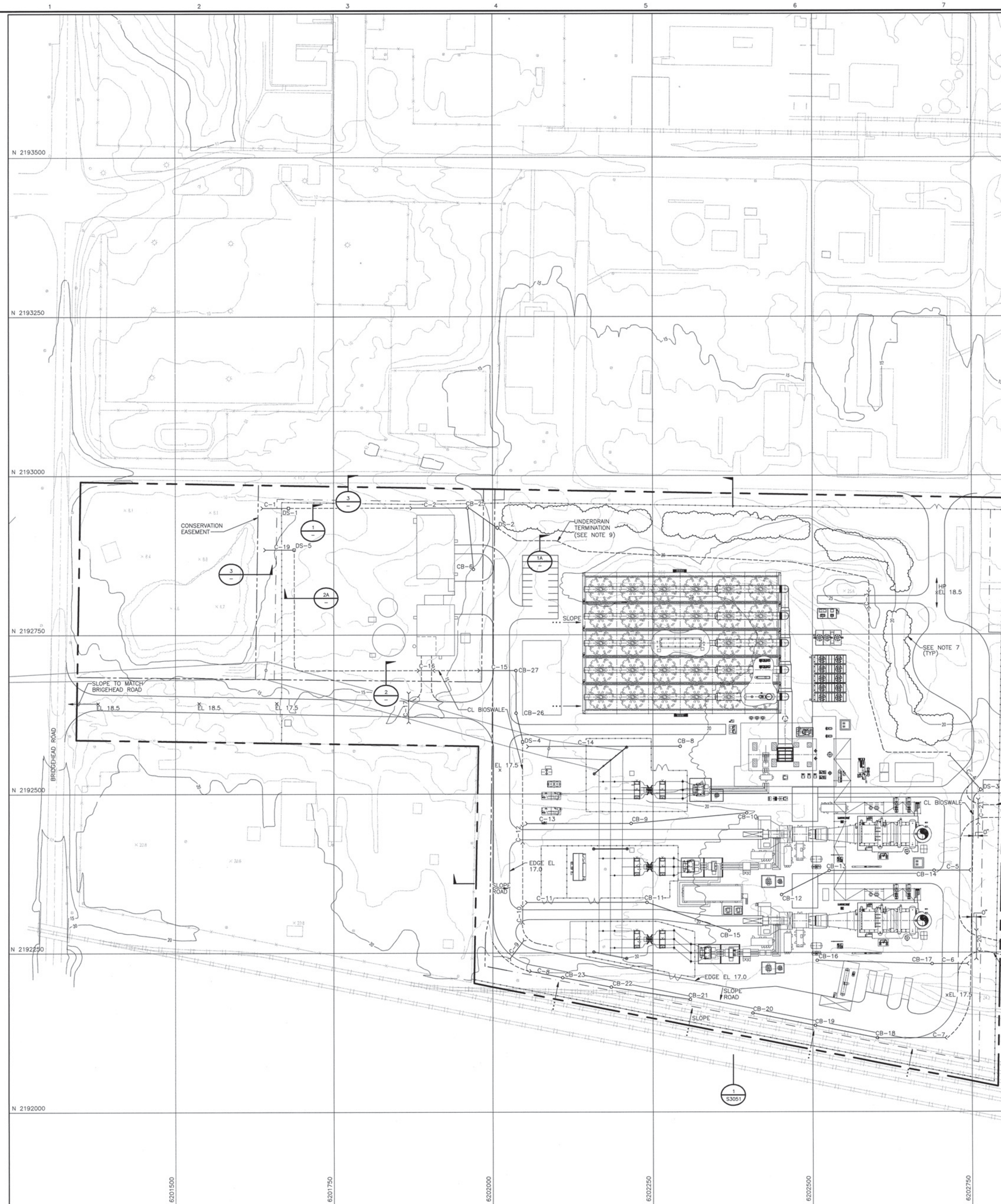


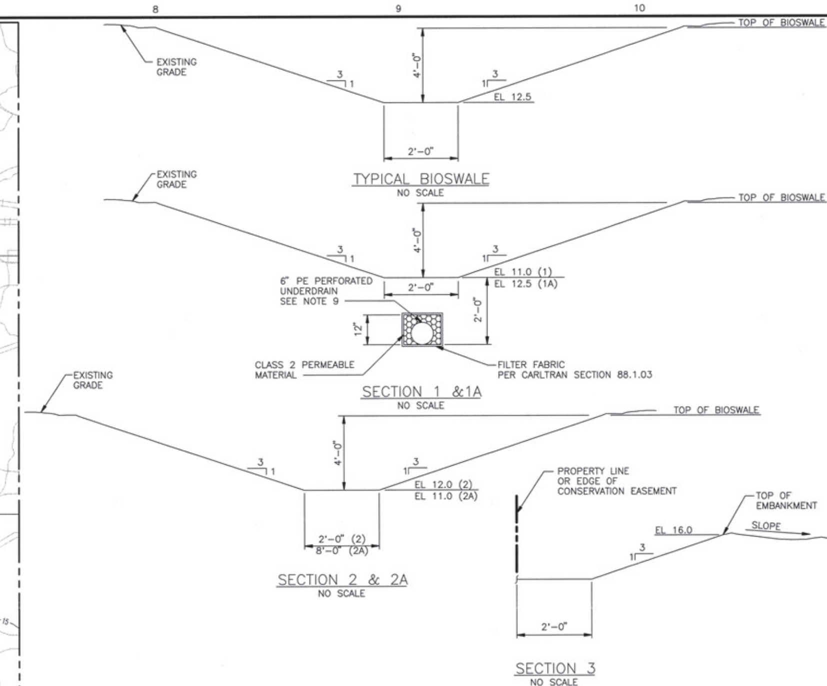


## ABBREVIATIONS APPLICABLE TO ALL SS-3000 SERIES DRAWINGS

| | | | |
|---|---|---|---|
| APPROX | APPROXIMATE | LTR | LATER |
| ASPH | ASPHALT | MAX | MAXIMUM |
| AVG | AVERAGE | MH | MANHOLE |
| BND | BEND | MIN | MINIMUM |
| BLDG | BUILDING | MJ | MECHANICAL JOINT |
| B/MH | BOTTOM OF MANHOLE ELEVATION | MSL | MEAN SEA LEVEL |
| BOC | BOTTOM OF CONDUIT ELEVATION | NO. | NUMBER |
| BOD | BOTTOM OF DUCTBANK ELEVATION | NTS | NOT TO SCALE |
| BOP | BOTTOM OF PIPE ELEVATION | OD | OUTSIDE DIAMETER |
| BU | BELL-UP | OWS | OIL WATER SEPARATOR |
| C | CULVERT | OWMH | OILYWASTE MANHOLE |
| CB | CATCH BASIN | PC | POINT OF CURVATURE |
| CD | CABLE DUCT | PE | PLAIN END |
| CHDPE | CORRUGATED HIGH DENSITY POLYETHYLENE PIPE | PI | POINT OF INTERSECTION |
| | | PLCS | PLACES |
| CL | CENTERLINE | PM | PLANT MANHOLE |
| CLR | CLEAR | POT | POINT OF TANGENT |
| CMH | CHEMICAL MANHOLE | PT | PIPE TERMINATION |
| CND | CONDUIT | PVC | POLYVINYL CHLORIDE PIPE |
| CONC | CONCRETE | QTY | QUANITY |
| CO | CLEAN OUT | R | RADIUS |
| CS | CARBON STEEL | RCP | REINFORCED CONCRETE PIPE |
| CW | CIRCULATING WATER | RD | ROOF DRAIN |
| DB | DUCTBANK | REV | REVISION |
| DBC | DIRECT BURIED CABLE | RGS | RIGID GALVANIZED STEEL |
| DET | DETAIL | RR | RAILROAD |
| DIA | DIAMETER | SECT | SECTION |
| DIP | DUCTILE IRON PIPE | SIM | SIMILAR |
| DWG | DRAWING | SLS | SANITARY LIFT STATION |
| DWP | DOUBLE WALL PIPE | SMH | SANITARY MANHOLE |
| EC | ELECTRICAL CONDUIT | STMH | STORM MANHOLE |
| ECC | ECCENTRIC | STRL | STRUCTURAL |
| EF | EACH FACE | T/C | TOP OF CONCRETE ELEVATION |
| EHH | ELECTRICAL HANDHOLE | T/G | TOP OF GRADE ELEVATION |
| EL | ELEVATION | THH | TELEPHONE SERVICE HANDHOLE |
| EMH | ELECTRICAL MANHOLE | T/MH | TOP OF MANHOLE ELEVATION |
| EW | EACH WAY | T/P | TOP OF PAVEMENT ELEVATION |
| FC | FIELD CHECK | TP | MECH PIPE TERMINAL POINT |
| FDN | FOUNDATION | TYP | TYPICAL |
| FF | FLAT FACE | UGL | UNDERGROUND LIGHTING CONDUIT |
| FRP | FIBERGLASS REINFORCED PIPE | UNO | UNLESS NOTED OTHERWISE |
| GR | GRADE | VERT | VERTICAL |
| HDM | HOT DRAIN MANHOLE | WGT | WEIGHT |
| HDPE | HIGH DENSITY POLYETHYLENE PIPE | WTR | WATER |
| HP | HIGH POINT | W/ | WITH |
| HYD | HYDRANT | W/O | WITHOUT |
| ID | INSIDE DIAMETER | WP | WORK POINT |
| INV | INVERT | XFMR | TRANSFORMER |
| JBX | JUNCTION BOX | | |
| L | LENGTH | | |
| LP | LOW POINT | | |

## LEGEND APPLICABLE TO ALL S3000 DRAWINGS

- NEW CULVERT
- CL BIOSWALE
- SECTION OR DETAIL NUMBER / DRAWING DESIGNATION NUMBER (1 / S3000)
- FINISHED SPOT ELEVATIONS (326.5)
- SURVEY MONUMENT/CONTROL POINT (BM-1)
- EXISTING FENCE
- NEW SECURITY FENCE
- TEMPORARY CONSTRUCTION FENCE
- EROSION CONTROL METHOD (TR-1)
- NEW SLIDE GATE
- NEW SWING GATE
- EXISTING POWER POLE
- NEW CATCH BASIN (CB-101)
- NEW DROP STRUCTURE
- PROPERTY LINE
- BOUNDARY LINE
- EXISTING CONTOURS (126)
- GRADE TO DRAIN (DIRECTION OF ARROW)

## NOTES APPLICABLE TO ALL SS-3000 SERIES DRAWINGS

1. COORDINATES ARE BASED ON CALIFORNIA COORDINATE SYSTEM CCS83, ZONE 3. ELEVATION ARE BASED ON, NGVD 29 DATUM. BENCHMARK IS NATIONAL GEODETIC SURVEY BENCH MARK "W 563", LOCATED ADJACENT TO THE FLAGPOLE AT THE DUPONT PLANT ENTRANCE, ELEVATION = 11.168 FEET. TO OBTAIN DUPONT PLANT DATUM ELEVATION, ADD 0.70 FEET TO THE ELEVATIONS SHOWN. TOPOGRAPHIC DATA IS BASED ON AERIAL PHOTOGRAPH DATED JUNE 11, 2001. AERIAL SURVEY INFORMATION WAS OBTAINED BY RONALD GREENWELL & ASSOCIATES, INC.
2. NEW GRADE ELEVATIONS SHOWN ON THE SITE GRADING AND DRAINAGE PLANS INDICATE FINISH GRADE UNLESS NOTED OTHERWISE.
3. ALL CUT AND FILL SLOPES SHALL BE 3 HORIZONTAL TO 1 VERTICAL OR FLATTER, UNLESS NOTED OTHERWISE.
4. SEE DWG SS-3050 FOR GRADING AND DRAINAGE DETAILS INCLUDING CULVERT, CATCH BASIN AND DROP STRUCTURE CHARTS.
5. TOP OF CONCRETE ELEVATIONS AND FINISH FLOOR ELEVATIONS FOR ALL EQUIPMENT AND BUILDINGS IS EL 18.0. FINISH GRADE ADJACENT TO ALL FOUNDATIONS IS EL 17.5.
6. CL OF ALL PAVED ROADS IS EL 17.5 UNO.
7. TREES TO REMAIN. GRADE TO REMAIN UNCHANGED WITHIN 20' OF TREE BASE.
8. TEMPORARY ROAD FROM LAYDOWN AREA. ROAD AND CULVERT UNDER ROAD TO BE REMOVED AT END OF CONSTRUCTION.
9. UNDERDRAIN CONTINUOUS UNDER BIOSWALE FROM UNDERDRAIN TERMINATION TO CONSERVATION EASEMENT. UTILIZE UNPERFORATED PIPE BETWEEN DS-2 TO C-2 OUTLET AND DS-1 TO C-1 OUTLET.

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GRADING AND DRAINAGE – SITE PLAN – SHEET 1

PROJECT / DRAWING NUMBER: 163994–SS–3001 REV 0

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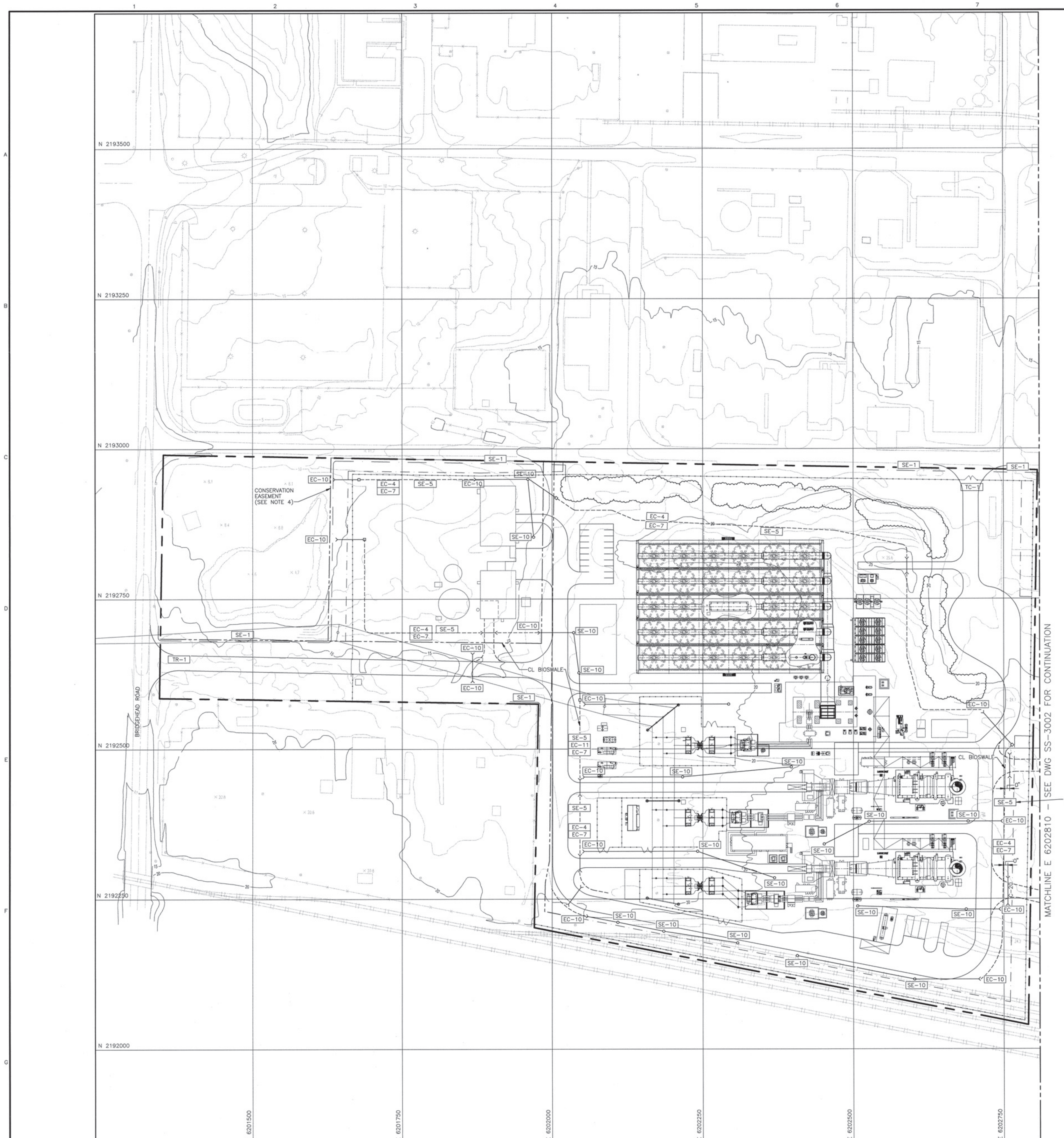


## NOTES APPLICABLE TO ALL SS-3000 SERIES DRAWINGS

1. SEE DRAWING SS-3001 FOR GENERAL NOTES AND LEGEND.
2. SEE DWG SS-3001 FOR GRADING & DRAINAGE PLAN
3. SEE DWG SS-3150 FOR SOIL EROSION CONTROL SECTIONS AND DETAILS.
4. NO CONSTRUCTION ACTIVITY SHALL OCCUR WITHIN CONSERVATION EASEMENT.
5. SE-5 MAY BE REMOVED AFTER BIOSWALE GRASS OBTAINS 70% COVERAGE.
6. SEE DWG SS-3201 FOR SITE SURFACING PLAN. ALL GRASS OR LANDSCAPE AREAS SHALL BE SEEDED AND FERTILIZED EC-4 AND COVERED WITH HYDRAULIC MULCH EC-3

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SOIL EROSION CONTROL — SITE PLAN — SHEET 1

PROJECT / DRAWING NUMBER: 163994–SS–3101
REV: 0
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