BMP Retrofit Pilot Program

Basis of Design Report
Treatment Units Design
District 7 Procurement

Caltrans Report ID #: ctsw-rt-98-68-d1

August 1998

Prepared for:
California Department of Transportation
Sacramento, California

Prepared by:
Brown and Caldwell
16735 Von Karman Avenue, Suite 200
Irvine, California 92606
# Table of Contents

LIST OF APPENDICES .................................................................................. ii

1.0 INTRODUCTION ..................................................................................... 1
  1.1 General (Purpose & Scope) ................................................................. 1
  1.2 Objectives ......................................................................................... 1
  1.3 Project Locations ............................................................................. 1
  1.4 Construction Drawings, Figures ...................................................... 2
  1.5 Calculations ..................................................................................... 2
  1.6 Construction Costs .......................................................................... 2

2.0 HYDROLOGIC CHARACTERISTICS .................................................... 2
  2.1 Rainfall Characteristics .................................................................... 2
  2.2 Soil Types and Infiltration ................................................................. 3
  2.3 Methodology and Procedure ............................................................. 3
  2.4 Discussion of Individual Sites .......................................................... 4
  2.5 Summary of Results ........................................................................ 5

3.0 DESIGN DISCUSSION ......................................................................... 5
  3.1 Design Criteria ............................................................................... 5
  3.2 Media Filter Design ......................................................................... 5
    3.2.1 Drainage Inlet Unit ................................................................ 6
    3.2.2 Sedimentation Basin .............................................................. 6
    3.2.3 Filtration Basin ...................................................................... 7
    3.2.4 Sump for Collection of Filtered Runoff .............................. 7
    3.2.5 Provision for Overflow Bypass ............................................. 8
    3.2.6 Flow Measuring Devices and Samplers ............................. 8
  3.3 Oil/Water Separator ....................................................................... 8
  3.4 Multi-Chamber Treatment Units ...................................................... 8
    3.4.1 Catchbasin Inlet Chamber ..................................................... 9
    3.4.2 Main Settling Chamber ......................................................... 9
    3.4.3 Filter Chamber ..................................................................... 9
    3.4.4 Effluent Sump ....................................................................... 9
    3.4.5 Input Values and Assumptions ............................................. 9
    3.4.6 Summary of MCTT Sizes ..................................................... 10

REFERENCES ............................................................................................. 11
LIST OF APPENDICES

APPENDIX A. DESIGN PLAN DRAWINGS

APPENDIX B. TREATMENT UNIT SITES PHOTOGRAPHS

APPENDIX C. RAINFALL ZONE MAP
   TREATMENT UNIT CALCULATIONS

APPENDIX D. CONSTRUCTION COST

APPENDIX E. PRELIMINARY SOILS REPORT

APPENDIX F. TREATMENT UNIT SITES DRAINAGE AREAS

APPENDIX G. OIL/WATER SEPARATOR INFORMATION

APPENDIX H. MCTT REVIEW COMMENTS
ACRONYMS

ac       Acre
acft     Acre feet
BMP      Best Management Practice
Caltrans California Department of Transportation
cfs      cubic feet per second
gpm      gallons per minute
NRDC     National Resources Defense Council
BMP Retrofit Pilot Program – 
Basis of Design Report

1.0 INTRODUCTION

1.1 General (Purpose & Scope)

Pursuant to the Caltrans Consent Decree, a BMP Retrofit Pilot Program is required to investigate the constituent removal efficiency, technical feasibility and costs of retrofitting Caltrans facilities with selected Best Management Practices (BMPs). This report documents the design parameters associated with implementation of Best Management Practices for storm water discharges from eight Caltrans District 7 facilities. These facilities include four Caltrans Maintenance Stations and four Park and Ride Facilities. Siting information for each of these locations is provided in the report entitled “Scoping Study, Retrofit Pilot Program, Caltrans District 7”, dated April 28, 1998 by Robert Bein, William Frost & Associates (RBF). The BMP Pilot Projects discussed in this report are four sand media filters, three multi-chambered treatment trains (MCTT), and one oil/water separator.

1.2 Objectives

The purpose of this study is to provide design criteria in support of the construction drawings of the BMP Retrofit Pilot Program projects. Specifically, the objectives of this report are as follows:

- Define hydrologic criteria for the design of the BMPs.
- Develop discharges for the design conditions above.
- Define hydraulic criteria for the design of the BMPs.
- Define design parameters for each BMP.
- Provide technical calculations supporting the drainage facility designs shown on the construction drawings.

1.3 Project Locations

There are eight sites that are located in different cities. A list of all these sites is provided below.

- Alameda Maintenance Station, 1740 East 15th Street, Los Angeles
- East Regional Maintenance Station, 1940 S. Workman Mill Road, Whittier
- Metro Maintenance Station, 2187 Riverside Drive, Los Angeles
- Foothill Maintenance Station, 850 East Huntington Drive, Monrovia
- Termination Park and Ride, I-105/I-605 Intersection, Norwalk
Via Verde Park and Ride, Intersection of Via Verde and San Dimas Rd., San Dimas
Paxton Park and Ride, I-210/Paxton Intersection, San Fernando
Lakewood Boulevard Park and Ride, I-105/SR19 Intersection, Downey

1.4 Construction Drawings, Figures

Construction drawings of the media-filters, multi-chamber treatment trains and oil/water separator are shown on Drawings D-1 through D-8, and are included in Appendix A. Photographs of the project sites are included in Appendix B as Figures 1 through 8.

1.5 Calculations

Calculations supporting the drainage facility designs shown on the construction drawings are included in Appendix C.

1.6 Construction Costs

The construction cost received in a July bid for the eight sites is $2,712,769. A construction cost breakdown is included in Appendix D.

2.0 HYDROLOGIC CHARACTERISTICS

2.1 Rainfall Characteristics

The amount of rainfall from a 1 year, 24 hour storm was estimated in order to calculate storm water runoff for designing the detention basins. To develop rainfall values for the study area, Brown and Caldwell analyzed precipitation records (24-hour rainfall totals) for the Los Angeles International Airport (LAX) weather station from 1944 to 1995. Analysis was performed using the log-Pearson type III method and by the annual series data method. As a comparison to the LAX rainfall data, a second and third set of rainfall records were analyzed, using only an annual series data method, from the Van Nuys and the downtown Los Angeles weather stations. Both of these stations are located in the same rainfall region (coastal plain), as defined by the Los Angeles Department of Public Works (LACDPW), as the station at the LAX airport.

From the analysis, at the LAX weather station, the calculated 24-hour rainfall total for a one-year storm frequency event equaled 0.5-inches (log-Pearson) and 1.12-inches (annual series data method). The log-Pearson analysis was heavily influenced by two extreme drought years. The results for the Van Nuys and downtown Los Angeles stations were 0.71 and 0.73-inches respectively using the annual series data method. Because of the uncertainty of the exact size of a one-year frequency storm, a 1.0-inch value was chosen to represent the amount of rainfall for a
one-year, 24-hour storm within the Los Angeles Coastal Plain (Caltrans Zone K and L). Because of the uncertainty of the method in the one-year analysis, a one-inch storm corresponds to about 1.2 year storm using the LAX weather station data and the log-Pearson analysis method. A rainfall zone map showing the extent of the rainfall zones within Caltrans District 7 is included in Appendix C.

2.2 Soil Types and Infiltration

Soils at all eight sites have been previously disturbed, graded and compacted during the construction of the park and ride or maintenance station facilities. Soil types range from clayey sand to silty sand and coarse sand at different sites. Ground water was encountered only at two sites (Lakewood and Metro maintenance Station). Cobbles were found at the Paxton and Foothill sites. Preliminary soils report and design data is included in Appendix E.

2.3 Methodology and Procedure

**Design Storm Water Runoff Volume.** The areas within the Caltrans boundary around the eight facilities were determined. The total runoff volume for the 1-year, 24 hour storm was then calculated using the following assumptions (per Appendix D of the “California Storm Water Best Management Practice Handbook, Municipal.”):

- 0.06-inches of rainfall captured in local depressions,
- Runoff coefficient of 0.9 for impervious surfaces,
- Runoff coefficient of 0.15 for pervious surfaces.

Calculations for the design of storm water runoff volume are included in Appendix B.

**Peak Storm Water Flow Rate.** The modified Rational Method was used to develop the peak storm water flow rate to the basins. This is the same method used in the Caltrans District 7 Hydraulics Manual, which is based upon the Los Angeles Department of Public Works (DPW) method. DPW is responsible for providing flood control protection in Los Angeles County.

The design storm rainfall intensity values were determined by evaluating average intensity duration curves from the District 7 Hydraulics Manual. Although the peak intensity is only available for a 10-year, 25-year, and 50-year storms, a conversion curve is available to convert a 50-year storm intensity to a one-year storm. The conversion curve, from the District 7 Hydraulics Manual, page III-038, was used to convert the 50-year peak intensity values to the 1-year, 24-hour design storm by multiplying the 50-year rainfall intensity value by 0.445 (this conversion value is provided on the curve). The peak storm water flow rate was then calculated by multiplying the peak rainfall intensity value in inches/hour by the total impervious drainage area, and then converting to gallons per minute (gpm).
A duration of peak rainfall equal to the time of concentration was used to determine peak rainfall from the curves. Concentration time 10 minutes was used.

Peak Rainfall Intensity was taken as 1.47 for all sites except Foothill Maintenance Station and Via Verde Park and Ride where Peak Rainfall Intensity was considered as 1.67.

Calculations for peak storm water flow rates, including copies of the 50-year Average Intensity Duration Curve and the Conversion Curve are included in Appendix C.

2.4 Discussion of Individual Sites

Runoff at each site was collected from as much of the site as practical. The following discussion describes the tributary area at each site. Figures showing the drainage of each site is included in Appendix F.

**Alameda Maintenance Station.** The oil/water separator has been located to collect flow from about one-third of the site. This portion of the site includes the area in front of the main building where trucks and other vehicles park. The oil/water separator has been located so that the entire system can flow by gravity without pumping. This eliminated costs for pumps, pump sump, and reduced cost for electrical power supply and maintenance of such facilities. Due to the location and elevation of the oil-water separator, no other runoff can be diverted to it.

**Eastern Regional Maintenance Station.** The site is graded to flow to the west and the south. Most of the runoff at the site is collected in a Vee-gutter located in front of the main building on site. The media filter has been located to intercept flow from this gutter. As designed the media filter treats about 80 percent of the site runoff. A large portion of the remaining portion of the site is an unpaved area for equipment storage.

**Foothill Maintenance Station.** The existing site is graded to flow from north to south with runoff collected in a series of drainage inlets. The filter will treat runoff draining to a separate southern drain inlet. The tributary area includes the fueling area, parking, and general maintenance areas. The northern inlets will be used for other pilot BMPs (catch basin inserts) and therefore their additional tributary areas are not available for treatment by the media filter.

**Termination Park and Ride.** The site drains from north to south with runoff collected in three Vee-gutters. The media filter is located to treat flow from the center gutter, which receives runoff from about one-third of the entire site. Flow could have been collected from the rest of the site with an additional increase in size and depth of the unit. However, it was decided that the proposed design is representative of the site and could be implemented with the least disruption to the Park and Ride facility.
**Paxton Park and Ride.** About 95% of the site drains to a single drain inlet at the west corner of the site. Runoff is diverted from this drain inlet to the media filter. A trench drain is provided to capture runoff that would normally exit the site to the street through the site access driveway.

**Via Verde Park and Ride.** The entire site drains to a single drain inlet at the west corner of the site. Runoff is diverted from this drain inlet to the MCTT unit.

**Metro Maintenance Station.** Runoff from the existing site flows to the west where it is collected in a drainage ditch along the edge of the site. Runoff from this collection ditch is diverted into the MCTT unit, allowing flow from almost all of the site to be treated.

**I-105/Lakewood Park and Ride.** Almost all of the runoff from the paved portion of the facility drains to a drain inlet located along the southeast portion of the site. Runoff from this drain inlet is diverted into the MCTT. Only runoff from a small portion of the site that flows offsite through the access driveway is not captured for treatment.

### 2.5 Summary of Results

A summary of the parameters used and the storm water runoff volume and peak storm water flow rates are presented in Appendix C.

### 3.0 DESIGN DISCUSSION

#### 3.1 Design Criteria

In order to maximize the effectiveness of the treatment units to protect water quality, various design criteria were used including detention time, water depth, and drainage area, type of runoff that resulted in three different types of treatment units namely Media Filters, MCTTs, and Oil/Water Separator. These are discussed below.

#### 3.2 Media Filter Design

The primary function of the treatment units is to provide removal of particulate pollutants from storm water runoff. In addition, heavy metals and other toxic chemicals that will attach to particulate matter will also be removed.

Recommended design criteria per the Scoping Study include a detention time of 24 hours for average conditions.
Basic Set-up. The media filter setup consists of:

- Drainage inlet unit,
- Sedimentation basin,
- Filtration basins,
- Sump for the collection of filtered runoff
- Provision for overflow bypass
- Flow measuring devices and samplers at both inlet and outlet

Major components and their designs are discussed briefly.

3.2.1 Drainage Inlet Unit

The inlet drainage units are designed to capture the runoff from the facility. Some sites have been provided with open trench inlet that carry the intercepted flow to the Drainage Inlet Unit. At other sites the Drainage Inlet Units are connected to the existing catch basins.

3.2.2 Sedimentation Basin

The removal of discrete particles by gravity settling is primarily a function of surface loading. Basin depth is of secondary importance as settling is inhibited only when basin depths are too shallow. The particles selected for complete removal in the sedimentation basin are those which are greater than or equal in size to silt with the following characteristics:

- particle diameter 0.0007 foot (20 microns) and
- specific gravity of 2.65.

Surface Area of Sedimentation Basin. The surface areas of the sedimentation basins were calculated by dividing the total volume of runoff in 24-hr period by the depth of the sedimentation basin. The minimum depth of the sedimentation basin was arbitrarily chosen as 7ft (2.13 m). This allows the Sedimentation Basin to store the entire volume of runoff of a 1 year, 24–hr storm.

Outlet Pipe. The outlet pipe conveys the water quality volume from the sedimentation basin to the filtration basin. The outlet structure is designed to provide for a minimum drawdown time of 24 hours. A 6-inch diameter PVC standard pipe with perforations to achieve required draw down time is installed in the sedimentation basin wall. The water is conveyed to the filtration basin through the perforations.

Basin Geometry. The length to width ratio of basin was kept as nearly as possible to 2:1 in order to maintain a smooth flow regime and avoid short circuiting. However, short circuiting is not a significant problem because the flow out of the sedimentation basin will generally be less than the flow into the basin. Energy will be dissipated as it enters the pool of water in the sedimentation basin.
3.2.3 Filtration Basin

For filtration basins, surface area is the primary design parameter. The required surface area is a function of sand permeability, bed depth, hydraulic head and sediment loading. A filtration rate of 0.0545 gallons per minute per square foot (10.5 feet per day or 3.4 million gallons per acre per day) has been selected according to the Austin filter design guidelines. This filtration rate is based on Darcy’s Law coefficient of permeability of 3.5 feet per day, an average hydraulic head of three (3) feet and a sand bed depth of 18 inches. The minimum surface area required for filtration basin was calculated using the following equation:

\[ A_f = A_D H / 18 \]

Where

- \( A_f \) is the minimum surface area of the filtration basin in acres
- \( A_D \) is the contributing drainage area in acres
- \( H \) is the runoff depth in feet (1.0 inch = 0.0833 feet).

**Inlet Structure.** The outlet structure described in the sedimentation basin is the inlet structure for the filtration basin. As flow enters the filter chamber it flows over a weir to distribute the flow evenly across the filter and reduce scouring.

**Sand Bed.** The top layer is a minimum of 18 inches of 0.02 – 0.04 inch diameter sand. Under the sand is a layer of 1/2-inch to 2-inch diameter gravel which provides a minimum of two inches of cover over the top of the under drain lateral pipes. The sand and gravel layers are separated by a layer of geotextile fabric.

**Underdrain Piping.** The underdrain piping consists of main collector pipe and perforated lateral branch pipes. The main collector pipe has an internal diameter of 6-inches. The internal diameters of lateral branch pipes is minimum 4-inches or greater. Perforations are minimum 1/2-inch on both sides of the pipe and are at 6-inch intervals along the length. All piping is schedule 40 PVC. Maximum grade of piping is kept at 1 percent slope.

3.2.4 Sump for Collection of Filtered Runoff

A sump for collection of filtered water is provided at each treatment unit. The water is discharged from the sump to the existing drains using a sump pump which is activated based on water level in the sump. Each sump pump is specified according to the flow at a particular treatment unit. The pumps generally discharge to the original storm drain or storm channel.

Initially it was thought that flow through the media filter might be able to occur completely by gravity, but this was not possible due to the minimal slope at the site, and the need to discharge to the existing storm drainage system.
3.2.5 Provision for Overflow Bypass

An overflow provision is provided at each site. The units are in the drainage path, therefore excess flow automatically bypasses the treatment unit and drains to an existing discharge point.

3.2.6 Flow Measuring Devices and Samplers

A straight length of pipe is provided to accommodate any flow measuring devices and samplers that may be required at the site. A concrete housekeeping pad is provided for mounting of the flow measuring and sampling equipment.

3.3 Oil/Water Separator

The commercial oil/water separator is being constructed at the Alameda Maintenance Station. The peak flow at the station is 474 gpm. The selected oil/water separator has a peak flow capacity of 500 gpm.

Other design considerations include:

- Reynolds Number <2000 (laminar flow)
- Designed in accordance with Stokes Law
- Designed in accordance with API 421 (Design and Operation of Oil/Water Separators)

Vendor information and other details are provided in Appendix G.

3.4 Multi-Chamber Treatment Units

The Multi-Chamber Treatment Train (MCTT) is a process unit which has been designed to maximize pollutant removal, and is documented in Stormwater Treatment At Critical Areas, Vol. 1: The Multi-Chambered Treatment Train (MCTT) (Robert Pitt, et.al. issued by National Risk Management research Laboratory, U.S. EPA, October 1997). The MCTT designs were reviewed by Robert Pitt and his suggestions incorporated where possible (see Appendix H).

The MCTT includes a catch basin/grit chamber followed by a two-chambered tank that is intended to reduce a broad range of toxicants. The runoff enters the catch basin chamber by passing over a flash aerator (small column packing balls) to remove highly volatile air components, if present, and to capture large debris. This catch basin also serves as a grit chamber to remove the largest particles. The second chamber serves as an enhanced settling chamber to remove smaller particles and has inclined tube settlers to enhance sedimentation. This chamber also contains sorbent pads to further enhance the removal of floatable hydrocarbons and additional volatile compounds. The water is then transferred to the final chamber containing a mixed media slow filter, with a filter fabric top layer. The MCTT is sized to totally contain all of the runoff from a 0.4 inch rainfall event.
3.4.1 Catchbasin Inlet Chamber

The catchbasin is effective in removing coarser runoff solids. The dimensions of the catch basin are as identified in the Scoping Study.

3.4.2 Main Settling Chamber

The main settling chamber uses a hydraulic loading rate (depth to time ratio) for removal estimates. This loading rate is equivalent to the conventional surface overflow rate (SOR), or upflow velocity for continuous-flow systems, or the ratio of water depth to detention time for static systems. The required runoff depth storage capacity increases as the depth of the main settling chamber increases. The settling depth for all the MCTT sites was selected as 8 feet (5 feet of storage plus 3 feet of tube settlers and distribution plenum).

Water is pumped from the main settling chamber to the filter chamber. Early designs included gravity flow from the settling chamber to the filter chamber, but this caused the filter chamber to be extremely deep. The extreme depth would make construction difficult, increase wall thicknesses, and in some cases encountering groundwater was a possibility. To reduce construction costs, intermediate pumping was added. This has the added benefit of being able to more easily control the holding time of the storm water in the settling chamber.

3.4.3 Filter Chamber

The final MCTT chamber is a mixed media filter device. It receives water which has been partially treated by the grit and the main settling chambers. The media is a 50/50 mix of sand and peat moss which has been found to be good at removing metals with minimal detrimental effects. The filter bed consists of 18 inches of media over drain gravel. A geotextile fabric is placed on top of the media to provide better distribution of liquid and eliminate scouring. The fabric is also placed between the media and the gravel to minimize the migration of media into the gravel. Perforated PVC pipe is located in the gravel layer to collect water and transport it to a sump.

3.4.4 Effluent Sump

A sump and pump is provided at each filter to collect the filtered water and lift the liquid to the existing site storm drainage system. The sump pump is sized based on the range of flows expected at each site. The pump is activated based on the water level in the sump.

3.4.5 Input Values and Assumptions

Water is pumped from the settling chamber to the filter. Runoff is held for 24 hours before pumping is started.

The selected pollutant removal goal is 90 percent. The assumed TSS concentration in influent is about 100 mg/l with the assumed TSS concentration after pre-settling being 50 mg/l. The filter solids loading rate (based on the peat/sand mixture) is 5000g SS/sq. meter per year.
### 3.4.6 Summary of MCTT Sizes

<table>
<thead>
<tr>
<th>Site</th>
<th>Storage Capacity, cf</th>
<th>Sedimentation, Surface Area, sf</th>
<th>Filtration Surface Area, sf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Via Verde</td>
<td>1780</td>
<td>365</td>
<td>188</td>
</tr>
<tr>
<td>Metro Maint. Station</td>
<td>7480</td>
<td>1515</td>
<td>755</td>
</tr>
<tr>
<td>Lakewood Park and Ride</td>
<td>3150</td>
<td>645</td>
<td>340</td>
</tr>
</tbody>
</table>
REFERENCES


California Department of Transportation. As-built drainage system drawings.


APPENDIX A

DESIGN PLAN DRAWINGS
INDEX OF SHEETS

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ADJACENT TO
STATE HIGHWAY
IN LOS ANGELES COUNTY
AT VARIOUS LOCATIONS

To be supplemented by Standard Plans dated July, 1997

LOCATION OF CONSTRUCTION

<table>
<thead>
<tr>
<th>LOC</th>
<th>ROUTE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>ALAMEDA MAINTENANCE STATION</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>EASTERN REGIONAL MAINTENANCE YARD</td>
</tr>
<tr>
<td>3</td>
<td>210</td>
<td>FOOTHILL MAINTENANCE STATION</td>
</tr>
<tr>
<td>4</td>
<td>105</td>
<td>TERMINATION PARK AND RIDE</td>
</tr>
<tr>
<td>5</td>
<td>210</td>
<td>PAXTON PARK AND RIDE</td>
</tr>
<tr>
<td>6</td>
<td>210</td>
<td>VIA VERDE PARK AND RIDE</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>METRO MAINTENANCE STATION</td>
</tr>
<tr>
<td>8</td>
<td>105</td>
<td>LAKEMOOR PARK AND RIDE</td>
</tr>
</tbody>
</table>

The Contractor shall possess the Class or Classes of license as specified in the "Notice to Contractors".
CONSTRUCTION NOTES

1. Relocate any existing underground wiring on the proposed site.
2. Install drain interceptor, see detail 1/0-18.

MEDIA FILTER

CONTOUR GRADING AND DRAINAGE PLAN, SITE 4
(termination park and ride)

SCALE 1:200

D-4
CONSTRUCTION NOTES

1. REMOVE EXISTING ISLAND AND TREE
ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

FLOW METERING SAMPLING BOX
CATCH BASIN
300 mm PVC PIPE
GATE (4.5 m WIDE)
300 mm PVC PIPE
DRAIN INLET
PIER FOUNDATION
BOT EL 108.4
PIER FOUNDATION
BOT EL 107.9
FENCING

MULTI-CHAMBER TREATMENT TRAIN (MCTT)

CONTOUR GRADING AND DRAINAGE PLAN, SITE 7
(METRO MAINTENANCE STATION)
SCALE 1:400
D-7
APPENDIX B

TREATMENT UNIT
SITES PHOTOGRAPHS
Fig. 1 Alameda Maintenance Station.

Fig. 2 Eastern Regional Maintenance Station
Fig. 3 Foothill Maintenance Station.

Fig. 4 Termination Park and Ride
Fig. 5 Paxton Park and Ride

Fig. 6 Via Verde Park and Ride
AVERAGE INTENSITY DURATION CURVES

PROBABLE 50 YEAR FREQUENCY
OF RAINFALL FOR DISTRICT VII

AVERAGE INTENSITY IN INCHES PER HOUR

DURATION IN MINUTES
Peak Storm Water Runoff Flow Rate

Using 50 yr. Duration Curve and converting it to 1 yr. 24 hr. storm using intensity ratio

\[ = 0.445 = \frac{1 \text{ yr. peak intensity}}{50 \text{ yr. peak intensity}} \]

Duration = Time of Concentration
\[ t_c = 10 \text{ minutes} \] for all sites except
Via Verde & Foothill M. Yards

Fifth Curve 50 yr. frequency

All sites except Via Verde & Foothill
50 yr. intensity, inches/hr = 3.18

Converting to 1 yr. design storm using intensity ratio 0.445

All sites except Via Verde & Foothill
0.445 \times 3.18 = 1.41

Peak Rainfall Rate
\[ \text{Alamoza} = 0.75 \text{ ft.}^{2} \times 43.56 \text{ in}^{3} \times \frac{1}{14.1} \text{ in}^{3} \times \frac{1}{12} \text{ in} \]
\[ = 7.48 \text{ gal/ft}^{2} \times \frac{hr}{60 \text{ min}} \times 1 = 474 \text{ gal/min.} \]
2. Eastern Regional

\[ 1.45 \times 43560 \times 1.41 \times \frac{1}{12} \times \frac{7.48}{60} \times 0.9 \]

\[ = 826 \text{ gpm} \]


\[ 4.59 \times 43560 \times 1.41 \times \frac{1}{12} \times \frac{7.48}{60} \times 1.0 \]

\[ = 2901 \text{ gpm} \]

4. Terminal Park & Ride

\[ 3.79 \times 43560 \times 1.41 \times \frac{1}{12} \times \frac{7.48}{60} \times 0.9 \]

\[ = 11539 \text{ gpm} \]

5. Paxton Pa R

\[ 1.36 \times 43560 \times 1.41 \times \frac{1}{12} \times \frac{7.48}{60} \times 0.9 \]

\[ = 755 \text{ gpm} \]

6. Lakewood

\[ 1.93 \times 43560 \times 1.41 \times \frac{1}{12} \times \frac{7.48}{60} \times 1.0 \]

\[ = 1221 \text{ gpm} \]
For Via Verde & Foothill
nom curve 50 yr. frequency curve L
= 3.71

Converting to 1 yr. design storm using intensity ratio of 0.445

= 0.445 x 3.71 = 1.67 1 yr. peak intensity in./hr

Peak Rainfall Rate

Via Verde

= 1.09 acre x 43560 ft²/acre x 1.67 in/hr x 1/12 hr/ft² x 2.48 in

x 0.9 = 73.2 gpm

Foothill

= 1.75 x 43560 x 1.67 x 1/12 x 7.69 x 1/50 x 0.9 = 13.12 gpm
E. Regional Maintenance Station:

Volume of water = 115.63 cu m

= 4080 cu ft.

Assuming a depth of 7 ft for sedimentation basin.

Surface Area = \( \frac{4080}{7} \) = 581.43 sq ft.

Size of Sedimentation Basin = 582 sq ft.

= 6.0 m x 9.0 m

= 54 m²

= 582.0 sq ft.

Media Filter Area

\[ A_f = \frac{A_d \cdot H}{18} \]

\[ A_d = \text{Drainage Area} = 1.45 \text{ ac} = 62560 = 63,162 \text{ sq ft} \]

\[ H = \text{depth of rainfall} = 1" = \frac{1}{12} \text{ ft} \]

\[ A_f = \frac{63,162 \times \frac{1}{12}}{18} = 292.89 \text{ sq ft} \]

\[ A_f = 6.0 \times 4.5 = 27 \text{ m}^2 = 291.6 \text{ ft}^2 \]
Foothill Maintenance Unit

\[
\text{Volume} = \frac{216.30 \text{ m}^3}{7653.87 \text{ ft}^3} = 0.025 \text{ ft}^3
\]

Assuming a depth of 7 ft =

Surface Area = \frac{7653.87}{7} = 1097.7 \text{ sq ft}

Size of Sed. Basin = \frac{12.75 \times 8.0}{102} = 10.97 \text{ sq ft}

Media Filter

\[
A_f = \frac{A_d \times H}{18}
\]

\[
A_d = \text{Drainage Area} = 1.75 \text{ acre} = 43560 = 76,230 \text{ sq ft}
\]

\[
H = 1" = \frac{1}{12} \text{ ft}
\]

\[
A_f = \frac{76,230 \times \frac{1}{12}}{13} = 353 \text{ sq ft}
\]

Surface Area: \( A_f = 353 \text{ sq ft} \)

Size of Media Filter: \( 5 \times 5.0 \text{ m} = 40 \text{ m}^2 = 430 \text{ sq ft} \)
Vol. of water = 222.36 m³

= 7846.5 ft³

Assuming depth = 7'

Sedimentation Basin Surface Area = \( \frac{7846.5}{7} \) = 1121.6

Size of Sed. Basin = 12.0 m x 9.5 m

= 114 m²

= 1226.4 ft²

Media Filler:

\[ A_f = \frac{A_3}{18} \]

\[ A_3 = 2.79 \text{ acre} \times 43560 = 121532.4 \text{ ft}^2 \]

\[ H = 1'' = \frac{1}{12} \text{ ft} \]

\[ A_f = \frac{121532.4 \times \frac{1}{12}}{18} \]

\[ A_f = 562 \text{ ft}^2 \]

(See) Media Filler = 6.0 m x 9.5 m = 57 m²

= 613 ft²
PARTON PARK SEWER

Sewer Basin

Vol. of Water: 107.11 m³

= 3779.65 m³

Assuming Depth of Sel. Basin = 7'

Surface Area of Sel. Basin = \frac{3779.65}{7} = 547.84 ft²

Size of Sel. Basin: 9.0m x 6.0m = 54 m²

= 581 sq ft = 52

Media Fill

\[ A_f = \frac{A_{H}}{18} \]

\[ A_{H} = 1.34 \text{ acre} = 58370.4 \text{ sq ft} \]

\[ H = \frac{1}{2} \text{ ft} \]

\[ A_f = \frac{58370.4 \times \frac{1}{2}}{18} = 271 \text{ sq ft} \]

Size of Media Fill: 4.5m x 6.0m = 27 m²

= 291 sq ft = 52
Aloha de Mahalaula Sta:

Volume of water = 65 15 m³

= 2299 33 cft

= 17,196.3 x 17,200 gal

Unit selected for site =
## Runoff Volume for Caltrans Pilot Study Sites Based on Retrofit Method

<table>
<thead>
<tr>
<th>BMP Location</th>
<th>Drainage area, acres</th>
<th>Imperviousness</th>
<th>Rainfall Zone</th>
<th>Rainfall, inches</th>
<th>Peak Rainfall, inches/hr</th>
<th>Peak Flow, gpm (Q=CIA)</th>
<th>Volume of Water, gal</th>
<th>Volume of Water, cubic meters</th>
<th>Sed. Basin Area</th>
<th>Media Filter Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alameda Maintenance Station</td>
<td>0.75</td>
<td>100%</td>
<td>K</td>
<td>1</td>
<td>1.41</td>
<td>474</td>
<td>17,212</td>
<td>65.15</td>
<td>329</td>
<td></td>
</tr>
<tr>
<td>Eastern Regional Maintenance Station</td>
<td>1.45</td>
<td>90%</td>
<td>K</td>
<td>1</td>
<td>1.41</td>
<td>826</td>
<td>30,549</td>
<td>115.63</td>
<td>583</td>
<td>293</td>
</tr>
<tr>
<td>Metro Maintenance Station</td>
<td>4.58</td>
<td>100%</td>
<td>K</td>
<td>1</td>
<td>1.41</td>
<td>2,901</td>
<td>105,288</td>
<td>398.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foothill Maintenance Station</td>
<td>1.75</td>
<td>100%</td>
<td>L</td>
<td>1.4</td>
<td>1.67</td>
<td>1,312</td>
<td>57,305</td>
<td>216.90</td>
<td>1,094</td>
<td>353</td>
</tr>
<tr>
<td>Termination Park and Ride</td>
<td>2.79</td>
<td>90%</td>
<td>K</td>
<td>1</td>
<td>1.41</td>
<td>1,589</td>
<td>58,748</td>
<td>222.36</td>
<td>1,122</td>
<td>563</td>
</tr>
<tr>
<td>Via Verde Park and Ride</td>
<td>1.09</td>
<td>90%</td>
<td>L</td>
<td>1.4</td>
<td>1.67</td>
<td>732</td>
<td>32,590</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paxton Park and Ride</td>
<td>1.34</td>
<td>90%</td>
<td>K</td>
<td>1</td>
<td>1.41</td>
<td>765</td>
<td>28,300</td>
<td>107.11</td>
<td>540</td>
<td>271</td>
</tr>
<tr>
<td>8605.91 (S)</td>
<td>0.80</td>
<td>100%</td>
<td>K</td>
<td>1</td>
<td>1.41</td>
<td>506</td>
<td>18,377</td>
<td>69.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85/8605</td>
<td>6.80</td>
<td>54%</td>
<td>K</td>
<td>1</td>
<td>1.41</td>
<td>2,324</td>
<td>96,325</td>
<td>364.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-5/Lakewood Blvd Park and Ride</td>
<td>1.93</td>
<td>100%</td>
<td>K</td>
<td>1</td>
<td>1.41</td>
<td>1,221</td>
<td>44,334</td>
<td>167.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a - Based on field study for Retrofit Project
b - The volume of rain is calculated based upon 0.06-inches of rain loss due to local ponding and 90-percent runoff from impervious surfaces and 15-percent runoff from pervious surfaces
APPENDIX D

CONSTRUCTION COST
**Construction Costs from July Bid**

<table>
<thead>
<tr>
<th>Site</th>
<th>Construction Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Alameda</td>
<td>$172,040</td>
</tr>
<tr>
<td>#2 Eastern</td>
<td>$267,570</td>
</tr>
<tr>
<td>#3 Foothill</td>
<td>$400,648</td>
</tr>
<tr>
<td>#4 Termination</td>
<td>$372,982</td>
</tr>
<tr>
<td>#5 Paxton</td>
<td>$317,947</td>
</tr>
<tr>
<td>#6 Via Verde</td>
<td>$309,633</td>
</tr>
<tr>
<td>#7 Metro</td>
<td>$483,911</td>
</tr>
<tr>
<td>#8 Lakewood</td>
<td>$388,038</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$2,712,769</strong></td>
</tr>
</tbody>
</table>
PROJECT MEMORANDUM

Brown and Caldwell  
16735 Von Karrman  
Irvine, CA 92606  

June 12, 1998  
97-1019E

Attention: Mr. Robert Finn

Subject: Geotechnical Design Parameters for Caltrans District 7 I-105/Lakewood Blvd, Via Verde, Metro, Paxton, Foothill, Termination, Eastern Regional and Alameda sites

Robert:

We are submitting preliminary design data as requested for shoring and retaining walls for the referenced sites. Boring logs will be included with the design data.

Shoring

Design of shoring for the proposed excavations, should utilize the following design parameters:

TABLE 1: SHORING DESIGN DATA

<table>
<thead>
<tr>
<th>Structural Pressures</th>
<th>Cohesion (lb/ft²)</th>
<th>Friction Angle (deg)</th>
<th>Unit Wt. (lb/ft³)</th>
<th>Unit Wt. (kN/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-105/Lakewood</td>
<td>0</td>
<td>30</td>
<td>125</td>
<td>19.6</td>
</tr>
<tr>
<td>Via Verde P &amp; R</td>
<td>0</td>
<td>33</td>
<td>120</td>
<td>18.8</td>
</tr>
<tr>
<td>Metro M. S.</td>
<td>0</td>
<td>30</td>
<td>120</td>
<td>18.8</td>
</tr>
<tr>
<td>Paxton P &amp; R</td>
<td>0</td>
<td>33</td>
<td>120</td>
<td>18.8</td>
</tr>
<tr>
<td>Foothill M. S.</td>
<td>0</td>
<td>30</td>
<td>120</td>
<td>18.8</td>
</tr>
<tr>
<td>Termination P &amp; R</td>
<td>0</td>
<td>34</td>
<td>125</td>
<td>19.6</td>
</tr>
<tr>
<td>East Regional M. S.</td>
<td>0</td>
<td>34</td>
<td>125</td>
<td>19.6</td>
</tr>
<tr>
<td>Alameda M. S.</td>
<td>0</td>
<td>30</td>
<td>120</td>
<td>18.8</td>
</tr>
</tbody>
</table>

All shoring shall be designed by the contractor in accordance with the California Trenching and Shoring Manual and shall conform to the California Code of Regulations Title 8, Construction Safety Orders Sections 1504, 1539 – 1543.
Active and At-Rest Pressure

Walls of the BMP and other buried pipes and structures will be subjected to lateral earth pressures from the retained soils. Caltrans Structural Backfill shall be used per Standard Specifications 19-3.06. Assuming structural backfill is used, walls should be designed to resist an equivalent fluid pressure of 36 lb/ft² (5.6 kN/m²).

The lateral earth pressures should be applied in a triangular pressure distribution. The resultant force for the at-rest condition should be applied at the mid-height of the wall. The value is based on the assumptions that; (1) back-fill is level with a height no greater than 30-feet, and; (2) back-fill materials are well-drained and non-expansive with an Expansion Index (EI) no greater than 30, as determined by the UBC Standard Test 29-2.

Determination of appropriate wall design conditions (active or at-rest) will depend on the flexibility of the wall. Cantilevered walls are those capable of rotating at least 0.001 radian about their base. Walls restrained against rotation should be designed for appropriate at-rest earth pressures.

Surcharge loads (dead or live) should be added to the indicated lateral earth pressures. Surcharge pressures should be applied as a uniform (rectangular) pressure distribution. A traffic surcharge of 2-feet (600 mm) of soil shall be added where appropriate. The corresponding lateral earth pressure coefficients for a uniform vertical surcharge behind the wall and bearing values are as follows:

<table>
<thead>
<tr>
<th>Site</th>
<th>Wall Design Condition</th>
<th>Lateral Earth Pressure Coefficients</th>
<th>Bearing Value (lb/ft²)</th>
<th>Bearing Value (kPa)</th>
<th>Settlement (in)</th>
<th>Settlement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-105/Lakewood</td>
<td>Active</td>
<td>0.33</td>
<td>2000</td>
<td>95.6</td>
<td>2/3</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>At-Rest</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Via Verde P &amp; R</td>
<td>Active</td>
<td>0.39</td>
<td>3000</td>
<td>143.6</td>
<td>1/2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>At-Rest</td>
<td>0.56</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metro M. S.</td>
<td>Active</td>
<td>0.32</td>
<td>3000</td>
<td>143.6</td>
<td>1/2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>At-Rest</td>
<td>0.48</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paxton P &amp; R</td>
<td>Active</td>
<td>0.30</td>
<td>3000</td>
<td>143.6</td>
<td>1/2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>At-Rest</td>
<td>0.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foothill M. S.</td>
<td>Active</td>
<td>0.33</td>
<td>2000</td>
<td>95.6</td>
<td>2/3</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>At-Rest</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Termination</td>
<td>Active</td>
<td>0.30</td>
<td>4000</td>
<td>191</td>
<td>1/2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>At-Rest</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Regional</td>
<td>Active</td>
<td>0.30</td>
<td>4000</td>
<td>191</td>
<td>1/2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>At-Rest</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alameda M. S.</td>
<td>Active</td>
<td>0.33</td>
<td>2000</td>
<td>95.6</td>
<td>2/3</td>
<td>17</td>
</tr>
</tbody>
</table>

2
Vertical surcharges setback behind the wall at a horizontal distance greater than the exposed wall height, need not be added to the design pressures. Surcharge pressures due to concentrated loads may be evaluated after geometric constraints and loading conditions are determined.

**Passive Pressure**

Lateral load resistance may be provided by a combination of friction acting at the base of the slabs, and passive earth pressure developed against the sides of buried walls. Friction and passive pressure may be used in combination, without reduction, in determining the total resistance to lateral loads.

**TABLE 3: LATERAL LOAD RESISTANCE**

<table>
<thead>
<tr>
<th>Site</th>
<th>Coefficient of Friction</th>
<th>Lateral Bearing Value (lb/ft²-ft)</th>
<th>(kPa/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-105/Lakewood</td>
<td>0.40</td>
<td>240</td>
<td>3.5</td>
</tr>
<tr>
<td>Via Verde P &amp; R</td>
<td>0.45</td>
<td>200D+600</td>
<td>29D+8.75</td>
</tr>
<tr>
<td>Metro M. S.</td>
<td>0.40</td>
<td>200</td>
<td>2.9</td>
</tr>
<tr>
<td>Paxton P &amp; R</td>
<td>0.45</td>
<td>300</td>
<td>4.3</td>
</tr>
<tr>
<td>Foothill M. S.</td>
<td>0.45</td>
<td>300</td>
<td>4.3</td>
</tr>
<tr>
<td>Termination P &amp; R</td>
<td>0.45</td>
<td>300</td>
<td>4.3</td>
</tr>
<tr>
<td>East Regional M. S.</td>
<td>0.45</td>
<td>300</td>
<td>4.3</td>
</tr>
<tr>
<td>Alameda M. S.</td>
<td>0.40</td>
<td>240</td>
<td>3.5</td>
</tr>
</tbody>
</table>

*D=*Depth Below Lowest Adjacent Grade

A coefficient of friction may be used for dead loads acting upon on-site soils. The allowable lateral bearing value can be used for the sides of buried walls placed against competent native soils.
Corrosion Tests

Selected, combined samples from bulk samples were tested in the laboratory to evaluate soluble chlorides, soluble sulfates, pH and Minimum Resistivity in accordance with ASTM D512-89, CTM 417, and CTM 643 test procedures, respectively. The results of the tests are given in Table 2, Corrosion Test.

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Sample Depth (m)</th>
<th>Soluble Sulfate (ppm)</th>
<th>Soluble Chloride (ppm)</th>
<th>Minimum Resistivity (ohm-cm)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>0.6-1.5</td>
<td>148</td>
<td>50</td>
<td>6,003</td>
<td>10.4</td>
</tr>
<tr>
<td>B-2</td>
<td>1.5-3.0</td>
<td>198</td>
<td>200</td>
<td>*</td>
<td>8.68</td>
</tr>
<tr>
<td>B-3</td>
<td>3.0-4.5</td>
<td>115</td>
<td>80</td>
<td>*</td>
<td>8.05</td>
</tr>
<tr>
<td>B-4</td>
<td>0.6-1.5</td>
<td>1,098</td>
<td>74</td>
<td>*</td>
<td>6.40</td>
</tr>
<tr>
<td>B-5</td>
<td>0.6-1.5</td>
<td>123</td>
<td>65</td>
<td>*</td>
<td>8.30</td>
</tr>
<tr>
<td>B-6</td>
<td>1.5-3.0</td>
<td>115</td>
<td>37</td>
<td>*</td>
<td>8.94</td>
</tr>
<tr>
<td>B-7</td>
<td>0.6-3.0</td>
<td>90</td>
<td>89</td>
<td>*</td>
<td>8.38</td>
</tr>
<tr>
<td>B-8</td>
<td>1.5-3.0</td>
<td>115</td>
<td>45</td>
<td>*</td>
<td>8.22</td>
</tr>
</tbody>
</table>

* in progress

Ground water was encountered at the I-105/Lakewood and the Metro during the field exploration and could be encountered during the excavation of the proposed BMPs. If such a situation occurs, the contractor should be prepared to de-water the site prior to construction in order to successfully complete the project. If de-watering of the proposed BMP is determined to be too costly, an alternate solution could be to re-design by raising the elevation of the BMP inverts.

Also, during excavating, there is still the possibility ground water may be encountered as other shallower perched ground water zones. This water should be de-watered during construction.

Cobbles may cause excavation difficulties at the Paxton and Foothill sites. At the Via Verde site, fill was encountered to below the BMP structure and sump pump inverts. At the present time information about the placement of the fill is unknown. While excavating in the fill, windrows or randomly placed cobbles and/or boulders could be encountered. Trash, rebar or used concrete can be another factor if uncovered within the fill during construction.

See boring logs for site specific lithology and encountered materials, ground water levels and moisture/density information.

A final report for each site will follow as completed.
If you have any questions, please do not hesitate to contact The LKR Group, Inc. at (310) 320-5100.

THE L.K.R GROUP, INC.

[Signature]

Steven Kolthoff, Project Geologist

971019e9

Attached Draft Log of Test Borings:

1) I-105/Lakewood Blvd. P & R
2) Termination P & R
3) Eastern Regional M. S.
4) Via Verde P & R
5) Foothill M. S.
6) Paxton P & R
7) Metro M. S.
8) Alameda M. S.
GROUND SURFACE

30mm of AC

(SP) Light brown GRAVELLY SAND, damp

(SM) Brown SILTY SAND, fine-grained with GRAVEL, moist

Grades to coarse-grained SAND

(SP) Brownish gray SAND, fine to coarse-grained, moist

Grades to with 1/2" GRAVEL

(SM) Light gray SILTY SAND, fine to coarse-grained

Color changes to light brown with GRAVEL

05-16-98

PROFILE

VERTICAL: 0 1 2 3 4 5
HORIZONTAL: 10 20 30 40
Ground Surface

100mm of AC

(SM) Greenish gray SILTY SAND, fine to medium-grained, with GRAVEL, damp

Intercalated in SILT, finer-grained SAND

Color changes to brown, carbonate stringer

(SP) Light gray SAND, fine to medium-grained, with 1/2" GRAVEL

Gray mottled reddish brown SILT SAND, fine-grained, moist

Color changes to brown, porous, carbonate stringers

Coarser grained SAND

Fine to coarse-grained SAND

Profile

VERTICAL

HORIZONTAL
APPENDIX F

TREATMENT UNIT SITES
DRAINAGE AREAS
Appendix G

Oil/Water Separator Information
Oil/Water Separators and Interceptors

Working Together for a Cleaner Environment.

Highland Tank
## Schedule of Standard Size Oil Water Separator with Coalescer

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TOTAL VOLUME</th>
<th>TOTAL SPILL CAPACITY</th>
<th>FLOW RATE</th>
<th>DIA.</th>
<th>LENGTH</th>
<th>INLET/OUTLET</th>
<th>APPROX WEIGHT (LBS.)</th>
<th>GENERAL NOTES</th>
<th>ACCESSORIES FOR EACH SEPARATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTC - 550</td>
<td>550</td>
<td>275</td>
<td>55</td>
<td>3'-6&quot;</td>
<td>7'-9&quot;</td>
<td>4&quot;</td>
<td>2,024</td>
<td></td>
<td>Double Wrap Shell: Type I or Type II</td>
</tr>
<tr>
<td>HTC - 1,000</td>
<td>1,000</td>
<td>500</td>
<td>100</td>
<td>4'-0&quot;</td>
<td>12'-0&quot;</td>
<td>6&quot;</td>
<td>3,001</td>
<td></td>
<td>Hold Down Straps: Size -</td>
</tr>
<tr>
<td>HTC - 2,000</td>
<td>2,000</td>
<td>1,000</td>
<td>200</td>
<td>5'-4&quot;</td>
<td>12'-0&quot;</td>
<td>6&quot;</td>
<td>4,122</td>
<td></td>
<td>Test: Tumbrillies:</td>
</tr>
<tr>
<td>HTC - 3,000</td>
<td>3,000</td>
<td>1,500</td>
<td>300</td>
<td>5'-4&quot;</td>
<td>18'-0&quot;</td>
<td>6&quot;</td>
<td>5,001</td>
<td></td>
<td>Gauge / Thickness: Heads -</td>
</tr>
<tr>
<td>HTC - 4,000</td>
<td>4,000</td>
<td>2,000</td>
<td>400</td>
<td>5'-4&quot;</td>
<td>24'-0&quot;</td>
<td>6&quot;</td>
<td>5,760</td>
<td></td>
<td>Shell -</td>
</tr>
<tr>
<td>HTC - 5,000</td>
<td>5,000</td>
<td>2,500</td>
<td>500</td>
<td>6'-0&quot;</td>
<td>23'-10&quot;</td>
<td>6&quot;</td>
<td>8,082</td>
<td></td>
<td>Paint: Interior:</td>
</tr>
<tr>
<td>HTC - 6,000</td>
<td>6,000</td>
<td>3,000</td>
<td>600</td>
<td>6'-0&quot;</td>
<td>28'-0&quot;</td>
<td>10&quot;</td>
<td>9,484</td>
<td></td>
<td>Paint: Exterior:</td>
</tr>
<tr>
<td>HTC - 7,000</td>
<td>7,000</td>
<td>3,500</td>
<td>700</td>
<td>7'-0&quot;</td>
<td>24'-4&quot;</td>
<td>10&quot;</td>
<td>11,124</td>
<td></td>
<td>Construction: Flat Flanged Heads -</td>
</tr>
<tr>
<td>HTC - 8,000</td>
<td>8,000</td>
<td>4,000</td>
<td>800</td>
<td>7'-0&quot;</td>
<td>26'-0&quot;</td>
<td>10&quot;</td>
<td>11,950</td>
<td></td>
<td>Lap Weld - Outside Only</td>
</tr>
<tr>
<td>HTC - 9,000</td>
<td>9,000</td>
<td>4,500</td>
<td>900</td>
<td>8'-0&quot;</td>
<td>24'-0&quot;</td>
<td>12&quot;</td>
<td>11,963</td>
<td></td>
<td>(Unless otherwise noted)</td>
</tr>
<tr>
<td>HTC - 10,000</td>
<td>10,000</td>
<td>5,000</td>
<td>1,000</td>
<td>8'-0&quot;</td>
<td>26'-8&quot;</td>
<td>12&quot;</td>
<td>12,696</td>
<td></td>
<td>Special Notes: sR2 is Standard</td>
</tr>
<tr>
<td>HTC - 12,000</td>
<td>12,000</td>
<td>6,000</td>
<td>1,200</td>
<td>8'-0&quot;</td>
<td>32'-0&quot;</td>
<td>12&quot;</td>
<td>14,131</td>
<td></td>
<td>*LevelSensor, Alarm Box, Inlet and Outlet Tees and Oil Skimmer are Optional Equipment</td>
</tr>
</tbody>
</table>

---

**Notes:**
- HTC - 550 to HTC - 10,000: Refer to drawing for specific dimensions and configurations.
- HTC - 12,000 and above: Refer to manufacturer's brochure for detailed specifications.

**Copyright 1992 By Highland Tank & Mfg. Co.**

---

**Highland TANK & MFG. CO.**

One Highland Road • Stoystown, PA 15563  
Ph.: 814-893-5701 • FAX: 814-893-6126

Registered U.S. Patent Office  
- U.S. Patent No. 4,722,800 -

Approved by the City of New York Board of Standards and Appeals under Calendar Number 1215-88-SA

Canadian Patent No. 1,296,283

---

**Customer:**

**Order No.:**

**Project:**

**Scale:**

**Drawn By:**

**Date:**

**Dwg. No.:**

**NONE** • SJM
Highland Tank & Manufacturing Company
Oil/Water Separator Specifications
Model HTC

Provide and install _________ Highland Tank & Mfg. Co. Model HTC-_______ parallel
corrugated plate gravity displacement Oil Water Separator. Separator(s) shall be ________ in
diameter, ________ long, having a total volume of _________ gallons.

1.0 Application

The separator shall be designed for gravity separation of free oils (hydrocarbons and other
petroleum products) along with some settleable solids from water. The source of the influent to the
separator shall be gravity flow from storm water runoff and spills.

2.0 Performance

2.1 Influent Characteristics

Provide Oil Water Separator designed for intermittent and variable flows of water, oil, or
any combination of non-emulsified oil-water mixtures ranging from zero to ______ gpm.
Operating temperatures of the influent oil in water mixture shall range from 40°F to 180°F.
The specific gravities of the oils at operating temperatures shall range from 0.68 to 0.95 and
the petroleum hydrocarbon concentration less than or equal to 200,000 mg/l (20%). The
specific gravity of the fresh water at operating temperatures shall range from 1.00 to 1.03.

2.2 Effluent Characteristics

The oil and grease concentration in the effluent from the oil water separator shall not
exceed 10 mg/l (10 ppm). To achieve this goal, it will be necessary to remove all free oil
droplets equal to and greater than 20 microns.

3.0 Design Criteria

3.1 The oil water separator shall be designed in accordance with Stokes Law and the
American Petroleum Institute Manual on Disposal of Refinery Wastes, Volume on Liquid
Wastes as stated in Chapter 5, Oil Water Separator Process Design and API Bulletin No.
Facilities.

The oil water separator shall comply with the following design criteria:

3.2 Capacities, dimensions, construction, and thickness shall be in strict accordance
with Underwriters Laboratories, Subject UL-58 Standard for Safety, Steel Underground
Tanks for Flammable and Combustible Liquids.

3.3 Corrosion Control System shall be in strict accordance with sti-P₃® specifications as
applied by a licensee of the Steel Tank Institute. Manufacturer must be a licensee of Steel
Tank Institute. No assigning or subcontracting of sti-P₃® licensing shall be permitted.
3.4 Separator shall be the standard product of a steel tank manufacturer regularly engaged in the production of such equipment. No subcontracting of tank fabrication shall be permitted.

3.5 Separator shall be fabricated, inspected and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation. Inspection and test reports shall be supplied to customer on Manufacturer's letterhead.

3.6 Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions.

3.7 Separator shall have an oil storage capacity equal to about 50% of the total vessel volume and an emergency oil spill capacity equal to 80% of the total vessel volume.

3.8 Separator shall consist of inlet and outlet connections, non-clogging flow distributor and energy dissipator device, stationary under flow baffle, presettling chamber for solids, sludge baffle, oil coalescing chamber with parallel corrugated plate and polypropylene coalescers to optimize separation of free oil from liquid carrier, effluent downcomer positioned to prevent discharge of free oil that has been separated from the carrier liquid, access for each chamber, lifting lugs, fittings for vent, oil pump out, sampling, and gauging.

4.0 General Description

The separator shall be a cylindrical parallel corrugated plate gravity displacement type oil water separator with construction and thickness in strict accordance with Underwriters Laboratories Subject 58, using flat flanged heads. The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:

4.1 An influent connection __________ inch, flanged.

4.2 An internal influent nozzle at the inlet end of the separator, located at the furthest diagonal point from the effluent discharge opening.

4.3 A velocity head diffusion baffle at the inlet to:
• reduce horizontal velocity and flow turbulence.
• distribute the flow equally over the separators cross sectional area.
• direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume.
• completely isolate all inlet turbulence from the separation chamber.

4.4 A sediment chamber to disperse flow and collect oily solids and sediments.

4.5 A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.

4.6 An Oil Water Separation Chamber containing a parallel corrugated plate coalescer to:
• shorten the vertical distance than an oil globule has to rise for effective removal.
• enhance coalescence by generating a slight sinusoidal (wave like) flow pattern thereby causing smaller, slow rising, oil globules to coalesce on the undersides of the plates forming larger, rapidly rising sheets of oil.
• direct the paths of the separated oil to the surface of the separator.
4.7 An Oil Water Separation Chamber containing a removable "PETRO-SCREEN™
polypropylene coalescer designed to intercept oil globules equal to and
greater than 20
microns in diameter to produce an effluent quality of 10 ppm oil and
grease.

4.8 An internal effluent downcomer at the outlet end of the separator, to allow for
discharge from the bottom of the separation chamber only.

4.9 An effluent connection _________ inch, flanged.

4.10 Fittings for vent, interface/level sensor, and waste oil pump out, sampling, and
gauge.

4.11 Two 24" diameter UL-approved, manholes (18" on 550 gallon), complete with
_________ ft. extensions, cover, gasket, and bolts. One manway shall be placed
between the inlet and the parallel corrugated plate coalescer to facilitate access into the
sediment chamber for solids removal. One manway shall be placed between the parallel
corrugated plate coalescer and outlet to facilitate access into the oil water separation
chamber for oil removal.

4.12 Lifting lugs at balancing points for handling and installation.

4.13 Identification plates: Plates to be affixed in prominent location and be durable and
legible throughout equipment life.

4.14 sti-P₃® Corrosion Protection System consisting of:
• Isolation spool pieces
• Dielectric isolation gaskets and bushings
• External surfaces commercially sand blasted and coated 10 mils on shell, 15 mils on
head. DFT Polyurethane or 60, 100 or 125 mils head and shell, Fiberglass Reinforced
Polyester
• Cathodic protection system using zinc anodes
• PPPI Protection Prover
• sti-P₃® Limited 30-year Warranty: Thirty year protection against external corrosion and
structural defects.

4.15 Internal surfaces commercially sand-blasted, coated 15 mils DFT Polyurethane

5.0 Construction And Materials

Refer to U.L. 58 and sti-P₃® Specifications.

6.0 Quality Assurance

6.1 Submittals:
• Shop Drawings: for oil water separators shall show principal dimensions and location
of all fittings:
• Provide three complete sets of installation, operation, and maintenance instructions with
seperator.
• Quality control and inspection procedures and reports shall be considered of the
submittal package.
6.2 Warranty
- The manufacturer shall warrant its products to be free from defects in material and
workmanship for a period of one year from the date of shipment. The warranty shall be
limited to repair or replacement of the defective part(s). sti-P3 Limited Warranty:
Lifetime protection for structural defects. Thirty year protection against external
corrosion and structural defects.

7.0 Approved Manufactures

The Oil Water Separator shall be manufactured by Highland Tank and Mfg. Co., One Highland
Road, Stoystown, PA 15563, Phone (814) 893-5701, Facsimile 814-893-6126.

8.0 Accessories

8.1 Separator furnished with intrinsically safe oil level controls to activate high level
alarm at a predetermined oil level. All components enclosed in NEMA _____________
enclosure.

8.2 Separator furnished with oil level/liquid level controls to start and stop oil pump and
to activate high level alarm at predetermined levels. All components enclosed in NEMA
___________ enclosure.

8.3 Separator furnished with bucket type oil skimmers which can be manually adjusted to
drain off precisely the amount of oil desired, to a separate waste oil tank.

8.4 A Highland Tank & Mfg. Co. Waste Oil Storage Tank for separated oil. Tank
capacity shall be __________ gallons. Tank shall be __________ in diameter and
___________ long. Construction and thickness of tank shall be in strict
conformance with Underwriters Laboratories Subject 58, using flat flanged heads. The
corrosion control system shall be in strict accordance with sti P-3 specifications as applied
by a licensee of the Steel Tank Institute.

8.5 Consult Manufacturer for:
- Special coating (interior or exterior)
  1. Polyurethane
  2. Fiberglass Reinforced Polyester
  3. Coal Tar Epoxy
  4. Primer
  5. Enamel
  6. Vinyl
  7. Epoxy Phenolic
  8. Epoxy Polyamide Combination
- Aboveground Skids
- Pump Out Systems with integral compartment sumps:
  1. Oil Pump Out
  2. Water Pump Out
  3. Sludge Pump Out
- Level Controls
- Heating Systems
  1. Electric
  2. Steam
- Tank Accessories: Refer to Highland Tank Catalog
Highland's Patented Design

Highland Tank's patented design combines state-of-the-art technology with time-tested materials, making Highland separators the strongest and most reliable high-performance separators in the industry.

The oil/water separator is a stationary underground, wastewater treatment vessel, filled with water. Internal baffles and coalescers accelerate the oil/water separation process. Waste accumulates within the separator while effluent is discharged by gravity.

Diffusion Baffle

The velocity head diffusion baffle, located near the inlet of the separator, is designed to serve four basic functions:
1. To displace the velocity head, thereby improving the overall hydraulic characteristics of the separator.
2. To direct incoming fluid downward and outward, maximizing the use of the separator volume.
3. To reduce flow turbulence and to distribute the flow evenly over the separator's cross-sectional area.
4. To isolate inlet turbulence from the rest of the separator.

Internal Chambers

In the sediment chamber, heavy solids settle out, and concentrated oil slugs rise to the surface. As the oily water passes through the parallel corrugated plate coalescer (an inclined arrangement of parallel corrugated plates) the oil rises and coalesces into sheets on the underside of each plate. The oil then clumps up the plate surface, and breaks loose at the top in the form of large globules. These globules then rise rapidly to the surface of the separation chamber where the separated oil accumulates.

The effluent flows downward to the outlet downstream, where it is discharged by gravity displacement from the lower regions of the separator.

Petro-Screen™

For enhanced oil removal efficiency, a "Petro-Screen™" polypropylene coalescer (a bundle of oleophilic [oil attracting] fibers, layered from coarse to fine and extruded within a solid framework) is used to intercept droplets of oil too minute to be removed by the parallel corrugated plate coalescer.

Monitoring Systems

For easy and efficient operation and maintenance, an oil level sensor can sound an alarm at high oil levels so waste oil can be removed from the separator. Double-wall separators can be furnished with a leak detection system for the intermediate space.

Additional monitoring equipment is available for oil or water level sensing, alarm and pumpout control.
COMMENTS ON MAY 11, 1989 SITE VISIT AND REVIEW OF MCTT DESIGNS

General Comments

- The MCTT sizes appear to be reasonable for the locations. A continuous simulation of the main settling chamber performance was conducted using a series of 112 LAX rains for 1983 through 1985. 1983 had 28.4 inches of rain, over 64 separate events, while 1984 only had 7.4 inches of rain and 23 events and 1985 had 9.1 inches of rain and 28 events. The long-period average rain depth for LAX is 14.9 inches, which was close to the average of these three years. Southern California is known for extreme variations in rain conditions, and this modeling evaluation was therefore important to evaluate the range of conditions represented by these three years.

- The most efficient hydraulic resident time in the main settling chamber is 48 hours and the expected runoff volume captured in that chamber ranges from 0.45 to 0.52 inches of runoff for this rain series for the three installations.

- In all three installations, the average performance for these three rain years is expected to be greater than 80% control for suspended solids, toxicity (indicated using Microtox®), lead, zinc and for most organic toxicants (such as fluoranthene, pyrene, pentachlorophenol, and phenol). Volatile suspended solids, COD, and unfiltered heavy metals should be controlled at levels of about 60%. Excessively wet years would have reduced performance, while drier years would have better performance (increases and decreases in annual average performance of about ±10% may be expected).

- The filtration/ion exchange/sorption chambers are also appropriately sized for the site conditions (having about 3 m/d filtration rates). The flow rates through the media are suitable, and the expected life of the media before clogging may occur is expected to be from 3 to 5 years.

Suggestions

- The ion exchange/sorption media should be a mixture of 50% sand and 50% peat, not just sand alone. This layer should be about 12 inches thick, on top of a 6 inch layer of sand. This should be on top of a filter fabric layer, separating the underdrainage layer. The top of the media should be covered by a filter fabric layer (recommend the Amoco 4557) to act as a flow distributor, to sorb small quantities of oil, and to attract fine particles that are discharged from the main settling chamber.
• The main settling chamber should have a small sump pit installed (possibly several feet across and deep) to assist in cleaning out the captured sediment. This may make cleaning the sediment from the MCTT easier by allowing the sediment to be washed towards this sump where it could be removed during the infrequent cleanings.

• It may be more suitable to pump the water from the main settling chamber to the final ion exchange/sorption chamber, instead of relying on the very small orifices that would otherwise be needed. If orifices are used, then special care would be needed to prevent clogging. A relatively large cage could be constructed around the orifice plate, with many holes slightly smaller than the orifice itself. In all cases, the orifice (or pump) should be easily accessible for inspection and cleaning.

Even though we have only experienced minimal clogging problems with the orifices in the existing full-size MCTT units currently in operation, it is expected that small pumps would provide better control and more reliable performance. The required pump capacities would be very small and would therefore be inexpensive. They could be automatically activated after several inches of water accumulates in the main settling chamber, above the inclined tubes. The pumps would be automatically shut off when the water level dropped to the top of the inclined tubes. The following table shows the approximate necessary pumping rates, average orifice flows, and orifice diameters that would be needed for the three installations:

<table>
<thead>
<tr>
<th>Location</th>
<th>Approx. Pumping Rate</th>
<th>Comparable Average Orifice Discharge</th>
<th>Approximate Orifice size (diameter, in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Via Verde Park and Ride</td>
<td>280 gal/min</td>
<td>0.01 cfs</td>
<td>0.3</td>
</tr>
<tr>
<td>Metro maintenance yard</td>
<td>1170 gal/min</td>
<td>0.04 cfs</td>
<td>0.6</td>
</tr>
<tr>
<td>Lakewood Blvd. Park and Ride</td>
<td>490 gal/min</td>
<td>0.02 cfs</td>
<td>0.5</td>
</tr>
</tbody>
</table>

• Floating sorption sock/pillows should be placed in the main settling chamber.

• For uncovered MCTT units, bypassing flows (after the main settling chamber is full) should be diverted around the last chamber to prevent scouring of the media and other damage. Extend the concrete walls above the pavement surface by about 6 inches, for example, and have another inlet (above the catchbasin inlet elevation, but below this extended wall elevation) for this excessive water to re-enter the drainage system.

• A general inspection should be made of the MCTTs every 6 months, or so. It may be necessary to clean the catchbasin inlet and to replace the sorption sock/pillows at this interval. A general inspection of the whole unit should be conducted at this interval to
indicate the accumulation rate of material in the main settling chamber and to check the condition of the top filter fabric in the last chamber.

• The catchbasin sumps need to be at least 1 m below the hooded outlets. If the sumps were deeper, less frequent cleaning would be needed.

• The inlet to the main settling chamber from the catchbasin should terminate with a perforated flow distributor running across the tank.

• At all three sites, evaluate ways to decrease the installation depths of the MCTT units. One way may be to only monitor flow at the discharge from the MCTTs, while also monitoring water elevations in the main settling chamber and in the final sorption/ion exchange chamber. This information will enable the “before storm” conditions to be known and to also enable flow-weighted composite sampling. This may enable the units to be elevated by about 1 m, reducing site installation problems. However, the extra storage volume eliminated will slightly decrease the MCTT performance during the extreme rains (this extra benefit was not included in the modeling evaluations reported above).

• At the Metro maintenance yard, replace the stripping column balls in the inlet chamber with an adverse sloped inclined screen to minimize clogging problems associated with the vegetation at this site.

• The MCTT units at Lakewood and Via Verde may be shifted slightly to allow water to enter the catchbasin inlet of the MCTT directly through a surface grating (assuming that flows would be monitored at the MCTT discharge and that water levels in the MCTT would be monitored, as listed above). This would significantly reduce the project footprints at these locations, and possibly enable the units to be elevated.