Harding Lawson Associates

Engineering and Environmental Services

245 A

Draft Engineering Design Report
Remedial Action
Cascade Timber Log Yard No. 3
Port of Tacoma
Tacoma, Washington

Prepared for

Port of Tacoma
Post Office Box 1837
Tacoma, Washington 98401

HLA Project No. 12183.3

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March 24, 1994

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DISTRIBUTION

1.0 INTRODUCTION

This report presents the design assumptions and criteria that have been used to design the remedial cleanup action at the Cascade Timber Log Yard No. 3 (site). The site is located on Maxwell Way between Port of Tacoma Road and Thorne Road in Tacoma, Washington. This Design Engineering Report was prepared for the sole use of the Port of Tacoma (the Port), the only intended beneficiary of HLA's work. No other party should rely on the information contained herein without prior written consent of HLA. This report is written in conformance with the requirements of the Model Toxics Control Act (MTCA), WAC 173-340-400(4)(a) (Washington State Department of Ecology, 1991) and describes the site, the cleanup requirements, and design parameters for the selected cleanup action. The Port is working in accordance with Consent Decree No. DE93TC-S303 issued by the Washington State Department of Ecology (Ecology) to clean up the site in accordance with MTCA.

1.1 Project Description

The Cascade Timber No. 3 Log Sort Yard is an 18.57-acre parcel of land owned by the Port. The property is divided into two parcels: a 7.84-acre parcel to the northeast and a 10.73-acre parcel to the southwest. The Remedial Investigation/Feasibility Study (RI/FS) concluded that only the 10.73-acre parcel was impacted with metals. Therefore, this report addresses only the southwest parcel which requires cleanup.

The southwest parcel (the site) was leased to Cascade Timber Company (Cascade) from 1978 through 1987, to store and sort logs. Between January and March, 1982, approximately 500 tons of slag generated by Asarco Inc. of Tacoma, Washington was placed on the site by Cascade for use as a ballast material. In 1985, the Ecology completed an assessment of twelve log sort yards, including the site. Ecology concluded the Asarco slag ballast material was responsible for elevated concentrations of heavy metals in stormwater runoff from the log sort yards. Arsenic, zinc, copper and lead were identified as metals of concern. The site has not been in use since 1987.

HLA completed the RI/FS for the Port in conformance with MTCA to determine the nature and extent of metals onsite and leaving the site, and to develop a solution to clean up the facility. Results of the RI/FS were presented in an August 16, 1993 report titled "Remedial Investigation and Feasibility Study Report, Cascade Timber No. 3 Log Sort Yard, Tacoma, Washington." Of the remedial alternatives considered, capping the site to eliminate direct contact with heavy metals was the recommended remedy. A more detailed summary of the RI/FS is included in Section 2 of this report.

Based on the results of the RI/FS, HLA recommended capping the site as the preferred remedial action to mitigate the migration of metals from the site via stormwater runoff. The cleanup objectives of the remedial action for soil for the protection of human health are to reduce chemical concentration in soil to levels below 200 mg/kg for arsenic and 1,000 mg/kg for lead, or to minimize ingestion or direct contact with soil having concentrations greater than these. The cleanup objectives for soil for the protection of the environment are to minimize migration of chemicals that would contaminate groundwater or surface water in excess of groundwater and surface water requirements. The cleanup objective for groundwater was established for protection of the environment and not established for protection of human health because the groundwater in not considered a potential future drinking water source. The cleanup objectives for groundwater are to minimize the migration of groundwater with concentrations greater than 36 ug/l of arsenic, 10 ug/l for copper, 10 ug/l for lead, and 77 ug/l for zinc to surface water to meet ambient surface water quality criteria. The cleanup objectives for surface water are to reduce concentrations to levels at or below 36 ug/l of arsenic, 10 ug/l for copper, 10 ug/l for lead, and 77 ug/l for zinc in stormwater and to prevent contact of surface water with contaminated soil that may result in concentrations in surface water above these concentrations.

To meet the remedial action objectives, a low permeability cap will be constructed over the slag and impacted soil which will be left onsite in order to eliminate stormwater from coming in contact with slag and soil. The slag and impacted soil containing elevated levels of metals will be consolidated to several areas on the site to reduce the potential for disturbance and exposure as a result of future site activities. In addition, slag from outside of the property line will be moved onto the site. A low permeability cap, designed to eliminate infiltration, will be constructed over the slag and soil that are onsite. A cover system will be designed to withstand the planned future (post-closure) use of the site. Post-closure, the Port will probably use the site for a warehouse. Long term future use may be for intermodal container storage. Both uses are consistent with current planning issues. The cover will be graded to collect stormwater runoff for discharge into the City of Tacoma's existing storm drainage system. The City's system ultimately discharges into the Sitcum Waterway. A downstream analysis of the site was performed to verify that the City's system can accommodate this additional flow.

1.2 Facility Information

The Port of Tacoma (Port) is the owner of the site and is responsible for design and construction of the cap. The Port intends to implement the cleanup action by November 1, 1994. The Port will be responsible for operating and maintaining the site after construction is complete. The Port is also responsible for maintaining the integrity of the cap including placing institutional controls on future use of the site as necessary.

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1.3 Report Organization

This Design Engineering Report is organized in the following manner.

- Section 2 presents a summary of the RI and FS.
- Section 3 presents the engineering criteria for the low permeability cap.
- Section 4 describes the schedule for completing the remedial action.
- Section 5 describes the health and safety issues related to the remedial action and includes a description of the compliance monitoring that will occur during and after cleanup.
- Section 6 describes in general terms the operation and maintenance activities that will occur after completing the construction of the cap.

To facilitate reviewing this engineering report, Table 1 lists information required by the Consent Decree issued by Ecology to be included in the engineering design report. The table lists the requirements and where the information can be found in this report.

TABLE 1
CASCADE TIMBER LOG YARD NO. 3
DESIGN ENGINEERING REPORT
INFORMATION LOCATOR

Consent Decree Task Number **Task 1 - Draft Engineering Design Report**	**Design Engineering Report Section or Attachment where information can be found:**
(a) Goals of the cleanup action:	
- general	1.1 Project Description
- specific cleanup requirements	1.1 Project Description
- performance requirements	1.1 Project Description
(b) General information on the facility:	
- summary of the remedial investigation	2.1 Summary of the Remedial Investigation
- summary of the feasibility study	2.2 Summary of the Feasibility Study
- update of the RI/FS	2.3 Estimates of Volume of Media Requiring Remediation
(c) Identification of who will own, operate, and maintain the cleanup action:	
- during construction	1.2 Facility Information
- after construction	1.2 Facility Information
(d) Facility maps showing:	
- existing site conditions	Figure G3 - Existing Site Plan
- proposed location of cleanup action	Figure C1 - Slag Relocation Plan, Figure C4 - Drainage Plan
(e) Location of materials to be treated or otherwise managed, including contaminated soil and sediment	2.1 Summary of the Remedial Investigation 2.3 Estimates of volume of Media Requiring Remediation
(f) Schedule for remedial action and monitoring	4.1 Schedule for Design and Construction, Figure 1 - Schedule

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CASCADE TIMBER LOG YARD NO. 3
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Consent Decree Task Number **Task 1 - Draft Engineering Design Report**	**Design Engineering Report Section or Attachment where information can be found:**
(g) Description and conceptual plan of the: - cleanup actions - treatment units - facilities	 3.1 Conceptual Plan of Action Not applicable Not applicable
(h) Engineering justification for design parameters: - design criteria - design assumptions - design calculations - demonstration that cleanup action will achieve compliance with cleanup requirements by: - citing pilot or treatability test data - results from similar operations - scientific evidence from literature - justification for thickness, durability and permeability of asphalt cap system	 3.2 Drainage Criteria, 3.4 Subbase, 3.5 Low Permeability Cap 3.2 Drainage Criteria, 3.4 Subbase, 3.5 Low Permeability Cap Appendix A Not applicable 2.2 Summary of the Feasibility Study 2.2 Summary of the Feasibility Study 3.4 Subbase, 3.6 Low Permeability Cap, 3.5 Pavement Alternatives 3.7 Recommended Pavement Section
(i) Design features for control of hazardous materials spills and accidental discharge	5.1 Design Features for Control of Hazardous Releases
(j) Design features to assure long-term safety of workers and local residences	5.2 Design Features to Protect Workers and Local Residences
(k) Discussion of methods for management or disposal of any treatment residual and other waste materials generated	5.3 Management of Waste Materials Generated During Cleanup

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CASCADE TIMBER LOG YARD NO. 3
DESIGN ENGINEERING REPORT
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Consent Decree Task Number **Task 1 - Draft Engineering Design Report**	**Design Engineering Report Section or Attachment where information can be found:**
(l) Facility specific characteristics which may affect design, construction, or operation:	
- relationship of the proposed cleanup action to existing facility operations	1.2 Facility Information
- probability of flooding	3.12 Flooding and Seismic Activity
- waste settling/subsidence	3.4 Subbase
- temperature extremes	3.10 Temperature Extremes
- planned post-remedial sites uses/activities	1.1 Project Description
- local planning and development issues	1.1 Project Description
- soil characteristics	3.4 Subbase
- groundwater system characteristics	3.11 Groundwater
- surface water system characteristics	3.2 Drainage Criteria
(m) Information not provided in the RI/FS needed to fulfill the requirements of the State Environmental Policy Act (RCW 43.21C) and additional information needed to address applicable state, federal and local requirements	SEPA checklist included as Appendix F
(n) Copy of all permits	Contractor required to get grading and paving permits
(o) Final construction plans and specifications	Appendix G (bound separately)
(p) Quality control tests to be performed to document construction	4.2 Construction Testing

TABLE 1
CASCADE TIMBER LOG YARD NO. 3
DESIGN ENGINEERING REPORT
INFORMATION LOCATOR

Consent Decree Task Number **Task 1 - Draft Engineering Design Report**	**Design Engineering Report Section or Attachment where Information can be found:**
(q) Compliance monitoring plan in accordance with WAC 173-340-410:	
- during construction	5.4 Description of Compliance Monitoring
- during operation	5.4 Description of Compliance Monitoring
- sampling and analysis plan in accordance with WAC 173-340-820	Appendix C
- protection monitoring plan	Appendix C
- performance monitoring plan	Appendix C
- confirmation monitoring plan	Appendix C
(r) Safety and health plan per WAC 173-340-810	5.2 Design Features to Protect Workers and Local Residences, and Appendix B
(s) Operation and maintenance plan	Appendix D

2.0 SUMMARY OF REMEDIAL INVESTIGATION/FEASIBILITY STUDY

2.1 Summary of the Remedial Investigation

The RI field investigation, which was conducted intermittently from February, 1992 through March, 1993, included the following activities:

- Manually excavating 172 near-surface test holes to categorize materials present (i.e. slag, wood waste, sand, gravel, soil), identify relative percentages, and record vertical distribution;
- Collecting three soil samples from depth intervals of approximately 0- to 6-inches, 1.0- to 1.5-feet, and 2.5- to 3.0-feet below ground surface from 54 separate locations within the log yard;
- Drilling, installing, and developing seven shallow monitoring wells;
- Drilling and collecting soil samples from three shallow borings;
- Sampling eight monitoring wells (seven newly installed by HLA and one existing) during three separate sampling events.
- Recording monthly water-level elevations for each well, over a six-month long monitoring period;
- Conducting slug tests on three of the shallow monitoring wells; and
- Sampling stormwater runoff during three independent rain events, spaced approximately two or three months apart.

The results of the RI are summarized below:

- **Site Conditions** - Subsurface conditions encountered at the site are characterized by three deposits: a shallow fill layer composed primarily of wood waste, gravel and/or slag up to 3-feet thick; a sandy dredge fill layer up to 7-feet thick underlying the shallow fill layer; and a tidal marsh and delta deposit consisting of silty clay underlain by sand. Shallow groundwater occurs in the sandy dredge fill layer under unconfined conditions. The depth to water in this layer ranged from 2- to 8-feet below ground surface. A second water-bearing zone was encountered beneath the silty clay unit in the sandy layers of delta deposits. The silty clay separating this zone from the shallow water-bearing zone appears to range in thickness from 1- to 11-feet beneath the site. Stormwater accumulates in ponds and was observed to flow offsite in 3 of the 9 sub-basins identified during topographic mapping. Stormwater observed to run off the site discharges to the nearby Sitcum Waterway via the City of Tacoma's storm drain system.
- **Soil** - The occurrence of elevated levels of metals in soil generally corresponds to the distribution of slag. Figure C1 shows the location and depth of slag found during the RI. In areas where slag was observed, antimony, arsenic, copper, lead, and zinc were detected at concentrations exceeding the typical range for soil. Antimony, arsenic, and lead have a similar distribution pattern, with concentrations generally decreasing with depth. In areas where slag was observed, arsenic and lead concentrations typically decreased by 1 or 2 orders of magnitude within the upper 3-feet of soil and were within the typical range for soils at depths of 3-feet. The maximum concentrations of antimony, arsenic and lead (329, 1890, and 1030 milligrams per kilogram (mg/kg) respectively) were detected in the same sample, from a depth interval of 0.0- to 0.5-feet below ground surface. Samples that exceed the MTCA Method A industrial cleanup levels for arsenic and lead were all collected from the southwest parcel of the log yard (the site). Copper and zinc concentrations generally decreased with depth; however, occasionally the highest detected concentrations from individual sampling points were found in samples collected from beneath the surface sample. The maximum concentration of zinc (3190 mg/kg) was detected in the same sample as the maximum concentrations of antimony, arsenic

and lead. The maximum concentration of copper (2760 mg/kg) was detected in a sample collected from the 3.0- to 3.5-feet depth interval. Petroleum hydrocarbons were detected at concentrations up to 35,000 mg/kg. Results suggest that petroleum hydrocarbon contamination extends to a depth of approximately 5-feet below ground surface. Oil and grease were detected at concentrations up to 33,800 mg/kg, with results generally similar to petroleum hydrocarbon results.

- **Groundwater** - The unconfined aquifer at the site occurs in a poorly sorted sand and silty sand fill layer. This fill layer is underlain at approximately 11 feet bgs by a clayey layer which is laterally extensive beneath the site. The clayey layer is underlain by sand deposits which contain the second water-bearing zone beneath the site. These two water-bearing zones do not appear to be hydraulically interconnected. Groundwater at the site is not a current or potential future source of drinking water due to the fact that the water-bearing zones beneath the site are expected to produce small quantities of relatively poor quality water. Because of this, groundwater quality will be evaluated with respect to its ability to discharge to the closest surface water body and will be compared with federal and state marine chronic water quality criteria. Three rounds of groundwater samples were taken from eight monitoring wells during the RI process. Seven of the wells were sampled from the shallow fill unit and one well was sampled from the lower sand unit. No wells screened in the shallow fill unit exceeded the Marine Chronic criterion, with the exception of copper which was detected at a concentration of 3 ug/L. However, copper was also detected in the laboratory method blank associated with this sample.
- **Stormwater** - The estimated overland flow loading rates for antimony, arsenic, cadmium, copper, lead, and zinc are 50-, 2500-, 2-, 510-, 310- and 1100-pounds per year. All of these chemicals were detected at concentrations that meet or exceed ambient water quality standards for marine water, with the exception of antimony, which does not have established standards.
- **Fate and Transport** - Stormwater runoff is the primary transport mechanism for chemicals at this site. The mobility of metals through the soil profile is significantly retarded as evidenced by the decreases in metal concentrations with depth. Slightly elevated metals concentrations in groundwater beneath the southwest parcel of the log yard indicate that trace amounts of metals leached from the soil to the shallow water-bearing zone.

2.2 Summary of the Feasibility Study

The feasibility study (FS) looked at several remedial alternatives and combinations of options to immobilize the metals and keep them from migrating into the surface waters through stormwater runoff. To comply with MTCA, the selected alternative must protect human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, and provide for compliance monitoring. Construction of a low-permeability asphalt cap was recommended because it was a proven technology, easy to implement, and very cost-effective. In addition to the cap, groundwater monitoring annual inspections to verify cap integrity and a deed restriction to limit future development of the site were recommended remedial actions.

2.3 Estimates of Volume of Media Requiring Remediation

Concentrations of chemicals detected in groundwater do not exceed target cleanup levels and do not require remediation. For soils, the FS estimated the total volume of slag-affected soil as 12,000 cubic yards. The total annual runoff volume from the existing site was estimated to be 49,000 cubic feet, or 3.3 percent of the total rainwater volume falling on the southwest parcel. The runoff volume will be increased with the cap and pavement in place.

The estimated quantity of bark mixed with soil and/or slag is 16,700 cubic yards. Of this quantity, approximately 9,800 cubic yards is bark, based on visual estimations of the percentage of bark in the samples taken. The bark is mixed with the soil, making it difficult to separate. In some of the sampling areas, the slag has been identified within this bark/soil mixture; however, not in all cases. In some areas the slag depth goes below the soil/bark material.

3.0 ENGINEERING CRITERIA

3.1 Conceptual Plan of Action

The surficial soil, bark and slag onsite will be consolidated to an area onsite where future disturbance and exposure is less likely. Clean utility corridors will be constructed on the site by removing soil to a depth of one foot below the depth of slag indicated on Figure C1. The material in the bottom of the trench will be tested for arsenic and if clean, the trenches will be backfilled with imported material. It is the Port's intent to use these clean utility corridors for future utility installations. They will be delineated on the record drawings. All material removed will be relocated under the cap.

Areas of slag outside of the property line will be delineated in a supplemental survey before construction and submitted in a letter to Ecology for approval prior to construction. Slag material identified with the supplemental survey outside of the property lines will be relocated under the cap. The compliance monitoring plan, attached as Appendix C, lists the testing requirements to meet the cleanup standards required by Ecology's Consent Decree.

The material on-site will be mixed to reduce the organic content and make it suitable as a subbase material. The site will be graded for drainage and a low permeability cap installed to minimize surface water infiltration into the ground. The anticipated future use of the site is a warehouse, therefore the pavement design will take into consideration the potential vehicle loads associated with this use. The design will also take into consideration the inclusion of some organic material in the subbase.

Drawing G3 shows the existing site plan. The low permeability cap will be graded such that drainage is collected onsite and conveyed to the City of Tacoma's storm drain system, for ultimate discharge into the Sitcum Waterway northwest of the site. A preliminary evaluation of the capacity of the City's system in this vicinity has been made and the existing system can accommodate the anticipated runoff from the site. On-site storm water will pass through a detention vault and oil/water separator before entering the City's storm drainage system.

3.2 Drainage Criteria

The site drainage components will be designed to safely convey the 10-year, 24-hour storm event, which is the City of Tacoma's design criteria for connections into the existing system. A downstream analysis of the City's storm drainage system determined that it has the capacity to handle the flows from this site. Based on the isopluvial maps for design storms in Appendix AIII-1.1 of Ecology's Storm Water Management Manual for the Puget Sound Basin (SWMM), the 10-year, 24-hour design storm has a maximum rainfall of 2.9 inches.

The site will be graded with minimum surface slopes of one-half percent to catch basins located throughout the site. The design will minimize the number and the spacing of catch basins, and drainage swales will be generally symmetrical throughout the site. Catch basins will be located taking into consideration the potential future uses of the site. A warehouse could be located in the southeast corner of the site to allow for access off either Maxwell Way or Thorne Road. The maximum surface slopes across the drainage area will be limited to one percent. The onsite storm drains will be sloped as necessary to maintain site drainage.

The preliminary drainage plan is shown on Drawing C4. From the catch basins, the storm water will travel through storm drains into a spill containment vessel and oil/water separator before being discharged into the

City's storm drainage system along Thorne Road. The City's system then will convey the storm water northwesterly to the existing outfall at the Sitcum Waterway.

3.3 Vertical and Horizontal Alignment

The final cap will tie-in at the existing grades of the roads surrounding the site, namely Thorne Road to the west, Maxwell Road to the north, the adjacent parcel to the east and a City right-of-way to the south. The tie-in will seal the final cap to these roads at the property line in order to keep surface water from infiltrating at the connections. The surface will be sloped away from the interface to minimize surface water infiltration.

3.4 Subbase

A pre-design investigation was conducted to determine the strength properties of mixtures of the bark and soil onsite. Ten test pits were excavated in early December, 1993. Representative soil samples from the test pits were tested in the laboratory. A report was prepared to summarize the findings. The report entitled "Preliminary Report, Geotechnical Investigation and Pavement Design, Port of Tacoma, Cascade Timber No. 3 Log Sort Yard, Tacoma, Washington", (Pavement Design Report), dated March 1, 1994, investigated the feasibility of keeping the organic bark/soil material onsite and mixing it to produce a specified processed material to be used as a subbase, or removing all of the organic bark/soil material from the site and constructing the cap directly on the subgrade. This report is included as Appendix A.

The slag and surficial soils excavated from the clean utility corridors will be relocated toward the center of the site. The upper 0 to 2 feet across the site was identified as containing an average bark content of 30 to 40 percent by volume of dry soil. To prepare a subbase, this bark material will be thoroughly mixed or blended to produce a homogeneous mixture of seven to ten percent organic material by weight of dry aggregate. This processed material then will be placed as a subbase 24 inches thick (maximum) above the subgrade and below the low permeability cap and final pavement section. The pavement and cap design is based on allowing degradation of the organic material so as not to alter the low permeability status of the cap if the site settles.

3.5 Low Permeability Cap

The Pavement Design Report recommended a low permeability cap section will be used consisting of four inches of dense grade asphalt concrete (DGAC). The range of permeability for this material is 10^{-7} to 10^{-9} cm/sec. Within this DGAC, a geotextile fabric will be placed to improve the long term performance of the cap. To provide a suitable working surface for constructing the cap, four inches minimum of aggregate base would be placed on the subgrade before the low permeability cap is constructed. The low permeability cap will keep the surface water from infiltrating into the ground and becoming contaminated. The cap will be sealed around all penetrations of the fabric, such as at manholes and catch basins.

3.6 Pavement Alternatives

The Pavement Design Report evaluated four different pavement materials using the two subbase options described above -- 1) 24 inches subbase of bark/soil mixture, constructed on the subgrade, followed by the low permeability cap, and 2) all organic material removed from the site and the low permeability cap constructed directly on the subgrade. In both options, a minimum four inches of aggregate base was used as a leveling course under the low permeability cap. The four pavement materials evaluated were asphalt concrete (AC), Portland cement concrete (PCC), roller compacted concrete (RCC), and concrete block pavers (CBP). Pavement sections were analyzed using the heaviest vehicle expected to be used on the site during

the life of the property. For the anticipated future use as a warehouse, a standard highway truck was used, with an 18,000-pound Equivalent Standard Axle Load (ESAL). A container carrier was used in the analysis for potential long range site use as intermodal container storage with a wheel load of 26,675 pounds and tire pressure of 105 psi.

Each pavement material was evaluated with and without the bark/soil subbase material, using 100,000 repetitions of the container carrier as the critical design vehicle. A life cycle cost analysis for each surface type was prepared over a 20-year design life. The costs do not include any earthwork associated with getting the site to subgrade elevation, hauling excess material offsite, or processing the subbase material.

3.7 Recommended Pavement Section

The life cycle cost analysis presented in the Pavement Design Report indicated that the least expensive pavement alternative is the asphalt concrete pavement. For the warehouse site application, a minimum of four inches of asphalt was required, therefore no additional pavement wearing course is required. For the container storage application, a conservative pavement section of 9 inches (including low permeability cap) was selected assuming that organic material will remain onsite. Organics will be mixed with soil to a mixture of seven to ten percent organics by weight of dry aggregate. A minimum layer of four inches of aggregate base will be placed on top of the bark/soil mixture as a working surface for placing the low permeability cap.

Because the initial site use is for a warehouse, the minimum four inches of asphalt for the low permeability cap will be placed. If, in the future, the site is converted into a container storage facility, additional asphalt concrete will be added. Figure C6 shows the pavement section.

3.8 Quantity of Material to be Removed

The design of the low permeability cap over the site will not require any material to be removed from the site. As discussed in Section 3.1 small quantities of onsite material will be relocated under the cap to facilitate future site use.

3.9 Erosion and Sedimentation Control Plan

An erosion and sedimentation control plan (ESC) has been prepared for work during construction as part of the Storm Water Pollution Prevention Plan (SWPPP), as required by Ecology's National Pollutant Discharge Elimination System and State Waste Discharge Baseline General Permit For Storm Water Discharges Associated with Industrial Activities (NPDES Baseline General Permit). The plan is included in Appendix E. The plan addresses the control of potentially contaminated surface water and sediment to keep them from leaving the site. The ESC plan will be included in the Contract Documents and implementation of the plan will be required during construction while the site is uncapped.

3.10 Temperature Extremes

The air temperature in the Port of Tacoma area generally does not drop below zero degrees Fahrenheit for any significant amount of time. However, cold temperatures could cause any water in the pavement to freeze and cause pavement heaving and additional cracking. However, with good maintenance practices, the water infiltration is minimized, therefore, the pavement cracking is also minimized. As an added precaution, the low permeability cap includes a geotextile fabric which will minimize water infiltration into the subgrade.

3.11 Groundwater

The RI identified the depth of groundwater in the shallow aquifer at the site to range from 2.4 feet to 5.8 feet below existing ground surface during the six month groundwater monitoring program. The average depth of ground water ranged from 3.75 to 5 feet below existing round surface. The groundwater will probably not interfere with the construction of the low permeability cap, however, it will be a concern with installation of the storm drainage system. As a result, the Contractor will be required to retain construction dewatering water onsite for infiltration into the ground. It will not be allowed to leave the site and enter the City's storm drain.

3.12 Flooding and Seismic Activity

The probability of flooding at the site is very small. The nearest body of water (Sitcum Waterway) is over 3,000 feet from the site.

The site is located in seismic Zone 3. The probability of a major earthquake in this zone is low and this site is not considered to have a high importance value, like a hospital or water supply system. While an earthquake could cause cracks in the pavement and low permeability cap, the geotextile fabric within the cap will provide some defense against surface water infiltration. An earthquake could also damage the storm drainage system. If an earthquake occurs during construction or operation of the site, the Port should inspect and make any necessary repairs to the facilities as soon as possible.

4.0 SCHEDULE FOR DESIGN AND CONSTRUCTION

4.1 Schedule for Design and Construction

The Consent Decree issued by Ecology to the Port requiring remediation of the site requires submittal of a draft Engineering Design Report to Ecology by March 20, 1994. The draft Engineering Design Report includes plans and specifications, a list of the quality control tests to be performed during construction, a compliance monitoring plan for construction and operation, a site safety and health plan and an operation and maintenance plan. The final Engineering Design Report is due within three weeks following Ecology's comments. Construction is scheduled to be completed by November 1, 1994. A schedule is shown on Figure 1.

4.2 Construction Testing

During construction, the Port of Tacoma will perform various tests to determine whether the material and installation of the low permeability cap meets the specifications. The compaction achieved by the contractor for each lift of the dense grade asphalt concrete used for the low permeability cap will be tested at regular intervals. Any material not meeting the required compaction will be recompacted or replaced. The organic content of the subgrade material will be determined as well as the compaction of the subgrade. Certification by the contractor will be required to ensure that the geotextile fabric used in the low permeability cap meets the requirements of the specifications.

Slag material identified with the supplemental survey outside the property line will be moved onto the site to be capped. Soils within the clean utility corridors will be relocated toward the center of the site. The bottom of the trenches and areas outside the property line will be tested until the material meets the soil cleanup levels identified in the Consent Decree. Testing of soils will be done in accordance with the Compliance Monitoring Plan, included as Appendix C.

5.0 HEALTH AND SAFETY

5.1 Design Features for Control of Hazardous Releases

Soil which contains elevated levels of metals will be capped to reduce the possibility of metals migrating offsite via surface water. The cap will also minimize the amount of storm water percolating through the pavement and into the soil. Monitoring wells will be installed around the site to monitor the groundwater quality which will confirm the integrity of the cap. Regular inspection and maintenance of the cap will be required to maintain the cap's integrity. During construction, an erosion and sedimentation control plan will be implemented limiting the amount of surface water and sediment leaving the site. A spill containment vessel will be located on the drainage system outlet which can be isolated in the event of a hazardous material spill after construction is completed. The outlet will be valved such that the material can be contained in the vessel until it is pumped out and properly disposed of. Therefore, no hazardous material would enter the City of Tacoma's storm drain system and ultimately the Sitcum Waterway.

5.2 Design Features to Protect Workers and Local Residences

There are no residences in the vicinity of the site, therefore, safeguards will be required only for the construction workers prior to installing the cap. Once the cap is in place, no additional health and safety features will be required except that monitoring wells will be installed around the site to monitor the integrity of the cap. The onsite workers will be required to take a 24-hour hazardous training course in conformance with Occupational Health Standards WAC 296-62-3040. A site health and safety plan was prepared which will state the risks and procedures to follow during construction. The site Health and Safety Plan is included as Appendix B. The Contractor will be required to maintain a certification from all employees stating that they have read the site health and safety plan and they are aware of the site hazards. The site risks to workers include the potential to inhale dust containing arsenic and lead, or the potential to ingest arsenic and lead if soil remains on the hands of workers. All workers will wear the appropriate protective equipment as required by the site health and safety plan.

5.3 Management of Waste Materials Generated During Cleanup

During subgrade preparation, surficial materials will be moved to one area of the site and regraded to conform to the design grades of the cap. An erosion and sedimentation plan will provide measures to limit the surface water and sediment leaving the site during construction. The plan is included as Appendix E.

5.4 Description of Compliance Monitoring

During construction of the cap, the storm water will be collected and allowed to infiltrate or evaporate. Any storm water which leaves the site will be monitored to ensure the quality of storm water does not exceed the requirements. After construction, the storm water will be monitored at the connection to the City of Tacoma's storm drain system for the metals of concern. Monitoring wells will be installed and the groundwater also monitored for the metals of concern. A compliance monitoring plan was prepared to detail the method and frequency of compliance monitoring in accordance with the Consent Decree and MTCA WAC 173-340-410. The Compliance Monitoring Plan is included in Appendix C.

5.5 Description of Construction Health and Safety Procedures

An erosion and sediment control plan will be prepared and implemented during construction to contain any storm water runoff and sediment which may contain metals of concern. All vehicles which will be used

will either remain or will pass through a truck wash station to remove potentially contaminated soil before leaving the site. The truck wash will consist of a gravel pad and a power steamer. The vehicle leaving the site will drive onto the gravel pad, where the tires and chassis will be washed down. The wash water will be contained and either evaporate or infiltrate into the ground. The sediment will remain and will be covered by the cap. Once the cap is in place, the truck wash will no longer be necessary and will be removed. As previously mentioned, workers will be required to wear appropriate protective equipment as required by the site health and safety plan.

6.0 OPERATION AND MAINTENANCE

An operation and maintenance plan was prepared and is included as Appendix D. Activities associated with operation and maintenance will be performed in accordance with MTCA (WAC 173-340-400(4)(c)) and Exhibit D of the Consent Decree. At present the following items will be included in the Operation and Maintenance Plan:

- Semi-annual inspection of the pavement sections and repair cracks as needed.
- Inspection and cleaning of the storm drain system at least annually, and as needed to assure their design capacity is maintained. These activities will include, at a minimum, cleaning of catch basin inlets, and visual inspection of storm drains for accumulated debris.
- Inspection and cleaning of the spill containment vessel will be performed at least annually. Sediment from the spill containment vessel will be cleaned out when the depth of sediment reaches 0.8 feet (10 percent of the height of the vessel). During sediment removal, water in the vault will be removed and transferred into a sanitary sewer.

DISTRIBUTION

Draft Design Engineering Report
Remedial Action
Cascade Timber Log Yard No. 3
Port of Tacoma
Tacoma, Washington

March 24, 1994

Copy No. ___

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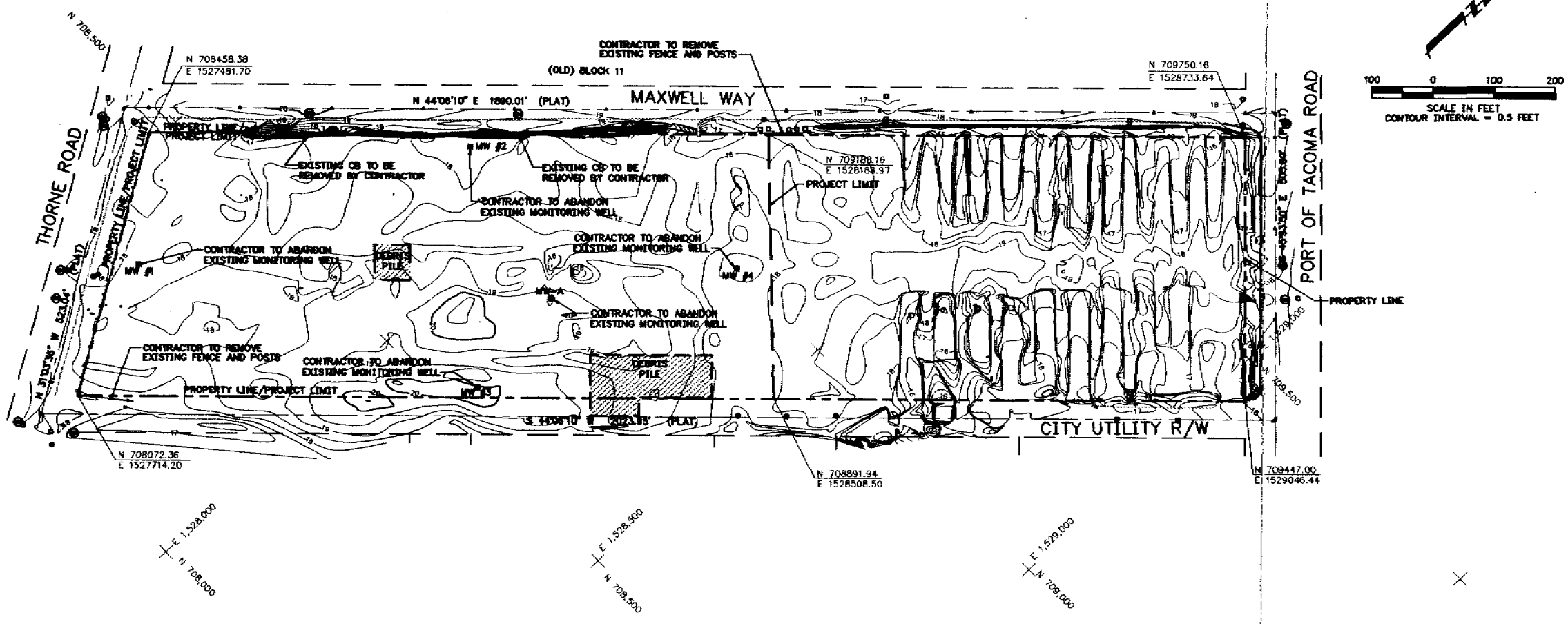
Quality Control Reviewer

_____

Gregory N. Richardson, Ph.D, P.E.
Technical Director, Solid Waste Services

ILLUSTRATIONS



NOTES:

1. THE LOCATION AND SIZE OF THE DEBRIS STOCKPILE IS APPROXIMATE. CONTRACTOR TO FIELD VERIFY.
2. SOURCE OF TOPOGRAPHICAL INFORMATION: HCE CONSULTING ENGINEERS, PLANNERS, AND LAND SURVEYORS, DATED JANUARY 1992.
3. THE VERTICAL DATUM IS EQUAL TO THE CITY OF TACOMA DATUM ADJUSTED TO THE MEAN LOW LOW WATER (MLLW), DATUM (USGS). BENCH MARK LOCATION AT THE INTERSECTION OF PORT OF TACOMA ROAD AND LINCOLN AVENUE. ELEVATION 10.909 MSL = PORT OF TACOMA 18.129 MLLW
4. HORIZONTAL DATUM IS PORT OF TACOMA STATE PLANE COORDINATES (NORTH AMERICAN DATUM, 1983).

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JRH 9/94 DRAWN BY DATE
AS-BUILT BY DATE
MB 9/94 CHECKED BY DATE
MED 9/94 PROJ.ENGR. DATE

MARK	REVISION	BY	APP.	DATE

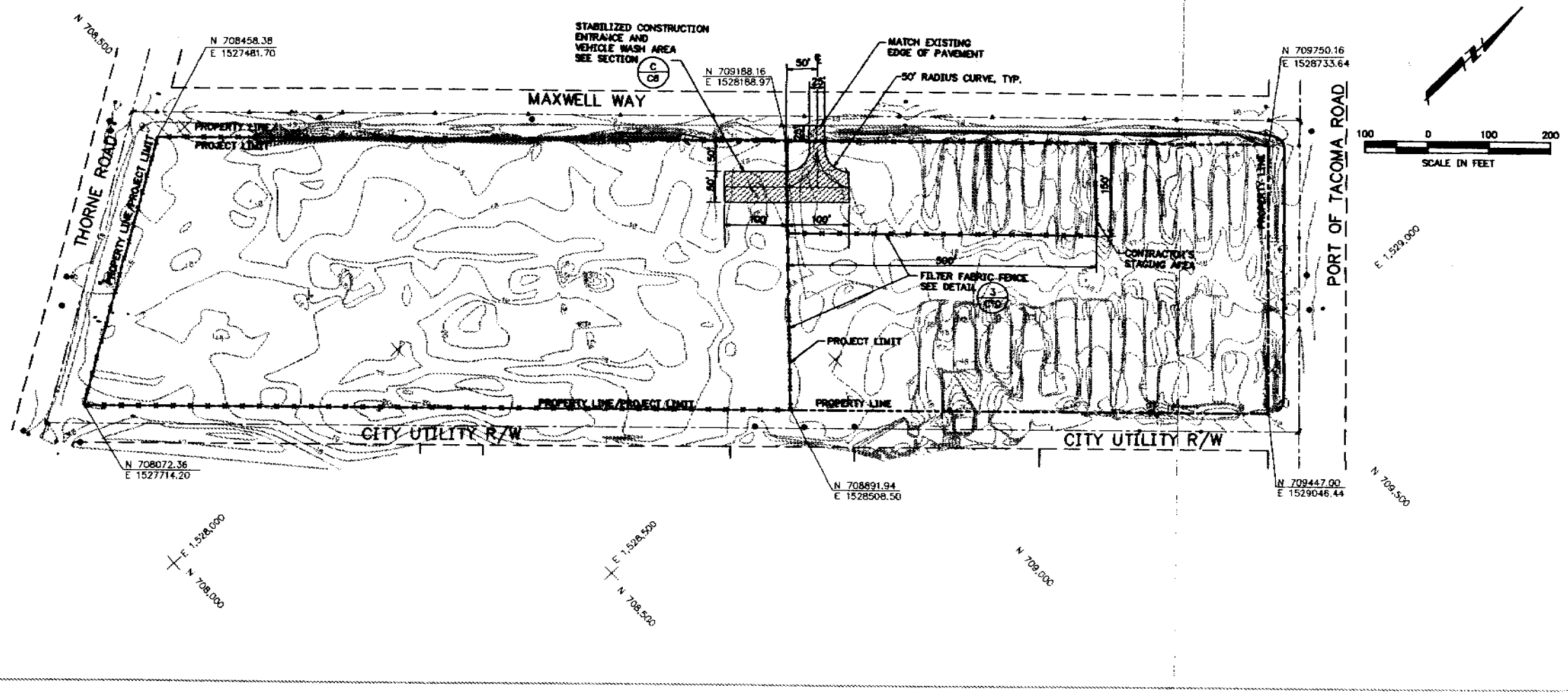
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT

EXISTING SITE PLAN

AUTOCAD FILE NUMBER 507

G3

DRAWING NO. EP-4670-16
CONTRACT NO. 12193
SHEET NO. 3 OF 14



NOTES:

1. SOURCE OF TOPOGRAPHICAL INFORMATION: HCE CONSULTING ENGINEERS, PLANNERS, AND LAND SURVEYORS, DATED JANUARY 1992.
2. THE VERTICAL DATUM IS EQUAL TO THE CITY OF TACOMA DATUM ADJUSTED TO THE MEAN LOW LOW WATER (MLLW). DATUM (USGS). BENCH MARK LOCATION AT THE INTERSECTION OF PORT OF TACOMA ROAD AND LINCOLN AVENUE. ELEVATION 10.908 MSL = PORT OF TACOMA 18.129 MLLW
3. HORIZONTAL DATUM IS PORT OF TACOMA STATE PLANE COORDINATES (NORTH AMERICAN DATUM, 1983).

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MR CHECKED BY 9/94 DATE
MED PROJ.ENGR. 9/94 DATE

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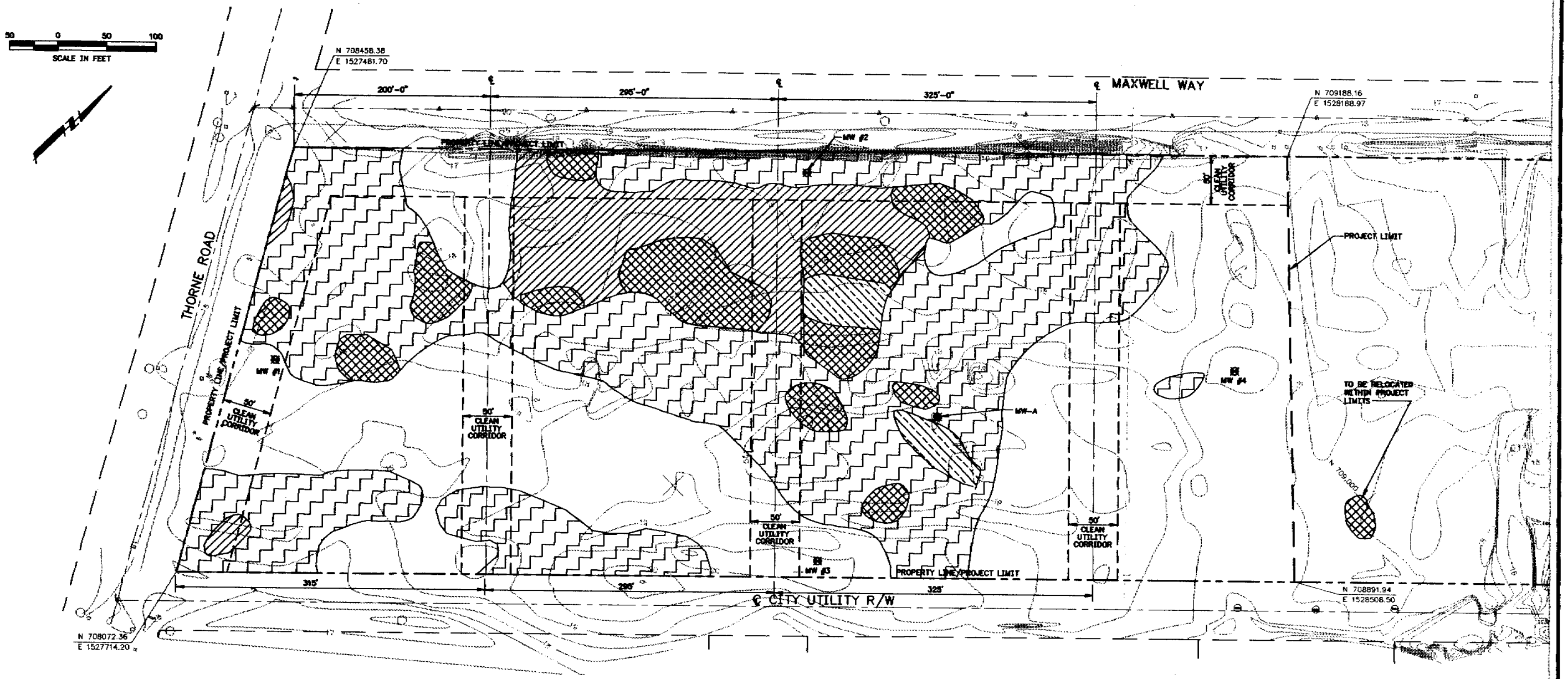
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT

SITE ACCESS AND STAGING AREAS

AUTOCAD FILE NUMBER 607

G4

DRAWING NO. EP-4670-16
CONTRACT NO. 1283
SHEET NO. 4 OF 14



LEGEND

- EXTENT OF SLAG 0.0 TO 0.5 FOOT DEPTH INTERVAL
- EXTENT OF SLAG 0.5 TO 1.0 FOOT DEPTH INTERVAL
- EXTENT OF SLAG 1.0 TO 2.0 FOOT DEPTH INTERVAL
- EXTENT OF SLAG 2.0 TO 4.5 FOOT DEPTH INTERVAL

NOTES:

1. SLAG AND ONE FOOT OF SOIL IN THE CLEAN UTILITY CORRIDORS WILL BE REMOVED TO OTHER AREAS OF THE SITE AND INCLUDED UNDER THE CAP.
2. CLEAN UTILITY CORRIDORS ARE FOR FUTURE UTILITY INSTALLATION BY OTHERS, NOT FOR THE STORM DRAIN SYSTEM.
3. SOURCE OF DRAWING: REMEDIAL INVESTIGATION AND FEASIBILITY STUDY REPORT, CASCADE TIMBER NO. 3 LOG SORT YARD, HARDING LAWSON ASSOCIATES, AUGUST 18, 1993.
4. SOURCE OF TOPOGRAPHICAL INFORMATION: HCE CONSULTING ENGINEERS, PLANNERS, AND LAND SURVEYORS, DATED JANUARY 1992.
5. THE VERTICAL DATUM IS EQUAL TO THE CITY OF TACOMA DATUM ADJUSTED TO THE MEAN LOW LOW WATER (MLLW) DATUM (USGS). BENCH MARK LOCATION AT THE INTERSECTION OF PORT OF TACOMA ROAD AND LINCOLN AVENUE. ELEVATION 10.909 MSL = PORT OF TACOMA 18.128 MLLW
6. HORIZONTAL DATUM IS PORT OF TACOMA STATE PLANE COORDINATES (NORTH AMERICAN DATUM, 1983).

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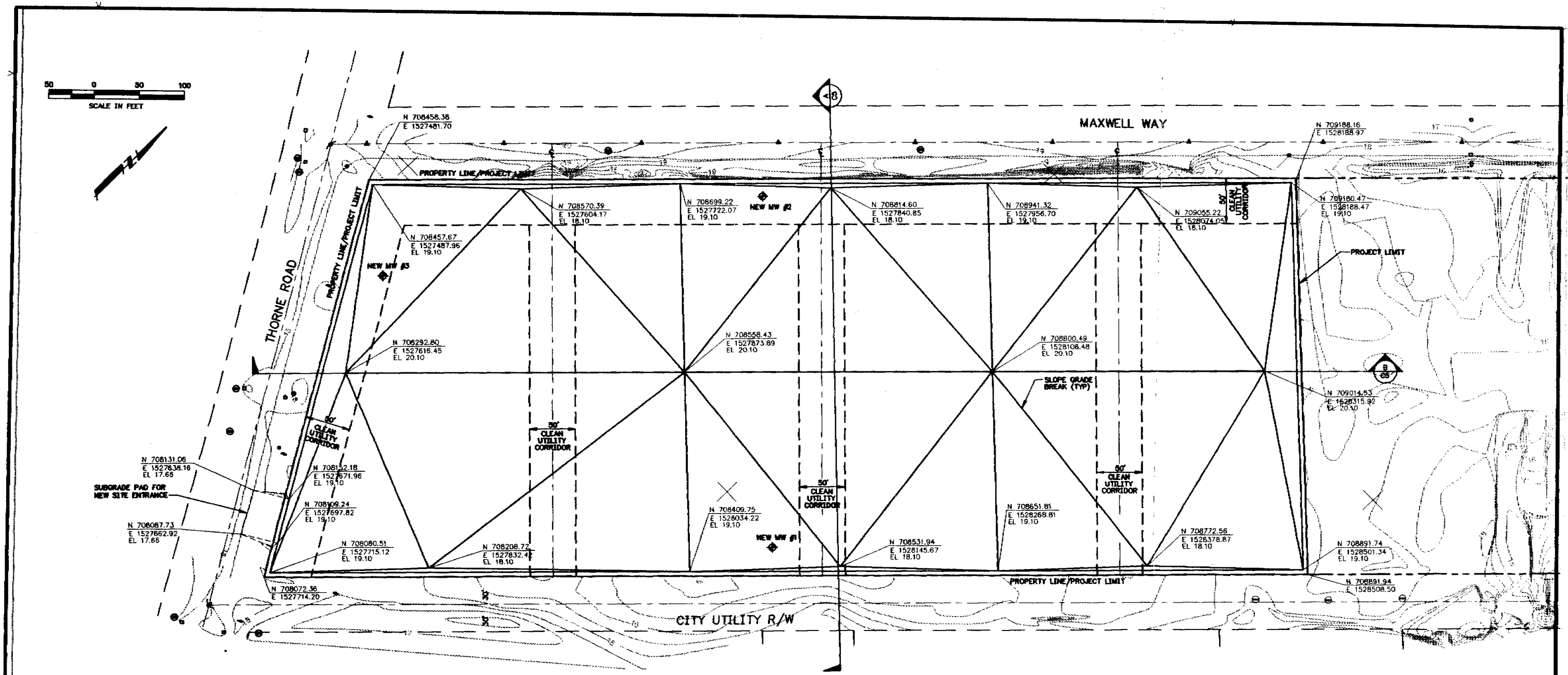
CASCADE TIMBER NO. 3 LOG SORT YARD
REMEDIATION PROJECT

SLAG RELOCATION PLAN

AUTOCAD FILE NUMBER 507

C1

DRAWING NO. EP-4670-16
CONTRACT NO. 12193
SHEET NO. 5 OF 14



NOTES:

1. SOURCE OF TOPOGRAPHICAL INFORMATION: HCE CONSULTING ENGINEERS, PLANNERS, AND LAND SURVEYORS, DATED JANUARY 1992.
2. THE VERTICAL DATUM IS EQUAL TO THE CITY OF TACOMA DATUM ADJUSTED TO THE MEAN LOW LOW WATER (MLLW), DATUM (USGS). BENCH MARK LOCATION AT THE INTERSECTION OF PORT OF TACOMA ROAD AND LINCOLN AVENUE. ELEVATION 10.909 MSL = PORT OF TACOMA 18.129 MLLW
3. HORIZONTAL DATUM IS PORT OF TACOMA STATE PLANE COORDINATES (NORTH AMERICAN DATUM, 1983).

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MDD 9/01 PROJ.ENGR. DATE

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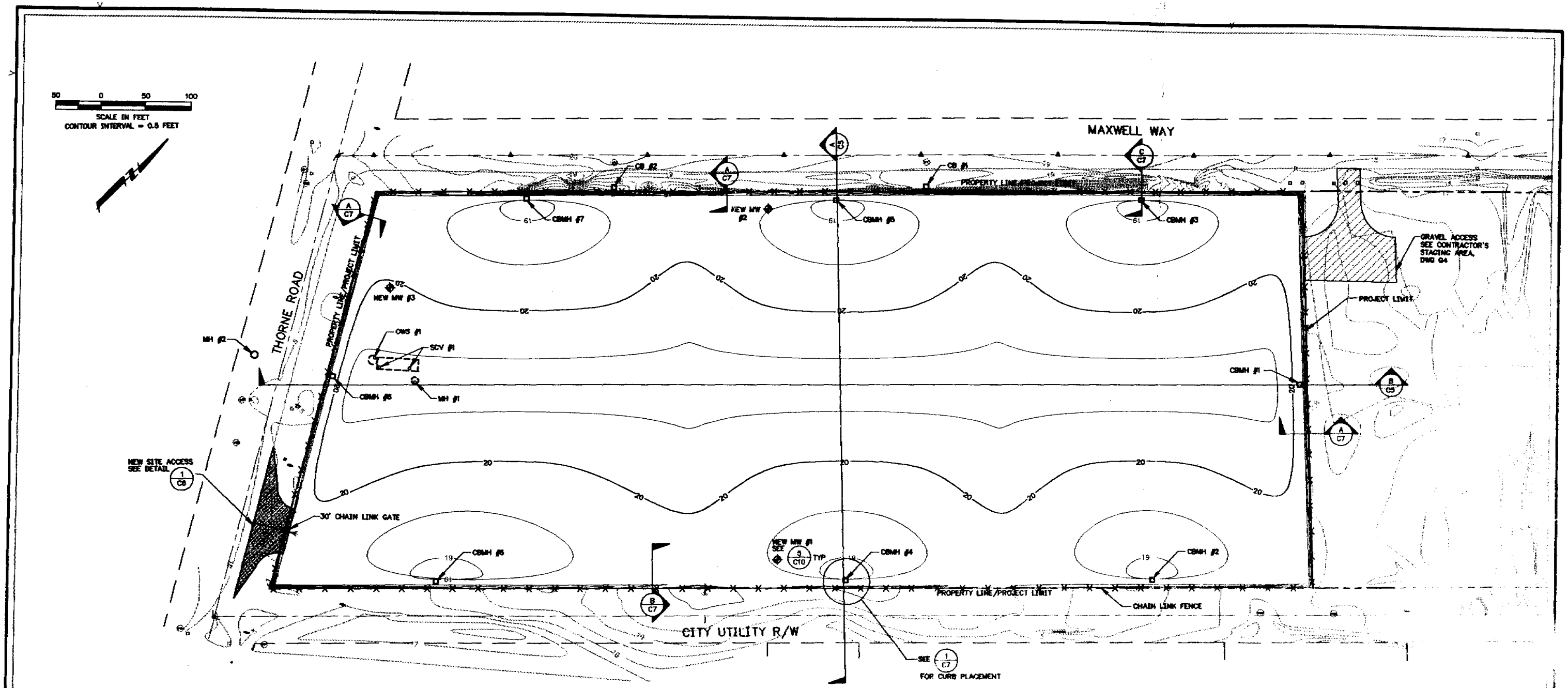
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT
SUBGRADE PLAN

AUTOCAD FILE NUMBER 607

C2

DRAWING NO. EP-4870-16
CONTRACT NO. 1283
SHEET NO. 6 OF 14



NOTES:

1. CONTRACTOR TO ADJUST GRADE BETWEEN OUTSIDE EDGE OF CURBING TO MEET GRADE 5 FEET AWAY AT THE PROPERTY LINE/ PROJECT LIMIT. SEE DETAILS ON DRAWING C7 FOR MORE INFORMATION.
2. SOURCE OF TOPOGRAPHICAL INFORMATION: HCE CONSULTING ENGINEERS, PLANNERS, AND LAND SURVEYORS, DATED JANUARY 1992.
3. THE VERTICAL DATUM IS EQUAL TO THE CITY OF TACOMA DATUM ADJUSTED TO THE MEAN LOW LOW WATER (MLLW), DATUM (USGS). BENCH MARK LOCATION AT THE INTERSECTION OF PORT OF TACOMA ROAD AND LINCOLN AVENUE. ELEVATION 10.909 MSL = PORT OF TACOMA 18.129 MLLW
4. HORIZONTAL DATUM IS PORT OF TACOMA STATE PLANE COORDINATES (NORTH AMERICAN DATUM, 1983).

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MCB PROJ.ENGR. 9/94 DATE

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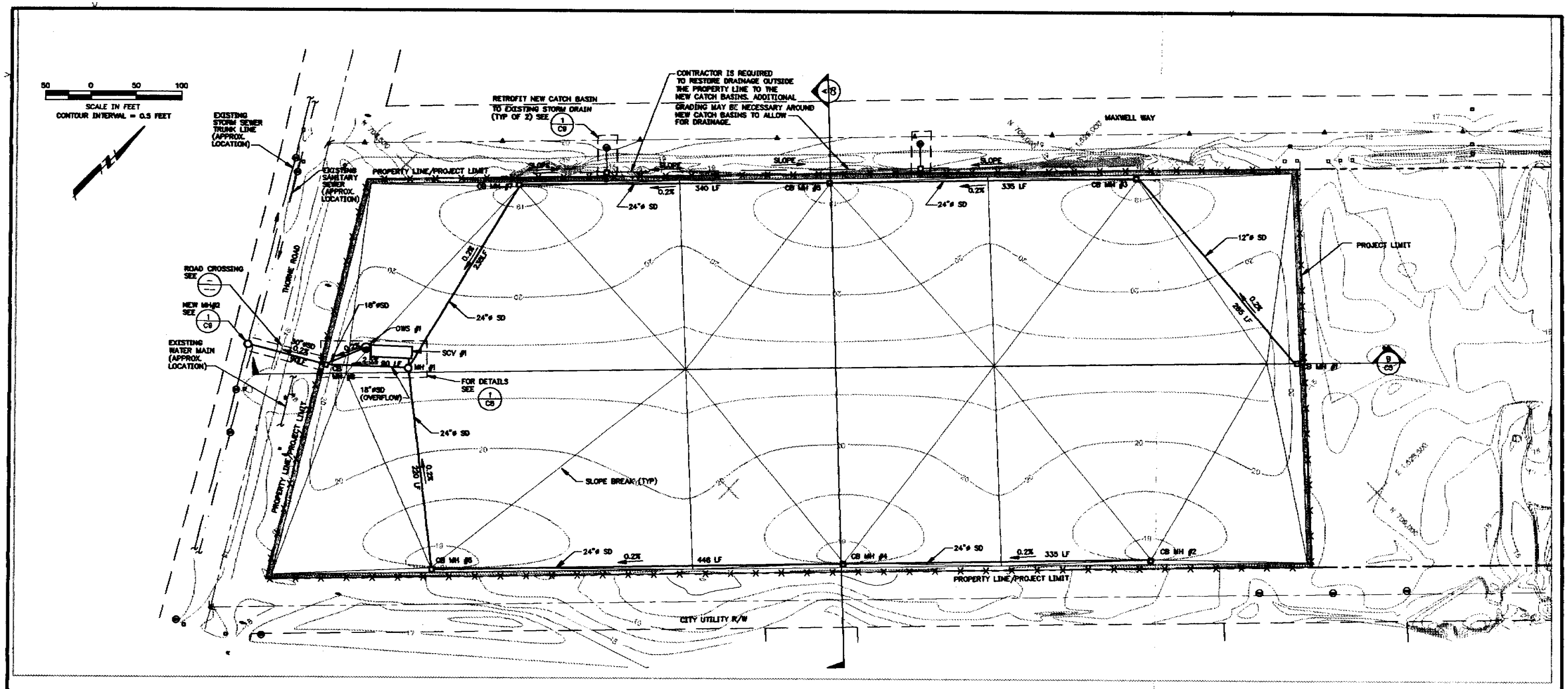
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT

FINAL GRADING PLAN

AUTOCAD FILE NUMBER 607 C3

DRAWING NO. EP-4870-16
CONTRACT NO. 1218B
SHEET NO. 7 OF 14



NOTES:

1. CONTOURS SHOWN WITHIN PROJECT LIMITS REFLECT FINAL GRADING. SEE SHEET C3 FOR FINAL GRADING PLAN.
2. LENGTHS OF PIPE ARE APPROXIMATE AND SHOULD BE FIELD VERIFIED.
3. LOCATION OF ALL EXISTING UTILITIES SHOWN NEAR THE SITE SHOULD BE FIELD VERIFIED.
4. SOURCE OF TOPOGRAPHICAL INFORMATION: HCE CONSULTING ENGINEERS, PLANNERS, AND LAND SURVEYORS, DATED JANUARY 1992.
5. THE VERTICAL DATUM IS EQUAL TO THE CITY OF TACOMA DATUM ADJUSTED TO THE MEAN LOW LOW WATER (MLLW), DATUM (USGS). BENCH MARK LOCATION AT THE INTERSECTION OF PORT OF TACOMA ROAD AND LINCOLN AVENUE. ELEVATION 10.908 MSL = PORT OF TACOMA 10.129 MLLW
6. HORIZONTAL DATUM IS PORT OF TACOMA STATE PLANE COORDINATES (NORTH AMERICAN DATUM, 1983).

STORM DRAIN/ STRUCTURE NO.	STRUCTURE *TOP ELEV (FT)	30" DIA SD I.E.—IN (FT)	30" DIA SD I.E.—OUT (FT)	24" DIA SD I.E.—IN (FT)	24" DIA SD I.E.—OUT (FT)	18" DIA SD I.E.—IN (FT)	18" DIA SD I.E.—OUT (FT)	12" DIA SD I.E.—IN (FT)	12" DIA SD I.E.—OUT (FT)	NORTHING	EASTING
CB MH #1	19.7	–	–	–	–	–	–	–	17.5	N 709037.78	E 1528338.17
CB MH #2	18.7	–	–	–	15.5	–	–	–	–	N 708772.05	E 1528379.54
CB MH #3	18.7	–	–	–	15.5	–	–	16.5	–	N 708055.28	E 1528072.77
CB MH #4	18.7	–	–	14.9	14.8	–	–	–	–	N 708530.74	E 1528145.96
CB MH #5	18.7	–	–	14.9	14.8	–	–	–	–	N 708814.39	E 1527840.03
CB MH #6	18.7	–	–	14.0	13.9	–	–	–	–	N 708268.05	E 1527834.48
CB MH #7	18.7	–	–	14.1	14.0	–	–	–	–	N 708571.61	E 1527802.21
CB MH #8	19.7	–	12.9	–	–	13.0,15.7**	–	–	–	N 708283.69	E 1527564.28
MH #1	20.7	–	–	13.5,13.5**	–	–	13.4,15.0**	–	–	N 708348.07	E 1527680.27
MH #2	18.0	12.7	–	–	–	–	–	–	–	N 708238.08	E 1527547.89
SCV #1	20.6	–	–	–	–	13.3	13.2	–	–	N 708348.89	E 1527638.58
OWS #1	20.6	–	–	–	–	13.1	13.1	–	–	N 708338.93	E 1527621.86

* APPROX ** OVERFLOW

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GBL CHECKED BY 9/94 DATE
MDD PROJ.ENGR. 9/94 DATE

MARK	REVISION	BY	APP.	DATE

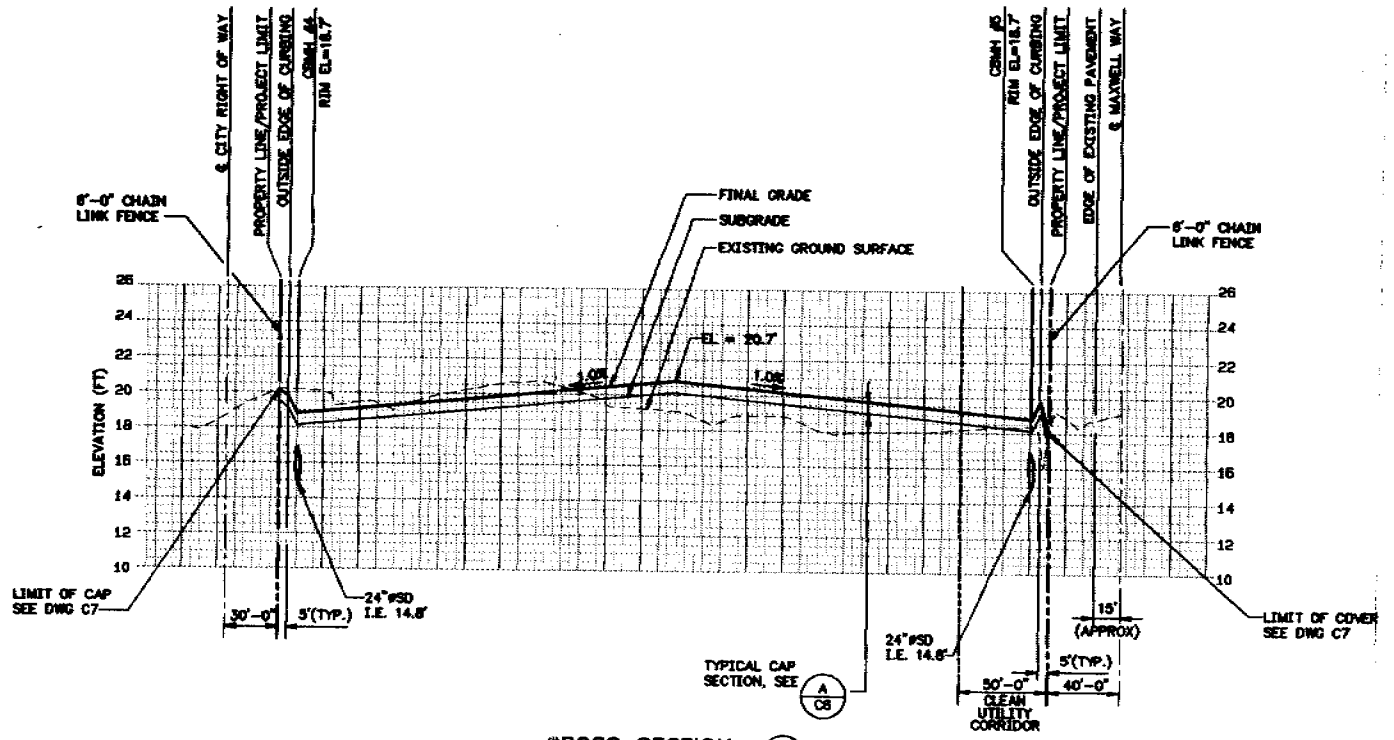
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT

DRAINAGE PLAN

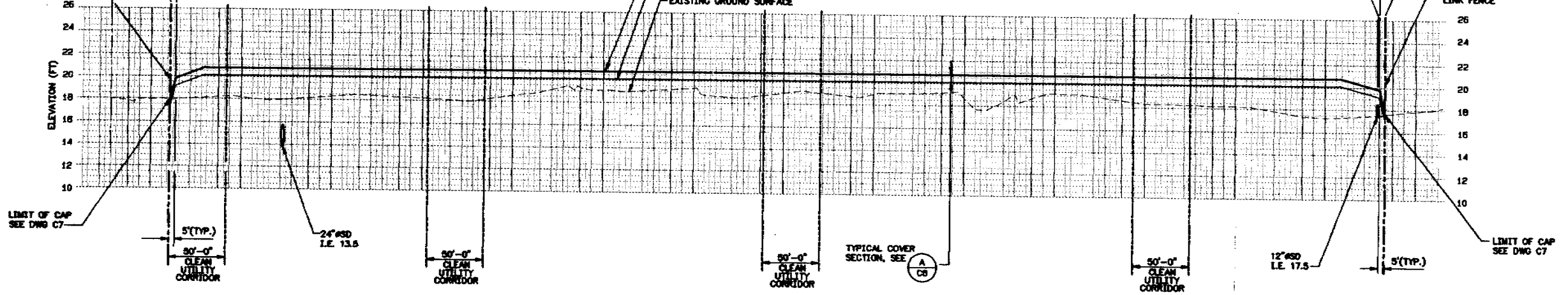
AUTOCAD FILE NUMBER 507

C4

DRAWING NO. EP-4670-16
CONTRACT NO. 1283
SHEET NO. 8 OF 14



CROSS SECTION A C2,C3,C4
SCALE: HORIZONTAL: 1"=50'
VERTICAL: 1"=5'



CROSS SECTION B C2,C3,C4
SCALE: HORIZONTAL: 1"=50'
VERTICAL: 1"=5'

NOTES:

1. VERTICAL DATUM IS M.L.L.W.
2. FOR PAVING SECTION TIE-IN DETAILS, SEE DWG C7.
3. FOR ELEVATIONS, SLOPES, AND INVERT ELEVATIONS OF THE DRAINAGE STRUCTURES, SEE DWG C4.
4. FOR LOCATION AND DEPTHS OF SLAG RELOCATION, SEE DWG C1.

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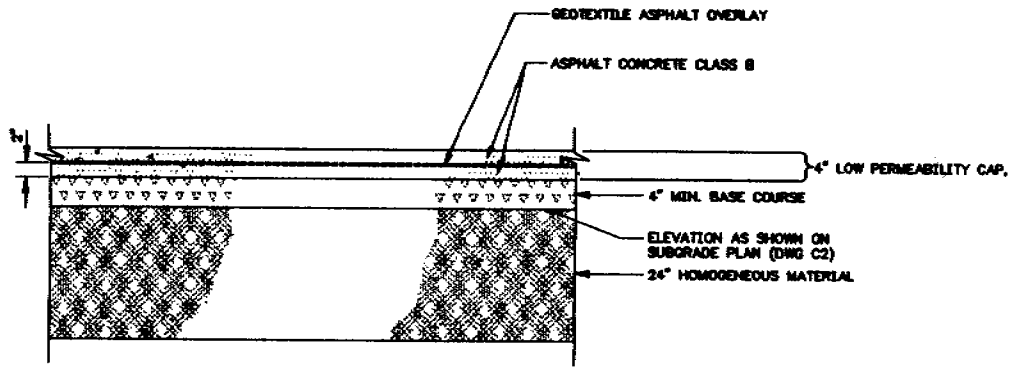
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT
CROSS SECTIONS

AUTOCAD FILE NUMBER 507
C5

DRAWING NO. EP-4670-16
CONTRACT NO. 1213
SHEET NO. 9 OF 14



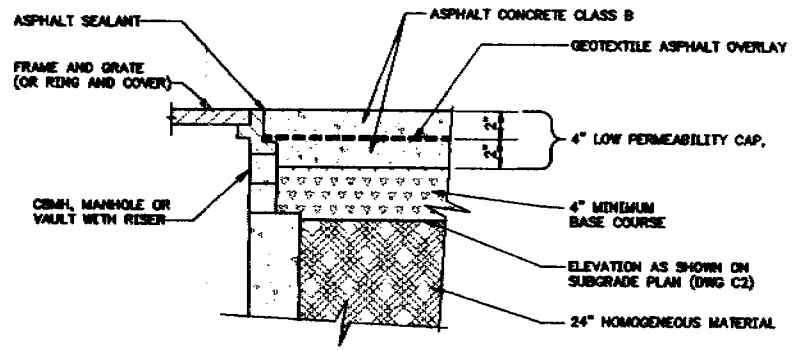
LOW PERMEABILITY CAP SECTION

SECTION (A) / – NOT TO SCALE

NOTES:

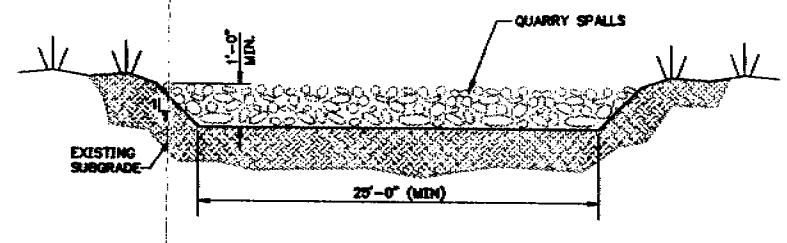
FOR SECTIONS A AND B THIS PAGE:

1. HOMOGENEOUS MATERIAL SHALL BE:
   A. CLEAN IMPORT MATERIAL IF LOCATED IN A CLEAN UTILITY CORRIDOR
   B. HOMOGENEOUS SOIL BARK MIXTURE IF LOCATED ANYWHERE ELSE WITHIN THE PROJECT LIMITS



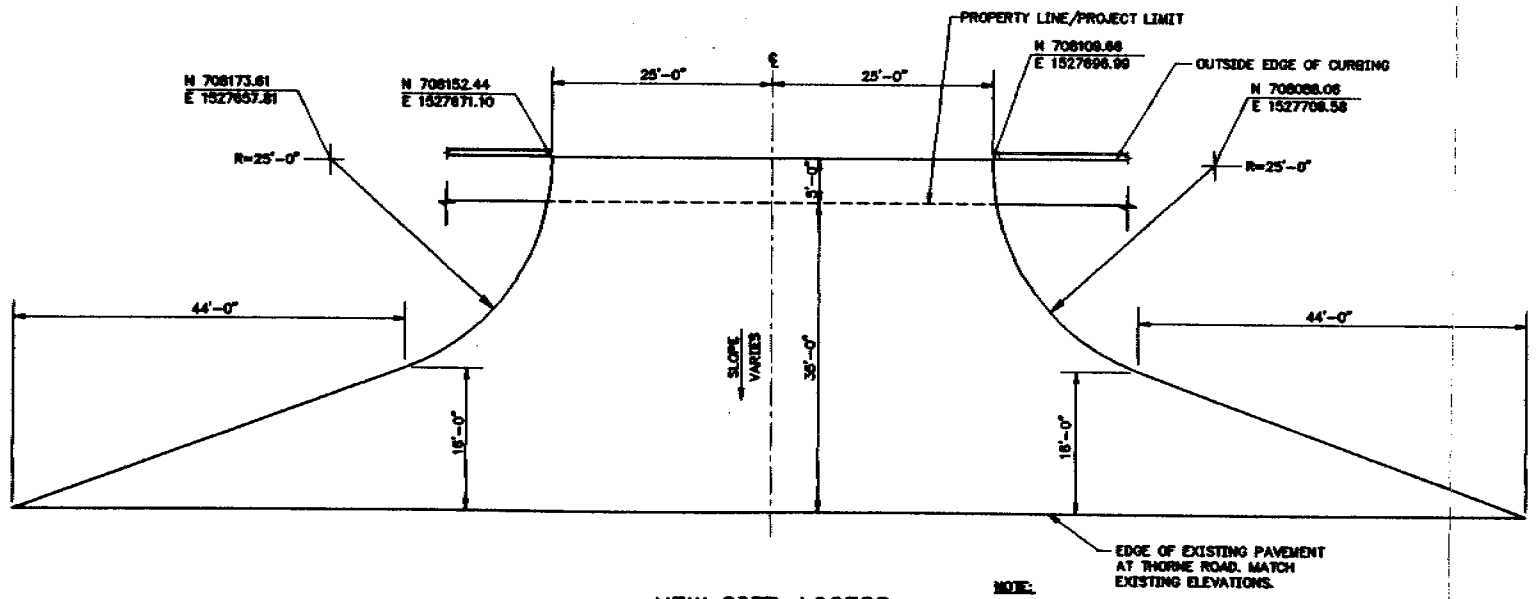
CAP PENETRATION

SECTION (B) / TYP NOT TO SCALE



STABILIZED CONSTRUCTION ENTRANCE AND VEHICLE WASH AREA

SECTION (C) / TYP NOT TO SCALE



NEW SITE ACCESS

DETAIL (1) / C3 NOT TO SCALE

NOTE:

1. ELEVATIONS ALONG OUTSIDE EDGE OF CURBING SHALL CORRESPOND WITH THE FINAL GRADING PLAN.
2. ACCESS SHALL BE 4 INCHES OF ASPHALT CONCRETE PAVEMENT OVER 4 INCHES OF BASE COURSE.

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MCD PROJ.ENGR. 9/94 DATE

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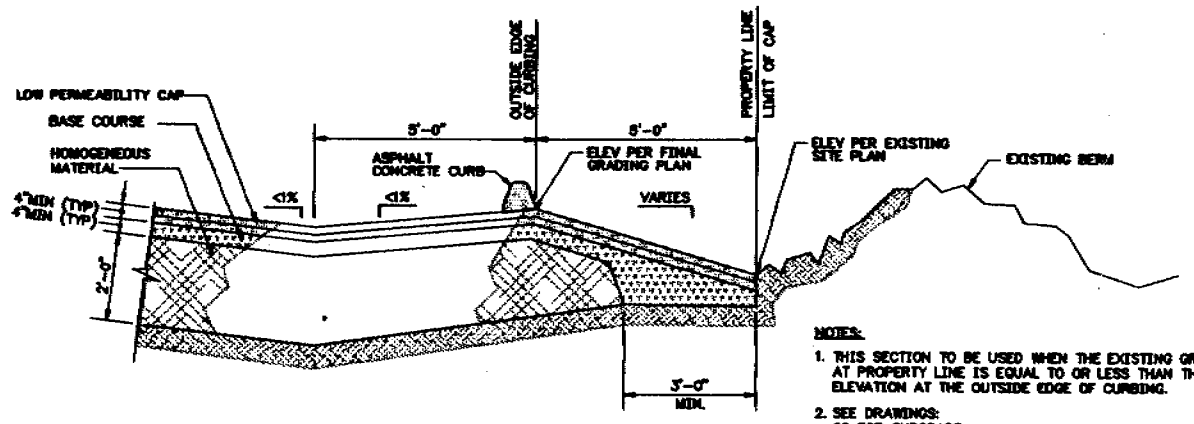
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT

PAVEMENT DETAILS

AUTOCAD FILE NUMBER 507

C6

DRAWING NO. EP-4670-16
CONTRACT NO. 1283
SHEET NO. 10 OF 14

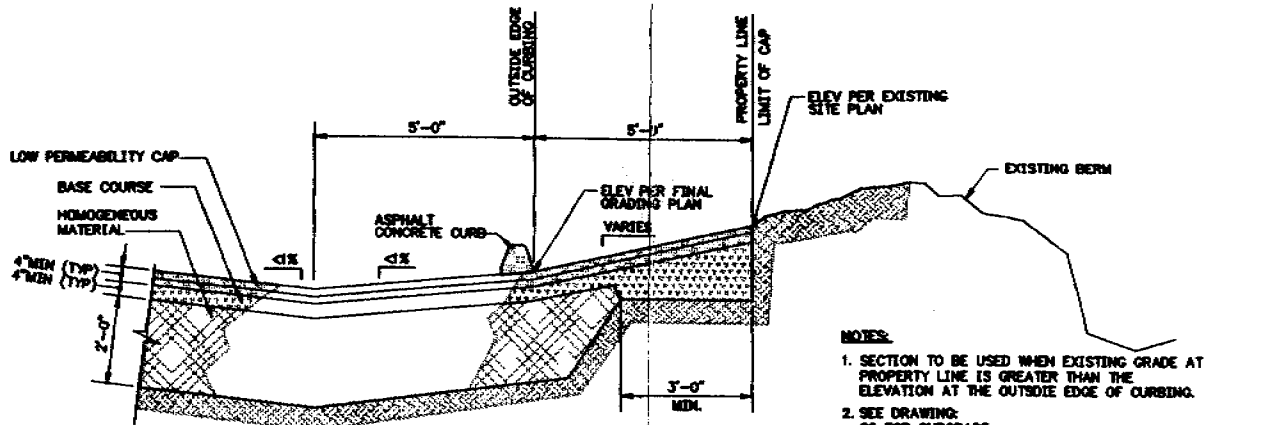


EDGE OF PAVEMENT TIE-IN

SECTION A / C3
NOT TO SCALE

NOTES:

1. THIS SECTION TO BE USED WHEN THE EXISTING GRADE AT PROPERTY LINE IS EQUAL TO OR LESS THAN THE ELEVATION AT THE OUTSIDE EDGE OF CURBING.
2. SEE DRAWINGS:
   C2 FOR SUBGRADE
   C3 FOR FINAL GRADE
3. NO WORK SHALL BE DONE OUTSIDE OF THE PROPERTY LINE/PROJECT LIMIT UNLESS DIRECTED BY THE ENGINEER. ANY DAMAGE OR DISTURBANCE OUTSIDE THE PROPERTY LINE/PROJECT LIMIT NOT DIRECTED BY THE ENGINEER SHALL BE RESTORED TO ORIGINAL CONDITIONS AT NO COST TO THE OWNER.
4. HOMOGENEOUS MATERIAL SHALL BE:
   A. CLEAN IMPORT MATERIAL IF LOCATED WITHIN A CLEAN UTILITY CORRIDOR.
   B. HOMOGENEOUS SOIL/BARK MIXTURE IF LOCATED ANYWHERE ELSE WITHIN THE PROJECT LIMITS.

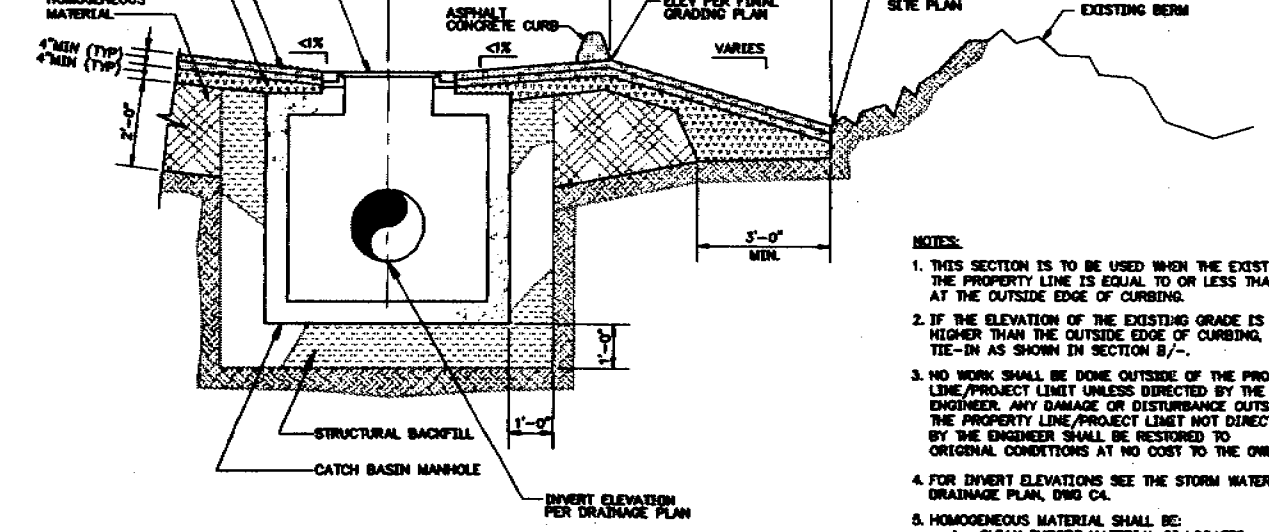


EASEMENT RIGHT OF WAY & EDGE OF PAVEMENT TIE-IN

SECTION B / C3
NOT TO SCALE

NOTES:

1. SECTION TO BE USED WHEN EXISTING GRADE AT PROPERTY LINE IS GREATER THAN THE ELEVATION AT THE OUTSIDE EDGE OF CURBING.
2. SEE DRAWING:
   C2 FOR SUBGRADE
   C3 FOR FINAL GRADE
3. NO WORK SHALL BE DONE OUTSIDE THE PROPERTY LINE/PROJECT LIMIT UNLESS DIRECTED OTHERWISE BY THE ENGINEER. ANY DAMAGE OR DISTURBANCE OUTSIDE OF THE PROPERTY LINE/PROJECT LIMIT NOT DIRECTED BY THE ENGINEER SHALL BE RESTORED TO THE ORIGINAL CONDITIONS AT NO COST TO THE OWNER.
4. THE CURB WILL BE OPENED A MINIMUM OF 24" IN ALIGNMENT WITH THE NEW CATCH BASINS. SEE DETAIL 1/-.
5. HOMOGENEOUS MATERIAL SHALL BE:
   A. CLEAN IMPORT MATERIAL IF LOCATED WITHIN A CLEAN UTILITY CORRIDOR.
   B. HOMOGENEOUS SOIL/BARK MIXTURE IF LOCATED ANYWHERE ELSE WITHIN THE PROJECT LIMITS.

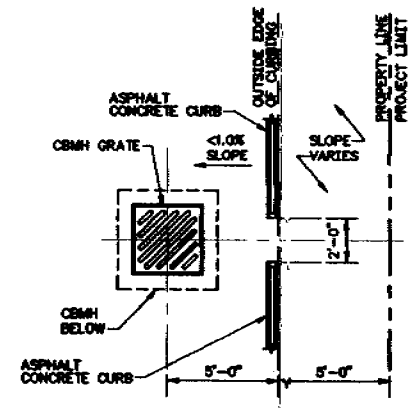


SECTION AT CATCH BASIN MANHOLE

SECTION C / C3
NOT TO SCALE

NOTES:

1. THIS SECTION IS TO BE USED WHEN THE EXISTING GRADE AT THE PROPERTY LINE IS EQUAL TO OR LESS THAN THE ELEVATION AT THE OUTSIDE EDGE OF CURBING.
2. IF THE ELEVATION OF THE EXISTING GRADE IS HIGHER THAN THE OUTSIDE EDGE OF CURBING, REVISE THE TIE-IN AS SHOWN IN SECTION 8/-.
3. NO WORK SHALL BE DONE OUTSIDE OF THE PROPERTY LINE/PROJECT LIMIT UNLESS DIRECTED BY THE ENGINEER. ANY DAMAGE OR DISTURBANCE OUTSIDE THE PROPERTY LINE/PROJECT LIMIT NOT DIRECTED BY THE ENGINEER SHALL BE RESTORED TO ORIGINAL CONDITIONS AT NO COST TO THE OWNER.
4. FOR INVERT ELEVATIONS SEE THE STORM WATER DRAINAGE PLAN, DWG C4.
5. HOMOGENEOUS MATERIAL SHALL BE:
   A. CLEAN IMPORT MATERIAL IF LOCATED WITHIN A CLEAN UTILITY CORRIDOR.
   B. HOMOGENEOUS SOIL/BARK MIXTURE IF LOCATED ANYWHERE ELSE WITHIN THE PROJECT LIMITS.



CURB OPENING AT CATCH BASIN MANHOLE

DETAIL 1 / TYP
NOT TO SCALE

PORT OF TACOMA
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CONSULTANTS
HLA Hartig Lennox Associates Engineering and Environmental Services
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APPROVED
CHIEF ENGINEER DATE

JER DRAWN BY 9/94 DATE
AS-BUILT BY DATE

SIL CHECKED BY 9/94 DATE
MDD PROJ.ENGR. 9/94 DATE

MARK	REVISION	BY	APP.	DATE

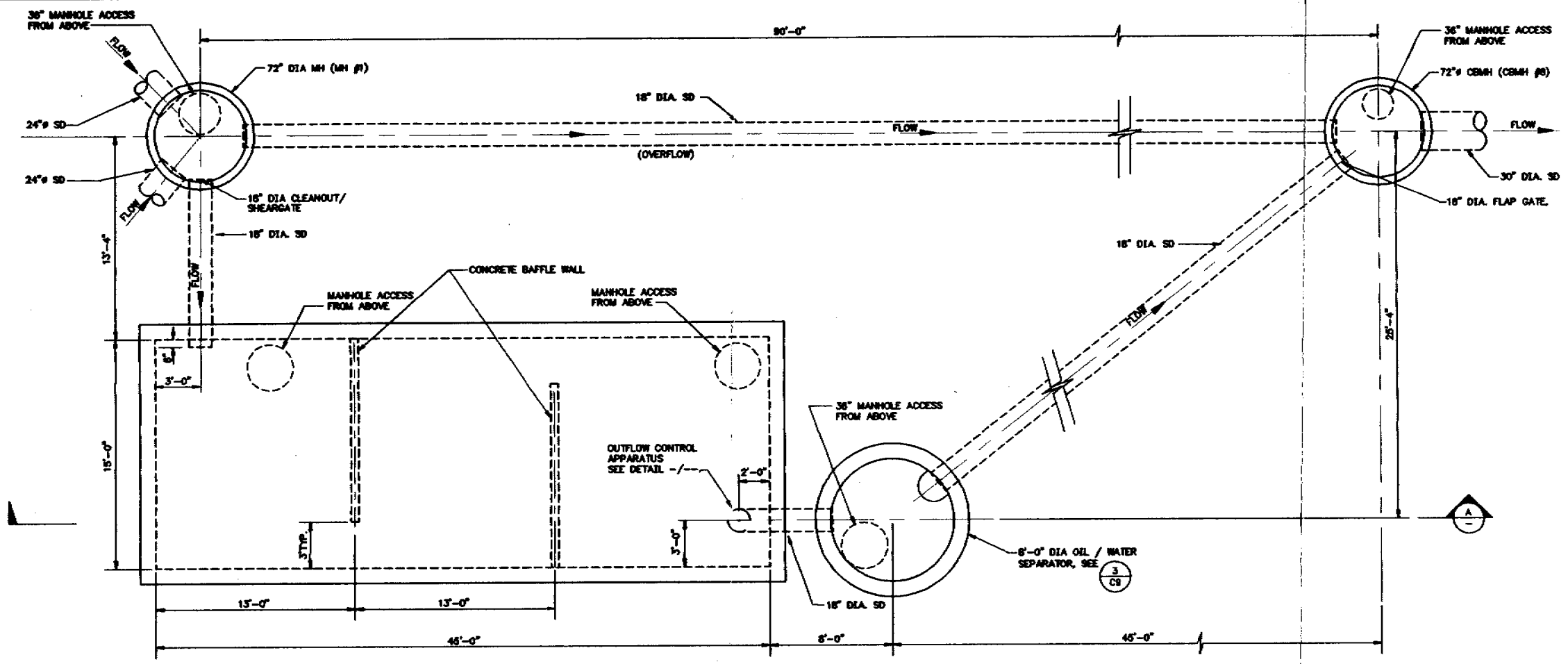
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT

PAVEMENT DETAILS

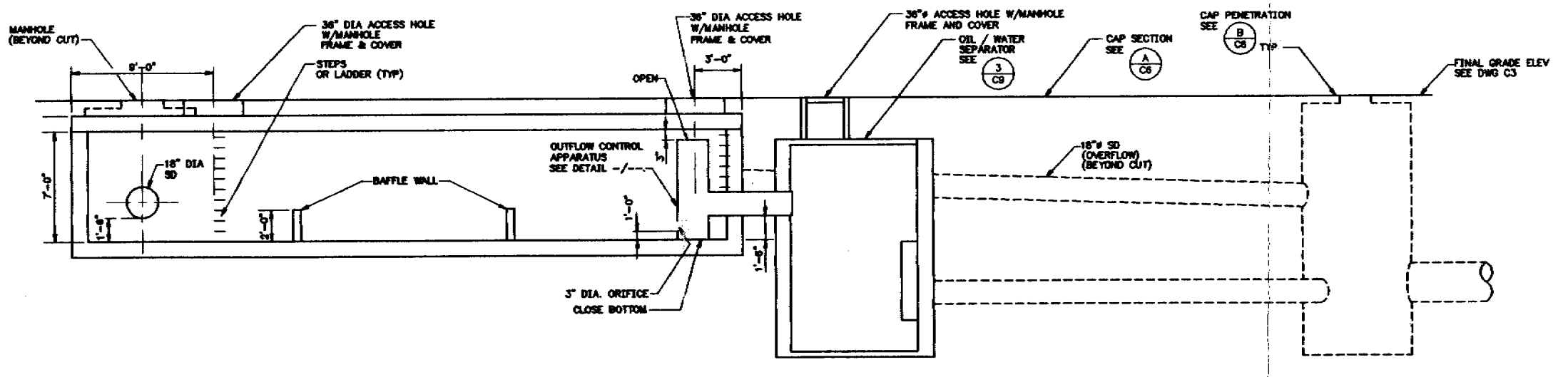
AUTOCAD FILE NUMBER 607

C7

DRAWING NO. EP-4670-16
CONTRACT NO. 12193
SHEET NO. 11 OF 14



PLAN
NOT TO SCALE



SECTION A
NOT TO SCALE

SPILL CONTAINMENT VESSEL

DETAIL 1/C4
NOT TO SCALE

NOTE:
1. SEE SCHEDULE ON DWG C4 FOR STORM DRAIN INVERT ELEVATIONS
2. THE STRUCTURAL COMPONENT OF THE SPILL CONTAINMENT VESSEL IS THE RESPONSIBILITY OF THE CONTRACTOR.

AUTOCAD FILE NUMBER 607 | C8

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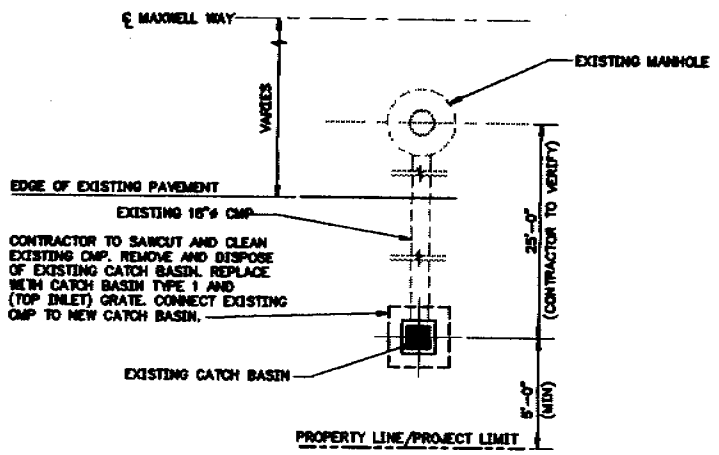
AS-BUILT BY DATE
RRL CHECKED BY 9/94 DATE
MKD PROJ.ENGR. 9/94 DATE

MARK	REVISION	BY	APP.	DATE

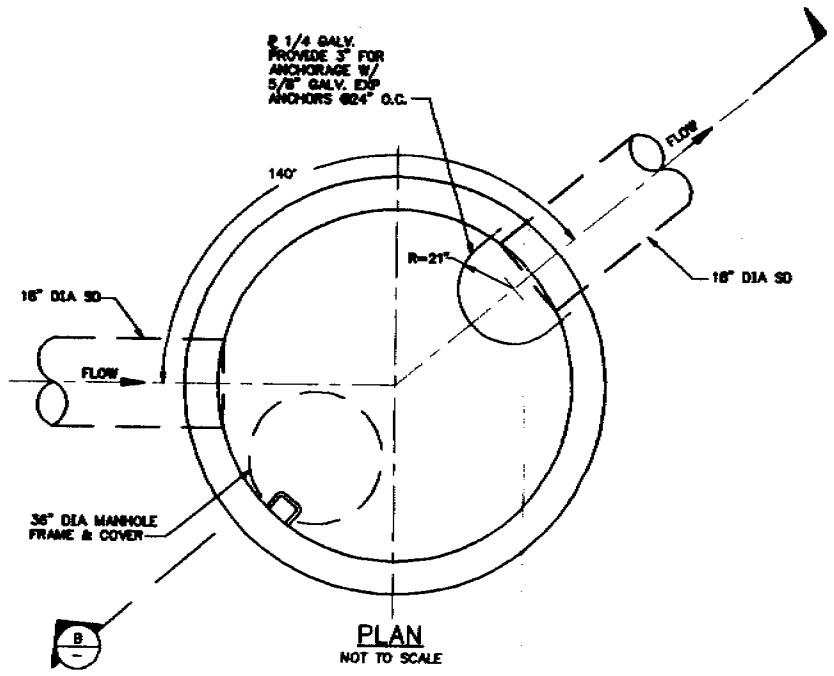
CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT
DRAINAGE DETAILS

DRAWING NO. EP-4870-16
CONTRACT NO. 1283
SHEET NO. 12 OF 14



CONNECTION TO EXISTING MANHOLE @ MAXWELL WAY

DETAIL 1 / C4 — NOT TO SCALE



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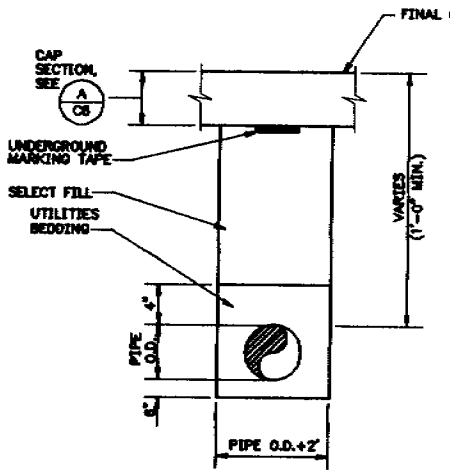

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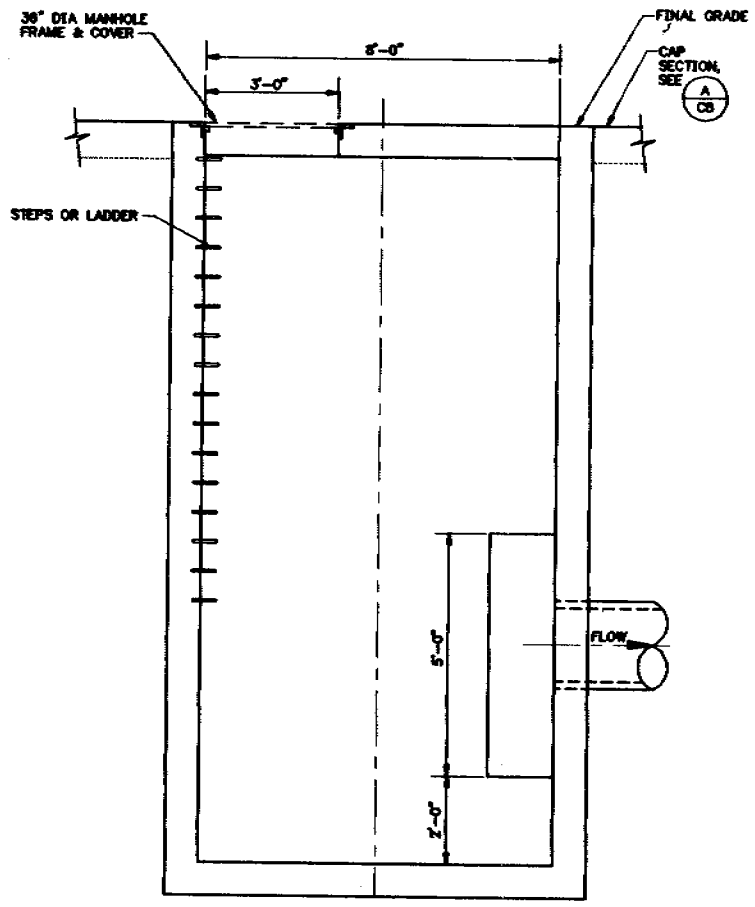
DETAIL 2 / TYP — NOT TO SCALE



SECTION B / – — NOT TO SCALE

OIL / WATER SEPARATOR

DETAIL 3 / C8 — NOT TO SCALE

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CHIEF ENGINEER DATE

JBR DRAWN BY 9/94 DATE
AS-BUILT BY DATE
GBL CHECKED BY 9/94 DATE
MKD PROJ.ENGR. 9/94 DATE

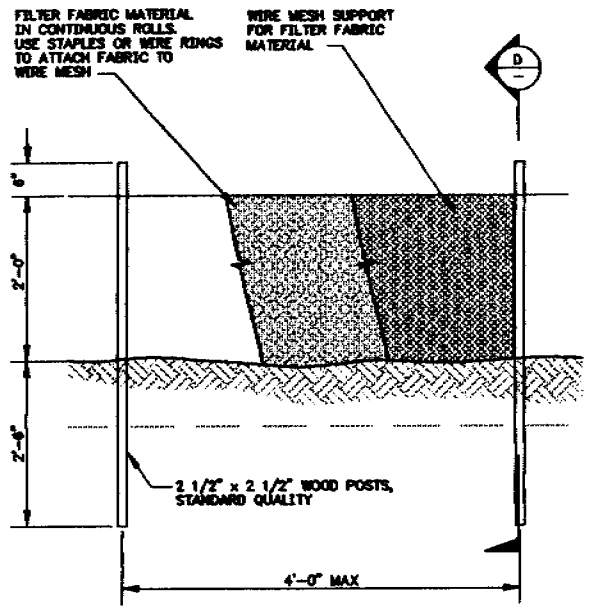
MARK	REVISION	BY	APP.	DATE

CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT

DRAINAGE DETAILS

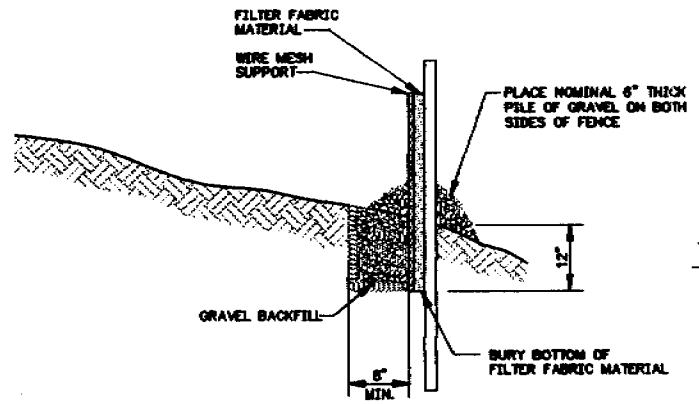
AUTOCAD FILE NUMBER 607 — C9

DRAWING NO. EP-4570-16
CONTRACT NO. 12183
SHEET NO. 13 OF 14



FILTER FABRIC FENCE INSTALLATION

NOT TO SCALE

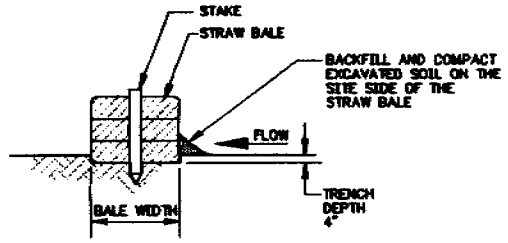


SECTION D

NOT TO SCALE

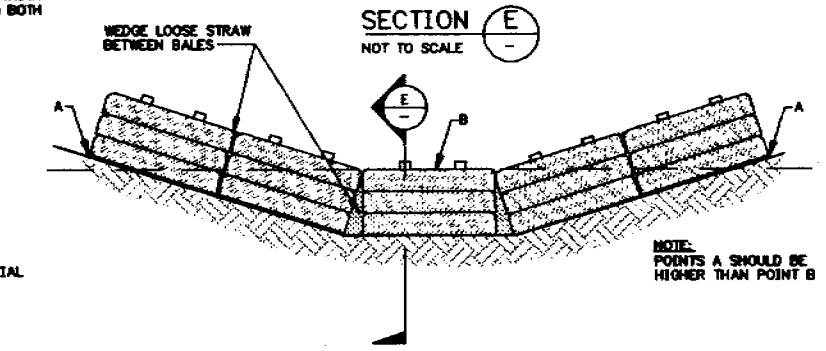
DETAIL 3

NOT TO SCALE



SECTION E

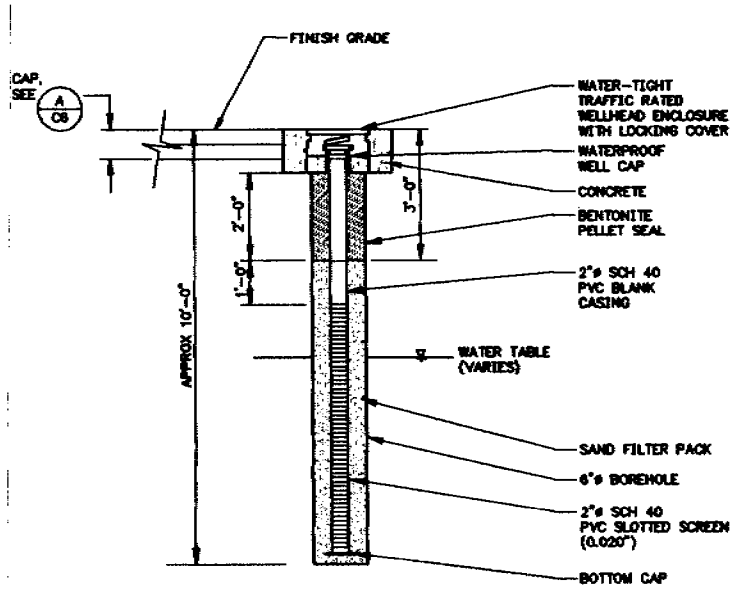
NOT TO SCALE



STRAW BALE BARRIER INSTALLATION

DETAIL 4

NOT TO SCALE



NEW MONITOR WELL INSTALLATION

DETAIL 5

NOT TO SCALE

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SEL CHECKED BY 9/94 DATE
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MARK	REVISION	BY	APP.	DATE

CASCADE TIMBER NO. 3 LOG SORT YARD REMEDIATION PROJECT

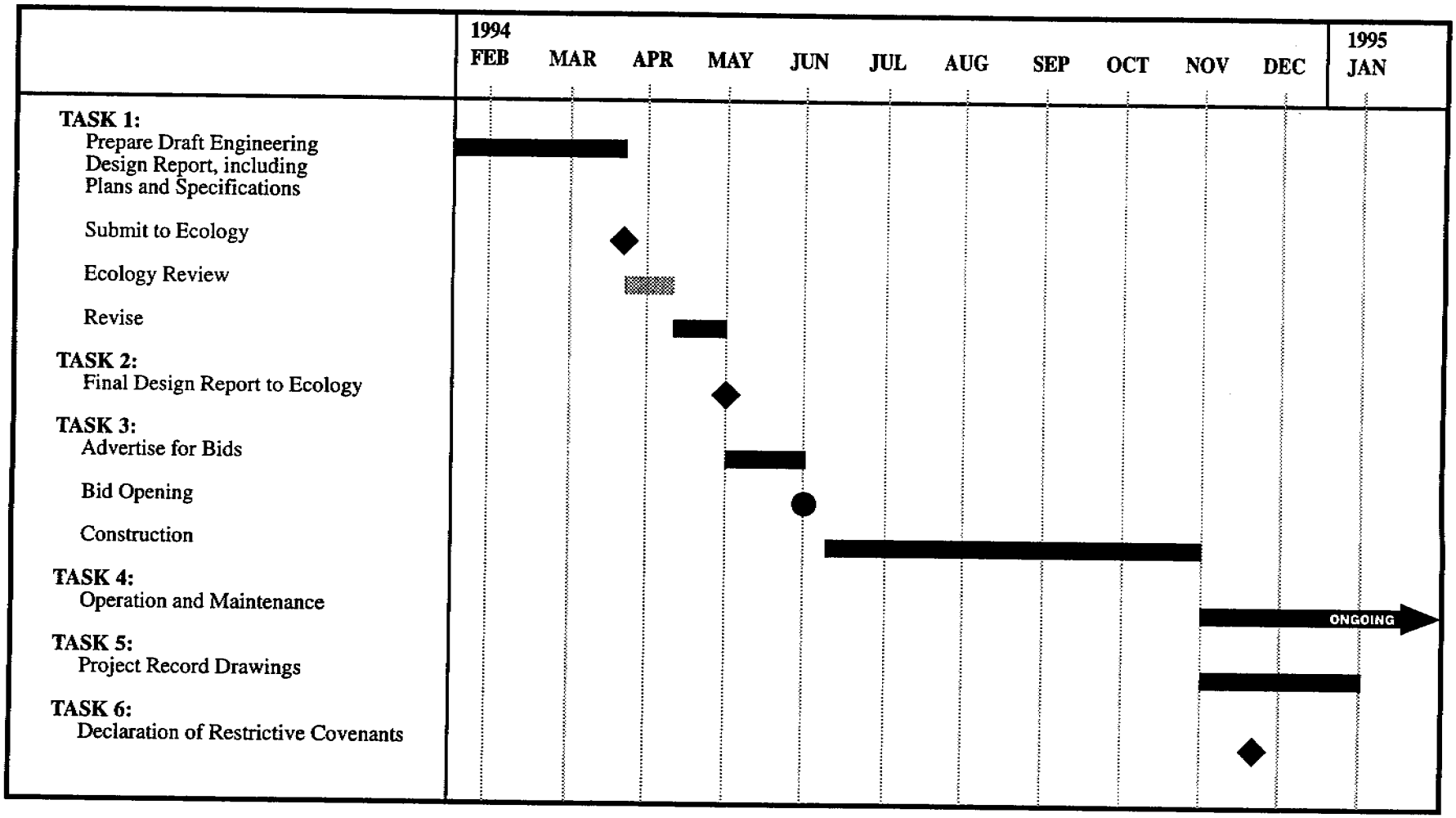
MISCELLANEOUS DETAILS

AUTOCAD FILE NUMBER 507

C10

DRAWING NO. EP-4670-16
CONTRACT NO. 1283
SHEET NO. 14 OF 14

FIGURE 1
CASCADE TIMBER LOG SORT YARD NO. 3
REMEDIATION PROJECT
SCHEDULE



APPENDIX A

APPENDIX A

PRELIMINARY REPORT,
GEOTECHNICAL INVESTIGATION AND PAVEMENT DESIGN,

PORT OF TACOMA,
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

A Report Prepared for

Port of Tacoma
P.O. Box 1837
Tacoma, Washington 98401

DRAFT REPORT
GEOTECHNICAL INVESTIGATION AND
PAVEMENT DESIGN, PORT OF TACOMA
CASCADE TIMBER No. 3 LOG SORT YARD
TACOMA, WASHINGTON

HLA Job N0. 12183.2

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March 1, 1994

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I. INTRODUCTION

This report presents the results of our geotechnical investigation for design of an impermeable cap cover and future pavement structures for the Port of Tacoma - Cascade Timber No. 3 Log Sort Yard. The log yard is located along Maxwell Way between Port of Tacoma Road and Thorne Road in Tacoma, Washington. The design of the impermeable cap has included considerations for the anticipated future use of the site, as an overflow containerized cargo terminal facility for the Port of Tacoma.

Our services were provided in accordance with our letter proposal dated October 22, 1993. The scope of services, as they relate to this report, consist of:

- Review Existing Data
- Conduct Pre-Design Investigation
    - Excavate, log and sample 10 test pits within the existing log yard.
    - Perform laboratory testing consisting of grain size distribution, organic content (bark content), Atterberg Limits, soil classification, and resistance value (R-value) testing.
    - Perform engineering analysis to determine the structural section required for the impermeable cap, a containerized terminal facility. Surface materials to be considered include asphalt concrete, Portland cement concrete, roller compacted concrete, and concrete block pavers. Initial construction and life cycle costs will be generated for each alternative considered.
    - Prepare a written report (this report) outlining our field investigation, laboratory testing and engineering analysis and provide recommended pavement section.

This draft report presents various pavement section thickness alternatives for a range of design parameters. The analysis evaluates the sensitivity of the various design

parameters and provides alternative pavement options. This report is intended to assist the Port of Tacoma in selecting the final pavement section.

II. FIELD EXPLORATION AND LABORATORY TESTING

We explored subsurface soil conditions by excavating 10 test pits to depths up to six feet at the locations illustrated on Plate 1 in the Appendix.

The test pits were excavated using a Case 580D backhoe. Our field engineer logged the test pits and obtained representative loose bulk soil samples at selected depths for visual classification and laboratory testing.

A summary of the test pits (TP1 through TP10) is presented on Table 1. The soils were classified in accordance with the ASTM D2487-85 method of classification shown on Plate 2 in the Appendix.

The soil samples were reexamined in our laboratory to confirm field classifications and to select representative samples for testing. The laboratory testing program included: percent passing the No. 200 sieve, moisture content, grain size distribution, organic content (bark content), Atterberg limits, and R-value (pavement design) tests. The test results are presented on Table 2, Summary of Soil Test Data, and on Plates 3 through 13 in the Appendix.

III. SITE CONDITIONS

A. Surface Conditions

The Cascade Timber No. 3 Log Sort Yard is located on Maxwell Way between port of Tacoma Road and Thorne Road in Tacoma, Washington. The log yard has an aerial extent of approximately 10.9 acres. Logs were previously sorted and stored in bays and unpaved roads provide access around the bays. The yard is currently vacant. In general, the ground surface across the site consists of a brown poorly to well-graded gravel with silt, silty clay, sand and gravel and various contents of organic (bark) material. Slag from the Asarco smelter was used as fill material across the site in the mid- to late-1970's.

B. Subsurface Conditions

As shown in Table 1, Test Pit Soil Summary, the subsurface soils consist of gravel with silt, sand, and cobbles; silt; and silty sand to depths up to 3.0 feet and poorly graded sand and silty clay to depths up to 5.0 feet. Free ground water was not encountered in any of the test pits during exploration.

IV. PAVEMENT DESIGN CONSIDERATIONS

A. General

The design of the structural sections was based on a rational design method using the computer program titled ELSYM5 which presents solutions for multilayered elastic systems. The program computes stresses, strains, and deflections at pre-selected locations in the pavement structure. The program requires the material properties of the individual layers in terms of the elasticity (resilient modulus), Poisson's ratio, and thickness. The vertical load and contact pressure are also required. With the computed stresses and strains, fatigue and rutting failure modes can be analyzed.

B. Design Parameters

1. Design vehicle

Two vehicles were considered in the design of the ultimate structural section. The Valmet container carrier and a Standard Highway Truck. The Valmet container carrier was also considered for the long term use of the facility with a wheel load of 26,675 pounds and a tire pressure of 105 psi. The Standard Highway Truck was evaluated based upon the 18,000 pound Equivalent Single Axle Load (ESAL).

2. Material Properties

A pavement section can generally be divided into the following layers:

- Surface Course - Asphalt concrete (AC) or Portland Cement Concrete (PCC), or some other type of wearing surface
- Base Course - Aggregate or stabilized material
- Subbase Course - Aggregate or processed material
- Subgrade - In-place soil or engineered fill soil

While a base and/or subbase is not required they are usually used to decrease the cost of construction by decreasing the thickness of the more expensive surface course. A

base layer will also serve as a working platform upon which the wearing surface is constructed. The following sections of this report discuss the material properties used in developing the alternative sections presented in Section "V. DISCUSSION OF RESULTS".

a. Subgrade

For the purpose of design, the subgrade soils were taken as the brown silty sand encountered at approximately 2 feet to 5 feet below the surface (Table 1). Laboratory tests indicate an R value of 66 (Table 2). An R-value of 50 was used in design and can be converted to a resilient modulus (Mr) value of 28,900 psi using relationships derived by the Asphalt Institute in Manual Series 1 (1).

b. Subbase

Based on the results of our tests, the upper 0 to 2 feet of material across the site contains average organic (bark) contents of 75 to 80 percent by volume of dry soil (Table 2). This material should be thoroughly mixed/blended to produce a homogeneous mixture, and placed to form 18 inches of processed material. The presence of the bark appears to cause little reduction in strength. The bark will have long-term effects on the consolidation of the bark layer. To control differential settlement caused by the decomposition of the bark, the material should be thoroughly mixed with the existing soils to insure even distribution of the bark. Laboratory testing indicates R-values ranging from 41 to 57 at various organic contents (see Figure 1). Because of the variability of the results and the potential of organic decomposition an R-value of 35 was used in design. An R-value of 35 can be converted to an Mr of 20,580 psi using the relationship previously discussed. The analysis also considered the possibility of complete removal of the soil/bark mixture thereby eliminating the "subbase" course.

c. Base

The base material considered in the analysis consisted of an aggregate base (AB). The aggregate base will be used as a working platform to enable the level

placement of the asphalt concrete cap. A typical R value for an aggregate base would be 70 and this can be converted to an Mr of 40,000 psi using the relationship previously discussed.

d. Surface Course

Four materials were considered for use as a surface course and include: asphalt concrete (AC), Portland cement concrete (PCC), roller compacted concrete (RCC), and concrete block pavers (CBP).

C. Asphalt Concrete Surface

The design of the AC section was based on a rational design method using the computer program ELSYM5. The parameters used in the analysis are summarized in Table 3. With the computed strains, several failure modes can be analyzed. These failure modes include:

1. Fatigue Cracking: Caused by repeated loads inducing tensile strains at the bottom of the AC layer.
2. Rutting: Caused by repeated loads inducing vertical compressive strain and permanent deformation on the top of the subgrade.

The fatigue criteria used was developed by Finn (2) and uses 10 percent cracking of the surface course as the limiting factor. The rutting criteria was developed by Chevron (3) and uses 3/4 inch rutting of the subgrade as the limiting factor.

Based on the design parameters discussed above, the cycles to failure for various AC thicknesses can be calculated and are shown in Tables 4 and 5. Table 4 considers the structural section with the soil/bark subbase mixture and Table 5 considers the structural section without the subbase. The results indicate that rutting is the controlling failure criteria. Figures 2 and 3 present plots of AC thickness verses cycles to failure using the rutting criteria for the container carrier and the highway truck.

D. Portland Cement Concrete Surface

The design of the PCC section was also based on a rational design method using ELSYM5 and the American Association of State Highway Officials (AASHTO) design procedures for the container carrier and the highway vehicle, respectively. The parameters used in the analysis are summarized in Table 3. The effects of fatigue are the controlling criteria for PCC thickness design. For the container carrier, a ratio of the flexural stress at the bottom of the PCC layer and the modulus of rupture (flexural strength) can be calculated and is known as the endurance limit (3). When the endurance limit is approximately 0.50 to 0.55 the concrete will withstand virtually unlimited stress repetitions without loss of load carrying capacity (4). An endurance limit of 0.50 was used in this analysis. Based on the design parameters discussed above, the PCC thickness required for various flexural strength values are shown in Tables 6 and 7. Table 6 considers the structural section with the subbase course and Table 7 considers the structural section without the subbase course.

Figure 4 presents plots of PCC thickness versus flexural strength for the container carrier with the soil/bark subbase and without the soil/bark subbase. Figures 5 and 6 present plots of Portland Cement Concrete thickness versus the cycles to failure for the Highway Truck with the soil/bark subbase and without the soil/bark subbase respectively.

E. Roller Compacted Concrete Surface

The design of RCC is essentially the same as the design for a PCC section. The only exception would be the flexural strength of the RCC used in the analysis. Typically, the flexural strength used for RCC would be between 200 and 400 psi. Figures 4, 5 and 6 which present PCC thickness verses flexural strength can be used for RCC design by limiting the flexural strength to between 200 and 400 psi. The AASHTO design

procedure does not consider PCC flexural strengths below 500 psi. Design thickness flexural strengths below 500 psi were extrapolated based upon the results for flexural strength between 500 to 700 psi.

F. Concrete Block Paver Surface

The design of the CBP system was based on work performed by the U.S. Army Engineer Waterways Experiment Station (5) in which the paver block is treated as equivalent to 6 1/2 inches of AC. A paver block thickness of 4 inches is recommended for heavy industrial floors and hardstands on which the vehicle speed does not exceed 35 miles per hour (6). A well graded, non plastic bedding sand is recommended beneath the paver block to provide a level surface for placing the block. The sand material used to fill the joint spacing between paver blocks and provide the required vertical block interlock should be slightly finer than the bedding sand.

V. DISCUSSION OF RESULTS

A. General

This section of the report discusses various pavement section alternatives and provides initial construction and life cycle maintenance costs. Figures 2 through 6 present pavement thicknesses for various surface treatments over a range of design parameters. Figures 7 through 11 present pavement section details for the impermeable cap and various pavement structures. The details presented in Figures 8 through 11 are based on an assumed maximum loading of 100,000 repetitions of the Container Carrier as the design vehicle. The 100,000 repetitions used in the analysis was provided by the Port of Tacoma.

Estimated initial construction costs and life cycle maintenance costs are presented in Tables 9 through 16. For comparison, the cost analysis is based on the structural section thicknesses required for 100,000 repetitions of the Container Carrier. Unit prices used in the analysis are summarized in Table 9.

B. Impermeable Cap

Slag from the Asarco smelter was used as a fill material across the site. The Department of Ecology has determined that heavy metals have been leached out of the slag from the site to the adjacent Blair Waterway. To prevent further leaching of the heavy metals, the preferred remedial alternative is an impermeable cap. The design of the impermeable cap has included considerations for the anticipated future uses of the site, both short term and long term. The site will be used as a container overflow terminal facility for the Port of Tacoma.

The structural section for the impermeable cap shall be constructed above the 18 inches of bark/soil processed material and shall consist of 4 inches of aggregate base (AB), and 4 inches of dense grade asphalt concrete (DGAC) (Figure 7). The service related

structural sections described later in this report shall be constructed directly above the impermeable cap.

C. Asphalt Concrete Surface

For comparison purposes, the AC sections were evaluated at 100,000 repetitions for each of the design vehicles considered. From Figure 2, The AC thickness required with the soil/bark subbase layer, is 10 inches for the container carrier and a minimum of 4 inches for the standard highway truck. Since the impermeable cap consists of 4 inches of AC the supplemental AC required for the container carrier would be 6 inches. Table 11 presents the life cycle cost analysis for the AC with the soil/bark subbase alternative using the container carrier design vehicle. From Figure 3 without the soil/bark subbase layer, an AC thickness of 8 inches can be obtained for the container carrier. Since the impermeable cap consists of 4" of AC the supplemental AC required for the container carrier would be 4 inches. Table 12 presents the life cycle cost analysis for the AC without the soil/bark subbase alternative, using the container carrier as the design vehicle.

The advantage in using an AC surface would be the inherent flexibility of asphaltic concrete material which would allow the surface to adjust due to the possible differential settlement caused by the decomposition of the organics (bark) in the "subbase" material.

The disadvantage to using AC would be the cost associated with the removal of additional contaminated material to accommodate the AC section. The advantages and disadvantages for each surface type are summarized in Table 8.

D. Portland Cement Concrete Surface

The design of the PCC section was based on varying concrete flexural strengths and unlimited repetitions. For comparison purposes, a flexural strength of 600 psi was used in the cost analysis. From Figure 4, with the soil/bark subbase layer, a PCC thickness

of 7 inches would the required for the container carrier. Table 13 presents the life cycle cost analysis for the PCC with the soil/bark subbase alternative, using the container carrier as the design vehicle. From Figure 4, without the soil/bark subbase layer, a PCC thickness of 6 inches can be obtained for the container carrier. This would be the minimum PCC section recommended. Table 14 presents the life cycle cost analysis for the PCC without the soil/bark subbase alternative using the log stacker as the design vehicle. A minimum thickness of 8 inches should be used for constructability reasons.

The advantage to using a PCC surface would be that the PCC structural section would allow for unlimited traffic repetitions.

The disadvantage to using a PCC surface would be the lack of flexibility and the high initial cost of the PCC.

E. Roller Compacted Concrete Surface

As previously mentioned, the design of the RCC is essentially the same as the PCC section, the only exception being the flexural strength of the concrete used in the analysis. For comparison purposes a flexural strength of 200 psi was used in the cost analysis. From Figure 4, with soil/bark subbase layer, a RCC thickness of 10 inches can be obtained for the container carrier. From Figure 4, without the soil/bark subbase layer a RCC thickness of 9.5 inches would be obtained for the container carrier. Table 15 presents the life cycle cost analysis for the RCC alternative with the soil/bark subbase and using the container carrier as the design vehicle.

The advantage of using a RCC surface would be a reduced cost compared to the PCC and jointing would not be required. Annual maintenance of the RCC surface would also be limited to sealing cracks.

The disadvantage of using RCC would be the maintenance associated with faulting and possibly a rough riding surface.

F. Concrete Block Paver Surface

The structural section recommended for the CBP system consists of a 4 inch block, a sand leveling course, a fabric interlayer and 4 inches of AC for the container carrier. The fabric layer is used to prevent the loss of bedding sand due to cracks which may develop in the AC layer. Table 16 presents the life cycle cost analysis for the RCC alternative with the soil/bark subbase and using the log stacker as the design vehicle.

The advantage of using a block paver surface would be if settlement does occur on the site, the effected blocks can be removed, the underlying material fixed, and the blocks replaced.

The disadvantage of the block paver surface would be the cost associated with the initial installation and the lack of experience using this type of construction.

G. Economic Analysis

A life cycle cost analysis was performed to evaluate the economic impacts of the various pavement alternatives. The life cycle analysis compares the initial costs and the future maintenance and rehabilitation costs. The future maintenance and rehabilitation costs were determined from local bid prices and information provided by the Port of Tacoma. The life cycle cost analysis and maintenance strategies provided, are based on experience on similar type pavement systems. A summary of the unit prices for the various items used in the cost estimates are presented in Table 9. The maintenance and rehabilitation strategies are presented in Table 10. The maintenance strategy for each pavement type is a basic plan to maintain the pavement throughout the design life. A discount rate of 4 percent per year was used for this evaluation. A life cycle cost analysis for each surface type is summarized in Tables 11 through 16. The economic analysis is based on 100,000 repetitions of the container carrier spread over a 20 year design life.

The present worth (PW) cost column in Tables 11 through 16 represents the cost incurred during the 20 year design period at today's dollar. The analysis includes the impermeable cap and all related maintenance activities for the surface material. The analysis also includes a salvage value which is the prorated value of the last major maintenance or rehabilitation activity performed on the pavement. The salvage value is used to normalize the analysis period so that it will be the same period for each pavement alternative

The economic analysis does not include any earthwork associated with getting the site to subgrade elevation or processing of the on site material to produce the soil/bark material (subbase). The economic analysis is based upon using the Soil/bark Layer throughout the site. Depending on the final pavement section selected and the amount of bark material left on site, the maintenance strategies and costs may change.

H. Construction Considerations

If the Soil/ Bark Subbase is to be used, the preparation of the Subbase will be critical to controlling the differential movement of the layer. The bark material will make normal density requirements and testing difficult to use. Of primary importance will the thorough mixing of the soil and bark throughout the site so that a homogeneous mixture is obtained. This mixture will not eliminate the consolidation of that layer but any consolidation that does occur will occur uniformly over the site. Determining if the mixture is consistent can be done visually during construction. Testing with a nuclear density gage may also be helpful. If testing is done with a nuclear density gage, the gage readings (unit weight, moisture content) will be useful to determine if the layer is homogeneous. This test method will only be able to give comparative results.

If import material is brought in to provide stability in certain areas this material should be mixed with uncontaminated bark to match the existing onsite material. This will help to control differential settlement.

Prior to the construction of the final structural section we recommend that the Port conduct falling weight deflectometer testing to determine the load carrying characteristics of the cap as it exists at that time and thereby refine the design on the final structural section.

I. Recommendations

The recommendation presented in this section is based upon the design assumptions and traffic levels presented in this report. If the design parameters are modified the recommendations will have to be reevaluated.

If the container carrier is used as the design vehicle, we recommend the use of asphalt concrete pavement section for the following reasons.

1. AC will perform better if differential settlement does occur due to the bark.
2. Lower life cycle cost.
3. Lower initial Cost

VI. REFERENCES

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5. Rollings, R.S. 1979. Precast Concrete Paving Block Pavement, U. S. Army Engineer Waterways Experiment Station, ETL 1110-3-310.

6. National Concrete Masonry Association, 1980. Concrete Block Pavements - Structural Design, TEK 115.

Table 1. Test Pit Soil Summary

* = Lab Classification

Test Pit No.	Depth Below Existing Grade (ft.)	Soil Description
TP-1	0-1.5	Dark Brown-Gray Poorly Graded Sand (SP) trace gravels -1" diameter and abundant wood waste
	1.5	*Brown Poorly Graded Gravel with Silt and Sand (GP-GM) Note: Visual classification only; est. 75-85% bark
	1.5-4.6	Brown Silty Sand (SM) Trace Gravels to 2" diameter - test pit wet at bottom
TP-2	0-2.2	*Brown Poorly Graded Gravel with Silt and Sand (GP-GM)
	2.2-3.3	Dark Grey Poorly Graded Sand (SP) with trace silts, medium grain sand at 3.0-3.3' saturated
	3.3-6.4	Green Grey Lean Clay (CL) with trace silts, moderately plastic
TP-3	0-2.0	*Brown Silty Gravel with Sand (GM)
	2.0-2.4	Brown Grey Clayey Gravel (GC) hard, dry, gravels are -1/4" diameter and well rounded
	2.4-4.0	Dark Grey Poorly Graded Sand (SP), sand is medium grained
TP-4	0-2.0	Brown Poorly Graded Gravel (GP) with abundant red-brown wood debris - gravels are well rounded, up to 5" diameter
	2.0-3.0	*Brown Poorly Graded Sand with Silt (SP-SM)
	3.0-4.0	Brown Grey Poorly Graded Sand (SP), sand medium grained, some oxidation, groundwater seepage at 4'
TP-5	0-0.5	Dark Brown Silty Sand (SM) with abundant roots and wood debris
	0.5-1.0	Red Grey Clayey Sand with Gravels (SC)
	1.0-3.5	Grey Brown Poorly Graded Sand (SP) with trace silts and minor oxidized zones
TP-6	0-0.6	*Brown Silty Gravel (GM) estimated organics at 80-90% (visual)
	0.6-1.6	Dark Brown Silty Sand with Gravel (SM)
	1.6-4.0	Grey Brown Silty Sand (SM) wet water seepage at bottom of test pit
TP-7	0-2.0	*Brown Poorly Graded Gravel (GP)
	2.0-4.0	Grey Poorly Graded Sand (SP)

Table 1. Test Pit Soil Summary
(Continued)

Test Pit No.	Depth Below Existing Grade (ft.)	Soil Description
TP-8	0-2.0 2.0-3.0	*Dark Brown Well-Graded Bark with Bark (BW-BB)? Grey Green Clayey Sand (SC) with boulders - rock is weathered, groundwater in bottom of test pit
TP-9	0-1.0 1.0-2.0 2.0-3.0 3.0-5.0	Dark Brown Wood Debris with Trace Silts Brown Grey Poorly Graded Sand with Gravel (SP) moist-wet *Brown Poorly Graded Sand with Silt and Gravel (SP-SM) Grey Poorly Graded Sand (SP), moist
TP-10	0-1.0 1.0-2.0 2.0-3.0	Dark Brown Silty Gravel with Sand (GM) with wood debris *Grey Brown Poorly Graded Gravel (GP) Dark Grey Poorly Graded Sand (SP)

Table 2.
Summary of Laboratory Test Data

Test Pit No.	Depth	Atterberg Limits		% Passing by Dry Weight						R-value	% Organics by Wt.	USCS
		LL	PI	6"	3"	No.4	No.30	No.50	No.200			
TP-1	1.5'									49		
TP-2	0.0-0.5			100	100	32.9	21	15	10			
TP-3	0.0-2.0			100	100	37.9	23	16	12.4	57		
TP-4	2.0'-3.0'	NP		100	100	100	86	56	8.2	66		
TP-5												
TP-6												
TP-7	0.0'-2.0'			100	100	13.4	8	6	3.6			
TP-8	0.0'-2.0'			100	100	46	9	5	0.9	41	100%	
TP-9	2.0'-3.0'			100	100	84	65	31	5.5			
TP-10	1.0'-2.0'			100	100	17.1	10	8	4.4			

Table 3.
Summary of Material Design Parameters

	R-Value	Flexural Strength	Resilient Modulus	Poisson's Ratio
Asphalt Concrete (Varies)			400,000 psi	0.35
Portland Cement Concrete (8" Minimum)		600 psi	3,420,000	0.20
Roller Compacted Concrete		200 psi	1,140,000 to 2,280,000	0.20
Aggregate Base (4" Minimum)			40,000	0.35
Subbase-Bark/Soil Material (18" Minimum)	35		20,580	0.40
Subgrade	50		28,900	0.40

Table 4

Cycles to Failure for Various Asphalt Concrete Thicknesses
(w/ soil/bark Subbase)

AC Thickness (inches)	Cycles to Failure			
	Fatigue Criteria		Rutting Criteria	
	Container Carrier	Highway Truck	Container Carrier	Highway Truck
4	96,299	26,805,471	1,904	5,565,938
5		332,672,324		9,804,556
6	159,240	22,416,054,034	10,710	18,026,124
7				33,056,543
8	335,559		47,328	
10	689,247		170,864	
12	1,419,551		523,573	
14	2,840,056		1,418,415	

Table 5
Cycles to Failure for Various Asphalt Concrete Thicknesses
(w/o soil/bark Subbase)

AC Thickness (inches)	Cycles to Failure			
	Fatigue Criteria		Rutting Criteria	
	Container Carrier	Highway Truck	Container Carrier	Highway Truck
4	99,079	18,794,366	5,755	8,395,776
5		164,972,860		8,395,776
6	209,320	3,442,856,663	29,604	14,643,815
8	407,650		123,270	
10	816,504		430,003	
12	1,607,078		1,277,866	
14	3,064,426		3,400,037	

Table 6.
Portland Cement Concrete Thickness Summary
(w/ soil/bark subbase)

Flexural Strength (psi)	Require PCC Thickness (inches)	
	Container Carrier	Highway Truck
200	9.5	9
300	8.5	8.5
400	8*	8*
500	8*	8*
600	8*	8*
700	8*	8*

* Minimum Recommended Thickness

Table 7.
Portland Cement Concrete Thickness Summary
(w/o soil/bark subbase)

Flexural Strength (psi)	Require PCC Thickness (inches)	
	Container Carrier	Highway Truck
200	9.5	9
300	8.5	8.5
400	8*	8*
500	8*	8*
600	8*	8*
700	8*	8*

* Minimum Recommended Thickness

Table 8:
Summary of Advantages and Disadvantages

Proposed Surface	Remarks
Asphalt Concrete	**Advantages**
	Flexible
	Low initial Cost
	Constructability- easy, fast
	Disadvantages
	Increased Structural Section
	Annual Maintenance
Portland Cement Concrete	**Advantages**
	Reduced Structural Section
	Unlimited Traffic Repetitions
	Disadvantages
	Rigid
	High Initial Cost
Roller Compacted Concrete	**Advantages**
	Reduced Structural Section
	Unlimited Traffic Repetitions
	Low Annual Maintenance
	Disadvantages
	Rigid
	Rough Finish
Concrete Block Paver	**Advantages**
	Flexible
	Easy to Maintain
	Disadvantages
	High Initial Cost
	Limited Construction Experience
	Labor Intensive

Table 9.

Construction Material Unit Prices

Item	Unit Price
Crack Seal (Asphalt Concrete)	$1/LF
Crack Seal (Portland Cement Concrete)	$2.5/LF
Joint Seal (Portland Cement Concrete)	$2/LF
Shallow Patch (Asphalt Concrete)	$3.5/SF
Deep Patch (Asphalt Concrete)	$7/SF
Aggregate Base	$25/CY
Asphalt Concrete	$32/TON
Portland Cement Concrete	$100/CY
Roller Compacted Concrete	$60/CY
4" Block Paver (includes sand layer)	$1.85/SF
Fabric	$1/SY

Maintenance Strategies For Alternative Pavement Surfacing

YEAR	ITEM	DESCRIPTION	QUANTITY	UNIT
		ASPHALT CONCRETE ALTERNATIVE		
7,14	CRACK SEALING	200' CRACK / 2500SF PAVEMENT	37,932	FT
7,14	PATCH-SHALLOW	25SF PATCH/2500 SF PAVEMENT	4,742	SF
7,14	PATCH-DEEP	25SF PATCH/2500SF PAVEMENT	4,742	SF
10	LEVELING COURSE	20% TOTAL AREA	94,830	SF
		PORTLAND CEMENT CONCRETE		
5,10,15	CRACK SEALING	2 SLAB LENGTHS/ 10 SLABS	6,322	FT
10	JOINT RESEALING	ALL	63,220	FT
10	SPALL REPAIR	2 SPALLS/10 SLABS	2,107	SF
10	CORNER BREAK	1 BREAK/ 20 SLABS	1,054	SF
10	SLAB REPLACEMENT	1% SLABS	139	CY
10	MUDJACKING	20% TOTAL AREA	421	SLBS
		ROLLER COMPACTED CONCRETE		
1,10	CRACK SEALING	ALL CRACKS (EVERY 50")	88,000	LF
10	SPALL REPAIRS	5 SF SPALL / 2500 SF PAVEMENT	948	SF
10	GRINDING	20% TOTAL AREA	94,830	SF
		CONCRETE BLOCK PAVERS		
5,10,15	REPLACE BLOCKS &	1% OF THE AREA	4,742	
5,10,15	ADD SAND			
10	LEVELING COURSE	20% TOTAL AREA	94,830	SF

LIFE CYCLE COST ANALYSIS FOR ASPHALT CONCRETE ALTERNATIVE WITH SOIL/BARK MIXTURE

YEAR	ITEM	QUANTITY	UNIT	COST	UNIT	TOTAL COST	PW COST
0	4" AB	474,150	SF	$0.32	SF	$151,728	$151,728
0	4" AC CAP	474,150	SF	$0.75	SF	$355,613	$355,613
0	5.0" AC	474,150	SF	$0.97	SF	$459,926	$459,926
						$967,266	$967,266
7	CRACK SEALING	37,932	FT	$1.00	FT	$37,932	$28,825
7	PATCH-SHALLOW	4,742	SF	$3.50	SF	$16,595	$12,611
7	PATCH-DEEP	4,742	SF	$7.00	SF	$33,191	$25,222
7	LEVELING COURSE (2"AC)	94,830	SF	$0.37	SF	$35,372	$26,880
						$123,089	$93,538
14	CRACK SEALING	37,932	FT	$1.00	FT	$37,932	$21,905
14	PATCH-SHALLOW	4,742	SF	$3.50	SF	$16,595	$9,583
14	PATCH-DEEP	4,742	SF	$7.00	SF	$33,191	$19,167
14	LEVELING COURSE (2"AC)	94,830	SF	$0.37	SF	$35,087	$20,262
						$122,805	$70,917
20	SALVAGE VALUE					($17,544)	($8,007)
				TOTAL		$1,195,617	$1,123,714
		TOTAL (cost per square foot)				$2.52	$2.37

Table 12.

LIFE CYCLE COST ANALYSIS FOR ASPHALT CONCRETE ALTERNATIVE WITHOUT SOIL/BARK MIXTURE

YEAR	ITEM	QUANTITY	UNIT	COST	UNIT	TOTAL COST	PW COST
0	4" AB	474,150	SF	$0.32	SF	$151,728	$151,728
0	4" AC CAP	474,150	SF	$0.75	SF	$355,613	$355,613
0	4.0"AC	474,150	SF	$0.75	SF	$355,613	$355,613
						$862,953	$862,953
7	CRACK SEALING	37,932	FT	$1.00	FT	$37,932	$28,825
7	PATCH-SHALLOW	4,742	SF	$3.50	SF	$16,595	$12,611
7	PATCH-DEEP	4,742	SF	$7.00	SF	$33,191	$25,222
						$87,718	$66,658
14	CRACK SEALING	37,932	FT	$1.00	FT	$37,932	$21,905
14	PATCH-SHALLOW	4,742	SF	$3.50	SF	$16,595	$9,583
14	PATCH-DEEP	4,742	SF	$7.00	SF	$33,191	$19,167
14	LEVELING COURSE (2"AC)	94,830	SF	$0.37	SF	$35,087	$20,262
						$122,805	$70,917
20	SALVAGE VALUE					($17,544)	($8,007)
				TOTAL		$1,055,932	$992,521
		TOTAL (cost per square foot)				$2.23	$2.09

LIFE CYCLE COST ANALYSIS FOR JOINTED PORTLAND CEMENT CONCRETE ALTERNATIVE WITH SOIL/BARK MIXTURE

YEAR	ITEM	QUANTITY	UNIT	COST	UNIT	TOTAL COST	PW COST
0	4" AB	474,150	SF	$0.32	SF	$151,728	$151,728
0	4" AC	474,150	SF	$0.75	SF	$355,613	$355,613
0	8." JCP	474,150	SF	$2.46	SF	$1,166,409	$1,166,409
						$1,673,750	$1,673,750
5	CRACK SEALING	6,322	FT	$2.50	FT	$15,805	$12,991
						$15,805	$12,991
10	JOINT RESEALING	63,220	FT	$2.00	FT	$126,440	$85,418
10	CRACK SEALING	6,322	FT	$2.50	FT	$15,805	$10,677
10	SPALL REPAIRS	2,107	SF	$70.00	SF	$147,513	$99,655
10	CORNER BREAK	1,054	SF	$120.00	SF	$126,440	$85,418
10	SLAB REPLACEMENT	139	SF	$2.62	SF	$364	$246
						$416,563	$281,415
15	CRACK SEALING	6,322	FT	$2.50	FT	$15,805	$8,776
						$15,805	$8,776
				TOTAL		$2,121,922	$1,976,931
		TOTAL (cost per square foot)				$4.48	$4.17

Table 14.

LIFE CYCLE COST ANALYSIS FOR JOINTED PORTLAND CEMENT CONCRETE ALTERNATIVE WITHOUT SOIL/BARK MIXTURE

YEAR	ITEM	QUANTITY	UNIT	COST	UNIT	TOTAL COST	PW COST
0	4" AB	474,150	SF	$0.32	SF	$151,728	$151,728
0	4" AC	474,150	SF	$0.75	SF	$355,613	$355,613
0	8" JCP	474,150	SF	$2.46	SF	$1,166,409	$1,166,409
						$1,673,750	$1,673,750
5	CRACK SEALING	6,322	FT	$2.50	FT	$15,805	$12,991
						$15,805	$12,991
10	JOINT RESEALING	63,220	FT	$2.00	FT	$126,440	$85,418
10	CRACK SEALING	6,322	FT	$2.50	FT	$15,805	$10,677
10	SPALL REPAIRS	2,107	SF	$70.00	SF	$147,513	$99,655
10	CORNER BREAK	1,054	SF	$120.00	SF	$126,440	$85,418
10	SLAB REPLACEMENT	139	SF	$2.62	SF	$364	$246
						$416,563	$281,415
15	CRACK SEALING	6,322	FT	$2.50	FT	$15,805	$8,776
						$15,805	$8,776
				TOTAL		$2,121,922	$1,976,931
		TOTAL (cost per square foot)				$4.48	$4.17

Table 15.

LIFE CYCLE COST ANALYSIS FOR ROLLER COMPACTED CONCRETE ALTERNATIVE WITH SOIL/BARK MIXTURE

YEAR	ITEM	QUANTITY	UNIT	COST	UNIT	TOTAL COST	PW COST
0	4" AB	474,150	SF	$0.32	SF	$151,728	$151,728
0	4" AC	474,150	SF	$0.75	SF	$355,613	$355,613
0	10" RCC	474,150	SF	$1.85	SF	$877,178	$877,178
						$1,384,518	$1,384,518
1	CRACK SEALING	88,000	FT	$2.50	FT	$220,000	$211,538
						$220,000	$211,538
10	CRACK SEALING	88,000	FT	$2.50	FT	$220,000	$148,624
10	SPALL REPAIRS	948	SF	$70.00	SF	$66,381	$44,845
10	GRINDING	94,830	SF	$3.33	SF	$315,784	$213,332
						$602,165	$406,801
				TOTAL		$2,206,683	$2,002,857
		TOTAL (cost per square foot)				$4.65	$4.22

Table 16.

LIFE CYCLE COST ANALYSIS FOR CONCRETE BLOCK PAVER ALTERNATIVE WITH SOIL/BARK MIXTURE

YEAR	ITEM	QUANTITY	UNIT	COST	UNIT	TOTAL COST	PW COST
0	4" AB	474,150	SF	$0.32	SF	$151,728	$151,728
0	12.5" AC	474,150	SF	$2.33	SF	$1,104,770	$1,104,770
0	FABRIC	52,683	SY	$1.00	SY	$52,683	$52,683
0	4"BLOCK/1"SAND	474,150	SF	$1.85	SF	$877,178	$877,178
						$2,186,358	$2,186,358
5	REPLACE BLOCKS	4,742	SF	$3.00	SF	$14,225	$11,692
						$14,225	$11,692
10	LEVELING COURSE (2"AC)	94,830	SF	$0.37	SF	$35,087	$23,704
10	REPLACE BLOCKS	4,742	SF	$2.00	SF	$9,483	$6,406
						$44,570	$30,110
15	REPLACE BLOCKS	4,742	SF	$3.00	SF	$14,225	$7,898
						$14,225	$7,898
				TOTAL		$2,259,377	$2,236,058
		TOTAL (cost per square foot)				$4.77	$4.72

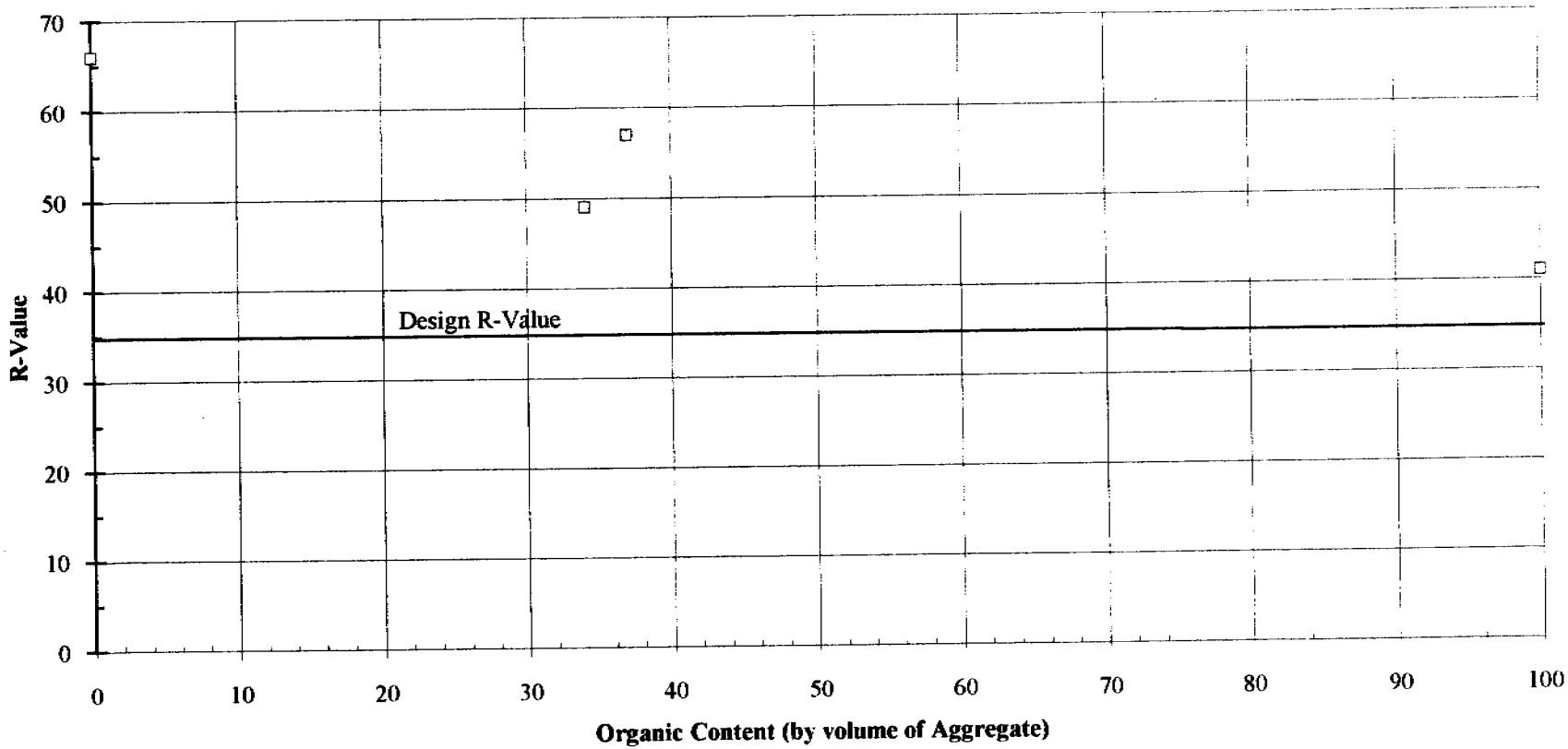


Figure 1. R-Value Verus Organic Content

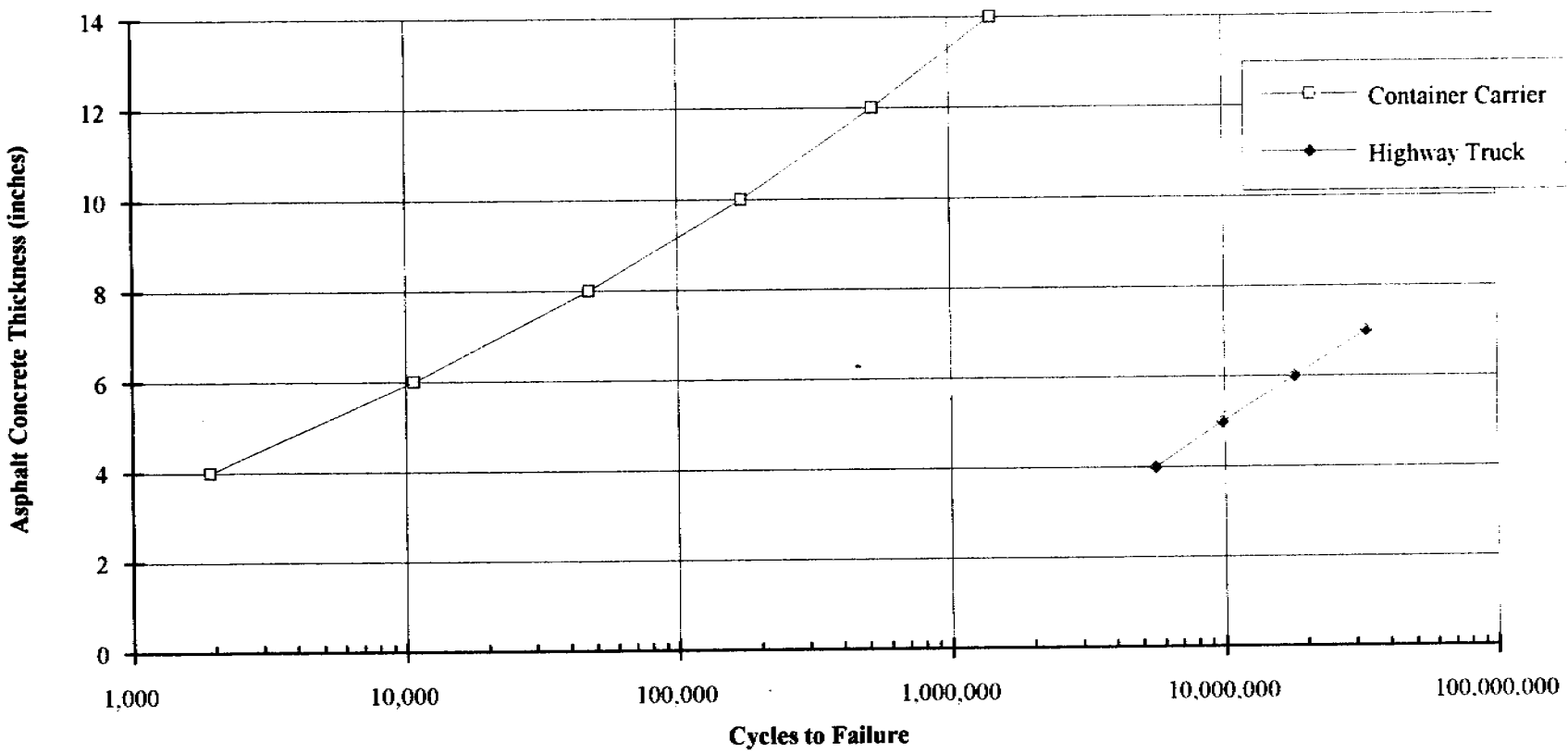


Figure 2. Asphalt Concrete Thickness Versus Cycles to Failure (w/ Soil/Bark Subbase)

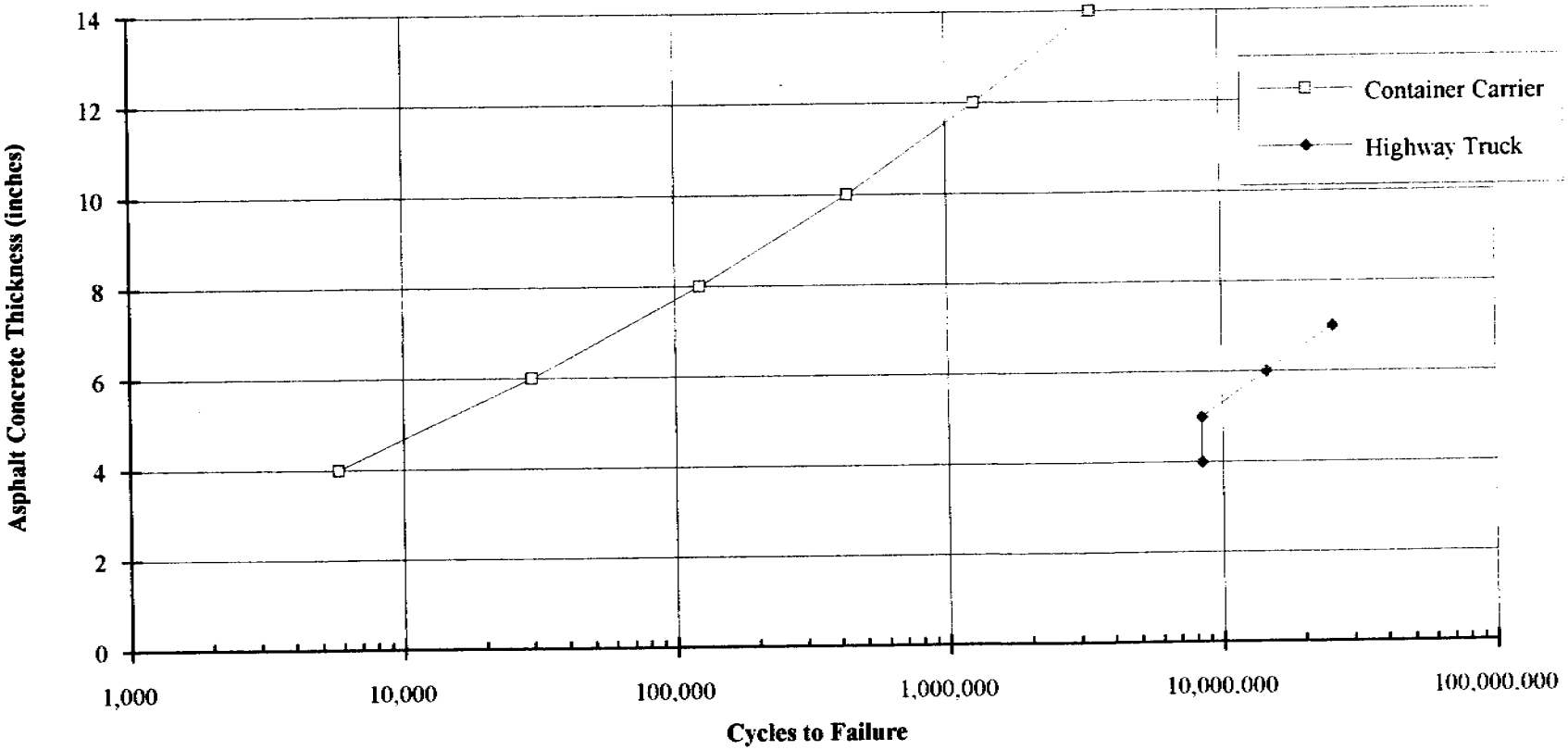


Figure 3. Asphalt Concrete Thickness Versus Cycles to Failure (w/o Soil/Bark Subbase)

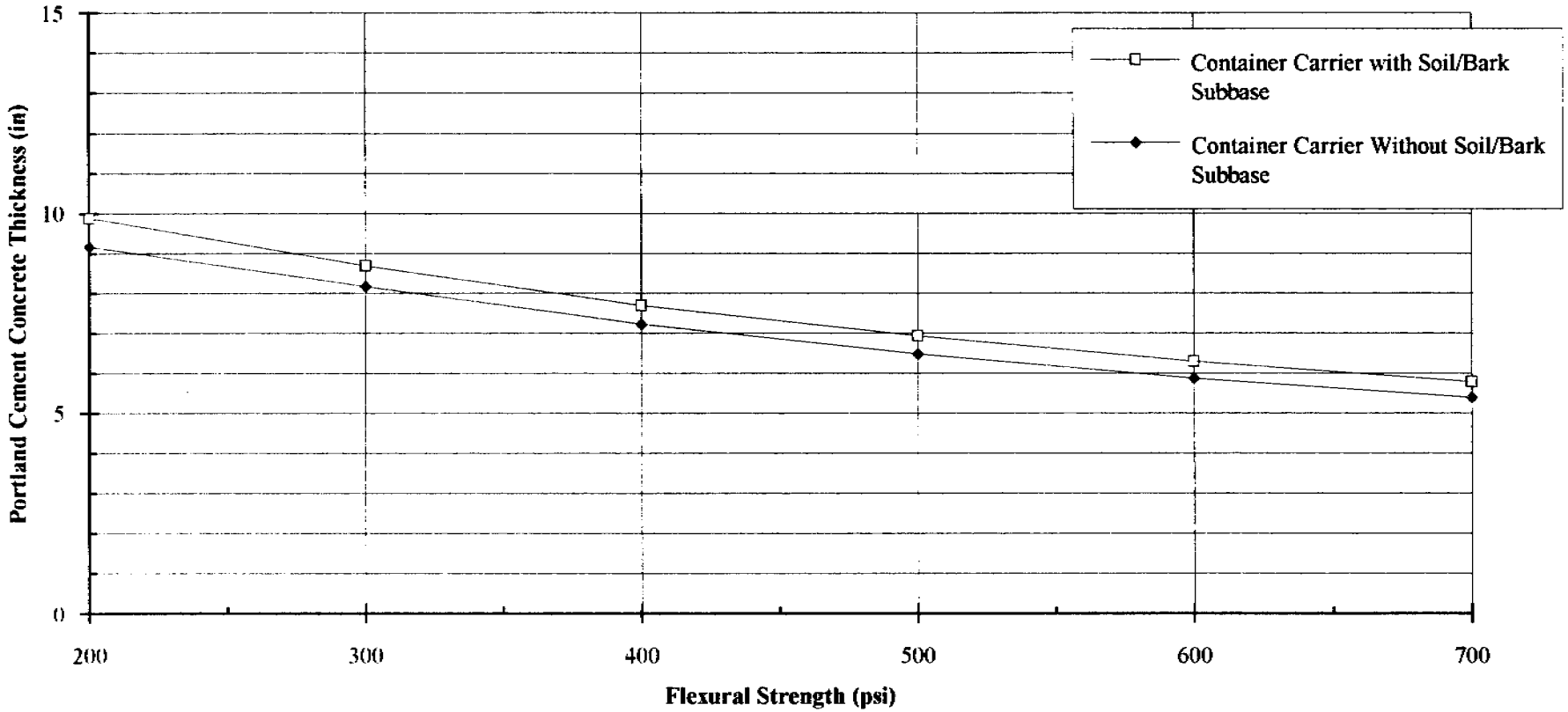


Figure 4. Portland Cement Concrete Thickness Versus Flexural Strength for The Container Carrier

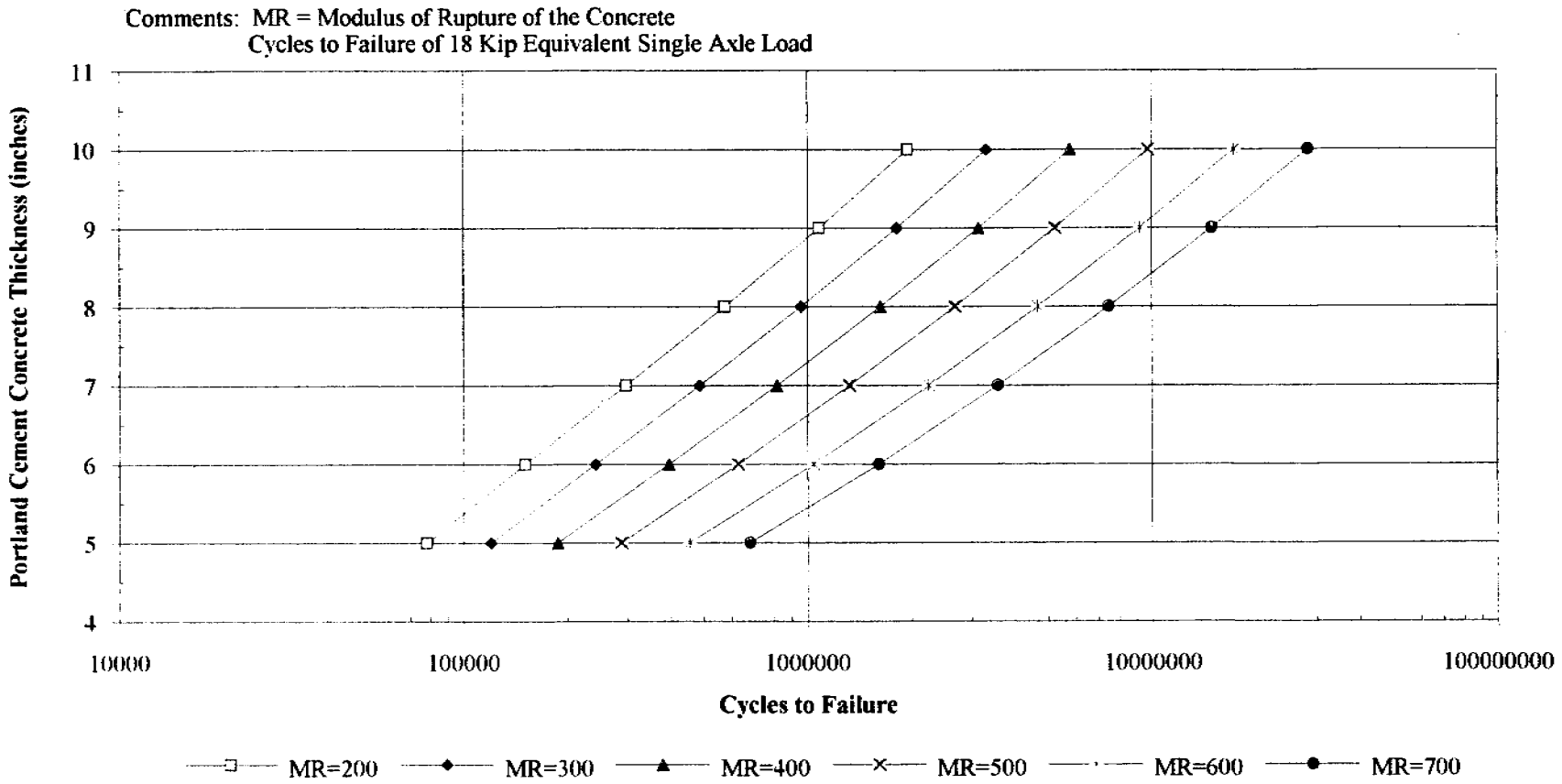


Figure 5. Portland Cement Concrete Thickness Versus Cycles to Failure (w/ Soil/Bark Subbase)

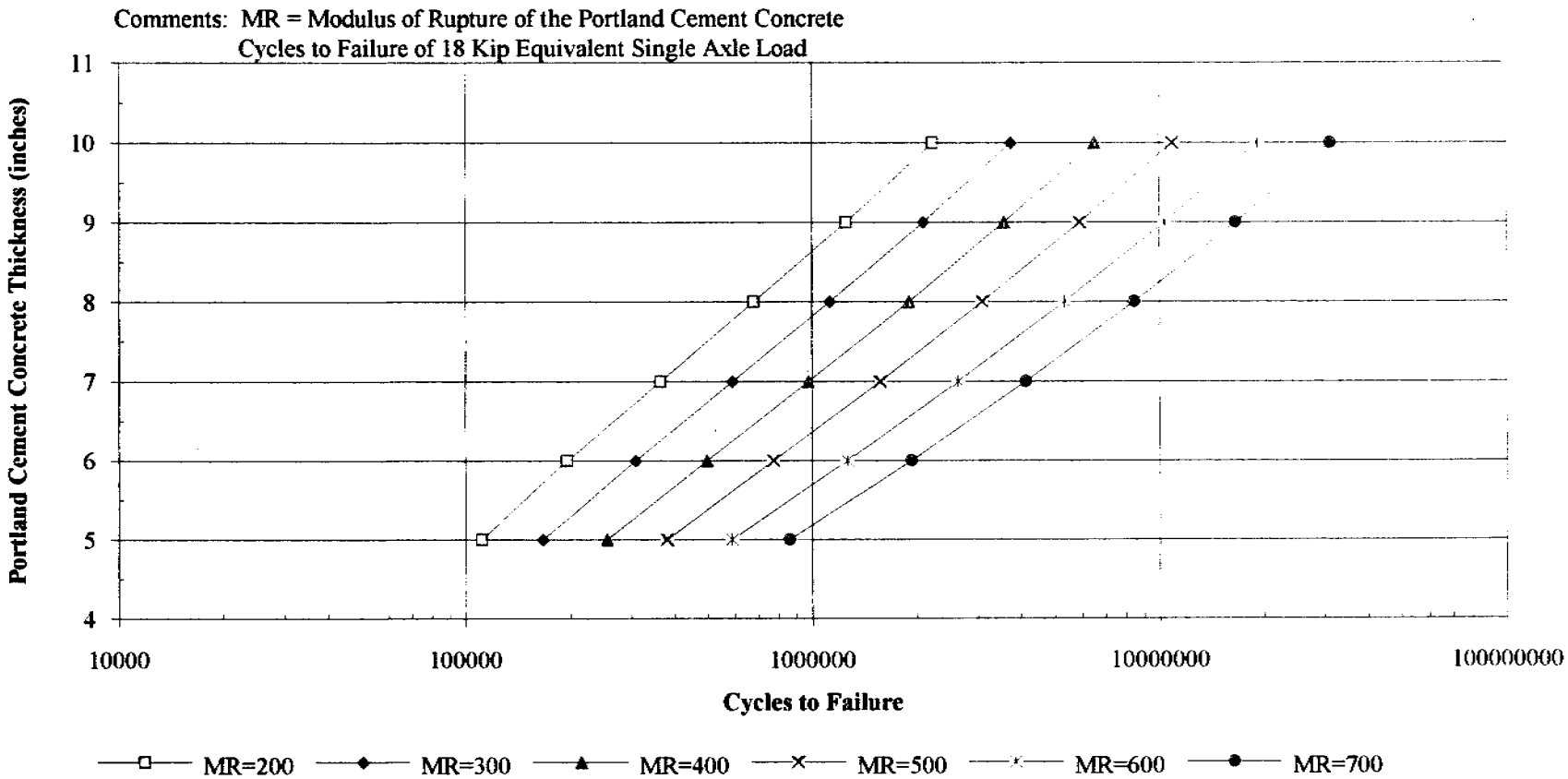
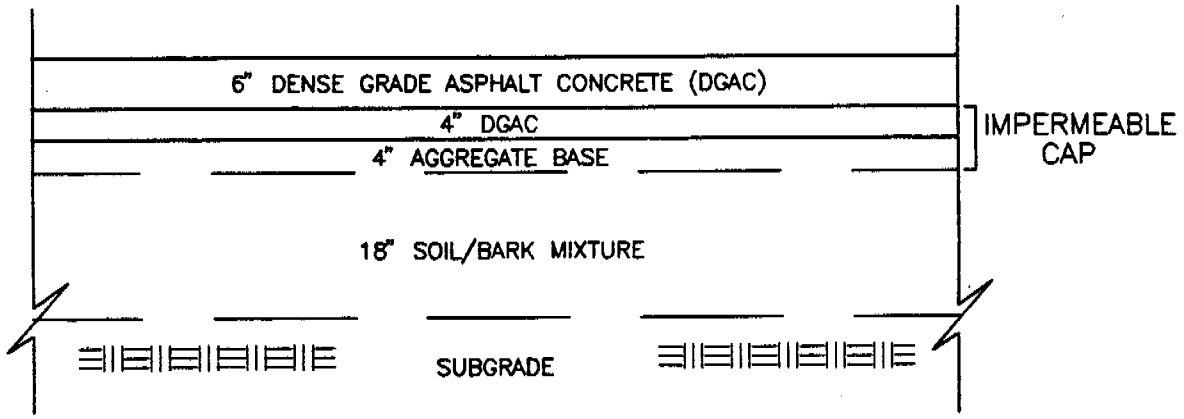
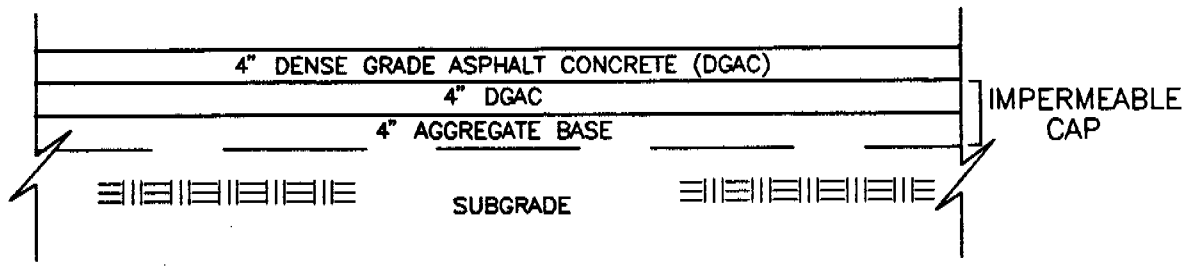


Figure 6. Portland Cement Concrete Thickness versus Cycles to Failure (w/o Soil/Bark Subbase)



ASPHALT SECTION FOR THE CONTAINER CARRIER WITH SOIL/BARK MIXTURE

N.T.S.



ASPHALT SECTION FOR THE CONTAINER CARRIER WITHOUT SOIL/BARK MIXTURE

N.T.S.

HARDING LAWSON ASSOCIATES
Engineering and Environmental Services

ASPHALT CONCRETE PAVEMENT SECTIONS
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

FIGURE 7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
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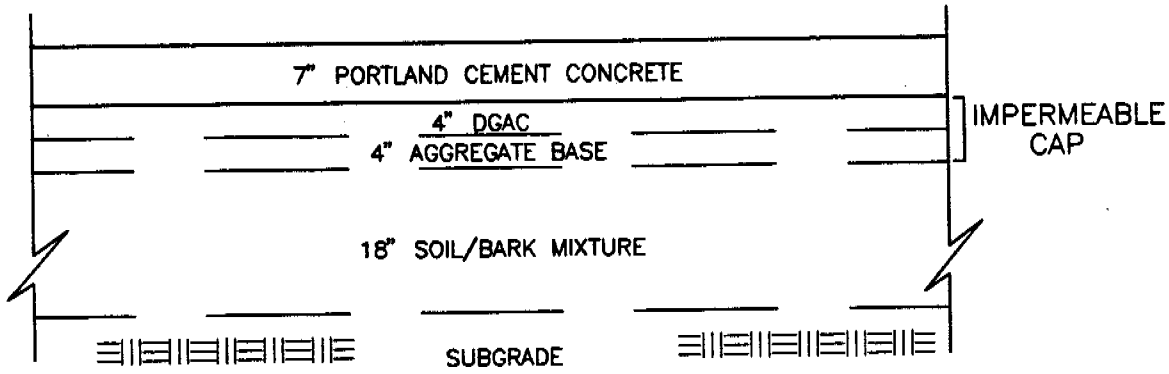
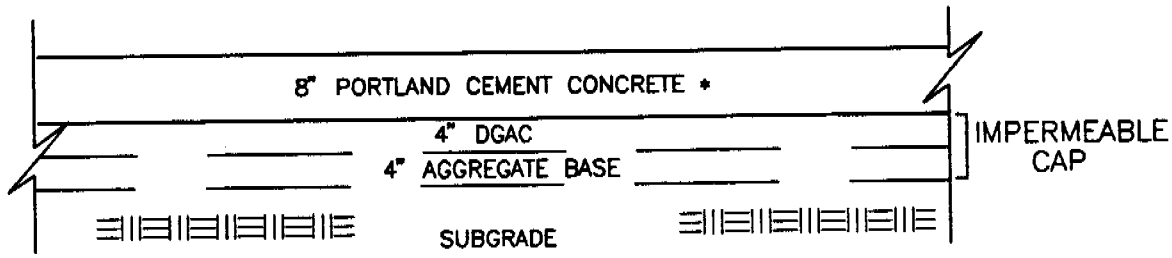


PORTLAND CEMENT CONCRETE SECTION FOR THE CONTAINER CARRIER WITH SOIL/BARK MIXTURE

N.T.S.



*MINIMUM RECOMMENDED SECTION

PORTLAND CEMENT CONCRETE SECTION FOR THE CONTAINER CARRIER WITHOUT SOIL/BARK MIXTURE

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PORTLAND CEMENT CONCRETE PAVEMENT SECTIONS
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FIGURE 8

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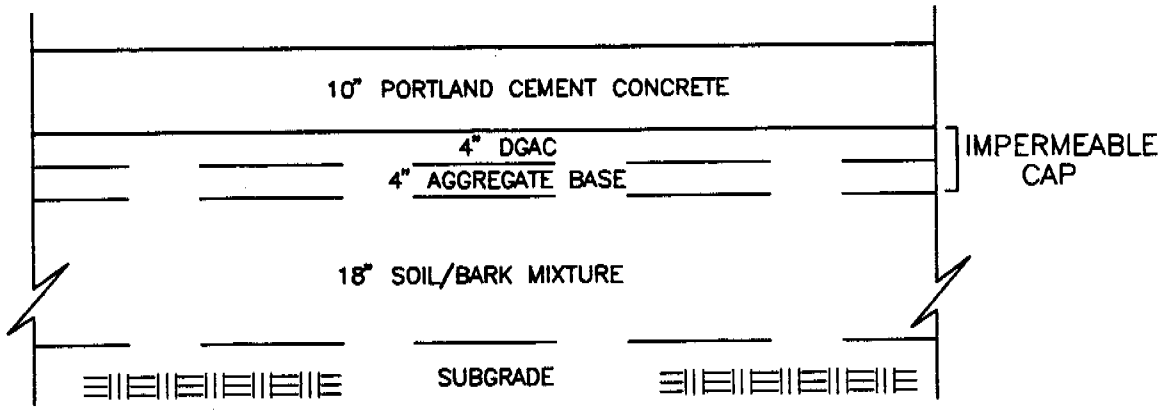

ROLLER COMPACTED CONCRETE SECTION FOR CONTAINER CARRIER WITH SOIL/BARK MIXTURE

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ROLLER COMPACTED CONCRETE PAVEMENT SECTION
PORT OF TACOMA
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TACOMA, WASHINGTON

FIGURE 9

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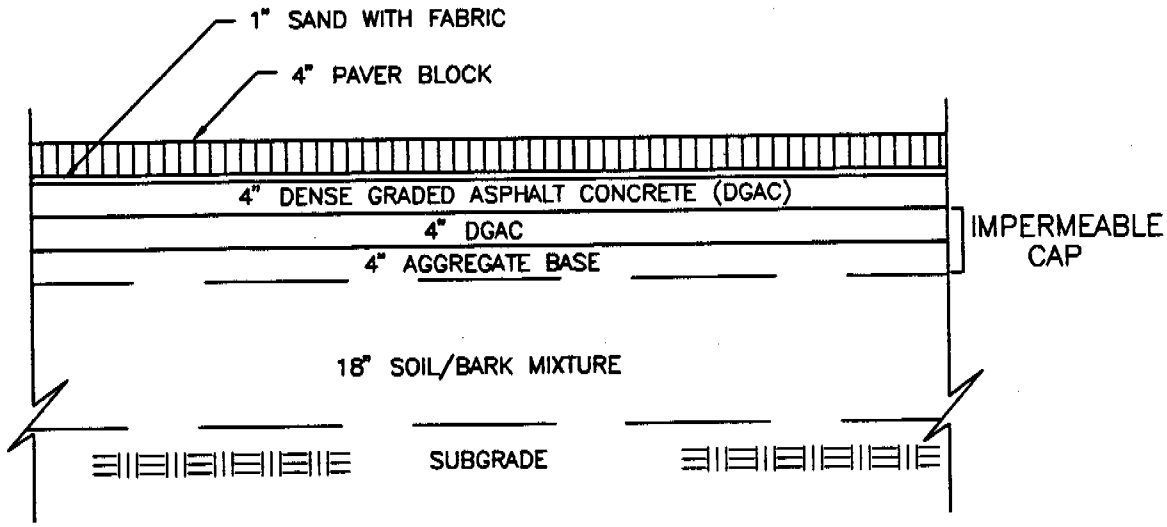

CONCRETE BLOCK PAVER SECTION FOR CONTAINER CARRIER WITH SOIL/BARK MIXTURE

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CONCRETE BLOCK PAVER PAVEMENT SECTION
PORT OF TACOMA
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TACOMA, WASHINGTON

FIGURE 10

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
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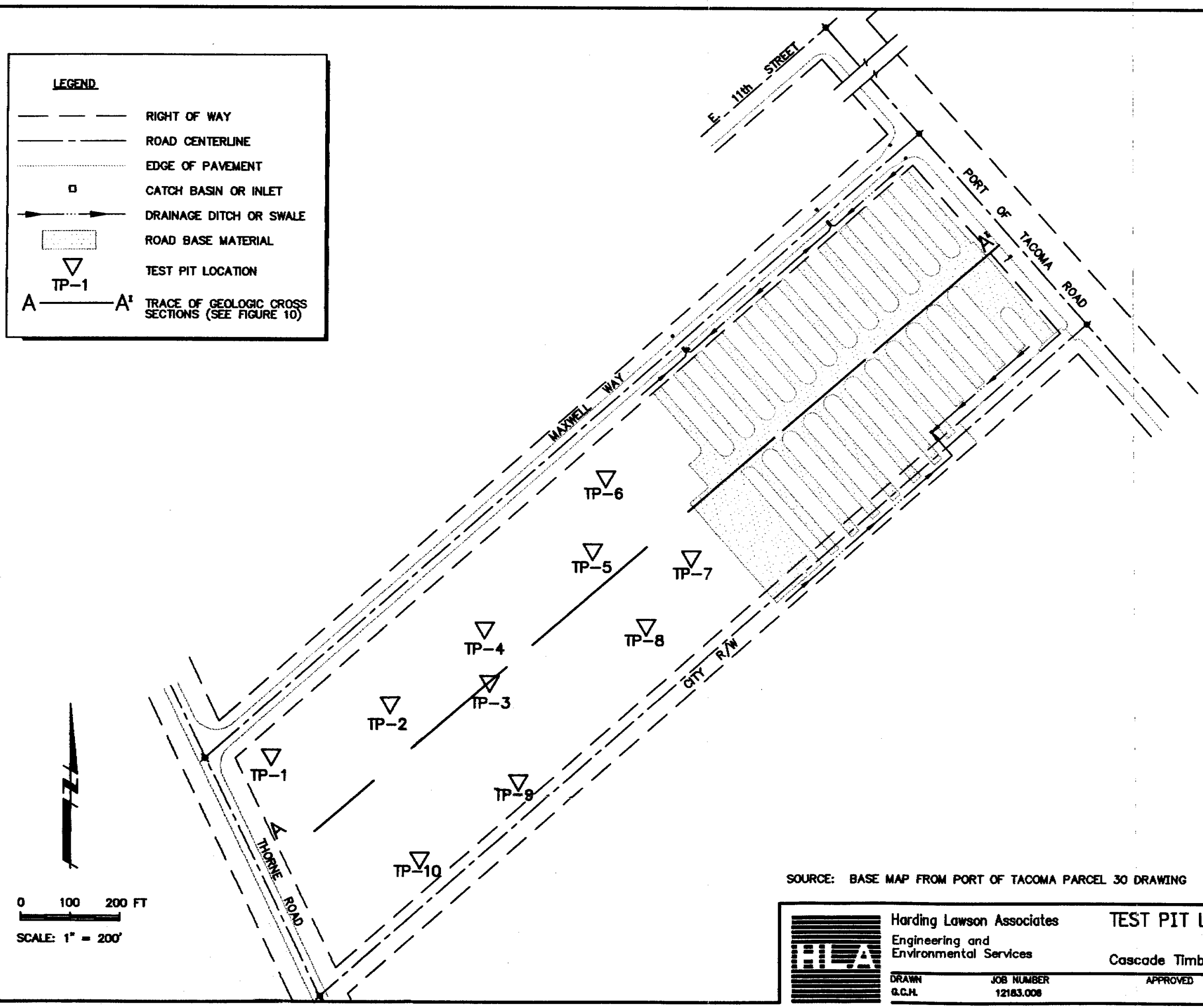
QUALITY CONTROL REVIEWER

Bruce Krater, P.E.
Consulting Principal Engineer

LEGEND

- RIGHT OF WAY
- ROAD CENTERLINE
- EDGE OF PAVEMENT
- CATCH BASIN OR INLET
- DRAINAGE DITCH OR SWALE
- ROAD BASE MATERIAL
- TP–1 TEST PIT LOCATION
- A — A' TRACE OF GEOLOGIC CROSS SECTIONS (SEE FIGURE 10)



SOURCE: BASE MAP FROM PORT OF TACOMA PARCEL 30 DRAWING

CPLATE1 2000
19940324.1412

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TEST PIT LOCATIONS

Cascade Timber No. 3 Log Sort Yard

PLATE 1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
G.C.H.	12183.008		01–05–93	03–11–93

UNIFIED SOIL CLASSIFICATION - ASTM D2487-85

MAJOR DIVISIONS					TYPICAL NAMES
COARSE-GRAINED SOILS MORE THAN HALF IS COARSER THAN No. 200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
			GP		POORLY GRADED GRAVEL WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM		SILTY GRAVELS, SILTY GRAVELS WITH SAND
			GC		CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN No. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
			SP		POORLY GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM		SILTY SANDS WITH OR WITHOUT GRAVEL
			SC		CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN No. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
			OL		ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS, FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC SILTS OR CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

KEY TO TEST DATA

M(80)	-	Moisture Content (%)
DD(105)	-	Dry Density(pcf)
Perm	-	Permeability
Consol	-	Consolidation
LL	-	Liquid Limit (%)
PI	-	Plasticity Index (%)
G_s	-	Specific Gravity
MA	-	Particle Size Analysis
OC	-	Organic Content
■	-	"Undisturbed" Sample
⊠	-	Bulk or Classification Sample

Shear Strength (psf)
Confining Pressure

TxUU 3200 (2600)	-	Unconsolidated Undrained Triaxial Shear
(FM) or (S)	-	(field moisture or saturated)
TxCU 3200 (2600)	-	Consolidated Undrained Triaxial Shear
(P)	-	(with or without pore pressure measurement)
TxCD 3200 (2600)	-	Consolidated Drained Triaxial Shear
SSCU 3200 (2600)	-	Simple Shear Consolidated Undrained
(P)	-	(with or without pore pressure measurement)
SSCD 3200 (2600)	-	Simple Shear Consolidated Drained
DSCD 2700 (2000)	-	Consolidated Drained Direct Shear
UC 470	-	Unconfined Compression
LVS 700	-	Laboratory Vane Shear

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SOIL CLASSIFICATION CHART/KEY TO TEST DATA
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

PLATE **2**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
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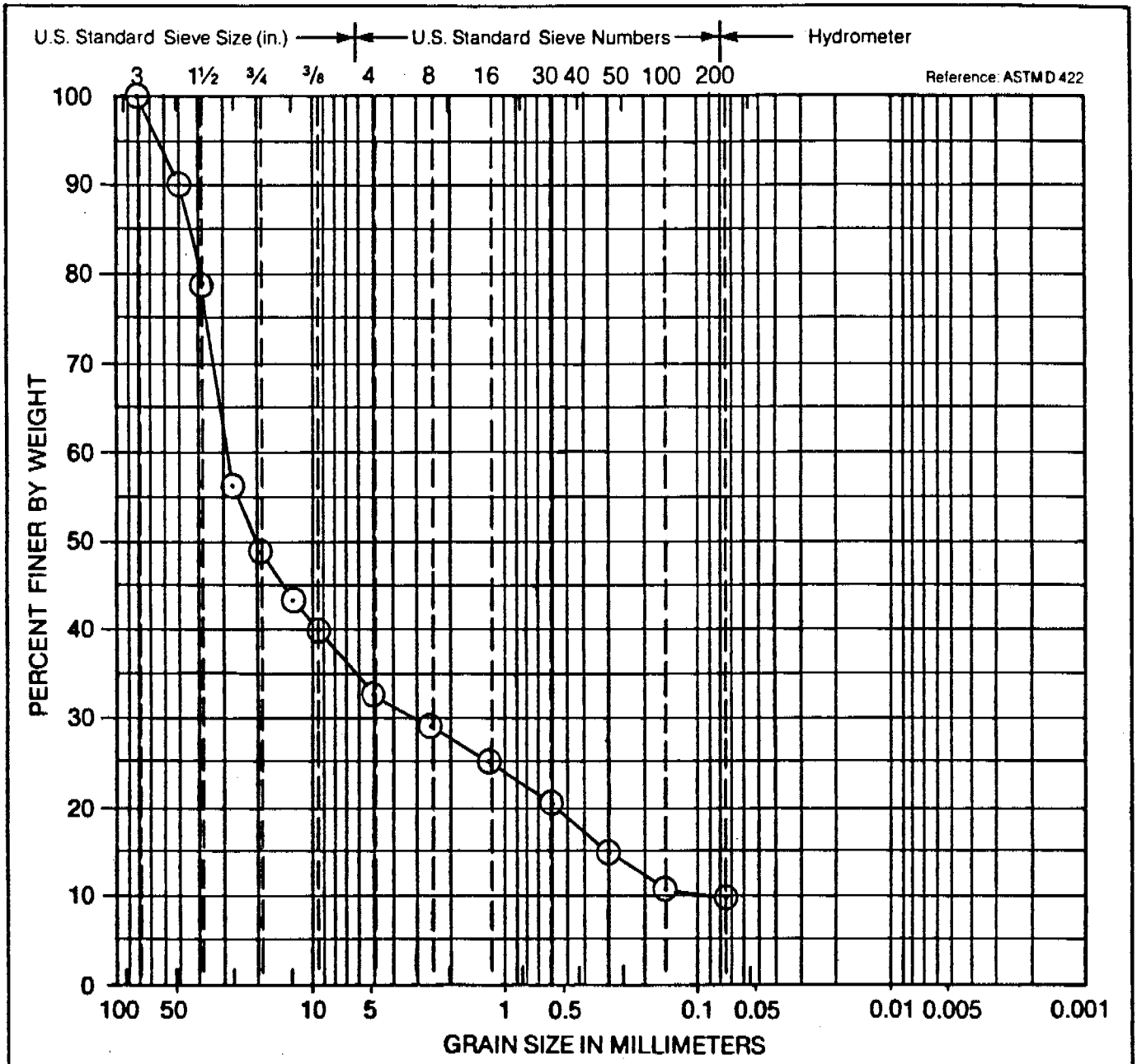

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	TP-2 @ 0.0' to 2.2'	BROWN POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)

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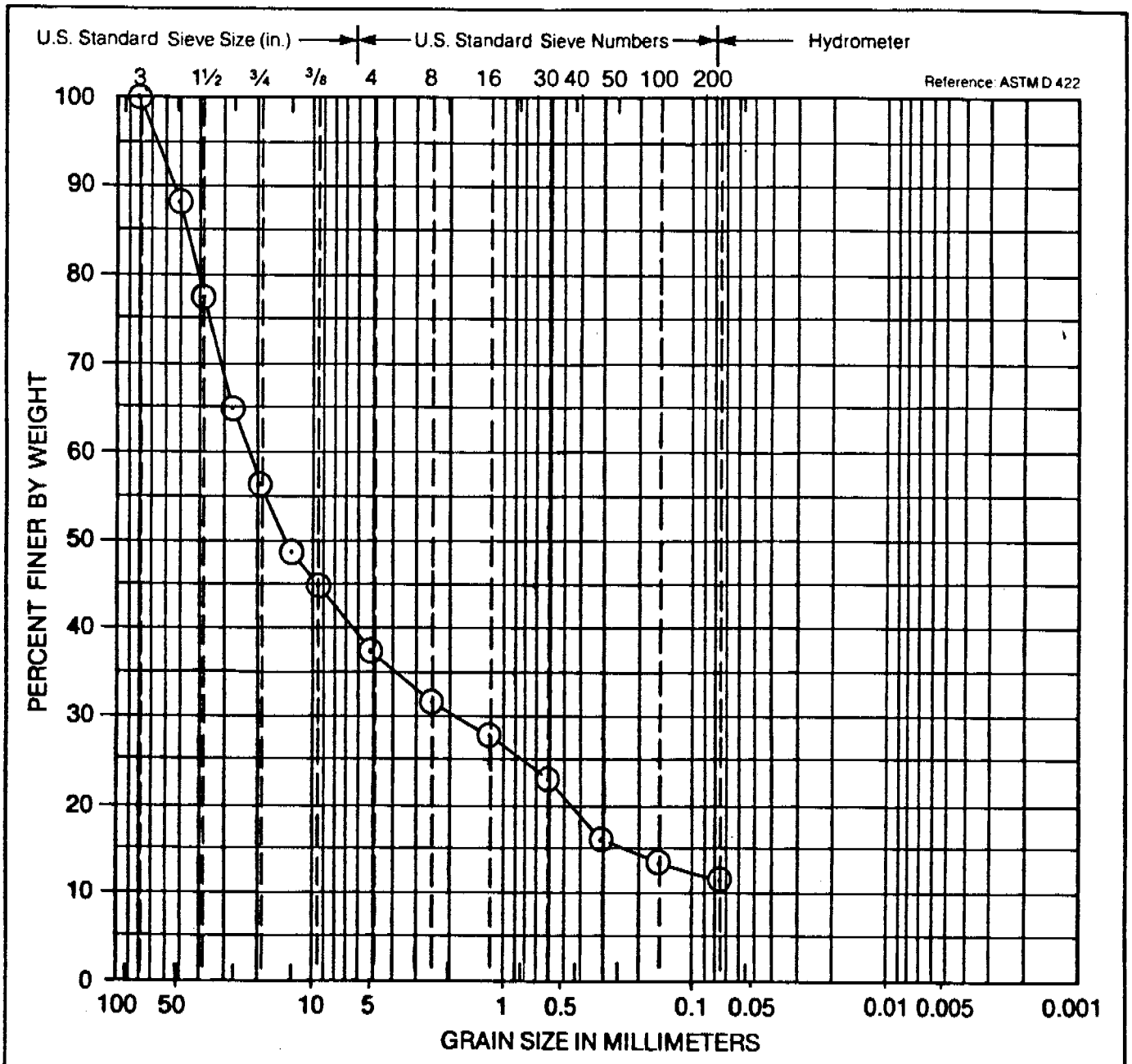
Particle Size Analysis
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

PLATE
3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	TP-3 @ 0.0' to 2.0'	BROWN SILTY GRAVEL WITH SAND (GM)

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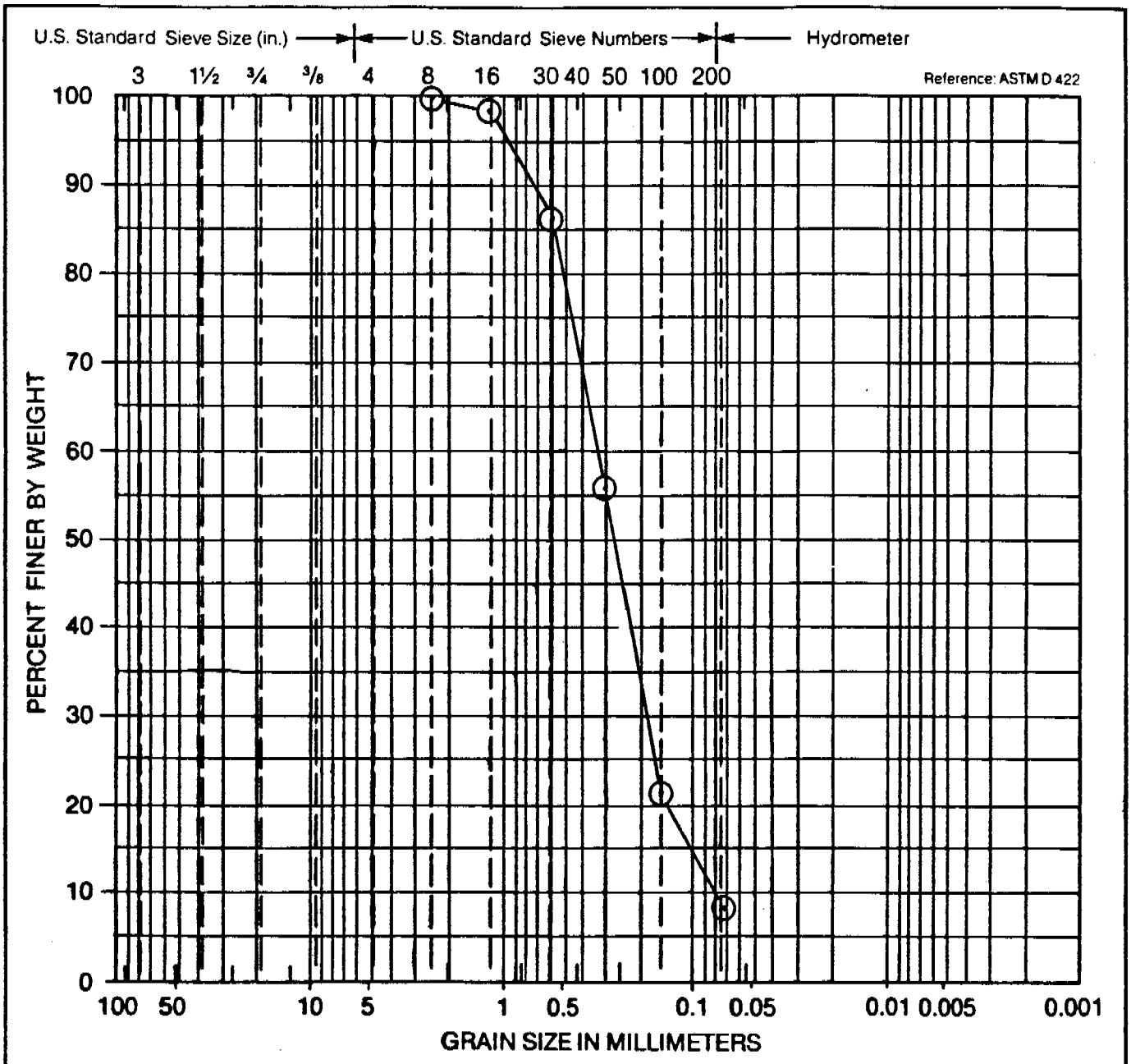
Particle Size Analysis
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

PLATE
4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		



Symbol	Sample Source	Classification
⊙	TP-4 @ 2.0' to 3.0'	BROWN POORLY GRADED SAND WITH SILT (SP-SM)

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PORT OF TACOMA
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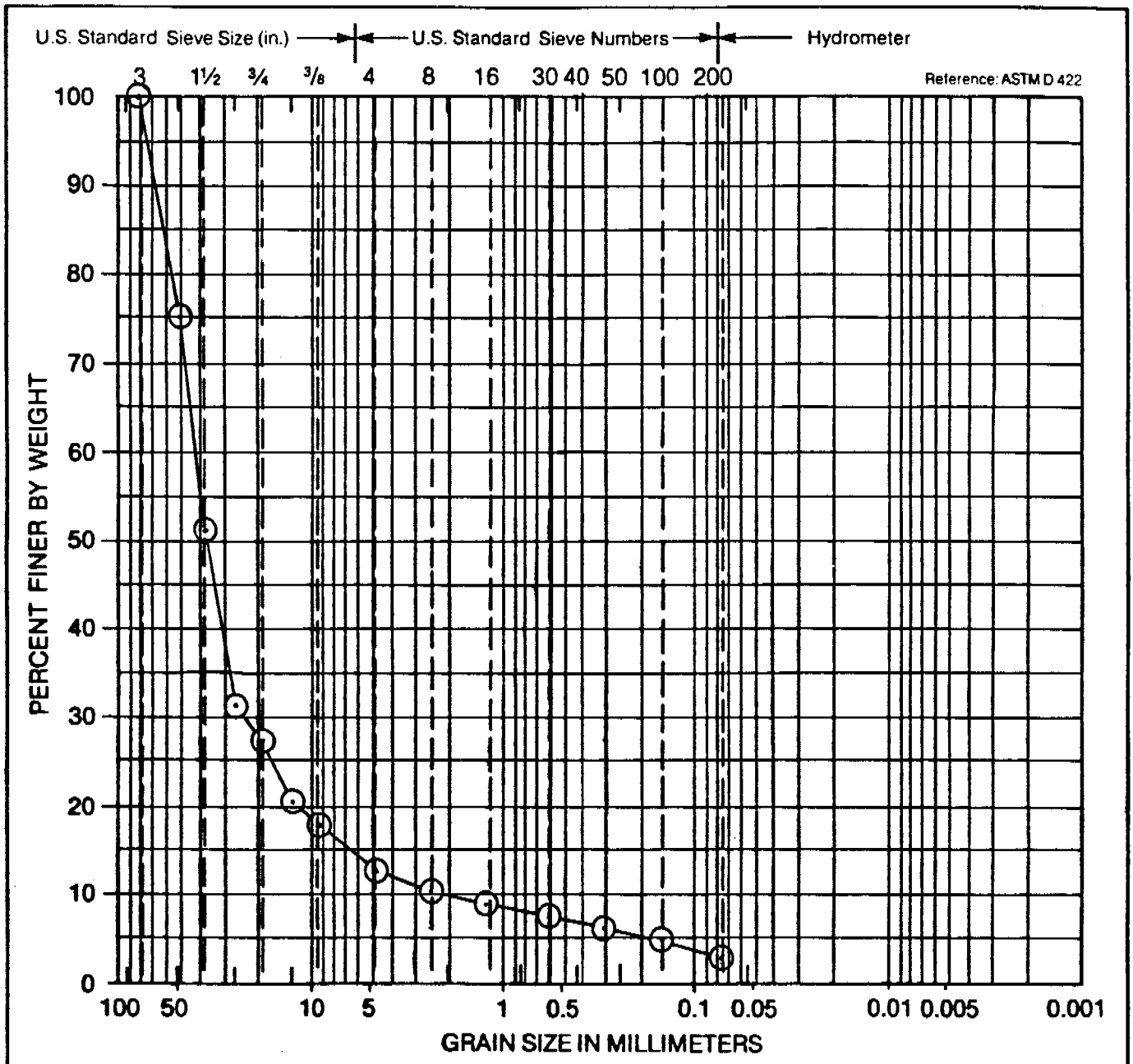
TACOMA, WASHINGTON

PLATE
5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		



Symbol	Sample Source	Classification
⊙	TP-7 @ 0.0' to 2.0'	BROWN POORLY GRADED GRAVEL (GP)

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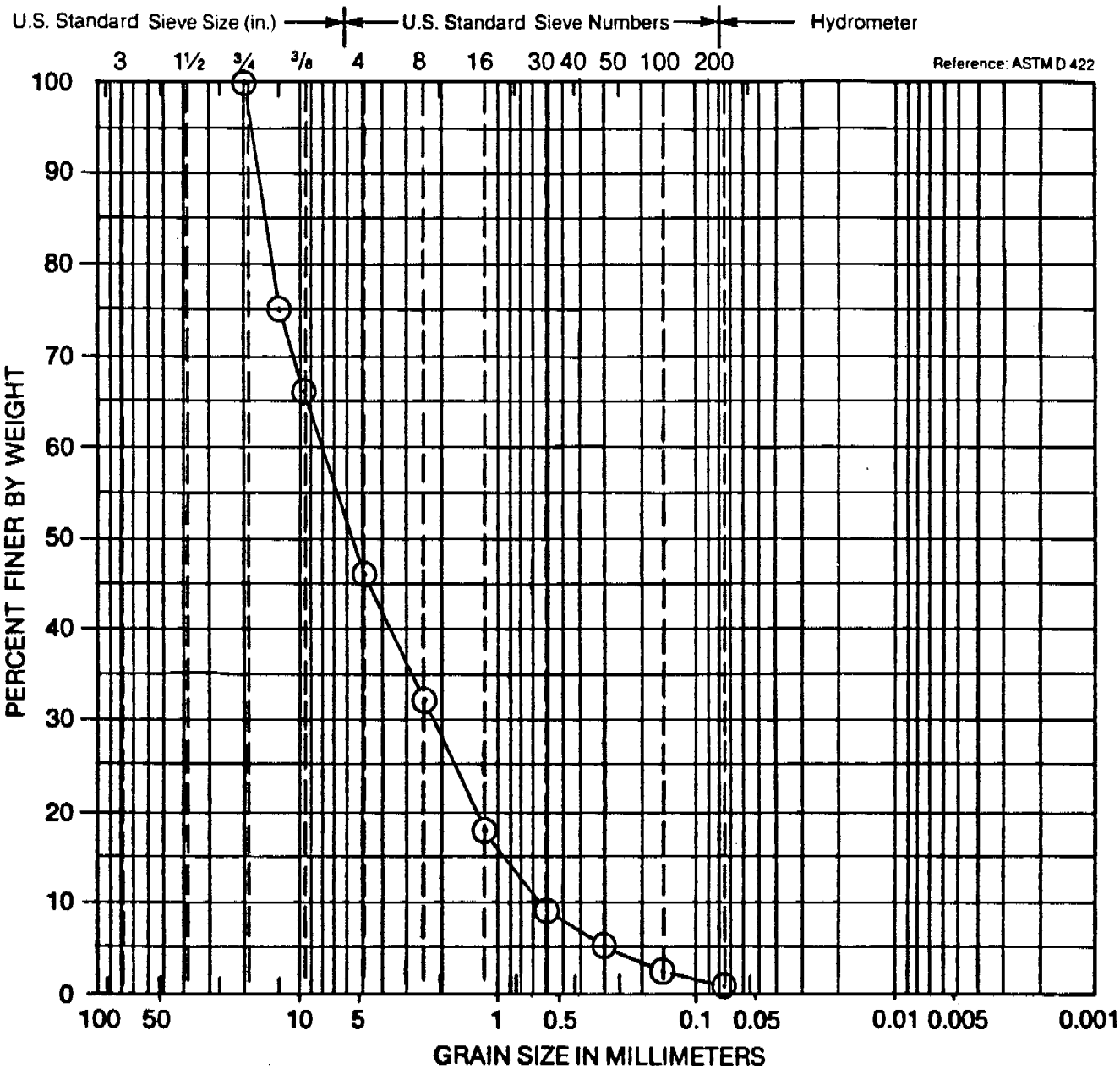
Particle Size Analysis
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

PLATE
6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	TP-8 @ 0.0' to 2.0'	DARK BROWN WELL GRADED BARK

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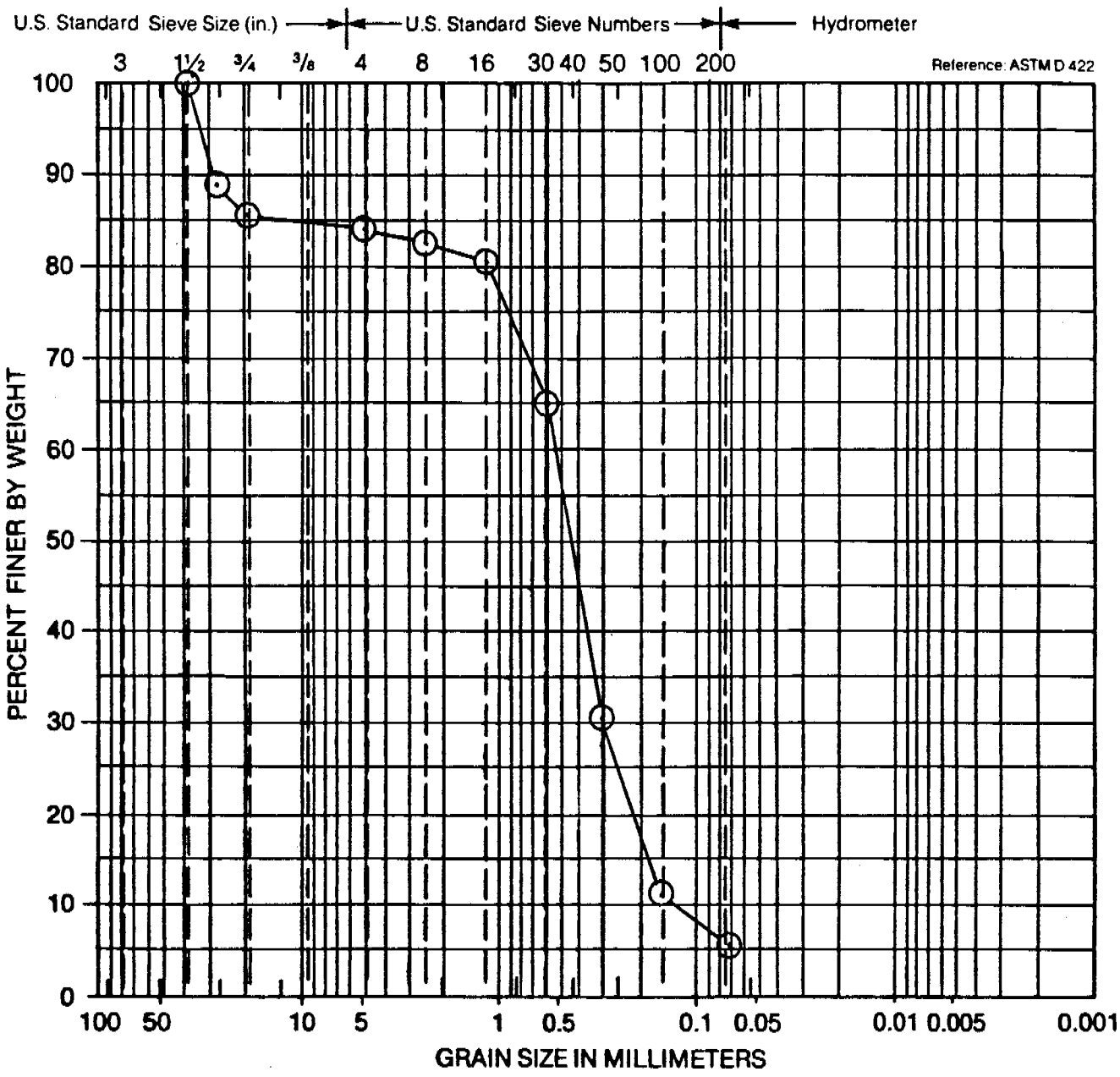
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

PLATE
7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		



Symbol	Sample Source	Classification
⊙	TP-9 @ 2.0' to 3.0'	BROWN POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)

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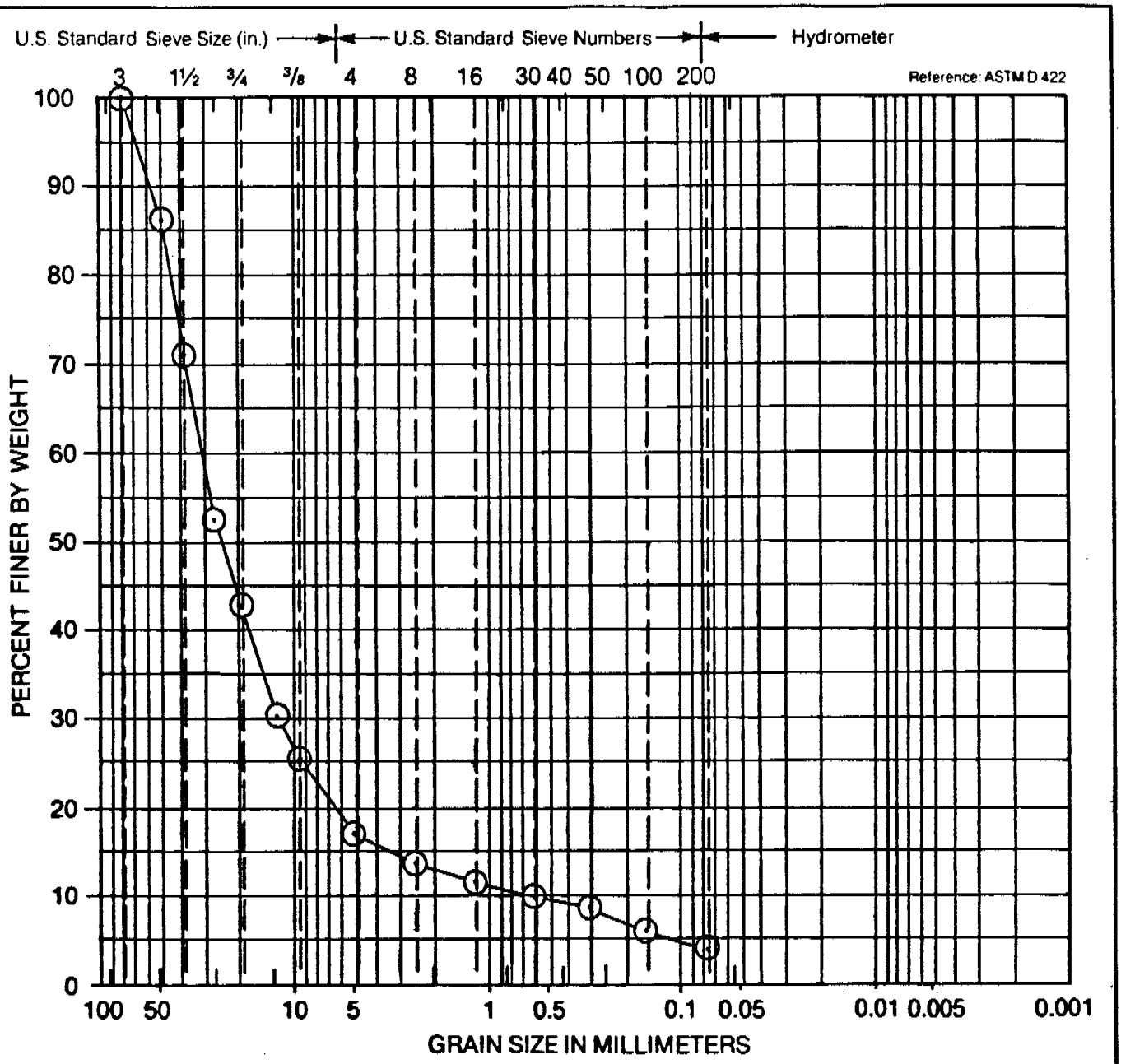
Particle Size Analysis
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

PLATE
8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	TP-10 @ 1.0' to 2.0'	GRAY-BROWN POORLY GRADED GRAVEL (GP)

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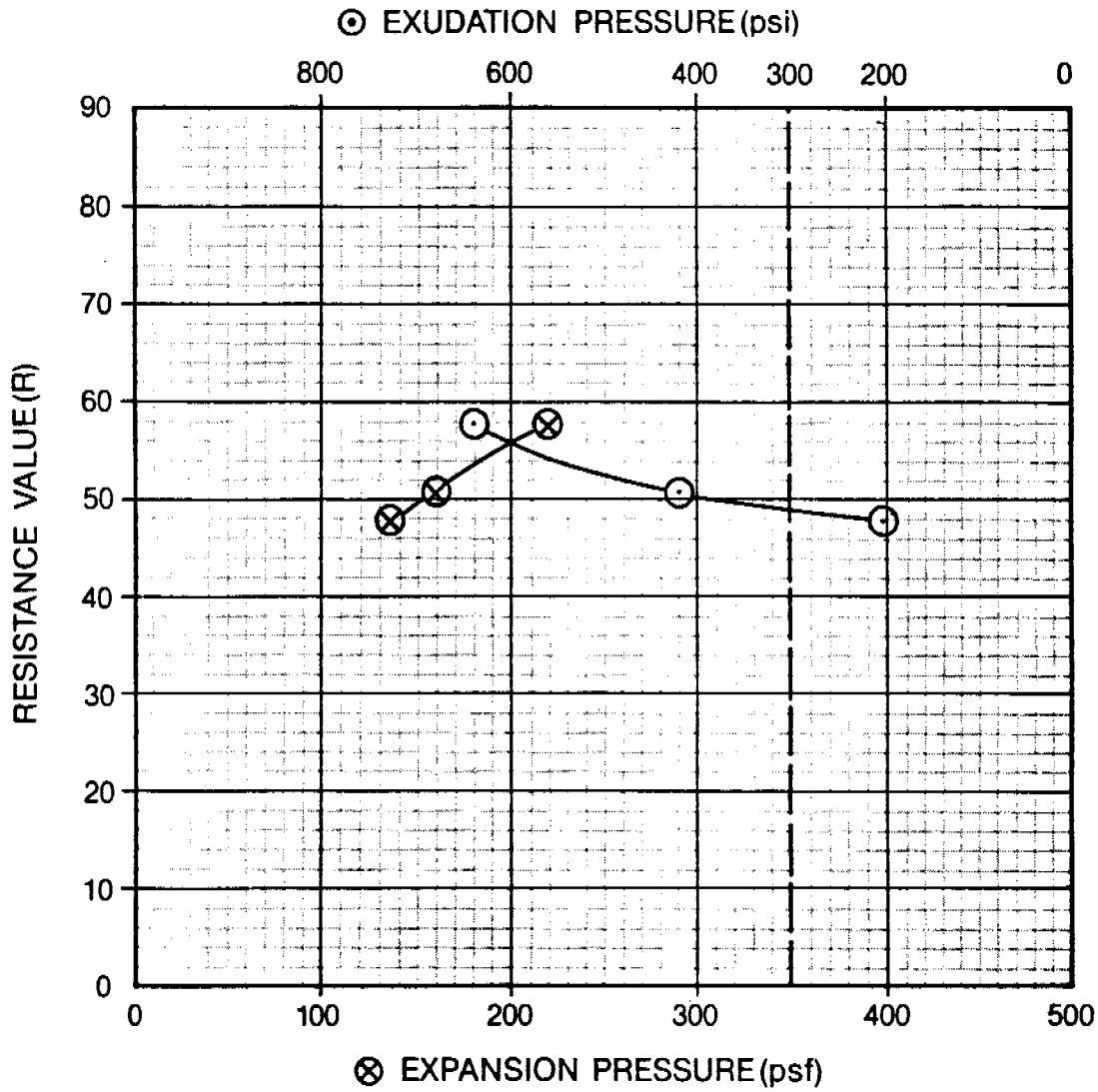
Particle Size Analysis
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

PLATE
9

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		

Reference State of California 301, ASTM D 2844



Specimen No.	1	2	3	
Water Content (%)	31.2	32.5	34.7	
Dry Density (pcf)	68.4	68.1	67.5	
Exudation Pressure (psi)	640	420	205	
Expansion Pressure (psf)	220	160	135	
Resistance Value (R)	58	51	48	

Sample Source	Classification	Sand Equivalent	Expansion Pressure	R value
TP-1 @ 1.5'	BROWN POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)	--	145	49

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Resistance Value Test Data
PORT OF TACOMA
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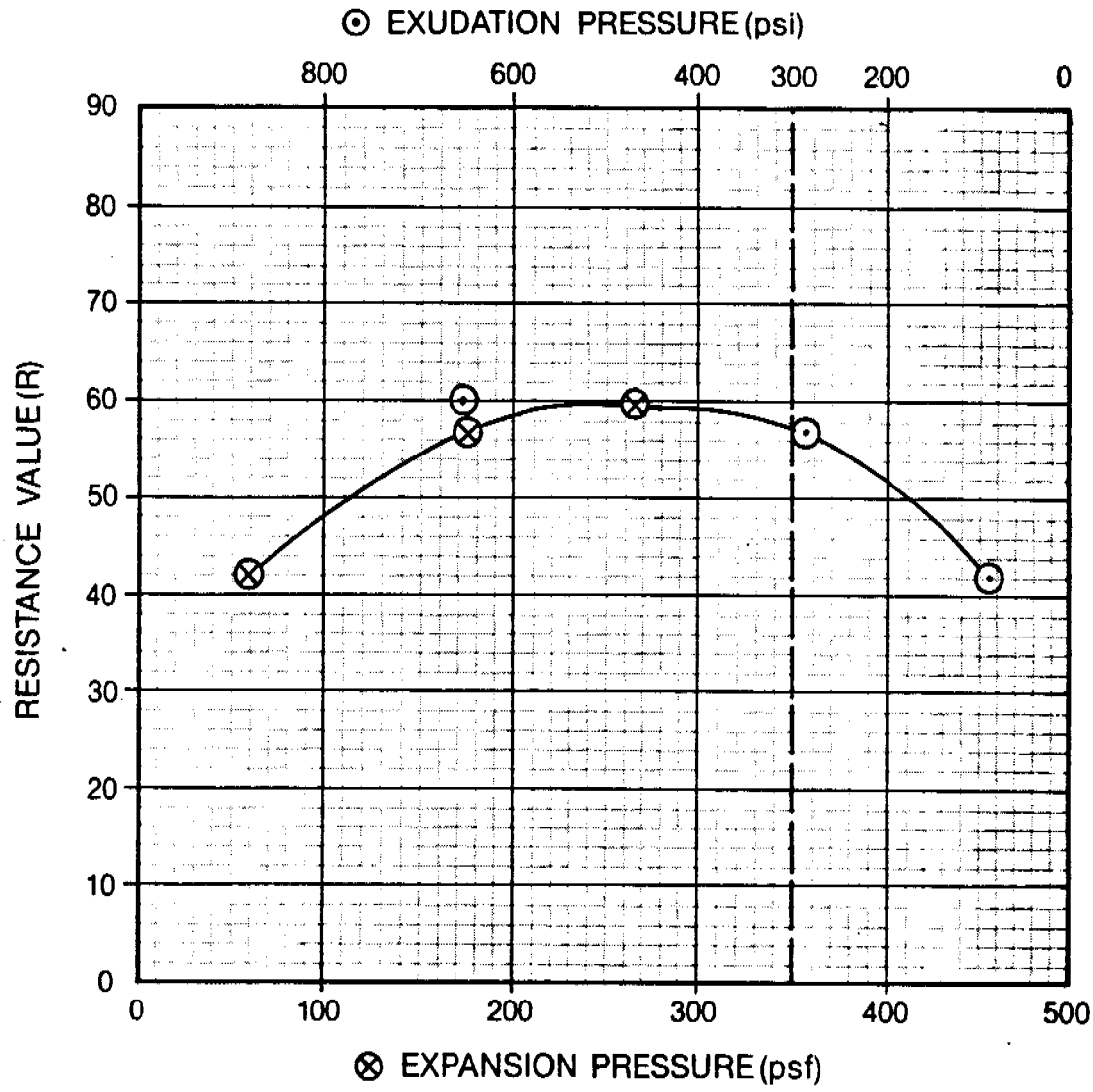
TACOMA, WASHINGTON

PLATE **10**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		

Reference: State of California 301, ASTM D 2844



Specimen No.	1	2	3	
Water Content (%)	27.0	38.1	44.4	
Dry Density (pcf)	77.8	73.7	66.8	
Exudation Pressure (psi)	655	290	90	
Expansion Pressure (psf)	265	175	60	
Resistance Value (R)	60	57	42	

Sample Source	Classification	Sand Equivalent	Expansion Pressure	R value
TP-3 @ 0.0' to 2.0'	BROWN SILTY GRAVEL WITH SAND (GM)	--	175	57

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Resistance Value Test Data
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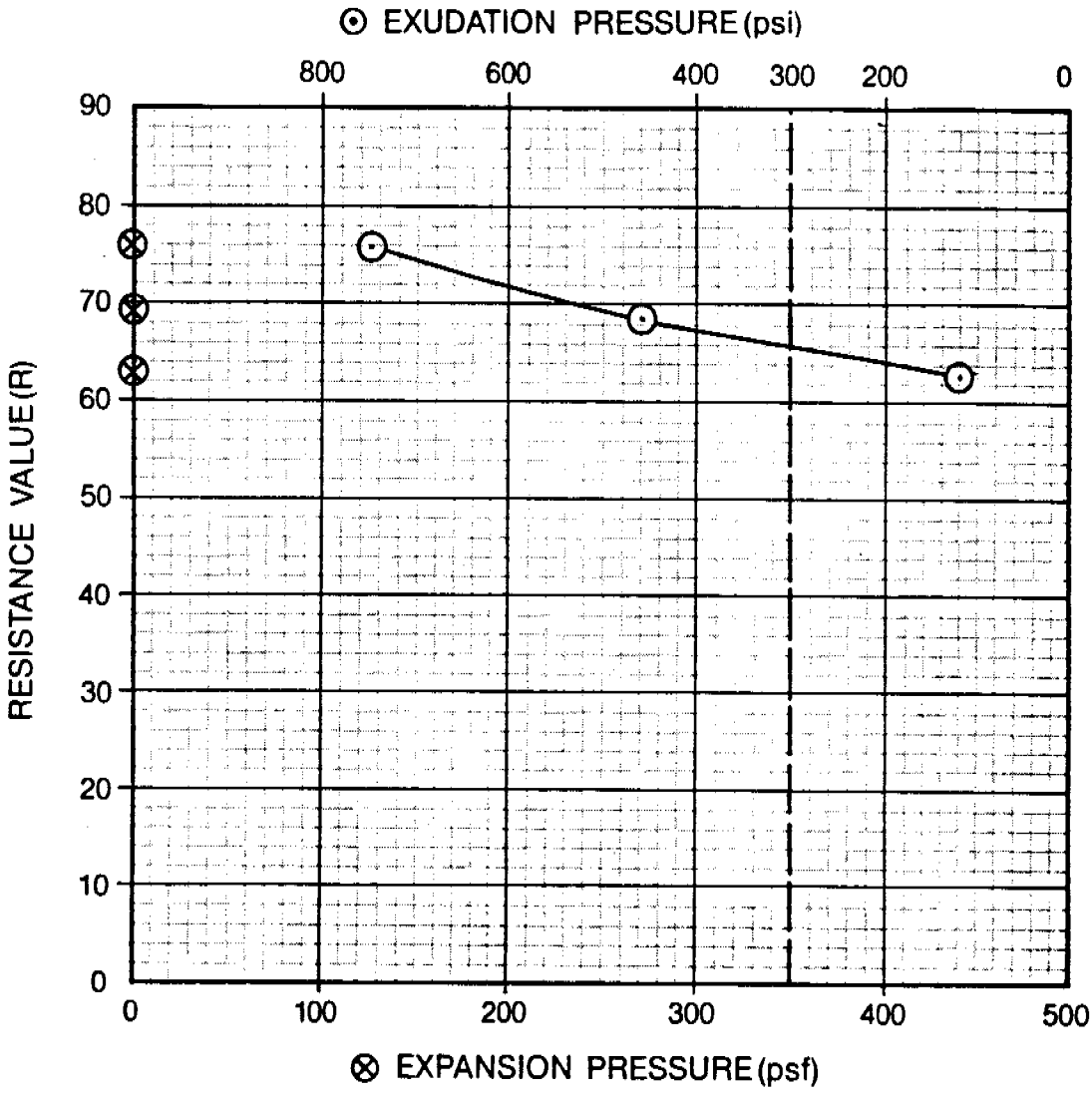
PLATE **11**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		

Reference: State of California 301, ASTM D 2844



Specimen No.	1	2	3	
Water Content (%)	11.1	12.0	12.9	
Dry Density (pcf)	103.7	103.0	102.4	
Exudation Pressure (psi)	750	460	120	
Expansion Pressure (psf)	0	0	0	
Resistance Value (R)	76	69	63	

Sample Source	Classification	Sand Equivalent	Expansion Pressure	R value
TP-4 @ 2.0' to 3.0'	BROWN POORLY GRADED SAND WITH SILT (SP-SM)	--	0	66

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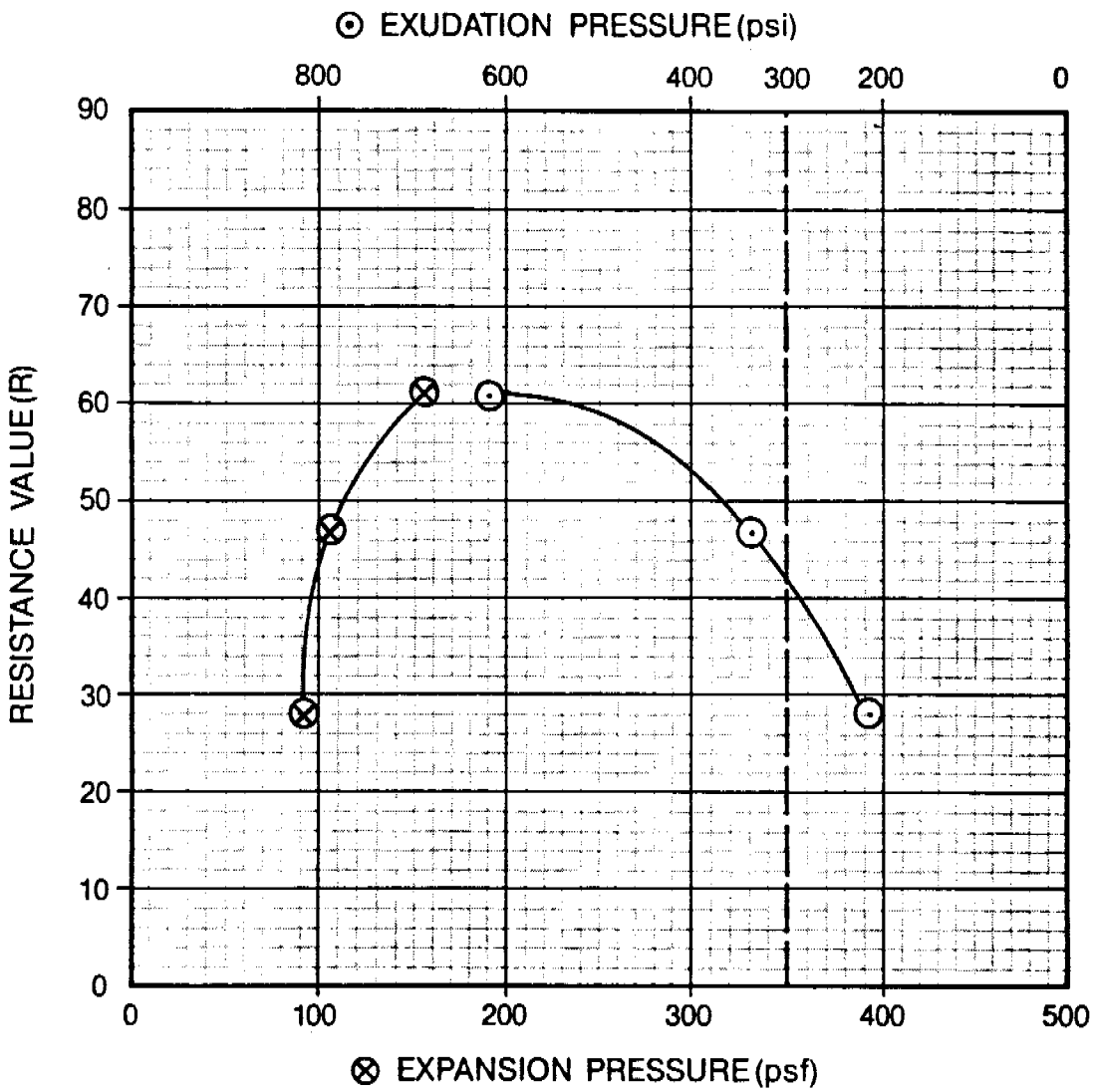
Resistance Value Test Data
PORT OF TACOMA
CASCADE TIMBER NO. 3 LOG SORT YARD
TACOMA, WASHINGTON

PLATE **12**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		

Reference: State of California 301, ASTM D 2844



Specimen No.	1	2	3	
Water Content (%)	79.6	90.6	106.2	
Dry Density (pcf)	28.8	26.8	25.2	
Exudation Pressure (psi)	620	340	215	
Expansion Pressure (psf)	155	105	90	
Resistance Value (R)	61	47	28	

Sample Source	Classification	Sand Equivalent	Expansion Pressure	R value
TP-8 @ 0.0' to 2.0'	DARK BROWN WELL GRADED BARK	--	95	41

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Resistance Value Test Data
PORT OF TACOMA
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TACOMA, WASHINGTON

PLATE **13**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	12183.2		3-1-94		

APPENDIX B

APPENDIX B

SAFETY AND HEALTH PLAN

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II Material Safety Data Sheets

SITE HEALTH AND SAFETY PLAN
CASCADE NO. 3 LOG SORT YARD

1.0 GENERAL INFORMATION

Site:	Cascade Timber No. 3 Log Sort Yard	Project No: 12183.3
Location:	Port of Tacoma Tacoma, Washington	
Prepared by:		Date:
Approved by:		Date:

1.1 Plan Objective

This health and safety plan, developed in accordance with the Occupational Safety and Health Act (OSHA) and the Washington Industrial Safety and Health Act (WISHA) standards for hazardous waste operations (29 CFR 1910.120 and WAC 296-62), establishes the minimum guidelines for onsite activities conducted at the Cascade No. 3 Log Sort Yard in the Port of Tacoma.

1.2 Proposed Date of Field Work

Date:

2.0 SITE/HAZARD OVERVIEW

Apparent Hazard		Type of Facility		Status of Facility	
Serious	___	Imp.	___	Active	___
Moderate	___	Dump	___	Inactive	X
Low	X	Landfill	___	Unknown	___
None	X	Open	___	Unknown	___
Enc.	___	Other	X	(Log storage yard)	

Waste Type(s)		Waste Characteristics		Type/Form of Hazard	
Gas	___	Toxic	X	Dust	X
Liquid	___	Corrosive	___	Liquid	___
Sludge	___	Ignitable	___	Fumes	___
Solid	X	Volatile	___	Vapors	___
Unknown	___	Radioactive	___	Contact	X
Other	___	Reactive	___	Respiratory	X
	___	Unknown	___	Other	___
	___	Other	___	IDLH	___

3.0 SITE DESCRIPTION AND HISTORY

The Cascade Timber No. 3 Log Sort Yard is an 18.57 acre parcel owned by the Port of Tacoma. The site is located along Maxwell Way between Port of Tacoma Road and Thorne Road (Figure 1) in Tacoma, Washington. The property is divided into two parcels: a 7.84-acre parcel to the northeast and a 10.73-acre parcel to the southwest.

The southwest parcel (the site) was leased to Cascade Timber Company (Cascade) from 1978 through 1987 to store and sort logs. Between January and March, 1982, approximately 500 tons of slag generated by Asarco Inc. of Tacoma, Washington was placed on the site by Cascade for use as a ballast material. In 1985, the Washington State Department of Ecology (Ecology) completed an assessment of twelve log sort yards, including the site. Ecology concluded the Asarco slag ballast material was responsible for elevated concentrations of heavy metals in stormwater runoff from the log sort yards. Arsenic, zinc, copper and lead were identified as metals of concern. The site has not been in use since 1987.

Based on the results of the RI/FS, HLA recommended capping the site as the preferred remedial action to mitigate the migration of metals from the site via stormwater runoff. The cleanup objectives of the remedial action for soil for the protection of human health are to reduce chemical concentration in soil to levels below 200 mg/kg for arsenic and 1,000 mg/kg for lead, or to minimize ingestion or direct contact with soil having concentrations greater than these. The cleanup objectives for soil for the protection of the environment are to minimize migration of chemicals that would contaminate groundwater or surface water in excess of groundwater and surface water requirements. The cleanup objective for groundwater was established for protection of the environment and not established for protection of human health because the groundwater in not considered a potential future drinking water source.

To meet the remedial action objectives, a low permeability cap will be constructed over the slag and impacted soil which will be left onsite in order to eliminate stormwater from coming in contact with slag and soil. The slag and impacted soil containing elevated levels of metals will be consolidated to several areas on the site to reduce the potential for disturbance and exposure as a result of future site activities. A low permeability cap, designed to eliminate infiltration, will be constructed over the slag and soil that are onsite. A cover system will be designed to withstand the planned future (post-closure) use of the site. Post-closure, the Port will probably use the site for a warehouse. Long term future use may be for intermodal container storage. Both uses are consistent with current planning issues. The cover will be graded to collect stormwater runoff for discharge into the City of Tacoma's existing storm drainage system. The City's system ultimately discharges into the Sitcum Waterway.

4.0 SUMMARY OF SCOPE OF WORK

The scope of work for the cap installation is described in the Engineering Design Report. Onsite activities will include the following:

- Various grading, trenching, and excavating activities, and
- Construct and install a drainage system,
- Install a low permeability cap,
- Install, develop and sample 3 groundwater monitoring wells.

All of the above activities will be required to adhere to the established health and safety requirements. A copy of this plan will be maintained onsite.

5.0 HAZARD EVALUATION

Various health and safety hazards will be present onsite. Listed below is a summary of the potential hazards and a statement of the hazard control measures and practices in place to minimize the risks of injury or illness. The hazard level for contaminants present during all remedial investigative activities is presumed to be low to none, requiring Level C or D personal protective equipment (PPE).

5.1 Physical Hazards

Head Hazards - Hazards include sharp objects, falling objects, overhead work, heavy equipment, and bump hazards. Hardhats will be worn by all personnel on site.

Foot and Ankle Hazards - Hazards include sharp objects, uneven or slippery walking surfaces, hazardous materials, and dropped heavy objects. Wear chemical resistant boots, steel-toed boots, fill in uneven walking surfaces, and barricade off sumps and open holes.

Eye Hazards - Hazards consist of sharp objects, poor lighting, flying debris or metal from cutting/ welding operations, chemical splashes, and contaminated soil particles. Safety glasses will be worn at all times. When there is a potential for chemical splashes, full face respirators or face shields will be worn when applicable.

Musculoskeletal Hazards - Hazards include lifting heavy objects, lifting improperly, overreaching or overextending. Hazard mitigation will consist of use of correct lifting practices, use of mechanical lifting devices, and proper placement of lift devices.

Noise Hazard - Hazard consists of presence of noise above 84 dBA peak. Disposable ear plugs or earmuffs will be worn.

Hazardous Energy - Hazard consists of uncontrolled hazardous energy. Use lockout and tag practice, use Ground Fault Circuit Interrupters (GFCIs), inspect electrical equipment weekly, and use line breaking permits for line cutting.

Mechanical Hazards - Heavy equipment will be present onsite. The equipment will be verified that it is in good condition prior to use. All heavy equipment will have backup alarms. Do not stand or walk under elevated loads.

5.2 Chemical Exposures

The materials onsite that pose the greatest health risk to personnel are heavy metals (antimony, arsenic, cadmium, copper, lead, nickel, and zinc). These are inhalation hazards, with a few of the contaminants having high toxicity. The heavy metal contaminants lie approximately zero to one foot below the surface of the site. A release of petroleum (crude oil) onto the site from a localized pipeline leak has resulted in elevated total petroleum hydrocarbon concentrations. Petroleum hydrocarbons were detected at concentrations up to 35,000 mg/kg. Results suggest that petroleum hydrocarbon contamination extends to a depth of approximately 5 feet below ground surface. Oil and grease were detected at concentrations up to 33,800 mg/kg, with results generally similar to petroleum hydrocarbon results. Exposure to these contaminants may occur during trenching, grading, excavating activities as well as drilling of the groundwater monitoring wells. Personal protective equipment (hardhats, gloves, tyvek, boots, respirators, and safety glasses) will be worn whenever the above work is to be conducted.

The toxicity and chemical properties of the potential compounds that may be detected onsite are presented in Table 1 and 2. Table 1 presents exposure limits established by Occupational Health and Safety Administration (OSHA), National Institute of Occupational Safety and Health (NIOSH), and American Conference of Government Industrial Hygienist (ACGIH); and Table 2 presents target organs and possible symptoms of exposure. In Table 1, the exposure levels are defined as follows:

PEL: OSHA permissible exposure limits (PELs) are 8-hour time-weighted average (TWA) concentrations. Short-term exposure and ceiling limits are recorded where applicable.

TLV: Threshold limit values (TLVs) are 8-hour TWAs recommended and established by the ACGIH. These levels are noted where they vary from the PEL.

IDLH: Immediately dangerous to life or health (IDLH) levels are defined by the Standards Completion Program (SCP) only for the purpose of respirator selection. They represent the maximum concentrations from which, in the event of respirator failure, one could escape within 30 minutes without experiencing any escape impairing or irreversible health effects. No IDLHs have been listed for potential human carcinogens.

5.3 Environmental Hazards

Potential environmental hazards onsite include biological hazards (*e.g.*, wild animals, insects, and poisonous plants), natural occurrences (*i.e.*, earthquakes, thunderstorms, and lightening storms), and temperature hazards.

Heat Stress - The risk of heat stress is high for those persons working in impermeable Level C personal protective garments. (See Section 6.0 for a description of the levels of personal protection equipment). Because this equipment does not allow evaporation of sweat, workers required to wear these suits will be monitored for heat stress when the ambient temperature is above or equal to 70°F. The degree of risk associated with working in these garments is directly related to numerous factors: ambient temperature, length of time in the suits, availability of shade, acclimatization of personnel, adequate fluids intake by workers, and length of rest periods.

Table 1. Exposure Limits

Chemical Group	Chemical Name	PEL Comment	TLV Comment (if different)	IDLH Level Comment
Metals	Antimony (as Sb)	0.5 mg/m³		80 mg/m³
	Arsenic (as As)	0.01 mg/m³ 0.002 mg/m³ (ceiling)	0.2 mg/m³	Carcinogen
	Beryllium (as Be)	.002 ppm		10 mg/m³
	Cadmium dust (as Cd)	0.2 mg/m³ 0.6 mg/m³ (ceiling)	0.01 mg/m³	Carcinogen
	Chromium (as Cr)	1 mg/m³	.5 mg/m³	N.E.*
	Copper:			
	Dusts & mists (as Cu)	1 mg/m³		
	Lead, inorganic fumes and dusts (as Pb)	0.05 mg/m³ 0.03 mg/m³ (action level)	0.15 mg/m³	700 mg/m³
	Nickel, metal and			
	Elemental	1 mg/m³	0.05 mg/m³	Carcinogen
	Soluble	0.1 mg/m³	0.05 mg/m³	
	Zinc:			
	Zinc Oxide Dust	10 mg/m³		N.E.*

* N.E. = No evidence can be found for the existence of IDLH.

Table 2. Exposure Routes, Target Organs and Symptoms

Group	Substance	Exposure Route	Target Organs	Symptoms
Metals	Antimony	Inhalation Skin/eye contact	Resp. system CVS Skin Eyes	Irritated nose, throat, mouth; coughing; dizziness; headache; nausea, vomiting, diarrhea; cramps; insomnia; anorexia; irritated skin; unable to smell
	Arsenic	Inhalation Absorption Skin/eye contact	Liver, kidneys Skin, lungs, lymphatic system	Ulceration of nasal septum, dermatitis, GI disturbances, respiratory irritation, hyperpig of skin, carcinogen
	Beryllium	Inhalation Ingestion Skin/eye contact	Lungs, skin, eyes, mucous membranes	Respiratory symptoms weak, weight loss, fatigue
	Cadmium	Inhalation Ingestion	Resp. system kidneys Prostate Blood	Symptoms usually delayed. Pulmonary edema, dyspnea, cough, fight chest, chest pains; headache; chills, muscle aches; nausea; diarrhea
	Chromium	Inhalation Ingestion Skin/eye contact	Respiratory system, skin	Histologic fibrosis of lungs, dermal sensitivity
	Copper	Inhalation Ingestion Skin/eye contact	Resp. system Skin Liver Kidneys	Irritated mucous membranes, pharynx; nasal perforation; eye irritation; metal taste; dermatitis
	Lead (Inorganic)	Inhalation Ingestion Skin/eye contact	GI Tract CNS Kidneys Blood Gingival Tissue	Lassitude; insomnia; pallor; headache; colic; hypotense; anemia; tremor; paralyzed wrist; gingival lead line
	Nickel	Inhalation Ingestion Skin/eye contact	Lungs Nasal Cavities Skin	Skin sensitization; allergic asthma; nasal cavity, eye, upper respiratory tract irritation (carcinogen)
	Zinc	Inhalation Skin/eye contact Ingestion	Resp. system	Sweet metallic taste; dry throat, cough, chills, fever, tight chest, dyspnea, blurred vision, muscle cramps
Petroleum	Crude	Inhalation Ingestion Skin/eye contact	Skin, eyes Respiratory system Central nervous system	Nausea, diarrhea, abdominal pain, liver and renal injury, pulmonary edema, dysthythmia, and central nervous system toxicity

Heat Stress - The risk of heat stress is high for those persons working in impermeable Level B or C personal protective garments. (See Section 6.0 for a description of the levels of personal protection equipment). The degree of risk associated with working in these garments is directly related to numerous factors: ambient temperature, length of time in the suits, availability of shade, acclimatization of personnel, adequate fluids intake by workers, and length of rest periods.

Heat Stress control and preventive measures include the following:

- Provide plenty of liquids to replace lost body fluids. Water and/or electrolyte drinks will be used for this purpose.
- Establish a work schedule that will provide appropriate rest periods.
- Establish work regimens consistent with American Conference of Governmental Industrial Hygienists (ACGIH) guidelines.
- Wear appropriate protective clothing for adverse weather conditions.
- Provide employee training on the causes of heat stress, signs and symptoms, and preventive measures.
- Possibly conduct work during nighttime shifts.

Heatstroke and heat exhaustion are possible results of physical exertion in the heat. Heatstroke is always life-threatening, while heat exhaustion is a milder condition. Symptoms of heatstroke consist of the following:

- Red or flushed skin,
- No sweating, and
- High body temperature.

Symptoms of heat exhaustion consist of the following:

- Pale, clammy skin,
- Profuse perspiration,
- Extreme tiredness or weakness, and
- Normal body temperature.

A person with heatstroke needs to be cooled quickly and will need medical care. For mild heat exhaustion, bedrest and salt are required. In order to reduce heat stress, frequent breaks are necessary to allow workers to cool down and replenish electrolytes. In addition, workers may wish to conduct field activities during cooler hours.

Cold Stress - Outdoor work may result in cold exposure, especially during the winter months in Tacoma, Washington. When the body loses more heat than it produces, the deep body temperature may be lowered to dangerous levels. This condition is known as hypothermia and can be serious. The symptoms of hypothermia include shivering, sleepiness, numbness (*i.e.*, frostbite), difficulty in movement, impaired ability to work, and diminished eyesight. If the condition is allowed to progress, heart failure may occur. First aid procedures for hypothermia is to seek immediate medical attention.

Methods to protect against hypothermia, field personnel must wear multilayer cold weather outfits, be aware of wind chill factors, have access to a readily available warm shelter, alternate scheduled work and rest periods, drink warm fluids (no alcoholic beverages), use the buddy system and monitor conditions of fellow workers.

6.0 PERSONAL PROTECTIVE EQUIPMENT

Level of Protection: A___ B___ C_X_ D_X_

The selection and use of Personal Protective Equipment (PPE) are detailed in this section. Wherever possible, engineering controls will be employed to control the potential for worker exposure to hazards. The basic requirements presented in this section and the decision to increase, decrease, or modify the level of worker protection can be made on site based on the professional judgment of the Site Health and Safety Officer or a Certified Industrial Hygienist (CIH) and with the approval of the Project Manager.

The descriptions presented below focus on heavy metals as being the primary exposure hazard. Work conducted at the Cascade No. 3 Log Sort Yard will involve designated levels of C and D work. Level A and B work are not deemed necessary at this time. Level C PPE will be used whenever there is a disturbance or potential disturbance of soil. The major hazards that field personnel will be exposed to during these activities consist of the following:

- Inhalation of airborne contaminants in the form, dust or contaminated soils, and
- Dermal contact with or ingestion of contaminated soils.

Personal monitoring will be conducted to evaluate personal exposure if there is a need to upgrade or possibly downgrade the level of protection and if the permissible exposure limit has (discussed below) been exceeded. The decision to upgrade to a higher level of protection or downgrade to a lower level will be based on risk assessments made by the Site Health and Safety Officer in conjunction with a CIH, and the Project Manager. The contractor/subcontractor shall provide a plan that details selection, training, cleaning, and maintenance of PPE. Descriptions of PPE are presented below.

Level A - Characterized by a fully encapsulating garment and self-contained breathing apparatus (SBCA). This level of protection will be used when the airborne hazards of reach is immediately dangerous to life or health (IDLH) levels. Specifically, this equipment consists of the following:

- Self Contained Breathing Apparatus (SCBA)
- Fully encapsulating chemical-resistant suit with inner chemical-resistant gloves,
- Neoprene rubber boots with steel toe/shank/insert, and
- Hardhat.

Level B - Characterized by a semiencapsulating garment and some form of air supplied respirator. This level of protection will be used when there are mixed airborne hazards, when there is an oxygen-deficient atmosphere or when there is a mixed airborne hazard for which an accepted mechanical filter respirator is not available. Specifically, this equipment consists of the following:

- MSA supplied air respirator (full-facepiece respirator, supplied air regulator, and 5- minute escape bottle or MSA SCBA apparatus),
- Chemical-resistant hooded splash suit (PVC, Saranex, or Neoprene); hooded PVC splash suits will be used on all RCRA Waste activities,
- Chemical-resistant gloves (Nitrile, Neoprene, or PVC),
- Chemical-resistant boots (steel toe/shank/insert),
- Hardhat,
- Vest (optional), and
- Hot work clothing (leather or other spark-proof clothing to prevent contact with chemical-resistant clothing).

Level C - Characterized by a semiencapsulating garment and a mechanical filter respirator. This level of protection will be used where there is no oxygen deficiency, when a respirator is available for the mixed airborne hazards, and when the hazards do not exceed the maximum use concentration (MUC) of the specified cartridge. The risk of skin contact with liquid/sludge is very low. Specially, this equipment consists of the following:

- Full-face respirator (NIOSH approved) for work around liquids/sludge,
- Half-face respirator (NIOSH approved) for work with no potential for splashing of liquids or sludge,
- Respirator cartridges (organic vapor/HEPA)
- Coverall (Tyvek for nonsplashing activities; polyethylene or Saranex-coated for work with potential for splashing),
- Chemical-resistant boots (steel toe/shank/insert),
- Chemical-resistant gloves (Nitrile, Neoprene, or PVC),
- Hardhat, and

- Safety glasses with side-shields.

Level D - Characterized by standard protective work clothing and no respiratory protection. This level is normally worn where no chemical exposure hazards are present that require special protective materials. Level D is typically will be utilized when there is no disruption of soil, prescribed for work in the Support Zone or other designated clean area. Specifically, this equipment consists of the following:

- Cotton coverall/field clothes,
- Leather work boots with steel toe/shank/insert,
- Safety glasses with side shields,
- Hardhat, and
- Gloves (cotton or leather).

All PPE will be decontaminated after use and will be properly stored in a dry clean designated area. The site safety officer will conduct weekly inspections as to the proper maintenance and storage of PPE. If employees find that their PPE is not adequate or malfunctioning, this must be reported to the site safety officer immediately.

7.0 EXPOSURE MONITORING PLAN

Exposure monitoring will be performed at the Cascade No. 3 Log Sort Yard to confirm that no personnel are being exposed to heavy metal concentrations greater than the established PEL's and to evaluate any changes in airborne contaminant concentrations that occur with the various activities. Exposure monitoring will include personal exposure monitoring with personal sampling pumps and real time monitoring of the work area while drilling for a potential release of gases and vapors.

7.1 Personal Monitoring

Personal monitoring will be performed on those individuals likely to have the highest potential exposure to those hazardous substances most likely to be present above permissible exposure limits. Tasks to be monitored will be chosen based on the existing chemical data for the media being sampled, results of previous personal monitoring conducted on site, and experience at other similar hazardous waste sites. Monitoring will begin as soon as feasible following the commencement of work on each task.

Personal monitoring for chemical substances will be conducted on the contractor and subcontractor employees by collecting air samples from the breathing zone utilizing direct reading instruments, personal sampling air pumps, or personal monitor badges operating either for the entire workday or only during times when potential exposure may occur. Initial monitoring strategy is to sample two employees (highest potential for exposure) the first two days of each new activity. Follow up monitoring strategy is to sample one employee per week who has the greatest exposure potential for each task described in the work plan. The contaminants to be monitored are based on the concentrations, physical properties, and toxicity of the contaminants to which individuals may be exposed during a given task. Samples will be collected and analyzed according to methods developed by the OSHA or the NIOSH. Written documentation shall be provided.

7.2 Work Area Monitoring

Action Levels

Prespecified conditions that will dictate the initiation of some type of action (*i.e.*, donning or upgrading PPE, leave the area) are termed action levels. The action levels for each direct reading instrument are described below.

Continuous real time monitoring for volatile organic hydrocarbons will be performed when any work involving disturbing the soil is conducted. Action levels established below will be implemented accordingly.

A. Gas and Vapors

1. *Unknown Contaminants.* Monitoring for unknown contaminants will occur when soil borings are collected and during the drilling and installation of groundwater monitoring wells. These readings will be taken in the breathing zone of the workers and will assist in determining if the level of protection may be downgraded or possibly upgraded. Additional organic vapor monitor (OVM) readings will be taken every 5 minutes after the initial reading until sampling and drilling is complete. Work will be stopped whenever a sustained reading (1 minute) of 5 ppm above background is measured in the breathing zone. Level C protection shall be utilized. If work is stopped, Level B protection will be utilized to properly characterize the unknown contaminant.

Breathing Zone OVM (Reading for 1 Minute)	Level of Protection
Background	Level D
>0 - 5 ppm above background	Level C
5 - 500 pm above background	Level B
500 - 1,000 ppm above background	Level A

2. *Known Contaminants.* The frequency of monitoring of known contaminants will follow the same methodology as stated for the unknown contaminants. However, direct reading instrument airborne concentrations in conjunction with Draeger tubes will be compared to the PELs as identified in Table D-2. Levels of protection and control measures will be implemented as necessary.

Instrument	Calibrated Standards	Action Level Above Background (Breathing Zone for 1 Minute)	Action
OVM	Isobutylene	Above background to 5 ppm	Monitor with Draeger tubes after donning Level C protection
OVM	Isobutylene	>5 ppm	Monitor with Draeger tubes after donning Level B protection
OVM	Isobutylene	550 - 1,000 ppm	Leave area (Level A)

Note: Any gas vapor concentration in excess of 5 ppm will be identified and characterized using Level B protection with positive pressure SCBA.

B. Explosion Hazard (if applicable)

Instrument	Action Level Above Background (Ambient Air)	Action
Gas Tech Model GX-86	More than 10% of LEL	Leave area

C. Oxygen Deficiency (if applicable)

Instrument	Action Level Above Background (Ambient Air)	Action
Gas Tech Model GX-86	Less than 19.5% or more than 25% O^2	Do not enter

D. Other Instruments (during intrusive work - excavating, grading, trenching)

Instrument	Action Level Above Background (Ambient Air)	Action
Miniram PDM-3	Dust - 5 mg/m^3	Modify work practices. Wet work area. Cover stockpiles with plastic.
Personal Sampling Pumps 37mm MCEF Cassettes	Contaminants monitored As, Be, Cd, Cu, Pd, Ni, Zn	Notify Employees of Results

The situation will then be evaluated by the Site Supervisor and the Site Health and Safety Officer to determine the need for further action and/or additional protective measures.

7.3 Calibration of Monitoring Equipment

Field equipment used to perform various measurements during the course of the site activities may include an OVM, GasTech GX-86, Miniram PDM-3, and personal sampling pumps. All instruments and equipment will be maintained, calibrated, and operated according to the manufacturer's guidelines and recommendations. Calibration checks will be conducted daily. Proper maintenance, calibration, and operation of each instrument will be the responsibility of the field crew. A list of equipment requiring calibration will be maintained throughout the duration of the project in a calibration notebook. A record of all instrument calibration activities will be maintained in the site calibration notebook. Any service, repairs, or parts replaced will be noted.

If an instrument is found, upon calibration, to have been used when it was out of calibration limits, a corrective action report will be filed and the extent that the resultant data would be invalidated will be assessed.

8.0 FIRST AID PROCEDURES

If an injury should occur onsite as a result of an accident, the local emergency contacts will be notified of the incident and of the potential contaminants the injured has been exposed to. Prior to transport to the medical care facility, if the victim is in Level C he/she will undergo a brief decontamination. This will reduce the chance of spreading contaminants to the ambulance and local hospital. The hospital location map (Figure 2), the Washington Industrial Safety and Health Administration (WISHA) Emergency Form, and the site Emergency Notification List will be located in the onsite HLA vehicle. In the unlikely event a work-related death or loss of limb occurs, WISHA will be notified within 24 hours of the incident. The phone number for the regional office is (206) 596-3868. At least one person onsite will be certified to perform cardiopulmonary resuscitation (CPR) and first aid.

8.1 Eye Contact

A portable eye wash station will be established in the near the work activities. If any chemical comes in contact with the eyes, immediately flush the eyes with copious amounts of water and seek medical attention. Contact lenses should not be worn in the field, because irrigation of the eye becomes much more difficult, as does removal of the lens.

8.2 Skin Contact

If any chemical comes in contact with the skin, wash with soap and copious amounts of water and seek medical attention, if necessary.

8.3 Physical Accidents

If an accident occurs onsite that results in a minor injury (*e.g.*, cut, contusion), first aid can be provided by a team member with first aid training. If the injury requires medical attention and is not life threatening, the injured will be transferred to the nearest neighborhood medical clinic. If an accident occurs onsite that results in a major trauma (*e.g.*, fractured bones, severe lacerations), the local emergency services will be contacted. If no potential exposure exists for the rescue team, the victim will remain where injured and will be moved by trained emergency technicians only. However, if there is a potential for exposure to the rescue team, the victim will be briefly decontaminated prior to receiving medical attention.

The hospital closest to the site is:

1) Tacoma General Hospital (206) 594-1000
Address: 315 South K Street
Cross Street: South Fourth Street

See Figure 2 for route to closest hospital.

8.4 Fire Contingency

In the event of a fire, attempt to extinguish with a Class A,B,C fire extinguisher if safe to do so. If the fire appears to be noncontainable, perform the following steps:

- Alert all other personnel with horns or radios,
- Notify the local fire department (911),
- Verify all personnel present at rally point,
- Remove vehicles if possible,
- Await firefighting forces,
- Contact personnel on the Emergency Notification List once the fire department is in control of the situation, and
- Notify adjacent businesses and residences (if applicable).

8.5 Hazardous Materials Release

In the event of a hazardous materials release, attempt to control, divert, absorb, neutralize, or secure the source if direct contact or inhalation hazards are not present. If direct contact or inhalation hazards are present, don appropriate PPE and attempt remedial measures (if safe to do so). The hazardous material release incident shall be reported to the fire department and the U.S. National Response Center (NRC) immediately after the spill occurs (if possible). The NRC will coordinate Federal aid in the clean-up if it is necessary. The phone number for the NRC is 1-800-424-8802. The following information would be helpful during a notification:

- Chemical name or DOT identification number,
- Hazard class,

- Cause of release,
- Quantity/concentration of the release,
- Potential for fire or off-site release,
- Injuries resulting from the release,
- Actions taken to mitigate the release or spill, and
- Actions taken to notify adjacent businesses and residences (if applicable).

8.6 Accident Investigation

In accordance with WISHA regulations, injuries and illnesses must be reported. The Site Health and Safety Officer and Site Construction Supervisor will be notified of all accidents, incidents, and near misses. An accident report will be completed by the injured party, his/her doctor, and the Site Safety Officer as soon as possible following an accident or illness. One copy will be sent to WIHSA and one copy will be sent to the injured party's employer.

All emergency actions (e.g., fire, hazardous material release, injury) and follow-up actions will be critiqued by the emergency. Changes to this plan will be made if necessary as determined by the critique.

9.0 SITE SAFETY WORKPLAN

9.1 Key Personnel

Project Manager:	To be identified by the Contractor
Site Supervisor:	To be identified by the Contractor
Project Health and Safety Mgr.:	Mark Winters (HLA)
Site Health and Safety Officer:	To be identified by the Contractor
Port of Tacoma Contact:	Suzanne Dudziak
Ecology Contact	

9.2 Health and Safety Responsibilities of Key Personnel

The Project Manager has the overall responsibility for the development coordination, and implementation of the work plan in a safe manner and is the central point of contact with client and regulatory agencies.

The Project Health and Safety Manager has the responsibility of providing technical guidance to the Project Manager and Site Health and Safety Officer on matters that are not specifically covered in the Site Health and Safety Plan, providing guidance on sampling strategies and protocols, assisting in the interpretation of monitoring data, and advising of changes needed in health and safety operating procedures or plans.

The Site Supervisor is responsible for implementing the steps of the work plan and Site Health and Safety Plan, supervising the field team members, and consulting with the Site Health and Safety Officer regarding the work plan and any changes that may affect the health and safety of field team members.

The Site Health and Safety Officer (SHSO) has the responsibility for the development, coordination, and implementation of the Site Health and Safety Plan. This will include the medical surveillance program, training requirements, monitoring procedures, PPE and consultation with their health and safety manager regarding the Site Health and Safety Plan. The SHSO will coordinate with the Project Manager, Site Construction Supervisor, and the Health and Safety Manager on all modifications to the health and safety plan.

9.3 Worker Training Requirements

Persons who are working on this project will meet the minimum training requirements described in this section. Training is defined as a combination of classroom instruction, instructor demonstration, and hands-on practical exercises.

Personnel who will be onsite to perform site activities must have certified completion of the basic 40-hour hazardous waste operations training as detailed in 29 CFR Part 1910.120 and WAC 296-62 Subpart P. For hazardous waste workers who will be required to work in Level B or greater protection an additional 40-hours of basic training will have been completed as required under WAC 296-62-3040 for a total to 80-hours of basic training. It is not expected at this time that Level B work will be required. In addition, each worker will have had at least three days additional supervised field experience.

Workers onsite for limited tasks where there is no possibility of overexposure to hazardous materials will have had, at a minimum, 24 hours of basic training and one day of supervised field experience.

Workers onsite who work exclusively outside the Exclusion Zone or Contamination Reduction Zone (e.g., office personnel) and for when there is no potential of exposure to the PEL will be required to read and understand the Job Site Health and Safety Plan and will sign the acknowledgment that this has been done.

Any person who comes onsite will receive specialized training covering the areas of emergency evacuation, emergency warnings, contingency plans, and hazard communication. This information will be covered by a combination of oral briefings, written statements, and daily safety meetings.

In addition to the basic training required of every worker onsite, the following specialized training required to accomplish certain specialized jobs onsite will be conducted in daily safety or tailgate meetings:

- Site fire protection and use of fire extinguishers,
- Lockout of hazardous electrical energy sources,

- Specialized respirator training on the use of chemical respirators with administrative limitations on use times,
- Lifting, back care, and ergonomics, and
- Confined space entry training and permits.

The SHSO will be responsible for ensuring that persons meet the minimum training required for site entry. The SHSO will also ensure that workers have received the necessary specialized training or annual refresher training to accomplish the designated work.

9.4 Medical Surveillance Requirements

All contractor and subcontractor personnel working onsite on a full-time basis will participate in the occupational health monitoring program required by 29 CFR Part 1910 and WAC 296-62-3050. The program provides for a baseline evaluation of the employee's health and determination of his/her fitness to work in the field with hazardous chemicals. The program provides yearly physicals with blood and urine analysis including the general test and specific chemistry for heavy metals to determine potential exposures and adequacy of PPE.

9.5 Documentation

All contractors, subcontractors, visitors, and agency personnel will read and understand the Site Health and Safety Plan. The "Acknowledgment Form" will be signed by each individual indicating this has been done. The Acknowledgment Form requiring signatures is presented in Exhibit I.

Documentation of employee medical surveillance, certificates and associated credential documentation, 40-hour training documentation, and respirator fit test records will be recorded and maintained onsite by the SHSO.

9.6 Hazard Communication Plan

The hazard communication program (HCP) has been incorporated into this health and safety plan. The SHSO is responsible for implementing the HCP. The material safety data sheets (MSDSs) for the hazardous substances listed on Tables 1 and 2 are included in Exhibit II. These MSDSs are

available for all onsite employees upon request made to the SHSO. Hazard communication employee training will be included in the safety indoctrination and orientation prior to entry onto site and will be supplemented by daily safety briefings. The physical hazards and health effects of the hazardous substance are included in Tables 1 and 2. Emergency procedures in the event of a release or exposure is included in Section 12 of this plan. All containers of known hazardous substances will be properly labeled identifying the hazardous substance, appropriate warnings (physical safety and health hazards), and name and address of manufacturer (if applicable).

9.7 General Safe Work Rules

The following general safe work rules will be followed by all persons entering and/or working on site:

- No employee or subcontractor may be allowed onsite without the prior knowledge and consent of the SHSO, Site Supervisor, or Project Manager.
- No activities will be conducted onsite without sufficient backup personnel. At a minimum, two persons must be present at the site (the buddy system). Visual, voice, or radio communication will be maintained at all times.
- All contractor or subcontractor personnel will bring to the attention of the SHSO any unsafe condition or practice associated with the site activities that they are unable to correct themselves.
- All accidents/injuries will be reported to the SHSO and an accident report completed.
- No smoking, eating, gum chewing, tobacco chewing, or drinking will be allowed in the restricted area. Gatorade or water for drinking will be provided in the support zone.
- Hands will be thoroughly cleaned prior to smoking, eating, or other activities outside the restricted area.
- Team members must avoid unnecessary contamination (i.e., walking through known or suspected "hot zones or contaminated puddles, kneeling or sitting on the ground, leaning against potentially contaminated barrels or equipment).
- Respiratory devices may not be worn with beards, long sideburns, or under other conditions that prevent a proper seal.
- Respiratory devices may not be worn with contact lenses.
- Personnel likely to wear air purifying or air-supplied respirators must meet the training and medical requirements of 29 CFR Parts 1910.120 and 1910.134.

- If chemical odors are noted during on-site activities, personnel should back off until the odors can be identified.
- Personnel should keep track of weather conditions and wind direction to the extent they could affect potential exposure.
- Personnel should be alert to any abnormal behavior on the part of other workers that might indicate distress, disorientation, or other ill effects.

10.0 SITE WORK ZONES

During mobilization for each separate work area and drilling site, work zones will be established based on known locations of contaminated materials; these zones are called the Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support Zone (SZ). Within these zones, work operations will be conducted utilizing trained workers with prescribed protective equipment. Movement between zones will be through designated checkpoints to control personnel access and spread of contamination.

All persons wishing to enter the CRZ or EZ must be cleared by the contractor. These persons must first be given the safety introduction and orientation, covering the Health and Safety Plan, the location of the work zones, the contingency plan, site emergency signals or phone numbers, and hazard communication information covering the hazardous materials onsite and the location of MSDSs. This briefing will be presented to each visitor at the site; for assigned employees, this briefing will be given once and reemphasized in daily safety meetings. All persons entering the CRZ or EZ must have documentation of all training, medical approvals, and respirator fit test cards on file with Harding.

At the time of the capping activities, the sort yard will not have site security (i.e., perimeter fence, security guards, etc.) therefore measures will be instituted by the contractor to minimize the possibility of exposing unprotected personnel and to control the spread of contaminated materials, including the following:

- Setting up and maintaining security barriers to warn and exclude personnel from the general area,
- Allowing the minimum number of personnel and pieces of equipment onsite consistent with effective operations,
- Establishing and demarking work zones onsite,
- Establishing control points to control contaminated area ingress and egress,
- Conducting cleanup operations in a manner that minimizes the potential for personal exposure and equipment contamination, and
- Enforcing strict decontamination practices.

10.1 Exclusion Zone

The EZ is the innermost area of the three work areas; this area is also referred to as the dirty area or hot zone. This is the area where active removal or handling of contaminated materials takes place and is the zone of highest hazard. An entry point will be established at the boundary line between the EZ and the CRZ. To pass through this point to the EZ, all personnel must be fully suited in the PPE required for their work task. Level C protection will be required for movement in this area dependent on the ongoing activity.

10.2 Contamination Reduction Zone

The CRZ is the area that lies between the EZ and the SZ. The line separating the EZ and the CRZ is called the hot line. The purpose of the CRZ is to provide a dedicated area to remove contamination from personnel and equipment and prevent it from being carried into the clean areas.

Exiting from the EZ to the CRZ will be through a designated access control point. Persons exiting from the EZ will be decontaminated in a multistep procedure described in Section 11.
The boundary between the CRZ and the next outward adjacent work area, the SZ, is called the contamination control line. This line marks the boundary between materials that are potentially contaminated and the work area that is considered free from contamination.

10.3 Support Zone

The outermost zone of the designated work area is called the SZ and is considered free of contaminated material hazards. Support vehicles, storage buildings, etc. that are used for general and administrative support of the project are located in this zone. Level D protection is considered adequate for movement or administrative work in this area.

11.0 DECONTAMINATION PROCEDURES

Consistent decontamination procedures will be used for all activities at the Cascade No. 3 Log Sort Yard. The objectives of decontamination are to prevent the introduction of contamination onto areas of the site that are currently not contaminated, to prevent contamination from leaving the site by way of equipment or personnel, and to prevent exposure of field personnel to contaminated materials. The following sections include general procedures to be followed to meet these objectives.

11.1 Personnel Decontamination Procedures

11.1.1 Entering the Contamination Reduction and Exclusion Zones

Before entering the CRZ or EZ, all personnel will:

a. Don coverall for the task assigned,

b. Don boots or shoe covers/overboots, as appropriate, with gloves, and tape the seams, and

c. Don C (if applicable) respirator and hardhat, and proceed to work area.

11.1.2 Leaving the Exclusion Area

Before leaving the EZ, all personnel will:

a. Wash the rubber boots in the first wash tub containing Alcanox cleanser. Brush the boots thoroughly using a stiff brush. Special attention is needed to brush all contaminated material from the boot tread.

b. Rinse the rubber boots in the second tub containing clean water,

c. Final rinse the rubber boots in the third tub containing clean water. Proceed to the CRZ.

d. Unzip the outer coverall then remove the outer gloves and dispose of them as contaminated trash.

e. Without removing the respirator, wipe the outer surface with a damp rag. Wipe down safety glasses, hardhat, and any other equipment (e.g., air monitors, cameras) with the damp rag. Dispose of the rag as contaminated trash.

f. Remove the rubber boots and place them on the boot rack.

g. Remove and wash the respirator.

h. Remove and dispose of the inner gloves as contaminated trash.

i. Regardless of the level of protection required, field personnel should thoroughly wash hands and face before taking any breaks and before leaving the site.

All contaminated PPE will be disposed of in covered and lined 55-gallon drums. Once full, the bags will be disposed of with the solid hazardous waste generated on site. The SHSO will frequently inspect respirators for cleanliness and general condition.

11.2 Equipment Decontamination

Decontamination procedures are designed to remove trace level contaminants from sampling equipment to prevent cross-contamination. All equipment used onsite will be cleaned prior to removal from the EZ.

The decontamination procedures are described in Remedial Investigation Work Plan. When the steam cleaner/pressure washer is used, waste form this operation will be collected and analyzed for treatment or disposal.

ALL EQUIPMENT MUST BE DECONTAMINATED BEFORE LEAVING THE EZ AND IS SUBJECT TO INSPECTIONS BY THE SITE SAFETY OFFICER TO DETERMINE ADEQUACY OF DECONTAMINATION PROCEDURES.

11.2.1 Small Equipment and Tools

A. All tools, such as hammers and screwdrivers, that can be submerged in water will be washed in the equipment decontamination tub at the hot line.

B. All equipment, such as personnel pumps, cameras, and monitoring gear, that cannot be immersed in water will be wet wiped until visibly clean at the hot line using a clean rag, which is disposed of after the equipment has been wiped.

11.2.2 Heavy Equipment and Vehicle

A. Use a pressure washer/steam cleaner to clean all tracks, tire tread, underbody areas, ledges, and any crevices where dirt and contamination can accumulate.

B. Wash the equipment using stiff brushes and water with detergent or Alcanox.

C. Wash down the path the truck follows off of the decon pad.

D. Collect all wash water for treatment or disposal.

11.3 Disposal

Trash bags holding disposable items will be disposed of in a lined, open-top, 55-gallon drum and will be disposed of with hazardous waste solids generated during the removal activities. Liquid waste will be disposed of in closed 55-gallon drums. All waste drums will be labelled and secured in the decontamination zone and will be disposed of according to Ecology regulations.

12.0 EMERGENCY INFORMATION

12.1 Local Resources

Emergency Response	911
Tacoma General Hospital	(206) 594-1000
Poison Control Center	(206) 594-1414
City of Tacoma Police Dept.	(206) 593-4721
City of Tacoma Fire Dept.	(206) 627-0151

The Tacoma General Hospital location is shown on Figure 2.

The address is: 315 South K Street
Tacoma, Washington

A non-life threatening injured person will be transported to the nearest neighborhood medical clinic.

12.2 Personnel Responsibilities

Vital responsibilities will be assigned to positions specific to the contingency plan. Onsite persons will be selected to fill these positions and carry out the assigned responsibilities in the event of an emergency. Each position will have an alternate to fulfill the responsibilities in the absence of the primary person. The positions and responsible persons are as follows:

Emergency Coordinator - This person will assess conditions, direct emergency actions, and initiate notifications and remedial action.

Emergency Coordinator:	Site Supervisor
Alternate:	Site Health and Safety Officer

Personnel Coordinator - This person will initiate a head count at the assembly area and account for persons on the EZ sign-in list.

Personnel Coordinator:	Site Health and Safety Officer
Alternate:	Site Supervisor

12.3 Emergency Notification List

In the event of an emergency, appropriate agencies will need to be contacted. Some will be contacted to request assistance and others will be contacted for reporting purposes only. The following list shall be posted at the field office:

Emergency Notification List

Agency/Company	Purpose	Phone Number
City of Tacoma Police Department	Police Activities	911 or (206) 593-4721
City of Tacoma Fire Department	Fire	911 or (206) 591-5147
Tacoma General Hospital	Medical	911 or (206) 594-1000
Agency Contact		
- Washington Dept. of Ecology Marc McKenna	Incident Reporting	(206) 753-2353
- U.S. Coast Guard	Spill Reporting	(800) 424-8802
- USEPA Region X	Spill Reporting	(206) 442-1263
- National Response Center	Spill Reporting	(800) 424-8802

12.4 Hazard Recognition

Hazard recognition is an essential part of the contingency plan. Initiation of the contingency plan relies on the employee's ability to recognize an emergency or potential for an emergency such as:

- Explosion,
- Fire,
- Chemical releases,
- Personal injury,
- Loss of communication abilities (*i.e.*, telephones), or
- Natural occurrences (*e.g.*, lightening, tornado, earthquake, flood).

12.5 Communications

Emergency communications will consist of three methods as described below:

Hand Signals

- Sweep hand across neck to indicate personnel to stop work and exit EZ,
- Grasp throat with hands to indicate inability to breathe,
- Thumbs up indicates OK, and
- Thumbs down indicates not OK.

Air Horn/Vehicle Horn

Air horns will be located at all work areas in the EZ and the SZ. If air horns fail or are lost, vehicle horns may be used as a substitute. Air horns will be the primary alarm system and used in the following manner:

One long blast: Evacuate EZ and proceed to assembly area.

Telephones, Mobile Phones

Telephones will be located in the construction trailer and will be used to notify off-site agencies of incidents and request assistance as necessary.

12.6 Assessment of Hazardous Events

The assessment process will consist of the following three stages:

- Initial,
- Emergency coordinator, and
- Remedial.

Initial - The initial assessment of hazardous events will most likely be made by onsite technicians. When an event recognized as an emergency occurs, the alarm system (air horns) will be used to notify personnel. As soon as the alarm is activated, the Emergency Coordinator (HLA Site Supervisor) will be notified.

Emergency Coordinator - Once the Emergency Coordinator is notified, the Emergency Coordinator will take into account the following information:

- Nature of emergency,
- Wind direction,
- Location of personnel,
- Monitoring results,
- Emergency equipment available, and
- Off-site population.

The following is the average prevailing weather conditions for the Tacoma area:

	Average Precipitation 1982-1990 (inches)	Average Temperature 1982-1990 (Fahrenheit)
January	6.05	41.9
February	4.03	42.7
March	4.19	47.2
April	2.58	51.5
May	2.45	56.7
June	1.78	62.2
July	0.87	65.6
August	0.76	66.0
September	1.27	60.8
October	3.56	53.3
November	7.17	45.7
December	4.78	39.1
Average Annual	39.46	52.7

Based on this information, the Emergency Coordinator will direct appropriate emergency action and agency notification.

Remedial - After the emergency has been controlled and the site is considered safe to reenter, the Emergency Coordinator will direct personnel to restore the site to full operating condition.

12.7 Evacuation

Employees will follow a route that avoids locations downwind from the emergency. Employees will proceed to the assembly area by the quickest route possible. When the assembly area is reached, employees will immediately check in with the SHSO. If the SHSO cannot account for personnel, search and rescue teams will take appropriate actions. These actions will be initiated by the Emergency Coordinator.

12.8 Emergency Equipment

Onsite emergency equipment will include equipment used during operations (heavy equipment) and reserve items stored at the decontamination/assembly area and at strategic areas on site. The following is a list of emergency equipment available:

Safety Equipment Checklist

- Emergency eye station
- First aid kit
- Class A,B,C, dry chemical fire extinguishers
- Emergency air horns
- Earplugs
- Drinking water/Gatorade

Monitoring and Surveillance Equipment

- Portable OVM (if applicable)
- Gas-Tech GX-86 H2S, LEL, Miniram PDM-3, and O2 Meter (if applicable)
- SKC personal air sampling pumps and sampling media

12.9 Training

All personnel will have a thorough understanding of the contingency plan before starting work. the contractor and the subcontractor will provide information on the emergency warning system as well as appropriate response by employees.

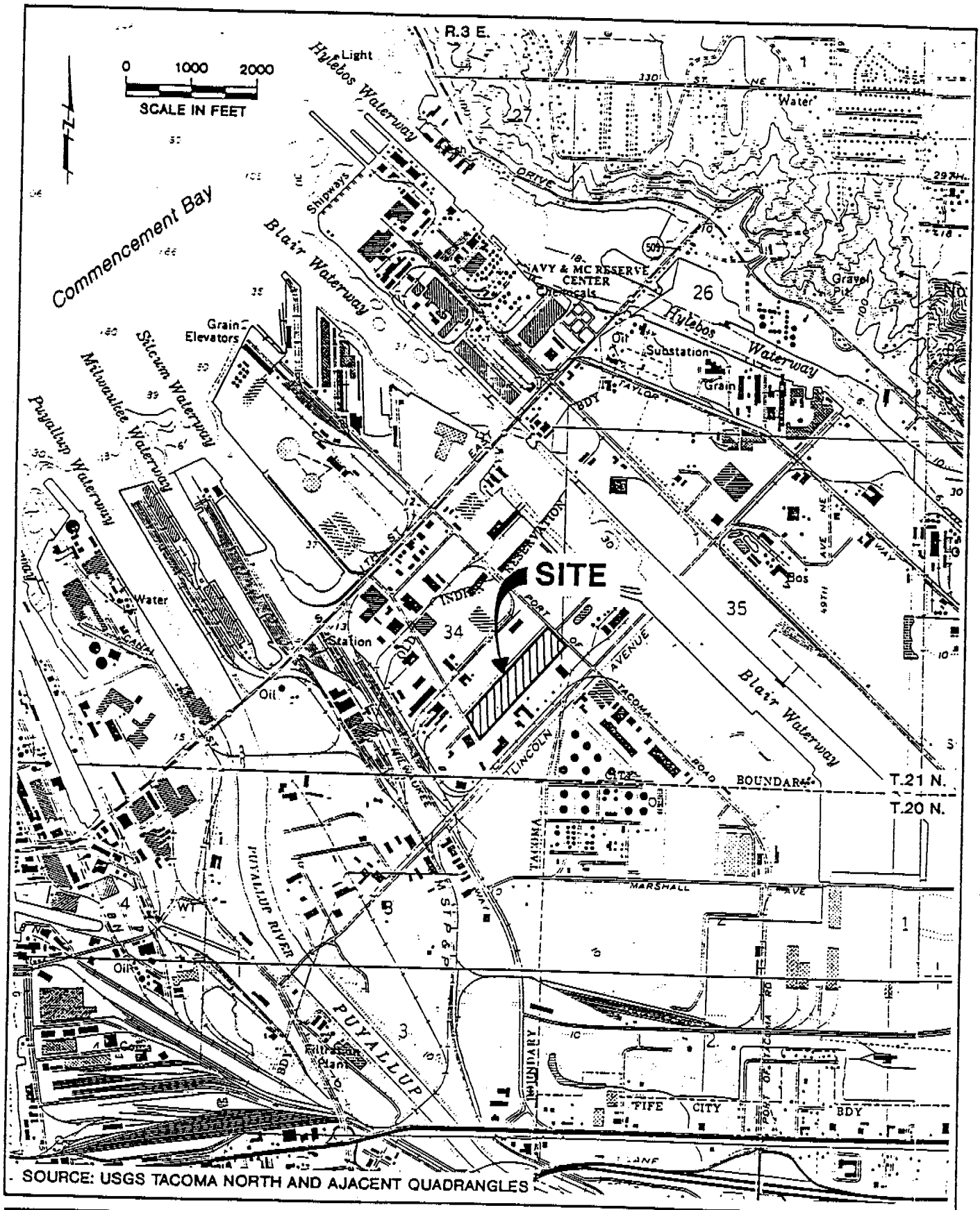
13.0 REFERENCES

American Conference of Industrial Hygienists, 1992, Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, 1991-1992.

U.S. Department of Health and Human Services, 1990, NIOSH Pocket Guide to Chemical Hazards, June 1990.

Washington Department of Ecology (Ecology), 1991, Agreed Order No. DE 91-S199.

FIGURES



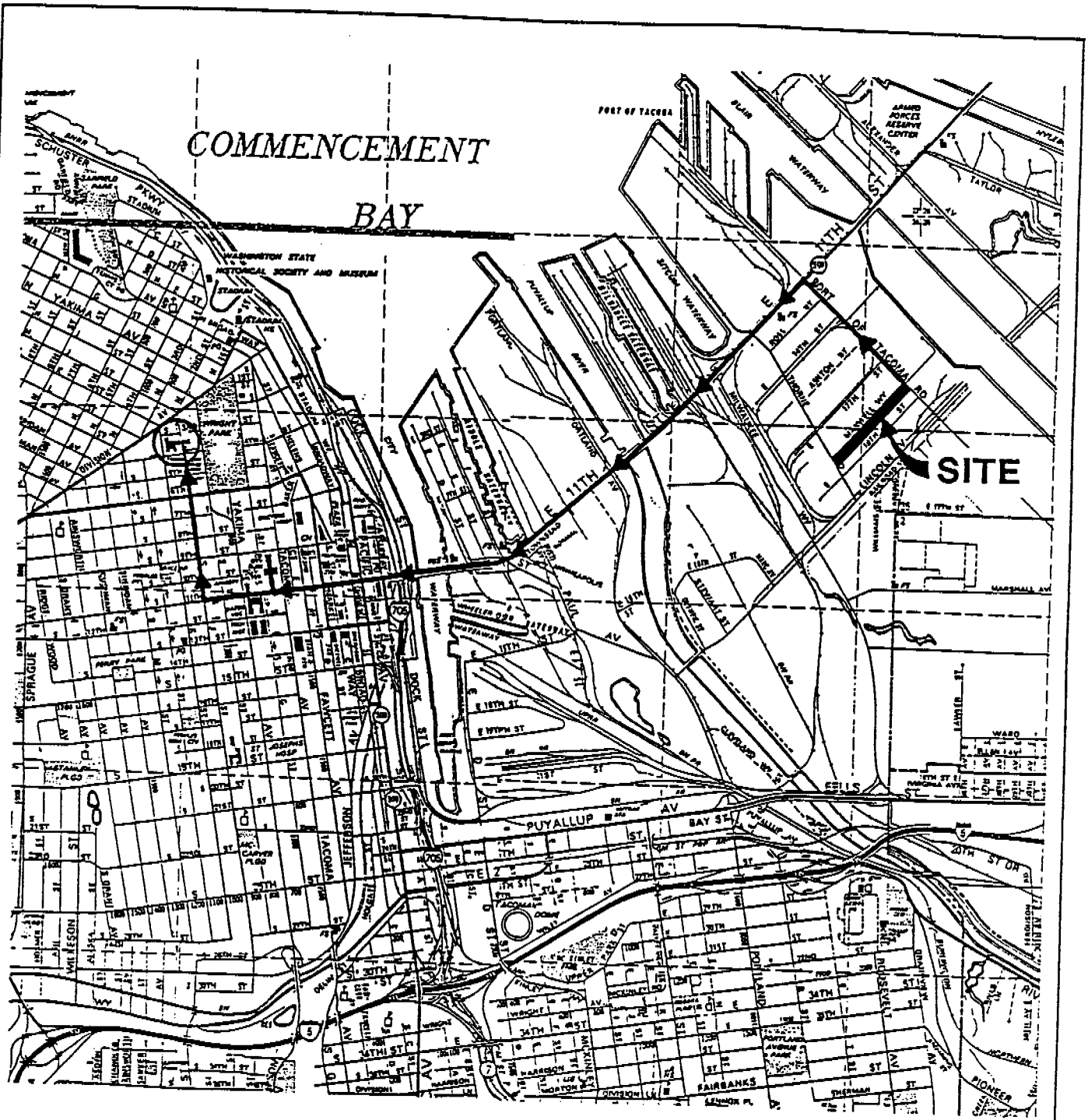
Harding Lawson Associates
Engineering and
Environmental Services

VICINITY MAP

Cascade Timber Yard No.3
Log Sort Yard

FIGURE 1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PS	20776,003.09		11/91	



TACOMA GENERAL HOSPITAL
315 S. K ST.
(206) 594-1000

EMERGENCY ENTRANCE LOCATED AT 4TH AND J

0 3000
SCALE IN FEET

Harding Lawson Associates
Engineering and
Environmental Services

ROUTE TO HOSPITAL

Cascade Timber No. 3
Log Sort Yard

FIGURE 2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PS	20776.003.09		11/91	

EXHIBIT I

ACKNOWLEDGEMENT FORM

ACKNOWLEDGEMENT LOG

A. PROJECT PERSONNEL LIST AND SAFETY PLAN DISTRIBUTION RECORD

A copy of this safety plan shall be provided to all contractors and subcontractors who may be affected by activities covered under the scope of this Site Safety Plan. All contractors and subcontractors must comply with applicable OSHA, EPA, and local government rules and regulations. All contractors and subcontractors must sign, indicating they have read and understood the Site Safety Plan.

Employee Name/Firm	Date Distributed	Signature

B. VISITOR - ALL VISITORS MUST FURNISH HIS/HER OWN PERSONAL PROTECTIVE EQUIPMENT. ALL VISITORS ARE REQUIRED TO SIGN THE VISITOR LOG AND COMPLY WITH THE SAFETY PLAN REQUIREMENTS. IF THE VISITOR REPRESENTS A REGULATORY AGENCY CONCERNED WITH SITE HEALTH AND SAFETY ISSUES, THE SITE SAFETY OFFICER SHALL ALSO IMMEDIATELY NOTIFY THE DHSO.

Date	Topics	Name of Attendee	Firm Name	Employee Initials

EXHIBIT II

MATERIAL SAFETY DATA SHEETS

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 70
Antimony Metal/Powder

Issued: 9/80 Revision: A, 11/89

Section 1—Material Identification

Antimony Metal/Powder Description: A naturally occurring ore found in sulfides, oxides, complex lead, silver, copper, and mercury sulfides. Prepared in the laboratory by reducing Sb_2O_3 with KCN. Used in manufacturing bullets, bearing metal, hard lead, blackening iron, coating metals, white metal, thermoelectric piles, storage batteries, cable sheaths, type metal, and alloys (Britannia or Babbitt metal). Pure antimony compounds are used as catalysts in organic synthesis, abrasives, plasticizers, pigment, and flameproofing compounds; also used in manufacturing paints, enamels, matches, glass, pharmaceuticals, explosives, and tartar emetic.
Other Designations: Stibium; antimony regulus; Sb; CAS No. 7440-36-0.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 3
S 3
K 1

Genium

HMIS
H 3
F 1
R 1
PPG*
* Sec.

Section 2—Ingredients and Occupational Exposure Limits

Antimony, ca 99%

OSHA PEL
8-hr TWA: 0.5 mg/m³ (as Sb)

ACGIH TLV, 1989-90
TLV-TWA: 0.5 mg/m³ (as Sb)

NIOSH REL, 1987*
10-hr TWA: 0.5 mg/m³

Toxicity Data†
Rat, intraperitoneal, LD_{50}: 100 mg/kg
Rat, oral, LD_{50}: 100 mg/kg

* NIOSH has proposed a 10-hr TWA of 0.5 mg/m³ with an action level at 0.25 mg/m³. The TLV was established at a level to prevent irritation and systemic effects.
† See NIOSH, *RTECS* (CC4025000), for additional data with references to toxic effects.

Section 3—Physical Data

Boiling Point: 2975 °F (1635 °C)
Melting Point: 1166.9 °F (630.5 °C)
Vapor Pressure: 1 mm Hg at 1627 °F (886 °C)
Molecular Weight: 121.76 g/mol

Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 6.68 at 77 °F (25 °C)
Water Solubility: Insoluble
Mohs Hardness: 3.0 to 3.5

Appearance and Odor: A brittle, flaky, crystalline solid with a lustrous blue-white color; however, a *noncrystalline* form is also known. The powder form is dark gray, lustrous.

Section 4—Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: Cloud,* 788 °F (420 °C); dust layer,* 626 °F (330 °C)	LEL: Dust cloud explosion, 0.42 oz/ft³	UEL: None report

Extinguishing Media: Dry chemical powder.
Unusual Fire or Explosion Hazards: Antimony bulk metal is combustible in air at *high temperature*. When ignited it burns with a brilliant flame, giving off dense, white antimony trioxide (Sb_2O_3) fumes. When exposed to heat or ignition sources, powdered antimony is a moderate fir and explosion hazard. Particle size and dispersion in air determine reactivity.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Personal protective clothing and eye protection are essential.

* Ninety-one percent of dust goes through a 74-µm sieve. A 1.92-J spark can ignite an antimony dust cloud.

Section 5—Reactivity Data

Stability/Polymerization: Antimony metal (bulk) is stable in dry air at room temperature in closed containers. It slowly tarnishes in moist air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Antimony is not very reactive with cold, dilute acids, but it reacts readily with aqua regia and hot, concentrated sulfuric acid. Powdered antimony* also reacts with hot, concentrated hydrochloric acid (HCl). On contact with acid, it emits toxic antimony trihydride (SbH_3) fumes; electrolysis of acid sulfides and stirred antimony halide yields explosive antimony. Antimony can react vigorously or violently with oxidizing agents such as nitrate salts, halogens, nitric acid, perchloric acids, chlorine trifluoride (ClF_3), potassium permanganate ($KMnO_4$), ammonium nitrate (NH_4NO_3), bromine trinitride (BrN_3), bromine trifluoride (BrF_3), chlorine monoxide (ClO), chlorine trifluoride (ClF_3), potassium nitrate (KNO_3), sodium nitrate ($NaNO_3$), and potassium oxide (K_2O_2).
Conditions to Avoid: Nascent hydrogen can react with Sb, or its alloys with Mg or Zn, to form antimony trihydride, a colorless, highly toxic g (causing headache, nausea, vomiting, abdominal pain, hemolysis (separation of hemoglobin from red blood corpuscles), hematuria (blood in the urine), and death) with a disagreeable odor (0.1-ppm TLV).
Hazardous Products of Decomposition: Thermal oxidative decomposition of antimony can produce toxic SbH_3 fumes.
* Powdered antimony reacts more vigorously than the bulk material and forms dangerous mixtures with oxidizing agents. Heating further increases its reactivity.

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No. 70 Antimony Metal/Powder 11/89

Section 6: Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists antimony as a carcinogen. However, its ore is a suspected carcinogen in antimony trioxide production. Antimony trioxide is prepared in the laboratory by a volatilization process involving antimony trichloride ($SbCl_3$) and water.
Summary of Risks: An irritant to mucous membranes, eyes, and skin. Exposures to dust/powder can cause eye inflammation (conjunctivitis), nasal irritation (rhinitis - perforation of the nasal septum), chronic dermatitis ranging from mild rashes to blemishes resembling chicken pox, and muscle pain and weakness. Some sources refer to antimony as a human poison by an unspecified route. Exposure to antimony may result in "metal fume fever," a flu-like syndrome with fever, fatigue, cough, and muscle ache.
Medical Conditions Aggravated by Long-Term Exposure: Chronic inhalation of subtoxic doses of dust or fume above the TLV may result in chemical pneumonia, intraalveolar lipid deposits, liver and cardiac involvement, and possible kidney disease.
Target Organs: Skin, eyes, mucous membranes, respiratory system, and cardiovascular system.
Primary Entry: Inhalation (dust and fume), ingestion.
Acute Effects: Acute ingestion may cause violent vomiting, diarrhea, slow pulse and low blood pressure, shallow breathing, and death.
Chronic Effects: Chronic exposures lead to dizziness, dry throat, sleeplessness, anorexia, and nausea.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: ***Contact physician!*** Never give anything by mouth to an unconscious or convulsing person. Give 1 to 2 glasses of water to dilute, although vomiting may be spontaneous after ingestion.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.
Physician's Note: If indicated, intravenous gastric lavage chelation therapy with BAL (British Anti-Lewsite) for 10 days is recommended.

Spill/Leak: Notify safety personnel of powder spills. Small spills can be removed by vacuuming or wet sweeping to minimize airborne dust. Cleanup personnel should use protective equipment.
Disposal: Return scrap metal to your supplier. Unsalvageable waste may be buried in an approved secure landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8: Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). Respirators should be available for nonroutine or emergency use for concentrations above the TLV: high-efficiency dust respirators for concentrations below 5 mg/m^3 and self-contained or air-supplied respirators with full facepiece for concentrations above 5 mg/m^3.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9: Special Precautions and Comments

Storage Requirements: Store in a dry, well-ventilated, low fire-risk area. Avoid heat and direct sunlight.
Engineering Controls: Avoid breathing dust or fumes. Practice good housekeeping and cleaning techniques to prevent dust accumulation and to minimize airborne particulates. Minimize skin contact by using barrier creams, rubber gloves and aprons, and good personal hygiene. Keep antimony dust off clothing. Provide preplacement and periodic medical examinations for those workers exposed regularly to antimony, with emphasis on the skin, mucous membranes, and the pulmonary, cardiac, and reproductive systems. Provide suitable training to those working with antimony. Monitor the workplace. Keep records.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Antimony compounds, inorganic, n.o.s.
IMO Hazard Class: 6.1
IMO Label: Poison/St. Andrews Cross (Stow away from foodstuffs)
IMDG Packaging Group: I, II, III

MSDS Collection **References:** 1, 2-12, 24, 26, 27, 31, 37, 38, 41, 81, 84, 87, 89, 90, 91, 100, 109
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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Material Safety Data Sheets Collection:

Sheet No. 296
Arsenic and Compounds

Issued: 4/90

Section 1. Material Identification

31

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 1
I 4
S 2
K 0

Genium: 3, 3, 2, -

HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL
8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

ACGIH TLV, 1989-90
TLV-TWA: 0.2 mg/m³

NIOSH REL, 1987
Ceiling: 0.002 mg/m³

Toxicity Data‡
Man, oral, TD_{Lo}: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
Rat, oral, TC_{Lo}: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.
† Inorganic compounds.
‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: sublimes at 1134 °F/612 °C
Melting Point: 1497 °F/814 °C
Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)
Atomic Weight: 74.92
Density: 5.724 at 57 °F/14 °C
Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid (HNO_3).

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, CO_2, water spray, or foam to fight fires.
Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.
Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

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Section 6: Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.
Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.
Target Organs: Liver, kidneys, skin, lungs, lymphatic system.
Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.
Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).
Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: If emesis is unsuccessful after two doses of Ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7: Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations‡
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.
‡ Listed as arsenic organic compounds (as As).

Section 8: Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[107]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9: Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.
Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid
DOT Hazard Class: Poison B
ID No.: UN1558
DOT Label: Poison
DOT Packaging Requirements: 173.366
DOT Packaging Exceptions: 173.364

IMO Shipping Name: Arsenic, metallic
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II
ID No.: UN1558

MSDS Collection **References:** 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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MSDS # 154
CADMIUM METAL POWDER

Issued: October 1985
Revised:

From Genium's MSDS Collection, to be used as a reference.

SECTION 1. MATERIAL IDENTIFICATION

18

MATERIAL NAME: CADMIUM METAL POWDER
OTHER DESIGNATIONS: Elemental Cadmium, Cd; CAS #7440 43 9
SUPPLIER: Available from several suppliers, including:

Alloychem, Inc.
641 Lexington Avenue
New York, NY 10022
(212) 644-1269

Cerac, Inc.
PO Box 1178
Milwaukee, WI 53201
(414) 289-9800

R 1
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K 4

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
CADMIUM, Cd	>99.8	8-hr. TWA: 0.05 mg/m^3, as Cd (dust)*
		Ceiling: 0.05 mg/m^3 as Cd (fume) **
		Inhalation, man: TCLo: 88 µg/m^3/8.6Y
		Inhalation, human: LCLo: 39mg/m^3/20M
		Oral, rat: LD50: 225 mg/kg

* Current (1985-86) ACGIH TWA TLV for Cd dust
** Current (1985-86) ACGIH ceiling limit for Cadmium Oxide (formed on heating Cd in air).

The OSHA PELs for Cadmium dust and fumes are as follows (as Cd):

Cd dust:	TWA = 0.2 mg/m^3	Ceiling = 0.6 mg/m^3
Cd fume:	TWA = 0.1 mg/m^3	Ceiling = 0.3 mg/m^3

The NIOSH-recommended TWA and ceiling concentration for cadmium (as Cd) are 0.04 mg/m^3 and 0.2 mg/m^3, respectively.

SECTION 3. PHYSICAL DATA

Melting Point ..... 320.9°C
Boiling Point ..... 767°C
Specific gravity ... 8.6
Vapor pressure @ 394°C ... 1 mmHg
Solubility in Water ..... Insoluble
Atomic Weight 112.4

APPEARANCE & ODOR: Grayish-white powder. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
N/A	570°C (dust cloud) 250°C (dust layer)	Not Available		

Cadmium dust will burn with the evolution of toxic cadmium oxide fumes. It is a weak fire and explosion hazard.
EXTINGUISHING MEDIA: Blanket burning material with dry powder extinguishing agents suitable for metal powder fires.

Firefighters should wear self-contained breathing apparatus and full protective gear.

SECTION 5. REACTIVITY DATA

Finely divided cadmium powder can be pyrophoric. It slowly oxidizes in moist air at room temperature. It is insoluble in water but soluble in acids. Contact with hydrochloric and sulfuric acids generates flammable hydrogen gas (reaction is slow). Oxides of nitrogen are evolved upon oxidation by nitric acid. Cadmium is not dissolved by alkali hydroxides.
Cadmium may react violently with fused ammonium nitrate. It is incompatible with strong oxidizing agents, elemental sulfur, selenium, tellurium and hydrazoic acid.

Heating cadmium metal produces toxic fumes of cadmium oxide.

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SECTION 6. HEALTH HAZARD INFORMATION

TLV See Section 2

Cadmium is toxic by ingestion and inhalation. Ingestion can cause severe gastrointestinal distress: vomiting, diarrhea, nausea, and abdominal pain. Inhalation, particularly of Cd fumes, can cause irritation of the nose and throat, cough, dyspnea, chest pains, fever and chills. Severe exposure can cause pulmonary edema and may be fatal. Symptoms of acute intoxication usually do not develop until several hours after the exposure. The primary effects of chronic inhalation in humans are pulmonary emphysema and kidney damage. The renal dysfunction is characterized by urinary excretion of low molecular weight proteins such as B-2 microglobulin. Skeletal abnormalities (osteoporosis and pseudofractures) and anemia have been reported following prolonged exposure to cadmium oxide. In a recent (9/84) Current Intelligence Bulletin (#42), NIOSH recommended that cadmium compounds be regarded as potential occupational carcinogens. This recommendation is based in part on recent epidemiological evidence of excess lung cancer among workers exposed to cadmium oxide. The IARC and NTP list "cadmium and certain cadmium compounds" as suspected carcinogens.

FIRST AID: EYE CONTACT: Flush eyes with running water, including under eyelids. Seek medical attention* if irritation develops. SKIN CONTACT: Wash contaminated area with soap and water. INHALATION: Remove person to fresh air. Restore and/or support breathing as required. Obtain medical attention* immediately for further treatment and observation. INGESTION: If person is conscious, give them a large quantity of water to drink; then induce vomiting. Seek medical attention*

* Medical Attention = Inplant, Paramedic, Community

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety/environmental personnel of powder spills. Remove sources of heat and ignition. Clean-up personnel should use personal protective equipment (overalls and rubber gloves). Respirators should be worn if dusting potential exists. Carefully pick up spilled material by vacuuming or wet clean-up methods. Vacuum must be for hazardous dust (i.e. equipped with HEPA filter). Avoid dust generation. Place material in suitable containers for recovery or disposal.

DISPOSAL: Place material in sealed containers for reclamation or disposal as a hazardous solid waste in an approved/secured chemical waste landfill. Where considerable waste is generated or accumulated, consider returning material to a smelter for reprocessing. Follow local, state and federal regulations.

EPA HAZARDOUS WASTE NUMBER: D006 (EP Toxicity, 40 CFR 261.24).

SECTION 8. SPECIAL PROTECTION INFORMATION

Use local exhaust ventilation to meet TLV requirements wherever cadmium dust or fumes may be generated. Where exposures are or may be above the applicable TLV, workers should wear NIOSH-approved respirator protection appropriate for the level of exposure. Respirator usage must be in accordance with OSHA requirements (29 CFR 1910.134). Avoid eye contact by wearing dust-resistant safety goggles where dusty conditions exist. Wear protective clothing appropriate for the work situation to prevent skin contamination. Showering after work with a complete change to street clothing may be desirable. Eye wash stations and washing facilities should be readily accessible in areas of use. Ventilation systems may require dust collectors to prevent reintrainment of dusts in air make-up systems or adjacent property contamination.
In addition to preplacement and periodic medical examinations, recommended medical surveillance procedures include urinary cadmium and protein determinations and pulmonary-function testing.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed containers in a cool, dry location. Protect containers from physical damage. Use with adequate ventilation. Maintain good housekeeping practices to prevent accumulation of dust. Use procedures (vacuuming/wet sweeping) that minimize dust generation. Follow good hygienic practice. Wash thoroughly after handling and before eating or smoking. Do not eat, drink or smoke in areas where cadmium dust or fumes are handled or generated. Vacuum contaminated clothing; do not shake. Avoid inhalation of dust/fumes. DO NOT INGEST!

DOT ID #: UN2570 (Cadmium compounds; 49 CFR 172.102).

DATA SOURCE(S) CODE (See Glossary) 2, 4, 8, 12, 19, 25, 27, 30, 49, 55, 57, 58, 59, 61, 62, MSDS #23.V

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APPROVALS 12/85

INDUST. HYGIENE/SAFETY 1/86

MEDICAL REVIEW: Jan 86

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Material Safety Data Sheets Collection:

Sheet No. 162
Copper

Issued: 12/85 Revision: A, 8/90

Section 1. Material Identification

Copper (Cu) Description: Widely distributed in nature in elemental state, arsenites, sulfides, chlorides, and carbonates. Prepared by crushing, grinding, and concentrating copper ores by flotation and leaching or by smelting copper ore concentrates to yield a blister (96 to 98%) copper which is electrolytically refined to yield 99.9+% copper. Copper is the most widely used structural metal, next to iron and aluminum. Used in electric wiring; switches, heating, plumbing, roofing, and building construction; alloys (brass, bronze, Monel metal, beryllium-copper); coins; chemical and pharmaceutical machinery; electroplated protective coatings and undercoats for nickel, chromium, zinc, etc., cooking utensils; insecticides; antifouling paints; and as a catalyst. Copper whiskers are used in thermal and electrical composites. Copper flakes are used as insulation for liquid fuels.

Other Designations: CAS No. 7440-50-8, bronze powder, copper slag-airborne, copper slag-milled.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(TM) for a suppliers list.

Cautions: *Copper may be toxic through contact, inhalation, and ingestion.* It may cause skin and eye irritation and metal fume fever. Copper is not considered a fire hazard, but fine particles may burn in air.

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Section 2. Ingredients and Occupational Exposure Limits

Copper, ca 100%

1989 OSHA PELs	1989-90 ACGIH TLVs	1988 NIOSH REL	1985-86 Toxicity Data‡
8-hr TWA: 1 mg/m³*	TLV-TWA: 1 mg/m³*	None established	Human, oral, TD_{Lo}: 120 µg/kg affects the gastrointestinal tract (nausea or vomiting)
8-hr TWA: 0.1 mg/m³†	TLV-TWA: 0.2 mg/m³†		Rat, oral, TD_{Lo}: 1210 µg/kg (35 weeks prior to mating) affects fertility (pre- and post-implantation mortality)

* Copper dusts and mists, as Cu.
† Copper fume.
‡ See NIOSH, *RTECS* (GL5325000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 4703 °F (2595 °C)
Melting Point: 1981 °F (1083 °C)
Vapor Pressure: 1 mm Hg at 2962 °F (1628 °C)
Molecular Weight: 63.546
Density/Specific Gravity: 8.94
Water Solubility: Insoluble

Appearance and Odor: Solid, various shapes, odorless, red/brown-colored metal or powder. Copper is ductile, tough, and easily worked. It is very resistant to corrosion, but readily attacked by alkalies.

Section 4. Fire and Explosion Data

Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire since copper does not burn. Finely divided copper burns in air, and in extreme cases ignites spontaneously.

Unusual Fire or Explosion Hazards: Liquid copper explodes on contact with water. High concentrations of fine copper particles in the air may present an explosion hazard.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit.

Section 5. Reactivity Data

Stability/Polymerization: Copper is stable at room temperature in closed containers under normal storage and handling conditions. However, on long standing, a white, highly explosive peroxide deposit may form. Copper's vapors are uninhibited and may form polymers in vents and flame arresters.

Chemical Incompatibilities: Copper reacts violently with ammonium nitrate, bromates, iodates, chlorates, ethylene oxide, hydrazoic acid, potassium oxide, dimethyl sulfoxide + trichloroacetic acid, hydrogen peroxide, sodium peroxide, sodium azide, sulfuric acid, hydrogen sulfide + air, and lead azide. A potentially explosive reaction occurs with acrylenic compounds. Copper ignites on contact with chlorine, fluorine [above 250 °F (121 °C)], chlorine trifluoride, and hydrazinium nitrate [above 158 °F (70 °C)]. It is also incompatible with 1-bromo-2-propyne; an incandescent reaction occurs with potassium dioxide.

Conditions to Avoid: Avoid prolonged exposure to air and moisture. On exposure to moist air, copper slowly converts to the carbonate.

Hazardous Products of Decomposition: Thermal oxidative decomposition of copper can produce metallic oxides (copper fumes).

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Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list copper as a carcinogen. Experimental studies show tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Copper is a necessary human nutrient, excessive intake levels of which the kidneys normally eliminate. In individuals with kidney disease or, rarely, Wilson's disease (abnormal retention and storage of copper in the body that damages the liver, kidneys, brain, blood, bones, and endocrine glands), copper levels may accumulate. Significant industrial exposure to copper occurs mainly through inhalation of fumes during welding, smelting, or refining operations; or through exposure to copper dusts and mists during mining, extracting, refining, or manufacturing processes. Copper particles may irritate, discolor, and damage eyes. Exposure to copper salts in many applications is potentially toxic. Copper dusts, fumes, and salts may irritate the upper respiratory tract. Long-term exposure may irritate the skin and discolor the skin or hair.
Medical Conditions Aggravated by Long-Term Exposure: Individuals with impaired pulmonary or renal function should avoid exposure.
Target Organs: Respiratory system, skin, eyes, liver, kidneys.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Inhalation of copper fumes may give rise to metal fume fever (after an incubation period of about 5 hr), an allergic reaction with flu-like symptoms—high temperature, metallic taste, nausea, coughing, general weakness, muscle aches, and exhaustion. These symptoms usually disappear within 24 hr. Direct contact with copper causes skin and (less often) eye irritation, and itching of the linings of the nose, mouth, and respiratory tract. Exposure to copper dust may cause a greenish-black skin discoloration. Copper ingestion causes nausea, vomiting, abdominal pain, and diarrhea. Ingestion of large doses may cause stomach and intestine ulceration, jaundice, and kidney and liver damage.
Chronic Effects: Continued exposure to copper may cause mild dermatitis and degeneration of the mucous membranes. Repeated or prolonged exposure to copper dusts and mists can discolor skin and hair and irritate the skin. Repeated inhalation can cause chronic respiratory disease. Individuals with Wilson's disease (1 in 200,000 individuals) are more susceptible to chronic copper poisoning. If undetected and untreated, this progressive condition is eventually fatal.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing with artificial respiration.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: A blood count shows leucocytosis if an individual has metal fume fever. Consider chellation with penicillamine or BAL (British Anti-Lewisite or dimercaprol) for chronic intoxication.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, remove all heat and ignition sources, and provide adequate ventilation. Avoid creating dusty conditions. Cleanup personnel should protect against vapor inhalation and skin and eye contact. Cleanup methods such as vacuuming (with the appropriate filter) or wet mopping minimizes dust dispersion. Absorb liquid containing copper with vermiculite, dry sand, or other inert materials. Place in appropriate containers for disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Some recommendations follow. For copper dust and mists greater than 50 mg/m^3, wear a high-efficiency particulate respirator, a supplied-air respirator, or an SCBA, all with a full facepiece. For copper dust and mists greater than 2000 mg/m^3, wear a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode. For copper fumes over 100 mg/m^3, wear either a powered air-purifying respirator with a high-efficiency filter, or a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Eye and face protection is required when grinding, welding, cutting, or remelting. Protect skin from molten metal and radiant heat when melting scrap. Machine turnings may also present a laceration hazard. When handling oil-contaminated copper, wear rubber gloves to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PELs and ACGIH TLVs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store copper in tightly closed containers in a cool, dry, well-ventilated area. Avoid exposure to air and moisture.
Engineering Controls: Avoid dust and fume inhalation and direct contact with skin and eyes. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Maintain exposures below the PEL/TLV. Monitor copper dust and mist levels in the air.
Other Precautions: Provide placement and periodic examinations that emphasize the skin, eyes, and respiratory system. Prevent exposing individuals with chronic respiratory disease or Wilson's disease.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 26, 38, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 134, 136, 138, 139, 143, 144
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: W Silverman, MD; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a construction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(TM) for a suppliers list.

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* Sec. 8

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 µg/m³
Action Level TWA*: 30 µg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 µg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 µg/m³

1988 NIOSH REL
10-hr TWA: <100 µg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 µg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system. The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

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Section 6. Health Hazard Data. *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

MSDS Collection References: 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 723
Nickel Metal

Issued: 8/90

Section 1. Material Identification

Nickel (Ni) Description: Found in ores in combination with sulphur, oxygen, antimony, arsenic, and/or silica. The Orford (sodium sulfide and electrolysis) and the Mond (nickel carbonyl) processes are used to refine nickel. Used in electroplating, casting operations for machine parts, manufacturing acid-resisting and magnetic alloys and tapes, synthesizing acrylic esters; in surgical and dental prostheses, coinage, catalytic gasification of coal, paint pigments, Ni-Cd batteries, ceramics and glass; and as a catalyst in hydrogenation of fats and oils.

Other Designations: CAS No. 7440-02-0, Raney alloy, Raney nickel.*

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(TM) for a suppliers list.

Cautions: Nickel is an eye, skin, and respiratory tract irritant. *Chronic inhalation of nickel dust or fumes may cause cancer of the lungs and nasal passages. Nickel powder (Raney nickel) is a dangerous fire hazard.*

	R	I	S	K
	0	3	2	1

NFPA

catalyst

HMIS	
H	2
F	4
R	0
PPG†	

Genium

metal

HMIS	
H	2
F	1
R	0
PPG†	

† Sec. 8

* Raney nickel is prepared by leaching (with 25% caustic soda solution) aluminum from an alloy of 50% aluminum and 50% nickel. It is used as a catalyst for hydrogenation. Raney nickel, a silvery gray metal powder, is a dangerous fire risk and ignites spontaneously in air (Sec. 4). Nickel catalysts cause many industrial accidents.

Section 2. Ingredients and Occupational Exposure Limits

Nickel, ca 100%

1989 OSHA PEL
8-hr TWA: 1 mg/m³

1989-90 ACGIH TLV
TLV-TWA: 1 mg/m³

1988 NIOSH REL
0.015 mg/m³

1985-86 Toxicity Data*
Dog, intravenous, LD_{Lo}: 10 mg/kg
Guinea pig, oral, LD_{Lo}: 5 mg/kg
Rat, implant, TD_{Lo}: 250 mg/kg

* See NIOSH, *RTECS* (QR5950000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 4945 °F (2730 °C)
Melting Point: 2651 °F (1455 °C)
Vapor Pressure: 1 mm at 3290 °F (1810 °C)
Atomic Weight: 58.71
Density: 8.90 at 25 °C
Water Solubility: Insoluble

Appearance and Odor: A silvery-white, hard, malleable and ductile metal.

Section 4. Fire and Explosion Data

Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported

Extinguishing Media: Smother with suitable dry powder or use large amounts of water.

Unusual Fire or Explosion Hazards: Nickel is combustible as dust or powder. Raney nickel ignites spontaneously in air. Nickel carbonyl (*MSDS Collection*, No. 226), a highly toxic substance, may form under fire conditions.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since nickel dust or powder is toxic if inhaled, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Nickel is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Nickel can react violently with fluorine, ammonium nitrate, hydrogen + dioxane, performic acid, selenium, sulfur, ammonia, hydrazine, phosphorus, and titanium + potassium chlorate. Nickel is also incompatible with oxidants. Raney nickel catalysts may initiate hazardous reactions with sulfur compounds, *p*-dioxane, hydrogen, hydrogen + oxygen, ethylene + aluminum chloride, magnesium silicate, methanol, and organic solvents + heat.

Conditions to Avoid: Avoid incompatibilities.

Hazardous Products of Decomposition: Thermal oxidative decomposition of nickel can produce highly toxic nickel carbonyl

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Section 6. Health Hazard Data

Carcinogenicity: The IARC and NTP classify nickel as, respectively, a human carcinogen (Group 1) and an anticipated human carcinogen.
Summary of Risks: Nickel dust or fume is a respiratory irritant that with chronic exposure may cause nasal or lung cancer in humans. The average latency period for the induction of these cancers appears to be about 25 yr (within a 4- to 51-yr range). Experimental studies show nickel also has neoplastigenic, tumorigenic, and teratogenic effects in laboratory animals. Hypersensitivity to nickel is common and can cause conjunctivitis, allergic contact dermatitis, and asthma. The allergic contact dermatitis ("nickel-itch," a pink papular erythema with pustulation and ulceration) usually clears within one week, but sensitization is permanent.
Medical Conditions Aggravated by Long-Term Exposure: Chronic pulmonary, upper respiratory tract, and skin disorders. Carcinoma of the paranasal sinuses, larynx, and lung may also develop.
Target Organs: Nasal cavities, lungs, skin.
Primary Entry Routes: Inhalation, dermal contact, and ingestion.
Acute Effects: Exposure to nickel fumes can cause upper respiratory tract irritation (with nonproductive cough, rapid breathing, dyspnea, chest tightness), metal fume fever (chills, fever, flu-like symptoms), asthma, inflammation of the lungs (noninfectious pneumonia), eye (conjunctiva) irritation, nausea, vomiting, and abdominal pain. Dermal contact causes "nickel itch." Ingesting large doses causes nausea, vomiting, and diarrhea.
Chronic Effects: Prolonged or repeated contact can cause nickel sensitization. Symptoms of sensitization include nickel dermatitis with eczematous skin and lichenification (hardened and leathery skin). Chronic inhalation exposure can cause chronic pulmonary irritation, chronic thickening of the mucous membranes of the nose, nasal sinusitis, anosmia (loss or impairment of the sense of smell), and perforation of the nasal septum. Chronic exposure to dust and fumes may cause carcinoma of paranasal sinuses, larynx, and lung.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Since oral toxicity for elemental nickel is low, inducing vomiting is seldom necessary. In cases of severe vomiting or diarrhea, treat for fluid replacement.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Chronic exposure to nickel dust may cause *eosinophilic pneumonitis* (Loeffler's syndrome) which responds well to systemic cortico-steroids. There are cases of host rejection of nickel-containing prostheses after development of nickel sensitivity.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personal should protect against vapor inhalation and dermal contact. Avoid dust generation. Using nonsparking tools, carefully scoop spilled material into appropriate containers for reclamation or disposal. After completing material pickup, wash spill site. Do not release to sewers or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, ACGIH TLV, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[107]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from incompatible materials (Sec. 2). Protect against physical damage. Store Raney nickel under inert gas or water in tightly closed containers away from heat or ignition sources, acids, caustics, and oxidizing materials.
Engineering Controls: Minimize all possible exposures to potential carcinogens. Avoid vapor inhalation and dermal contact. Use only with appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Provide preplacement and periodic medical examinations that emphasize the skin, nasal cavities, and lungs, including a 14" x 17" chest roentgenogram and urine nickel determinations.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Nickel catalyst, wetted with not less than 40% water or other suitable liquid, by weight, finely divided, activated, or spent
IMO Hazard Class: 4.2
ID No.: UN1378
IMO Label: Spontaneously combustible
IMDG Packaging Group: II

MSDS Collection References: 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 140, 142, 143
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Hardies, MD; Edited by: JR Stuart, MS

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Material Safety Data Sheet

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GENUM PUBLISHING CORP.

No. 45

ZINC OXIDE
(Revision A)
Issued: December 1978
Revised: February 1986

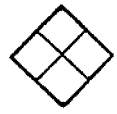
SECTION 1. MATERIAL IDENTIFICATION

19

MATERIAL NAME: ZINC OXIDE

DESCRIPTION: Fine metal oxide used as a pigment, filler, or reinforcing agent. An aerosol fume is formed when zinc metal is volatilized.

HMIS
H: 0
F: 0
R: 0
PPE: *



R 0
I 2
S 1
K -

* See Sect. 8

OTHER DESIGNATIONS: Flowers of Zinc, Zinc White, Chinese White, ZnO, CAS #1314-13-2

SUPPLIERS: Available from several suppliers, including:
Madison Industries, Inc., Old Waterworks Road, Old Bridge, NJ 08857; Telephone (201) 727-2225

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
ZINC OXIDE, ZnO Purity level may vary with grade. Typical impurities include lead and/or cadmium (normally <0.1%). Consult supplier's specification for impurity levels.	>99	See Note for TLV and PEL information
NOTE: Current (1985-86) ACGIH TLV and OSHA PEL: TLV / PEL DUST: 10 mg/m^3 (Total Dust) / None Established FUME: 5 mg/m^3 / 5 mg/m^3 NIOSH recommends (1975 criteria document) a 10-hr TWA of 5 mg/m^3 with a 15 mg/m^3 ceiling limit for dust and fumes.		Rat, Inhalation, LCLo: 400 mg/m^3

SECTION 3. PHYSICAL DATA

Melting Point ... ca 3587°F (1975°C) (Sublimes)
Specific Gravity ... 5.68
Solubility in Water @ 29°C ... 0.00016 gm/100cc
Vapor Pressure at 20°C ... Not Applicable
Molecular Weight ... 81.37

Appearance and odor: White or yellowish white powder. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not Applicable	Not Applicable	Not Applicable		

EXTINGUISHING MEDIA: Zinc oxide is noncombustible. Use extinguishing agents that are suitable for dousing the surrounding fire. If practical, wet down powder with water spray to reduce dusting and fume formation.

Fire fighters should wear self-contained breathing apparatus and fully protective gear for protection against dust and/or fumes that may be generated in a fire situation.

SECTION 5. REACTIVITY DATA

Zinc oxide is stable under normal conditions of handling and use. It does not polymerize. It is practically insoluble in water but is soluble in acids and alkalies and absorbs carbon dioxide from moist air.
When heated to elevated temperatures, zinc oxide sublimes to produce toxic fumes. (Also note that zinc metal burns at elevated temperatures in air to produce zinc oxide fume).
Zinc oxide and magnesium react explosively when heated. Mixtures of chlorinated rubber and zinc oxide can explode violently when heated to 419°F (215°C).

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SECTION 6. HEALTH HAZARD INFORMATION | TLV

Zinc oxide dust is considered to be of low toxicity and is classified by the ACGIH as a nuisance particulate. However, inhalation of zinc oxide fume causes a condition known as "zinc fume fever" (ZFF). ZFF is characterized by flulike symptoms with "metallic taste," coughing, weakness, fatigue, muscular pain, and nausea, followed by fever and chills. Onset of symptoms occurs about 4 to 12 hours after exposure. A tolerance to zinc oxide fume may be acquired but is lost within a day or two after exposure ceases. Zinc oxide fume has also been reported to cause gastrointestinal disturbances. Although zinc oxide is not known to be a skin irritant, under poor personal hygienic conditions contact with zinc oxide has been reported to cause dermatitis ("oxide pox").
Zinc oxide has not been identified as a known or suspected carcinogen by the IARC, NTP, or OSHA.
FIRST AID: EYE CONTACT: Flush well with running water to remove particles. Get medical attention if irritation persists.* SKIN CONTACT: Wash contaminated area thoroughly with mild soap and water. Seek medical attention if irritation persists.* INHALATION: Remove victim from exposure. Provide bed rest and aspirin. Contact physician. (Recovery is generally complete in 24 to 48 hours.) INGESTION: Give victim a large quantity of water to drink. Contact physician or poison control center for instructions.

*GET MEDICAL ATTENTION = In plant, paramedic, community.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Collect spilled material in a way that will minimize excessive generation of dust such as vacuuming (with absolute filter) or wet sweeping. If dusting occurs, cleanup personnel should wear appropriate respiratory protective equipment.

DISPOSAL: Reclaim material when possible. Unsalvageable waste may be buried in an approved sanitary landfill. Follow Federal, state, and local regulations.

Zinc oxide is not listed as a hazardous waste in 40 CFR 261.33. It has not been assigned a reportable spill quantity in 40 CFR 117.3.

SECTION 8. SPECIAL PROTECTION INFORMATION

Use general and/or local exhaust ventilation to maintain dust and fume levels below the TLV and PEL. Where concentrations exceed these limits, workers should wear NIOSH-approved respirators with protection factors suitable for the exposure concentration. High-efficiency particulate (dust/fume) filter respirators are suitable for ZnO fume exposures up to 50 mg/m^3 (250 mg/m^3 with full facepiece). Respirator usage must be in accordance with OSHA requirements (29 CFR 1910.134). Wear dustproof safety goggles where the possibility of eye contact exists. Gloves should be worn if prolonged or repeated contact is likely. Wear protective clothing (apron, coveralls, etc.) as required by the work situation to prevent gross contamination of skin and clothing.
Eyewash stations and washing facilities should be readily accessible to workers handling this material. Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a dry location. Protect containers from physical damage. Use with adequate ventilation. Maintain good housekeeping procedures to prevent accumulation of dust (avoid generating dust during cleaning).
Follow good personal hygiene practice. Wash thoroughly after handling. Launder contaminated clothing before reuse.
Individuals with preexisting pulmonary disease may be more susceptible to the effects of zinc oxide fume.
Avoid dust and fume inhalation.
Welding galvanized metal will generate zinc oxide fumes.

DOT Classification: Not listed in DOT Hazardous Material Tables (49 CFR 172.101 and 172.102).

Data Source(s) Code: 2, 4, 5, 12, 14, 19, 20, 25, 27, 49, 55, 61, 62, 82, CV

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Approvals JPO Received 6/86
Indust. Hygiene/Safety DJW 6/86
Medical Review

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Material Safety Data Sheets Collection:

Sheet No. 720
Petroleum (Crude)

Issued: 8/90

Section 1: Material Identification

Petroleum (Crude) Description: A highly complex mixture of paraffinic, cycloparaffinic (naphthenic), and aromatic hydrocarbons with molecular weights ranging from the very lightest to over 6000; also containing small amounts of benzene hydrocarbons, sulfur, and oxygenated compounds. Used as a source of gasoline, petroleum ether, fuel and lubricating oils, liquid and solid petrolatum, butane, isopropyl alcohol, and many other products.

Other Designations: CAS No. 8002-05-9, base oil, coal liquid, coal oil, crude oil, petroleum crude, petroleum oil, rock oil, and seneca oil.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(TM) for a suppliers list.

Cautions: Petroleum (crude) is toxic by ingestion and is irritating by skin contact. *It is a dangerous fire hazard when exposed to heat, flame, or powerful oxidizers. Its fumes are flammable, asphyxiating, and potentially toxic.*

R	1
I	-
S	2
K	4

NFPA: 3 / 1 / 0 / -

HMIS	
H	1
F	3
R	0
PPG*	

* See 8

Section 2: Ingredients and Occupational Exposure Limits

Petroleum (crude), ca 100%

1989 OSHA PEL	1989-90 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data*
None established	None established	None established	Mouse, skin, TD_{Lo}: 3744 mg/kg administered intermittently over a 2-yr period in a number of separate, discrete doses produces tumorigenic effects; skin and appendages (tumors)

Comment: Crude petroleum is a complex mixture of volatile hydrocarbons and gases. So-called "sour crude" contains toxic and dangerous hydrogen sulfide gas (*MSDS Collection*, No. 52).

* See NIOSH, *RTECS* (SE7175000), for additional mutative and tumorigenic data.

Section 3: Physical Data

Melting Point: -51 °F (-46 °C)
Density: 0.780 to 0.970
Water Solubility: Insoluble

Appearance and Odor: A viscous, dark yellow to brown or greenish-black, oily liquid with an unpleasant odor. Petroleum's (crude light's) upper and lower odor thresholds are 0.5 and 0.1 ppm, respectively.

Section 4: Fire and Explosion Data

Flash Point: 20 to 90 °F (-6.7 to 32.2 °C)	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: To fight fire, use dry chemical, foam, or carbon dioxide.
Unusual Fire or Explosion Hazards: Liquid petroleum contains and gives off considerable amounts of dissolved, possibly explosive gases that are a dangerous fire hazard when exposed to heat, flame, or powerful oxidizers.
Special Fire-fighting Procedures: Isolate hazard entry and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and fully encapsulating suit. If feasible, move containers from fire area. Otherwise, use a water spray to cool fire-exposed containers. Never apply water directly to a petroleum fire. Water fog or mist will act as a blanket to reduce vapors and cut off the air supply. Stay out of low areas. Vapors may travel to an ignition source and flash back. Be aware of runoff from fire control methods. Do not release to sewers or waterways where it could cause a fire/explosion hazard or pollution.

Section 5: Reactivity Data

Stability/Polymerization: Petroleum is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Petroleum (crude light) may act as a synergist (a substance that induces a greater effect when added to another substance) to pesticides. Incompatible with oxidizing agents.
Conditions to Avoid: Avoid exposure to heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of petroleum can emit acrid smoke and fumes.

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No. 720 Petroleum (Crude) 8/90

Section 6: Health Hazard Data

Carcinogenicity: The IARC does not classify petroleum (crude) as a human carcinogen (Group 3) since human and animal evidence are inadequate.
Summary of Risks: Petroleum is toxic by ingestion and is a skin irritant. Aspiration pneumonitis (pulmonary toxicity due to aspiration into the lungs) is the most serious toxic effect following ingestion. Cardiovascular and neurologic toxicity are the major concerns following inhalation.
Medical Conditions Aggravated by Long-Term Exposure: Chronic skin disease.
Target Organs: Skin, eyes, respiratory system, central nervous system.
Primary Entry Routes: Inhalation, accidental ingestion, skin contact.
Acute Effects: Ingestion causes nausea, vomiting, diarrhea, and abdominal pain. Liver and renal injury may occur following ingestion. Symptoms of aspiration include coughing, choking, shortness of breath, increased respiration, and pulmonary edema. Inhalation of petroleum or its dissolved gases may result in respiratory arrest, euphoria, cardiac dysrhythmia, and central nervous system toxicity.
Chronic Effects: Prolonged and repeated contact with petroleum can cause skin disorders such as dermatitis.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, do not induce vomiting since this increases the aspiration risk. Keep victim's head between knees. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Unless a large amount of petroleum is ingested, gastric emptying is not suggested. Consider administering activated charcoal, but administer it with caution because it may also cause vomiting and increase the risk of aspiration.

Section 7: Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. For small spills, take up with sand or other noncombustible absorbent material and place into appropriate containers for disposal. For large spills, dike far ahead of spill. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8: Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[105]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9: Special Precautions and Comments

Storage Requirements: Store in tightly closed drums or tanks in a cool, dry, well-ventilated area away from heat and ignition sources (naked lights, sparks, welding equipment). Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. In addition, conductive tires can further protect vehicles.
Engineering Controls: Use only with adequate ventilation. Workers should be educated about petroleum's hazards and potential dangers. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. To prevent dermatitis use appropriate protective gear and practice good personal hygiene procedures. Monitor storage facilities for gas buildup.
Other Precautions: Provide annual examinations with emphasis on the skin and respiratory system.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Petroleum crude oil
IMO Hazard Class: 3.1, 3.2, 3.3
UN No.: UN1267
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection **References:** 73, 84, 85, 101, 103, 124, 126, 127, 132, 133, 136, 139, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS 3

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APPENDIX C

APPENDIX C

COMPLIANCE MONITORING PLAN

COMPLIANCE MONITORING PLAN
CASCADE TIMBER LOG YARD NO. 3
PORT OF TACOMA
TACOMA, WASHINGTON

Prepared for

Port of Tacoma
Post Office Box 1837
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HLA Project No. 12183.4

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March 23, 1994

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A Sampling Quality Assurance Project Plan

DISTRIBUTION

1.0 INTRODUCTION

Harding Lawson Associates (HLA) was retained by the Port of Tacoma (Port) to prepare plans and specifications for the remediation of the Cascade Timber Log Yard No. 3, which is located on Maxwell Way, between Port of Tacoma Road and Thorne Road in Tacoma, Washington (Figure 1). This Compliance Monitoring Plan describes the monitoring to be performed during and subsequent to the construction of the selected remedy to assure these actions are protective of human health and the environment during construction, and to assure that the remedial action has attained cleanup standards after construction. This document was prepared for the sole use of the Port of Tacoma and the Department of Ecology, the only intended beneficiaries of HLA's work. No other party should rely on the information contained herein without prior written consent of HLA. This plan is written in conformance with the requirements of the Model Toxics Control Act (MTCA), WAC 173-340-410 (Washington State Department of Ecology, 1991).

1.1 Background

The Cascade Timber Log Yard No. 3 is an 18.57-acre, industrially zoned property owned by the Port of Tacoma (Port). The property is divided into two parcels: a 7.84-acre parcel to the northeast and a 10.73-acre parcel to the southwest. The southwest parcel (the site) was operated as a log sort yard by the Cascade Timber Company from 1978 through 1984. In 1982, approximately 500-tons of slag, generated by ASARCO Inc. of Tacoma, Washington was placed on the site for use as ballast material.

In 1983, the Commencement Bay area was identified as a federal Superfund site. In February, 1985, the Washington State Department of Ecology (Ecology) issued a report containing stormwater runoff data for numerous log sort yards, including the site. The report concluded that metals in excess of state and federal water quality standards were leaving log sort yards via stormwater runoff. In the 1989 Record of Decision for the Commencement Bay Nearshore/Tideflats Superfund Site, the Cascade Log Yard site is identified as a source of metals (arsenic, copper, zinc, and lead) discharging to Sitcum Waterway. In 1991, Ecology and the Port entered into an Agreed Order to complete a remedial investigation/feasibility study (RI/FS) to investigate the extent of metals on the site and to evaluate possible remedies for the site.

1.2 Summary of the Remedial Investigation

The purpose of the RI was to evaluate the extent of ASARCO slag and associated metals at the site by investigating the surface and subsurface soils, groundwater, and surface water. Results of the RI indicate the northeast parcel of the log yard is not a concern with respect to the presence of metals. Soil in the southeast parcel of the log yard was found to contain metals, with the maximum detected concentrations of arsenic at 2,650 milligrams per kilogram (mg/kg), copper at 2,760 mg/kg, lead at 1,180 mg/kg and zinc at 3,870 mg/kg found in surface soil. Subsurface soil at the 3-foot depth had concentrations of the metals of concern (arsenic, copper, lead and zinc) 1 to 2 orders of magnitude less than those detected at the surface.

There are two hydraulically separated water bearing zones beneath the site. The first zone is unconfined and located in a silty, sandy fill layer. Beneath the first water bearing zone is a laterally extensive clay layer, underlain by sand deposits, that comprise the second water bearing zone. Groundwater at the site is not a current or potential source of drinking water since both water bearing zones are expected to produce small quantities of poor quality water. Results of sampling groundwater from both zones indicates that groundwater is not currently a pathway for the migration of the metals of concern.

Surface water occurs on site in the form of stormwater runoff. Analytical results of stormwater sampling, conducted during several different sampling events, indicate that runoff is the primary pathway by which

metals are transported from the log yard via storm drains to the Sitcum Waterway. The maximum detected concentrations of arsenic at 435 micrograms per liter (ug/l), copper at 567 ug/l, lead at 231 ug/l and zinc at 21,300 ug/l exceed the federal Marine Water Quality Standards for both acute and chronic conditions.

1.3 Summary of Feasibility Study

Several different alternatives were identified and considered for the cleanup action plan. The remedy selected for implementation, based upon such criteria as effectiveness, ability to implement, regulatory guidelines, and cost, is the construction of an asphalt cap. The feasibility study recommended that after grading the site, the entire southwest parcel will be covered with an 8- to 12-inch layer of crushed aggregate base and topped with a 4- to 8-inch layer of asphaltic pavement. Groundwater will be monitored and a restrictive covenant will be placed on the property.

1.4 Scope of Work

Following completion of the RI/FS, Ecology and the Port entered into a Consent Decree, which specifies remedial actions to be performed on the site. Under Exhibit D of the Consent Decree, the Compliance Monitoring Plan (plan) is required to include a Protection Monitoring Plan, a Performance Monitoring Plan, and a Confirmation Monitoring Plan. The scope of work for the plan requires the following:

- Protection Monitoring Plan - description of how human health and the environment will be protected during construction of the asphalt cap; this is covered in Section 2.
- Performance Monitoring Plan - description of how cleanup limits will be achieved at any site areas outside the asphalt cap from where wood waste, soils, slag and ditch sediments will be excavated and transferred to the area to be capped; this is covered in Section 3.
- Confirmation Monitoring Plan - monitoring well locations, monitoring well construction plans, surface water monitoring locations, sampling and analysis methodology, and sampling frequency; this is covered in Section 4.

The objective of the compliance monitoring plan is to describe monitoring to be performed during construction and operation, and to evaluate the long-term effectiveness of the asphalt cap. The operation and maintenance plan for the remedial design should be followed to ensure the integrity of the constructed facility.

2.0 PROTECTION MONITORING PLAN

The purpose of the Protection Monitoring Plan is to provide a methodology for protection of both human health and the environment during implementation of remedial activities. Areas of concern identified in the RI/FS are: 1) potential human health risks from ingestion and inhalation of metals-contaminated soil and wood waste; 2) potential degradation of water quality in the Sitcum Waterway, attributable to surface water runoff containing elevated concentrations of metals; and 3) potential impacts on marine sediments.

2.1 Conceptual Plan of Action

The remedial activities associated with the construction of a low-permeability asphalt cap include: 1) mixing organics (bark) with soil during preparation of the subbase in order to provide a homogeneous mixture; 2) moving ASARCO slag and surficial bark from the clean utility corridors to other areas of the site; 3) installing new stormwater drainage features; 4) placing aggregate base on the subgrade; 5) constructing the asphalt concrete cap; and 6) constructing three groundwater monitoring wells along the boundaries of the cap. Design of the cap is expected to be complete by May, 1994 and construction is expected to begin in June, 1994.

2.2 Potential Human Health Risks

A site specific safety and health plan (SHP) will be prepared to address specific protection monitoring procedures to be followed during construction. All site workers will be required to complete a 24-hour, hazardous materials operations training course, in compliance with Occupational Health Standards (WAC 296-62-3040). Appropriate protective equipment, such as respirators equipped with particle filters, will be worn as necessary to avoid the possible inhalation and ingestion of contaminated materials. If conditions warrant, control measures such as watering may be employed to reduce dust generation.

2.3 Potential Degradation of Surface Water Quality

An erosion and sedimentation control plan will be prepared to address procedures to limit the amount of surface water and sediment leaving the site. These precautionary measures will restrict hazardous materials from entering the adjacent waterways.

During moving of contaminated soils and construction of the cap, storm water will be collected (as described in the erosion and sedimentation control plan) and allowed to either evaporate or infiltrate the soil on the site. All vehicles leaving the site will pass through a truck wash station, consisting of a gravel pad and a steam cleaner, to remove any contaminated soil. Wash water will be collected and allowed to either evaporate or infiltrate into the ground. The sediment collected at the truck-wash will remain and be covered by the cap. The truck wash station will be dismantled and removed concurrent with the completion of the cap.

2.4 Potential Impacts on Marine Sediments

Remedial actions specifically concerning the Sitcum Waterway sediments is currently being addressed in other activities pursuant to the Commencement Bay Nearshore/Tideflats Record of Decision. During moving of contaminated materials and construction of the cap, implementation of the erosion and sedimentation control plan will reduce or eliminate the potential migration of sediments containing elevated metals from the site.

3.0 PERFORMANCE MONITORING PLAN

Exhibit D to the Consent Decree requires that the Performance Monitoring Plan consist of a description of how cleanup limits will be achieved at areas outside the asphalt cap from where contaminated wood waste, soils, slag and ditch sediments will be excavated and transferred to the area to be capped. The design of the cap includes excavating, grading and mixing surface materials to prepare the subbase. The cap will cover the entire southwestern parcel of the log sort yard up to the property lines. No excavation and transferring of any materials from the northeast parcel of the log sort yard will be done except for the area indicated on Figure C1. Within the property lines, clean utility corridors will be constructed by excavating material a foot below the depths of slag determined from the RI/FS and as indicated on Figure C1. The material removed will be relocated to other areas of the site. Slag material identified with the supplemental survey outside of the property lines will be removed and relocated within the cap areas. Clean fill will be used to restore areas where material has been removed outside the property lines to their original grade where necessary.

After slag and surface materials have been excavated and removed, a grid with approximately 100-foot intervals will be used to designate sample collection points. Samples will be analyzed for arsenic and lead. Excavation of surface materials will continue until analytical results confirm that exposed soil meets the MTCA Method A cleanup standards of 200 mg/kg of arsenic and 1000 mg/kg of lead. Soil sampling procedures shall be in accordance with Appendix A.

4.0 CONFIRMATION MONITORING PLAN

Exhibit D of the Consent Decree requires that the Confirmation Monitoring Plan include the monitoring well locations, monitoring well construction plans, surface water monitoring locations, sampling and analysis methodology, and sampling frequency. To confirm the long term effectiveness of the remedial action, the following groundwater and stormwater monitoring will be conducted.

4.1 Monitoring Well Locations

Sections 6.1 and 6.2 of Exhibit C of the Consent Decree specify the installation of 3 new monitoring wells, to be located on the perimeter of the cap system near the property boundary and constructed to sample the uppermost water bearing zone. Figure C2 presents the proposed locations of monitoring wells.

4.2 Monitoring Well Construction and Development

A geologist will observe drilling and well installation. All three monitoring wells will be constructed and developed as described in Appendix A, as shown in detail 5 of Sheet C10 and in accordance with WAC 173-160, Minimum Standards for Construction and Maintenance of Wells. Monitoring well details will be submitted to Ecology upon completion of the wells.

4.3 Groundwater Sampling

Groundwater sampling will be conducted on an annual basis and will be analyzed for arsenic, copper, lead and zinc. Groundwater monitoring will be discontinued after a period of three years, unless a violation of cleanup standards is determined. Cleanup standards for groundwater, specified in Exhibit C of the Consent Decree, are summarized in Table 4-1. Sampling methodology, frequency, and other field procedures are included in the Sampling Quality Assurance Project Plan, presented in Appendix A.

TABLE 4-1
GROUNDWATER CLEANUP STANDARDS

Contaminant	Cleanup Level in ug/l [a] [b]
Arsenic	36
Copper	2.9 (10) [c]
Lead	8.5 (10) [c]
Zinc	86

(a) = U.S. EPA Water Quality Criteria - Marine Chronic Criteria

(b) = Natural background values may be substituted as cleanup objectives by Ecology if the requirements of WAC 173-340-708 (11) are satisfied.

(c) = Numbers in parentheses are the practical quantification limit (PQL). Ecology recognizes that the analytical method PQL may be higher than the cleanup standard for a given parameter. In these cases, the cleanup standard may be considered to be obtained if the parameter is undetected at the PQL and the conditions outline in WAC 173-340-707 are met.

4.4 Surface Water Sampling

Following completion of the construction of the cap, stormwater runoff will be sampled and analyzed for the metals of concern (arsenic, copper, lead and zinc). The cap design includes stormwater catch basins, that route runoff into a detention vault and oil/water separator before discharging into City of Tacoma storm drains that empty into the Sitcum Waterway. Figure C4 also shows the drainage plan with the locations of the catch basins, detention vault and oil/water separator. Samples will be collected from a point downstream from the oil/water separator immediately after the cap is complete on a one-time basis. If cleanup standards are achieved, no further stormwater monitoring will be performed. The draft Cleanup Action Plan contained in the Consent Decree states that no surface water cleanup standards have been set for this site because the asphalt cap should eliminate contact between storm water and contaminated surface materials. However, the quality of the surface water discharge from the site shall not cause, in the Sitcum Waterway, a violation of the U.S. EPA Water Quality Criteria-Marine Chronic Criteria as listed in Table 4-1.

Sampling methodology, frequency, and other field procedures are included in the Sampling Quality Assurance Project Plan, presented in Appendix A.

DISTRIBUTION

Compliance Monitoring Plan
Cascade Timber Log Yard No. 3
Port of Tacoma
Tacoma, Washington

March 24, 1994

Copy No. ___

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_____

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APPENDIX A

SAMPLING QUALITY ASSURANCE PROJECT PLAN

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1.0 QUALITY ASSURANCE OBJECTIVES

The overall QA objectives are to develop and implement procedures for obtaining and evaluating data in an accurate, precise, and complete manner so that analytical data, sampling procedures, and field measurements provide information that is internally comparable and representative of actual field conditions. The definitions for accuracy, precision, completeness, comparability, and representativeness are as follows (quoted from EPA's *Draft Supplement to: Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80):

- Accuracy - the degree of agreement of a measurement with an accepted reference or true value.
- Precision - a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Usually expressed in terms of the standard deviation.
- Completeness - the amount of valid data obtained from a measurement system compared to the amount that was expected and needed to be obtained to meet the project data goals.
- Comparability - expresses the confidence with which one data set can be compared to another.
- Representativeness - refers to a sample or group of samples that reflects the characteristics of the media at the sampling point. It also includes how well the sampling point represents the actual parameter variations which are under study.

Comparable data are obtained by the consistent use of standard analytical methods and by reporting all values in consistent units. Analytical data will be reported in consistent units of parts per million (ppm or mg/l), parts per billion (ppb or µg/l), or the units given in an approved reference methodology. Results of standard and nonstandard analyses will not be compared.

Representative data are obtained by following proper and consistent procedures for sample collection and other types of data collection as well as application of approved standard analytical methods.

2.0 DRILLING AND WELL INSTALLATION PROCEDURES

The following procedures will be implemented during drilling and well installation. These procedures are designed such that: 1) borings are properly logged; 2) wells are installed properly; and 3) borings and wells are properly sealed.

2.1 Drilling Methods

The hollow-stem auger method will be used for well installation in the upper-most aquifer.

2.2 Lithologic Logging

Soils encountered during drilling are classified by the field geologist, or hydrogeologist using the Unified Soil Classification System. For lithologic logging, cutting samples are collected at each observed change in lithology or at least every 2.5 feet. Observations, which include the following information, as appropriate, are recorded on a standard boring log form:

- Boring or well designation
- Boring or well location
- Drilling and sampling methods
- Names of field geologist and driller
- Dates and times started and completed
- Depth where ground water was first encountered
- Sample depth
- Blow counts, if appropriate
- Color of soils
- Grain size of soils
- Relative percentage of grain sizes
- Descriptive comments
- Estimated relative moisture content
- Variations in drilling rates and rig behavior
- Soil description: color, soil classification, estimated relative density or consistency, and estimated moisture content.
- Signature or initials of observer.

2.3 Well Installation

The purpose of installing groundwater wells is to monitor groundwater quality. Standard protocols given below are followed during well design and construction, geologic logging, water-level measurements, and sampling. The QA/QC program is implemented by monitoring the documentation of field observations and the implementation of the protocols described below.

Well specifications are reviewed prior to drilling and installing monitoring wells. Necessary permits and access agreements are obtained prior to well installation and appropriate local agencies are notified as required by local regulations.

A geologist or hydrogeologist observes drilling, prepares lithologic logs of borings, and supervises well installation under the supervision of a registered geologist or certified engineering geologist.

Shallow monitoring wells will be installed as described below. All drilling, sampling, and well installation equipment and material will be decontaminated as described in Section 6.0.

2.4 Shallow Monitoring Wells

Three single cased wells will be drilled using hollow-stem auger having a minimum 6-1/4-inch nominal inside diameter (I.D.). The wells will extend approximately 10 feet below surface, with soil samples collected at 2.5-foot intervals. A geologist or hydrogeologist will supervise the drilling and well installation and prepare lithologic logs of the borings using the Unified Soil Classification System. The monitoring well casing and factory slotted screen will be 2-inch diameter, Schedule 40, flush-threaded polyvinyl chloride (PVC). A slot size of 0.020 inch is anticipated, with a screen length of approximately 5-feet.

A filter pack of water-washed sand (sized to be compatible with aquifer materials and screen slot size) will be placed adjacent to the entire screened interval. No sand pack is emplaced that creates interconnection of two or more aquifer zones. The sand pack is placed by carefully pouring sand down the annulus between the hollow-stem auger and well casing. The hollow-stem augers are raised periodically and an auger flight removed to allow the sand to fill the annulus between the casing and the borehole wall. Sand levels within the borehole are confirmed by sounding with a weighted tape.

The average depth of groundwater for the site ranged from 3.75 to 5 feet below existing ground surface during the study period. This very shallow groundwater table will allow only a one foot, sand, filter-pack extending above the screen, followed by a two-foot bentonite seal. The two foot thick bentonite pellet seal is placed above the sand pack by gravity free-fall from the surface. The pellets expand under water to form a tight annular seal above the sand pack. If the bentonite pellet seal is placed above the static water level, crushed bentonite is used and potable water is poured onto it to saturate the seal, promoting swelling and the formation of a competent seal. The bentonite seal is placed in the same manner as the sand pack; material is poured down the annular space around the well casing. Levels are sounded with a weighted tape and any bridges will be broken with a weighted tape, tremie pipe, or similar device. The bentonite will be allowed to hydrate for 30 to 60 minutes (depending on manufacturer's specifications) to allow for expansion prior to addition of grout.

The annulus above the bentonite seal is grouted using a cement sand or cement/bentonite grout mixed with tap water that is generally pumped through a tremie pipe placed near the bottom of the open annulus (directly above the bentonite seal) to the surface, thereby effectively sealing the well from the bottom upward. If the grout seal is above the static water level, the materials will be thoroughly mixed at the surface and carefully poured into the annulus above the bentonite pellet seal to the top of the annular space (ground surface).

Monitoring wells will be completed below grade using a steel well housing with a locking cover set in the annular cement seal. These wells will be surrounded by a reinforced concrete utility box with a steel or concrete traffic cover installed over the wellhead, as appropriate. The utility boxes will be set in concrete about 1/4-inch above grade. The concrete will be sloped to promote surface water drainage away from the

wells. After the grout has set for at least 12 hours, each well is developed as described in Section 2.5. The identification number of each well is permanently marked on the well casing and on the locking well cover.

The top of each well casing will be surveyed at the groundwater level measuring point under the supervision of a registered land surveyor to obtain elevations relative to the MLLW datum to an accuracy of +0.01 feet. This information is necessary for measuring the elevation of the potentiometric surface level of the groundwater. The groundwater level measuring point will be permanently marked on the well casing.

2.5 Well Development

After the grout has set for at least 12 hours, each well is developed by surging, bailing, and/or pumping. Depending on the type of well, one or more of these methods may be used. A common procedure is to use a vented surge block in conjunction with pumping or bailing. Each well is developed until the discharged water is as visibly clear and as free of sediment as possible. The adequacy of well development will be determined by the site geologist or hydrogeologist.

3.0 SOIL SAMPLING PROCEDURES

The sampling protocol presented in the following section is designed to promote the implementation of consistent sampling methods that will yield information that is comparable to and representative of actual field conditions. The Quality Assurance objectives for the sampling program are described in Section 1.0.

Subsurface soil samples will be collected for lithologic description, chemical analysis, or physical analysis. Samples may be collected during the relocation of slag and during the installation of monitoring wells. In general, the following are sampling methods that will be used:

- For lithologic logging, regardless of the sampling method, soil samples are examined at observed changes in lithology or at least every 2.5 feet. When using the hollow-stem auger drilling method, soil samples are collected by driving a split barrel sampler or by pushing a split barrel sampler ahead of the drilling bit as the borehole is drilled (continuous coring). Soil samples are examined and classified according to the Unified Soil Classification System, in addition to descriptions of soil structure, stratification, alteration, cementation, etc.
- Soil grab samples will be collected and submitted for chemical analysis. Grab samples are collected by pushing a sample tube directly into the soil (for example, soil in a backhoe bucket) or by obtaining a sample using a clean hand trowel or shovel. These grab samples are firmly packed in stainless steel tubes or glass jars and sealed with foil-lined, taped caps or with Teflon-lined caps.
- Split-barrel samplers are either hydraulically or mechanically driven with a hand-held or rig-mounted hammer, or are hydraulically pushed ahead of the drilling bit as the borehole is drilled. Thin-walled samplers are hydraulically driven.

Sample handling, packaging, and transport are conducted as required based on the type of chemical analysis to be performed (Table A-1). Sample custody procedures are described in Section 7.0.

4.0 WATER SAMPLING PROCEDURES

This section presents the procedures used for sampling both ground water and surface water.

4.1 Groundwater Sampling

Groundwater samples will be collected as follows:

- All measuring and sampling equipment will be decontaminated prior to sample collection from each well.
- The water level will be measured and the purge volume calculated.
- Prior to sampling, a submersible pump, centrifugal pump, stainless steel or PVC bailer will be used for purging a minimum of three casing volumes from each well.
- Indicator parameters (temperature, conductivity, turbidity and pH) will be monitored during purging to verify complete purging of static water in the well.
- If a well is purged dry before three casing volumes have been removed, the sample will be taken after the well has recovered to within 80 percent of the water level above the bottom of the well prior to purging or after 24 hours, whichever comes first.
- Water samples will be collected with a stainless steel bailer or from a submersible bladder pump or equivalent.
- Sample containers will be filled directly from the bailer or pump discharge line. Sample containers, volumes, and preservation methods are specified in Table A-1.

The following information will be entered on the Groundwater Sampling Form and/or in a field notebook at the time of sampling:

- Sampler's name or initials
- Sample station and location
- Sample number
- Volume of each sample container
- Type of analysis
- Preservatives
- Purged volume and time of purging
- Unusual conditions (i.e., color, odor, solids, OVA readings, etc.)
- Groundwater level and total well depth measured prior to sampling
- Field conditions (i.e., weather, air temperature)
- Sampling technique
- Equipment used
- Indicator parameter measurements (pH, temperature, turbidity, conductivity).

Each sample will be packaged and transported appropriately as described in the following protocol:

- Collect samples in appropriate containers.
- With one exception, add correct preservatives as necessary immediately following sample collection. Groundwater samples collected for dissolved metals analysis will first be filtered in the field using 0.45 micron membrane filter then the preservative will immediately be added prior to preservation. Samples to be collected for total metals will not be filtered prior to preservation.

- Print clearly in waterproof ink on the sample label the preservative that has been added to each aliquot, the sample number, the HLA job number, the initials of the sample collector, and the date and time the sample was collected.
- Seal and package sample containers as appropriate.
- Fill out field sample log and chain of custody record.
- Separate and place samples into coolers according to laboratory destination. Each cooler must weigh less than 70 pounds including blue ice. Keep samples well protected from shipping damage.
- Place samples on ice, if necessary, using sealed, reusable ice packs only.
- Seal the top two copies of the chain of custody form inside a zip-lock bag. Use strapping tape to attach the packet to the inside of the cooler lid.
- Secure cooler with tamper-proof seal.
- Label coolers correctly; place "Fragile" and "This-end-up" labels on coolers, as appropriate.
- Coolers will be hand delivered to the analytical laboratories by designated couriers.

4.2 Storm Water Sampling

The goal of the surface water sampling portion of the confirmation monitoring plan is to verify that the impervious cap has restricted the metals of concern from leaching into the site stormwater runoff. To accomplish this, stormwater runoff samples will be collected from a point downstream of the oil/water separator. Sampling will occur shortly after cap completion, during a storm event that includes a rainfall of at least 0.6 inches in a 24-hour period. Sampling will consist of collecting grab samples in series as quickly as possible from the start of runoff to insure that the first flush is collected. Simultaneous with sample collection, the stormwater flow rate in the stormwater pipe will be recorded. Flow rates will be determined by measuring flow depth and velocity in the pipe at the sample location. Sampling will continue until the flow rate drops to a point where a sample cannot be collected. The first flush sample along with samples of the storm's mid- and end-points will be retained for analysis for arsenic, copper, lead and zinc. Packaging and handling of samples will be as described in Section 4.1.

5.0 WATER-LEVEL MEASUREMENT PROCEDURES

The methods presented below are intended to ensure that water-level measurements are consistent and reproducible when performed by various individuals.

5.1 Water-Level Monitoring

5.1.1 Ground Water

Water levels may be measured using a steel tape, or electric sounder. The following protocols will be employed while collecting water-level measurements for the investigation:

Steel Tape

- A graduated steel tape is the standard equipment used for water-level measurements and, when required, for a quality control check of other methods.
- The steel tape is periodically checked for kinks. Kinked tapes will not be used. If an approximate depth to water is known, the bottom 1 to 2 feet of the tape is chalked; otherwise, the bottom 5 feet is chalked before each measurement. The tape is slowly lowered into the well to avoid contact with a possibly wet casing.
- If oil products or films exist above the water phase, a separate measurement with water-finding paste, a clear acrylic bailer, and/or an oil-water interface probe is made to determine both depth to oil and depth to water.
- A steel tape is not used in wells with cascading water.
- Portions of the tape that are submerged below fluid levels in wells are cleaned according to the procedure described in Section 6.0.
- Tapes are maintained in a clean and functional condition.

Electrical Sounder

- A battery-powered sounder (Powers meter or equivalent) may be used for water-level measurements when a steel tape cannot be used because of cascading water in the well, because depth to water exceeds the length of the steel tape, or because the diameter of the access port is too small for a weighted steel tape. The sounder has firmly affixed or permanent marks on the sounder line at regular intervals of 5 feet or less.
- Calibration checks for electrical sounders are made periodically. The markings are checked for the proper spacing by physically comparing the spacings with a graduated steel tape. A water-level measurement made with the sounder is compared to the same measurement made with a steel tape. The difference between the two measurements must be less than 0.05 foot per 100 feet depth to water. These checks are made at the beginning of each sampling sequence and after any incident that may alter the accuracy of the instrument, such as cable stretching, entanglement, or sensor tip replacement.
- Portions of the cable that are submerged below fluid levels in wells are cleaned according to the procedure described in Section 6.0.
- Sounders are maintained in a clean and functional condition.

6.0 DECONTAMINATION PROCEDURES

6.1 Equipment Decontamination

All equipment that may come in contact with potentially contaminated soil, drilling fluid, or water is decontaminated prior to and after use. Decontamination consists of steam cleaning (high pressure, hot water washing) or phosphate-free detergent wash, and distilled, deionized (DI), or clean water rinse, as appropriate. All decontamination is conducted in such a manner that cleaning fluids can be disposed as described in Section 6.2.

Drilling, sampling, and monitoring well installation equipment is decontaminated as follows:

- Downhole equipment on drilling rigs such as augers, drill rods, and drill bits, as well as parts in contact with fluid, such as mud tanks and sand separators, are steam cleaned prior to use at the site. Visible soil and grease are removed at this time.
- Backhoe buckets are steam cleaned prior to use at the site and between trenches.
- Soil sampling equipment (e.g., split-barrel samplers, sampling tubes, etc.) is cleaned prior to each use and between sampling. The sampler may be steam cleaned or washed in a phosphate-free detergent solution and rinsed in tap water. Visible soil is removed at this time. Wash solutions and rinse water are replaced prior to each boring.
- Casing, screen, couplings, and caps used in monitoring well installation are steam cleaned prior to installation. Visible foreign matter is removed at this time.
- The exterior surfaces and accessible interior portions of submersible, centrifugal, and positive-displacement pumps are steam cleaned prior to each use or prior to each sampling round. Pump and hose interiors will be decontaminated by pumping several gallons of phosphate-free detergent solution followed by pumping deionized water.
- Bailers are steam cleaned or washed in phosphate-free detergent solution and rinsed twice in distilled or deionized water prior to each use. Rope or string (used with bailers or disposable sampling bottles) that has been in contact with the water in the well or boring is discarded, and replaced with new string after each sample is collected.
- Steel tapes, well sounders, transducers, and water quality probes are washed in a phosphate-free detergent solution, rinsed in distilled or deionized water and wiped clean after each use. Generally, only the wetted end of these devices requires cleaning.

6.2 Disposal Procedures

Depending on the location of the investigation, soils and fluids produced during the installation of monitoring wells and borings will be sampled and analyzed for selected chemicals. Based on these results, handling and disposal will be in accordance with applicable federal and state regulations. Until the analyses are complete, temporary storage of these materials will be in tanks or 55-gallon drums until an acceptable means of disposal has been determined. All tanks or 55-gallon drums will be clearly labeled and stored in a secure location until final disposal is arranged.

7.0 SAMPLE CUSTODY PROCEDURES

This section describes standard sample custody procedures. Sample custody procedures are followed through sample collection, transfer, analysis, and ultimate disposal to assure that 1) the integrity of samples is maintained during their collection, transportation, and storage prior to analysis, and 2) that sample material is properly disposed after analysis. Sample custody is divided into field procedures and laboratory procedures, as described below.

7.1 Field Custody Procedures

Sample quantities, types, and locations are determined before the actual field work commences. As few people as possible handle samples. The field sampler is responsible for the care and custody of the samples until they are properly transferred. Custody transfer is to be documented on the chain of custody form.

7.2 Field Documentation

Each sample is labeled and sealed properly immediately after collection. Sample identification documents are carefully prepared so that identification and chain of custody records can be maintained and sample disposition can be controlled. Forms are filled out with waterproof ink. The following identification documents are utilized during the investigation:

- Sample Labels
- Field Investigation Daily Reports
- Groundwater Sampling Forms
- Chain of Custody Forms

Sample Labels

Sample labels are necessary to prevent misidentification of samples. Preprinted sample labels are provided. Where necessary, the label is protected from water and solvents with clear label-protection tape. Each label contains the following information:

- Project name
- Job number
- Name of collector
- Date and time of collection
- Place of collection (job site)
- Sample number, station number, or boring number and depth

Field Investigation Daily Report

A field log is used to record daily activities as they relate to the progress of the investigation. The field logs are retained in the investigation files according to job number for that task. Entries in the field log can include the following information:

- Project name
- Job number
- Name of author, date, and time of entry
- Location of activity
- Names and affiliations of personnel on site
- Sample collection or measurement methods

- Number of samples collected
- Sample identification numbers
- Sample distribution (laboratory)
- Field observations and comments.

Chain of Custody Record

A chain of custody record is filled out for and accompanies every sample to the analytical laboratory to establish the documentation necessary to trace sample possession from the time of collection. A carbon copy of the chain of custody form is retained in the investigation files according to job number. The record contains the following information:

- Sample number or identification
- Names of samplers
- Signature of collector, sampler, or recorder
- Location of project
- Project manager's name
- Date of collection
- Place of collection (site location)
- Sample type
- Analyses requested
- Inclusive dates of possession
- Signature of person receiving sample
- Laboratory sample number where applicable
- Date/time of sample receipt.

Sample Transfer and Shipment

Samples are always accompanied by a chain of custody record. When transferring samples, the individuals relinquishing and receiving the samples sign and date the chain of custody record. Samples are packaged properly for shipment, including isolating samples thought to have high concentrations, and dispatched to the appropriate laboratory for analysis. Custody seals are not deemed necessary when the samples are in continuous possession of technical or laboratory personnel. Custody seals are used when samples are shipped via courier service. The chain of custody record accompanies each shipment. The method of shipment, courier name(s), and other pertinent information are entered on the chain of custody record.

Corrections to Documentation

Original data recorded in field notebooks, chain of custody records, and other forms are written in waterproof ink. None of these documents should be altered, destroyed, or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on a document compiled by one individual, that individual should make the correction simply by crossing a line through the error, entering the correct information, and initialing and dating the change. The erroneous information should not be obliterated. Any subsequent error(s) discovered on a document should be corrected by the person discovering the error. All corrections should be initialed and dated.

7.3 Laboratory Custody Procedures

A designated sample custodian accepts custody of the shipped samples and verifies that the information on the sample label matches that on the chain of custody form(s). Pertinent information as to sample condition, shipment, pickup, and courier are also checked on the chain of custody form(s). The custodian then enters the appropriate data into the laboratory sample tracking system. The laboratory custodian uses the sample number on the sample label or assigns a unique laboratory number to each sample. The custodian then transfers the sample(s) to the proper analyst(s) or stores the sample(s) in the appropriate secure area.

Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted. Data sheets and laboratory records are retained as part of the permanent documentation for at least three years.

7.4 Sample Storage

Samples and extracts are retained by the analytical laboratory for up to 30 days after the data are reported by the laboratory. Unless notified by one of the program managers, excess or unused samples should be disposed by the laboratory in a manner consistent with appropriate government regulations.

TABLE A-1

SAMPLE CONTAINERS, HANDLING, AND PRESERVATION PROTOCOLS FOR GROUNDWATER, SOIL SAMPLES, AND WIPE SAMPLES

Sample Matrix	Type of Analysis	Type and Size of Container	Number of Containers and Sample Volume (per sample)	Preservation	Maximum Holding Time*
Soil	Metals	6" stainless steel tube	1 completely filled tube	Cool to 4° C	30 days
Water	Metals	300 ml polyethylene or glass bottle	One 300 ml bottle	$HN0_3$, pH <2 Cool to 4° C	30 days

* Maximum holding time specified by "Methods for Chemical Analysis of Water and Wastes," Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, 1983, EPA-600/4-79-020.

DISTRIBUTION

Compliance Monitoring Plan
Cascade Timber Log Yard No. 3
Port of Tacoma
Tacoma, Washington

March 23, 1994

Copy No. ___

Copies 1 - 4:	Ms. Suzanne Dudizak, Environmental Program Manager Port of Tacoma Post Office Box 1837 Tacoma, Washington 98401
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Copy 6:	Harding Lawson Associates Seattle, Washington Chronological File

Quality Control Reviewer

_____

Gregory S. Laird, P.E.
Managing Associate Engineer

APPENDIX D

APPENDIX D

OPERATION AND MAINTENANCE PLAN

Draft Operation and Maintenance Plan
Cascade Timber Log Yard No. 3
Port of Tacoma
Tacoma, Washington

Prepared for

Port of Tacoma
Post Office Box 1837
Tacoma, Washington 98401

HLA Project No. 12183.4

Mary C. Dahl, P.E.
Senior Engineer

March 21, 1994

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APPENDIXES

A Compliance Monitoring Plan (bound as Appendix C of Design Engineering Report)
B Sample Forms for Data Collection

DISTRIBUTION

1.0 OVERVIEW

1.1 Introduction

This Operation and Maintenance Plan has been prepared for the Port of Tacoma to provide operation and maintenance requirements of the low permeability cap and drainage features which were constructed as part of the remedial cleanup action of the Cascade Timber Log Yard No. 3 (site). This plan was prepared in accordance with the requirements of Ecology's Consent Decree and the Model Toxics Control Act (MTCA) (WAC 173-340-400(4)(c)) and includes design criteria, and operating limits, operating procedures during normal and emergency operations, maintenance requirements and safety considerations. A Compliance Monitoring Plan is included as Appendix C. This plan was prepared for the sole use of the Port of Tacoma and the Department of Ecology, the only intended beneficiaries of the work. No other party should rely on the information contained herein without prior written consent of Harding Lawson Associates.

1.2 Project Description

The site is located on Maxwell Way between Port of Tacoma Road and Thorne Road in Tacoma, Washington. A low permeability cap was constructed over onsite material containing elevated metals associated with slag deposited by ASARCO. Incorporated into the final pavement is a storm drainage collection system consisting of catch basin manholes, spill containment vessels, and connection to the City of Tacoma's storm drainage system.

1.3 Responsible Individuals

The Port of Tacoma (Port) owns the site and will be responsible for operating and maintaining the site. The Port is also responsible for maintaining the integrity of the cap including placing institutional controls on future use as necessary. Contact persons with the Port are:

Mr. Curtis Ratcliffe, Chief Engineer
Ms. Suzanne Dudziak, Environmental Program Manager
Port of Tacoma
P.O. Box 1837
Tacoma, Washington 98401-1837
(206) 383-5841

1.4 Inventory

The following drainage facilities exist onsite:

Feature	Number	Size
Catch Basin Manholes	8	54-inch diameter
Manholes	1	72-inch diameter
Spill Containment Vessels		
• Detention Vaults	1	32-feet x 8-feet
• Oil/Water Separators	1	8-foot diameter
Storm Drain Pipe	1,075 LF	30-inch diameter
	1,270 LF	24-inch diameter
	300 LF	18-inch diameter

Figure C4 shows the layout of the drainage facilities.

2.0 DESIGN CRITERIA AND OPERATING LIMITS

2.1 Pavement and Cap

2.1.1 Design Criteria

The low permeability cap section consists of four inches of dense grade asphalt concrete with a geotextile fabric placed in the middle to improve the long term performance of the cap. To provide a suitable working surface for constructing the cap, four inches of aggregate base was placed on the subgrade before the low permeability cap was constructed. The low permeability cap will keep the surface water from infiltrating into the ground. The cap was sealed around all penetrations of the fabric, such as at manholes and catch basins.

Pavement design used the heaviest vehicle expected to be used on the site during the initial life of the property. Initial site use will be a warehouse, therefore a standard highway truck was used in the design, with an 18,000 -pound Equivalent Standard Axle Load (ESAL). Figure C6 shows the pavement section and cap penetration detail.

2.1.2 Operating Limits

The low permeability cap has been designed to withstand a standard highway truck with an 18,000-pound (ESAL). Equipment heavier than this should be restricted from the site until an upgrade of the cap is completed.

In the future, if the site is converted to a container storage yard, an additional 5-inches of asphalt concrete pavement must be added in order to withstand a front end loader with wheel load of 53,200 -pounds and a tire pressure of 90 psi.

2.2 Storm Drainage Facilities

2.2.1 Design Criteria

The site drainage components were designed to safely convey the 10-year, 24-hour storm event in accordance with the requirements of the City of Tacoma. Discharge of storm water from the site is into the City of Tacoma's storm water system and ultimately the Sitcum Waterway. Based on the isopluvial maps for design storms from NOAA Atlas 2 "Precipitation Frequency Atlas of the Western United States, Volume IX, Washington", the 10-year, 24-hour design storm has a maximum rainfall of 2.9 inches.

The site is graded with maximum surface slopes of one-half percent to catch basins located throughout the site. Drainage swales are roughly symmetrical across the site. From the catch basins, the storm water travels through storm drains into a detention vault and a oil/water separator before being discharged into the City's storm drain system. The onsite storm drains are sloped at or 1.0 percent to the connection. Figure C4 shows the drainage plan.

The spill containment vessel has been sized to pass the entire 6-month, 24-hour storm event, designated by Ecology's Storm Water Management Manual for the Puget Sound Basin (SWMM) as the water quality storm. This rainfall is defined as 1.3 inches. Flows higher than this storm will build up in the storm drain pipes and catch basin manholes before bypassing the spill containment vessel via the overflow pipe adjacent to the vessel. The storm water backup in the storm drains will remain below the catch basin manhole inlets for the 25-year, 24-hour storm. Figures C8 and C9 show the drainage details.

The catch basin manholes are 54-inch diameter in accordance with the Washington State Department of Transportation (WSDOT) "Standard Plans for Road, Bridge and Municipal Construction" (Standard Plans) No. B-23c. The metal frame and grate conform to WSDOT Standard Plan B-2a. The 72-inch diameter manholes conform to WSDOT Standard Plan B-23c, with the ring and cover confirming to Standard Plan B - 25.

2.2.2 Operating Limits

The storm drainage system has been designed to convey the 10-year, 24-hour storm event. The spill containment vessel has been designed to pass the water quality storm. For flows above the water quality storm, the flows will bypass the spill containment vessel. For storms larger than the 10-year, 24-hour storm event, the storm drain system may overflow. Flows should remain on site however, due to the grades of the site.

3.0 OPERATING PROCEDURES

3.1 Pavement and Cap

3.1.1 Normal Operation

The low permeability cap is 4 inches of asphalt concrete pavement, Class B in accordance with the Washington State Department of Transportation (WSDOT) Standard Specifications. The cap has a non-woven geotextile fabric placed in the center of it.

There are no special operating procedures for using equipment on the pavement and cap as long as the weight of the equipment does not exceed the design vehicle. See maintenance requirements later in this plan.

3.1.2 Emergency Operation

There are no special operating procedures for emergency operation, as long as the equipment used is within the design maximum.

3.1.3 Safety Features

The low permeability cap is a safety feature to minimize the surface water infiltration and to minimize direct contact with the contaminated soil. The penetrations through the cap (i.e., the manhole accesses, catch basin inlets, etc.) are sealed with additional geotextile and a tack coat of asphalt in order to minimize infiltration along the face of the drainage facilities.

3.2 Storm Drainage Facilities

3.2.1 Normal Operation

Under normal operation the storm drainage facilities do not need any special attention or procedures. See maintenance requirements later in this plan.

3.2.2 Emergency Operation During A Spill

During a spill, the shut-off valve downstream of the oil/water separator shall be shut immediately. The spilled material shall be cleaned up as soon as possible including pumping out the entire contents of the spill containment vessel. The spilled material and contaminated water shall be disposed of as required depending on the nature of the spilled material. The interior of the storm drains, manholes, catch basin manholes, and spill containment vessel shall be cleaned completely before opening downstream valve. Cleaning water shall be properly disposed, not released into the City's storm sewer system.

3.2.3 Safety Features

The spill containment vessel can be isolated for containing spilled materials. However, during a storm, the entire spill containment vessel may not be available for storage because it will have varying amounts of water in it.

To minimize dumping of material in the storm drains paint warning signs adjacent to all catch basin manhole inlets reading "DUMP NO WASTE - DRAINS TO BAY". Repaint warning as necessary.

4.0 MAINTENANCE REQUIREMENTS AND SCHEDULE

4.1 Pavement and Cap

The asphalt concrete pavement will require annual inspection and all cracks sealed as soon as possible. Cracks deeper than three inches should be noted in the maintenance records.

In addition, every seven years at most the pavement will require additional crack sealing and pavement patching, both shallow and deep. A leveling course will be required after approximately 14 years of operation, if not sooner. All crack sealing deeper than three inches and all pavement patching shall be recorded on the forms provided in Appendix B.

4.2 Storm Drainage Facilities

4.2.1 Structural

Catch basin manholes, manholes, and spill containment vessel, consisting of detention vault and oil/water separator, shall be inspected annually for structural integrity. Structural inspections and results shall be recorded on the forms provided in Appendix B.

All structural repairs shall be done as soon as possible and recorded.

4.2.2 Catch Basin Manholes

Catch basin manholes shall be inspected regularly for sediment deposits. Initial inspections shall occur every six months. Catch basin manholes shall be cleaned out if sediments are greater than six inches deep. If catch basin manholes are cleaned of more than six inches of debris every six months, the inspection interval shall be increased to three months. If catch basin manholes are not accumulating sediments which require cleaning every six months, inspection interval may extend to twelve months. If debris accumulating in catch basin manholes is woody material they shall be cleaned monthly. Remove debris from surface grates as needed. Record inspections and debris removal.

4.2.3 Manhole

Manholes shall be inspected regularly for sediment deposits. Initial inspections shall occur every six months. Manholes shall be cleaned out if sediments are greater than six inches deep. If manholes are cleaned of more than six inches of debris every six months, the inspection interval shall be increased to three months. If manholes are not accumulating sediments which require cleaning every six months, inspection interval may extend to twelve months. If debris accumulating in manholes is woody material they shall be cleaned monthly. Record inspections and debris removal.

4.2.4 Spill Containment Vessel

The detention vault shall be inspected regularly for sediments. Initial inspection intervals shall be every six months. Vault shall be cleaned out when sediments reach ten percent of the chamber depth or 8.4 inches in depth. Close influent and effluent shut-off valves before cleaning vault. (Shut-off valve on effluent line is in manhole downstream of oil/water separator.) Water in vault at the time of cleaning shall be pumped out and disposed in the sanitary sewer system. Check with the City of Tacoma regarding discharge requirements and locations prior to disposal. Record inspections, sediment depths and cleaning information.

Oil/water separator shall be inspected weekly for oil buildup. Oil/water separator shall be cleaned by October 15 every year and checked after all significant storms. Close effluent shut-off valve (located in downstream manhole) during cleaning. All water removed shall be disposed in the sanitary sewer system. All waste oil and residuals, including sorbent pads, shall be disposed in accordance with local Health Department regulations. Record inspections, oil depths, date and amount of oil removed.

4.2.5 Storm Drain Pipe

Storm Drain Pipe will not require any specific maintenance. If an obstruction is suspected, the pipe may need to be cleaned with a jet of water between catch basin manholes.

4.3 Sample Forms for Data Collection

Appendix B has forms for the collection of data.

5.0 SAFETY

5.1 Confined Space Entry

Confined space entry requirements shall be followed at all times whenever entering a catch basin manhole, manhole, or spill containment vessel. Personnel shall not enter any confined space without first testing the atmosphere for potentially dangerous gases or oxygen deficiencies.

5.2 Personnel Accidents

Personnel accidents which result in injury should be handled by calling 911 for serious accidents or by applying first aid on site for minor accidents. All personnel accidents shall be reported to the Port of Tacoma at (206) 383-5841.

5.3 Spills

Material spilled on the site shall be handled in accordance with Section 3.2.2, Emergency Operation. Cleanup personnel shall wear appropriate protective equipment before handling any spill.

6.0 COMPLIANCE MONITORING

A compliance monitoring plan has been prepared for this site and is included in Appendix C.

APPENDIX A

COMPLIANCE MONITORING PLAN
(Included as Appendix C of the Design Engineering Report)

APPENDIX B

SAMPLE FORMS FOR DATA COLLECTION

WELL MONITORING FORM

Project: _____
Project #: _____
Date: _____

Location: _____
Operator: _____
Equipment #: _____
Comments: _____

Probe Correction:
____ Corr. ____ Uncorr.

____ Well ____ Needs Repair
Comment: _____

Well ID	Time	TOC Elev.	Depth To Water	Depth To Petroleum	Petroleum Thickness	Petroleum Gravity	Hydro. Equiv.	Corrected DTW	Corrected Water Table Elev.

Harding Lawson Associates
Engineering and
Environmental Services

GROUND-WATER SAMPLING FORM

Job Name _____

Job Number _____

Recorded by _____ (Signature)

Well No. _____

Well Type: ❑ Monitor ❑ Extraction ❑ Other _____

Well Material: ❑ PVC ❑ St. Steel ❑ Other _____

Date _____ Time _____

Sampled by _____ (Initials)

WELL PURGING

PURGE VOLUME

Casing Diameter (D in inches):
❑ 2-inch ❑ 4-inch ❑ 6-inch ❑ Other _____
Total Depth of Casing (TD in feet BTOC): _____
Water Level Depth (WL in feet BTOC): _____
Number of Well Volumes to be purged (# Vols)
❑ 3 ❑ 4 ❑ 5 ❑ 10 ❑ Other _____

PURGE METHOD

❑ Bailer - Type: _____
❑ Submersible ❑ Centrifugal ❑ Bladder; Pump No.: _____
❑ Other - Type: _____

PUMP INTAKE SETTING

❑ Near Bottom ❑ Near Top ❑ Other _____
Depth in feet (BTOC): _____ Screen Interval in Feet (BTOC)
from _____ to _____

PURGE VOLUME CALCULATION:

$$\left(\underset{\text{TD (feet)}}{\_\_\_\_} - \underset{\text{WL (feet)}}{\_\_\_\_}\right) \times \underset{\text{D (inches)}}{\_\_\_\_}^{2} \times \underset{\text{\# Vols}}{\_\_\_\_} \times 0.0408 = \underset{\text{Calculated Purge Volume}}{\_\_\_\_} \text{ gallons}$$

PURGE TIME

_____ Start _____ Stop _____ Elapsed

PURGE RATE

Initial _____ gpm Final _____ gpm

ACTUAL PURGE VOLUME

_____ gallons

FIELD PARAMETER MEASUREMENT

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T ❑ °C ❑ °F	Other _____

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T ❑ °C ❑ °F	Other _____
Meter Nos.				

Observations During Purging (Well Condition, Turbidity, Color, Odor): _____

Discharge Water Disposal: ❑ Sanitary Sewer ❑ Storm Sewer ❑ Other _____

WELL SAMPLING

SAMPLING METHOD

❑ Same As Above
❑ Bailer - Type: _____
❑ Grab - Type: _____
❑ Submersible ❑ Centrifugal ❑ Bladder; Pump No.: _____
❑ Other - Type: _____

SAMPLING DISTRIBUTION

Sample Series: _____

Sample No.	Volume/Cont.	Analysis Requested	Preservatives	Lab	Comments

QUALITY CONTROL SAMPLES

Duplicate Samples

Original Sample No.	Duplicate Sample No.

Blank Samples

Type	Sample No.

Other Samples

Type	Sample No.

Harding Lawson Associates
Engineering and Environmental Services

CALIBRATION RECORD

INSTRUMENT ID. No.	INSTRUMENT DESCRIPTION	DATE CALIBRATED	NEXT CALIBRATION DUE
CALIBRATION STANDARD –		CALIBRATED BY:	

AS-FOUND CONDITION				CALIBRATION DATA			

COMMENTS:

NAME SITE

INSTRUMENT ID. No.	INSTRUMENT DESCRIPTION	DATE CALIBRATED	NEXT CALIBRATION DUE
CALIBRATION STANDARD –		CALIBRATED BY:	

AS-FOUND CONDITION				CALIBRATION DATA			

COMMENTS:

NAME SITE

INSTRUMENT ID. No.	INSTRUMENT DESCRIPTION	DATE CALIBRATED	NEXT CALIBRATION DUE
CALIBRATION STANDARD –		CALIBRATED BY:	

AS-FOUND CONDITION				CALIBRATION DATA			

COMMENTS:

NAME SITE

Sheet _____ of _____

Project: _____ Job No.: _____

Subject: FIELD INVESTIGATION DAILY REPORT Date: _____

Equipment Rental: _____ Company: _____ To: _____

Equipment Hours: _____ F.E. Time from: _____ to: _____ By: _____

(outside service and expense record must be attached for any outside costs)

Attachments:

Initial

FIELD LOG OF BORING SHEET ____ OF ____

LOCATION OF BORING:

PROJECT: | BORING NO. | TOTAL DEPTH:

JOB NO.: | LOGGED BY:

PROJ. MGR.: | EDITED BY:

DRILLING CONTRACTOR:

DRILL RIG TYPE:

DRILLERS NAME:

SAMPLING METHODS:

HAMMER WT.: | DROP:

STARTED, TIME: | DATE:

COMPLETED, TIME: | DATE:

BORING DEPTH (ft.)				
CASING DEPTH (ft.)				
WATER DEPTH (ft.)				
TIME:				
DATE:				

BACKFILLED, TIME: DATE: BY:

SURFACE ELEV.: | DATUM:

CONDITIONS:

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	SAMPLE CONDITION	DRILLING RATE (min/ft)				DEPTH IN FEET	GRAPHIC LOG
										1	
										2	
										3	
										4	
										5	
										6	
										7	
										8	
										9	
										10	

FF7

HARDING LAWSON ASSOCIATES

[redacted]ardin[redacted]son [redacted]ciate[redacted]

1325 Fourth Avenue, Suite 1800
Seattle, WA 98101
(206) 622-0812
(206) 292-8619 Telecopy

CHAIN OF CUSTODY FORM

Lab: _____

Samplers: _____

Job Number: _____

Name/Location: _____

Project Manager: _____

Recorder: _____
(Signature Required)

SOURCE CODE	MATRIX: Water	Sediment	Soil	Oil	#CONTAINERS & PRESERV.: Unpres.	H_2SO_4	HNO_3				SAMPLE NUMBER OR LAB NUMBER: Yr	Wk	Seq	DATE: Yr	Mo	Dy	Time	STATION DESCRIPTION/ NOTES	ANALYSIS REQUESTED: EPA 601/8010	EPA 602/8020	EPA 624/8240	EPA 625/8270	ICP METALS	EPA 8015M/TPH

LAB NUMBER: Yr	Wk	Seq	DEPTH IN FEET	COL MTD CD	QA CODE	MISCELLANEOUS

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE/TIME
RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE/TIME
RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE/TIME
RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE/TIME
DISPATCHED BY: *(Signature)* DATE/TIME	RECEIVED FOR LAB BY: *(Signature)*	DATE/TIME
METHOD OF SHIPMENT		

Laboratory Copy White — Project Office Copy Yellow — Field or Office Copy Pink

65

DISTRIBUTION

Draft Operation and Maintenance Plan
Cascade Timber Log Yard No. 3 Project
Port of Tacoma
Tacoma, Washington

March 21, 1994

Copy No. ___

Copies 1 - 3:	Mr. Suzanne Dudziak Environmental Program Manager Port of Tacoma Post Office Box 1837 Tacoma, Washington 98401
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Copy 6:	Harding Lawson Associates Seattle, Washington Chronological File

Quality Control Reviewer

_____

Gregory S. Laird, P.E.
Managing Associate Engineer

APPENDIX E

APPENDIX E

EROSION AND SEDIMENTATION CONTROL PLAN

Erosion and Sediment Control Plan
Cascade Timber Log Yard No. 3
Port of Tacoma

Prepared for

Port of Tacoma
Post Office Box 1837
Tacoma, Washington, 98401-1837

HLA Project No. 12183.4

Mary C. Dahl, P.E.
Senior Engineer

March 2, 1994

Harding Lawson Associates
Engineering and Environmental Services
1325 4th Avenue, Suite 1800
Seattle, WA 98101 - (206) 622-0812

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DISTRIBUTION

1.0 INTRODUCTION

1.1 Project Description

The Cascade Timber Log Yard No. 3 site (site) is located at the Port of Tacoma and has been identified as a site requiring cleanup under the Model Toxics Control Act (MTCA) due to elevated levels of metals in the soil and stormwater. In order to mitigate metals migration via stormwater transport, the site will be covered with a low permeability cap.

This Erosion and Sedimentation Control (ESC) Plan has been prepared using the Best Management Practices (BMPs) identified in the Stormwater Management Manual (SWMM) for the Puget Sound Basin, prepared by the Washington State Department of Ecology (Ecology), February 1992. This ESC plan will be implemented by the contractor during site remediation.

1.2 Project Location

The Port of Tacoma (Port) owns the 10.7 acre site, which is located on Maxwell Way between the Port of Tacoma Road and Thorne Road. See Figure 1 for a vicinity map. The site has not been in use since 1987. Figure G3 shows the existing site.

2.0 EXISTING SITE

2.1 Background

In the late 1970's, slag from the Asarco smelter was deposited as ballast at the site. In 1985, Ecology determined that runoff from the site contained high concentrations of metals in storm water runoff. In response to a Consent Degree issued by Ecology and as part of Ecology's Model Toxics Control Act (MTCA), the Port prepared a remedial investigation/feasibility study (RI/FS) to determine the amounts of metals leaving the site, the mode of transport, and to develop a solution to remediate the facility. The RI/FS, prepared by Harding Lawson Associates, August 16, 1993, recommended capping the contaminated soils in place.

2.2 Existing Site Conditions

The site is relatively flat with moderate vegetation in places. The site does not appear to drain. Water ponds on site and slowly infiltrates instead of running off. There is a ditch along Maxwell Way with two catch basins collecting flows and depositing water into the City of Tacoma's storm drain system. However, these catch basins appear to be clogged with sediment and are not currently draining the site.

2.3 Contaminates and Mode of Transport

The RI/FS report identified arsenic as the primary contaminant of concern, however, the extent of the contamination in the soils did not appear to go deeper than 5 feet below the ground surface. Monitoring wells were installed which indicated that the groundwater did not contain elevated levels of metals. The RI/FS report concluded that the surface water runoff was the primary concern for metals transport off the site.

2.4 Soils

The RI/FS report identified the soils on site as several distinct layers. The uppermost fill layer consists of wood waste, sand, gravel and/or slag. The thickness of this layer ranges between 1.6 to 3 feet. Beneath this upper layer is a sandy unit, with varying percentages of silt. This layer is interpreted as dredge fill. The thickness of this layer ranges from 5.5 to 8 feet deep. Groundwater was encountered in this layer. Depths of groundwater ranges from 2 to 8 feet below ground surface, based on water measurements taken from July to December 1992.

Below the dredge fill layer is a fine-grained silty clay unit, interpreted as native tidal marsh deposits. The thickness of this layer was determined in several well holes to be about three feet.

3.0 SITE REMEDIATION

3.1 Proposed Project

The RI/FS report looked at several remediation options to control the metals contamination. It was concluded that the most effective option is capping the contaminated soil and bark in place. The cap will be a layer of low permeability material, such as asphalt with a geosynthetic fabric, which will keep the surface water from coming in contact with the contaminated soils and carrying the metals off site. The site will be graded to a series of catch basins on site, connected by storm drains to a spill containment vault, an oil/water separator and then to a connection with the City of Tacoma's system.

3.2 Erosion and Sediment Considerations

The site is relatively flat. Erosion during grading of the soil and slag is expected to be minimal because the site is flat, therefore, the surface water will probably pond instead of flow. Sediment transport will be minimal because erosion will be minimal. It is expected that the ponded water will either infiltrate or evaporate. The water quality design storm will be the six-month, 24-hour event as required by Ecology in SWMM. For this site, the rainfall is 1.3 inches for this design storm.

Around the perimeter of the site, a filter fence and straw bale barriers will be installed to minimize the amount of sediment leaving the site as shown on Figure G4. After the site has been rough graded, depressions on the site will act as retention basins until the storm water infiltrates or evaporates. No storm water will be allowed to leave the site during grading operations.

As the cap is constructed, runoff from the capped area will leave the site via the new storm drain system. Capped areas will be protected from storm water and sediment by filter fence and straw bale barriers as necessary.

3.3 Adjacent Properties

The adjacent properties are Thorne Road, Maxwell Way, City of Tacoma Right-of-Way and the adjacent parcel of land. The cap will be constructed to meet the grades at the perimeter and will slope into the site from all four sides. A curb will contain stormwater on site.

During construction, the adjacent properties will be protected from storm water and sedimentation by filter fence and straw bale barriers. A stabilized construction entrance with a tire wash station will be constructed at the site entrance to minimize sediment leaving the site.

4.0 CONSTRUCTION

4.1 Erosion Control BMPs

4.1.1 Infiltration or Evaporation

Ecology's SWMM recommends reducing or eliminating erosion because without erosion, there is no sedimentation. Since the site is generally flat, erosion is expected to be minimal. Surface water will pond on site during grading and either evaporate or infiltrate. Infiltration is not considered to cause migration of the contaminants of concern to the groundwater since groundwater sampling performed during the Remedial Investigation (RI) study concluded that the groundwater did not contain elevated levels of the contaminants of concern. During construction there will not be any planned outlet for runoff from the site.

4.1.2 Stabilized Construction Entrance and Tire Wash

A stabilized construction entrance and tire wash will be located at the access to the site as shown on Figure G4. All vehicles will be required to have their chassis and tires washed before leaving the site. The tire wash will consist of a pad constructed of quarry spalls (four to eight inch size), 12-inches thick, and a minimum of 100 feet long. An example of a tire wash from the SWMM (Figure II-5.4) is shown on Figure 4. Vehicles exiting the site will drive onto the pad. A steam cleaner will then be used to wash the vehicle. Wash water will be contained in the gravel pad and will either infiltrate or evaporate. A filter fence will be installed down gradient from the tire wash pad to contain sediment captured at the site. If any sediment or soil still reaches Maxwell Way from vehicles leaving the site, it will be swept or shoveled up prior to washing the road. Contractor will be required to maintain the tire wash as described below. At the end of construction, the tire wash will be removed. All sediment will be contained and capped on site.

4.1.3 Dust Control

During grading of the site, dust may develop. Because there is a potential for site workers to breathe dust containing arsenic, the dust must be controlled. In order to reduce the dust, the contractor will be required to wet the soil as necessary. The contractor will not be allowed to overwater the soil such that it creates ponding or runoff of water. The contractor will be required to maintain a water truck on site at all times, to control dust as necessary.

4.2 Sediment Control BMPs

4.2.1 Filter Fence

With erosion minimal, sediment transport is not expected; however, even with a flat site, some runoff may leave the site. Filter fence will be installed around the entire site to capture sediment from the small drainage areas previously described. Filter fence does not work well for concentrated or large flows, such as in ditches, but because no significant concentrated flows are expected, filter fence is considered an acceptable option to stop sediment at the edge of the property.

The filter fence will be anchored at the base by burying it in an eight-inch by 12-inch deep trench as shown on Figure 5 (Figure II-5.18 from the SWMM). Posts will be two-inch square wood posts spaced at a maximum of six-feet, buried 2.5 feet deep. Fabric shall be used as a continuous roll, with splices only at posts, with a minimum six-inch overlap. Fabric and posts will be removed by the contractor when the site has been capped. Maintenance will be as described below.

4.2.2 Straw Bale Barrier

Straw bale barriers will be installed at locations along the edge of the site where sediment may be transported off site. Bales will be anchored in the ground four inches and backfilled on the upstream side with compacted soil as shown on Figures 6 and 7 (Figures II-5.19 and II-5.20 from the SWMM). Bales will be bound together and anchored into the ground with at least two stakes pushed flush with the top of the bales. The gaps between bales will be filled with straw to prevent water from passing between them. Maintenance will be as described below. Bales will be completely removed at the end of construction. Sediment will remain on site and be placed under the cover. Bales will be broken up, spread thin and placed under the cover.

4.3 Construction Schedule

Construction on the site remediation is scheduled to begin in June 1994 and be completed by November 1994. The site will be graded and capped during the late spring and summer when rainfall is expected to be low, therefore minimizing the amount of surface water on site.

4.4 Maintenance Requirements

During construction, the site will be inspected after all storm events to ensure that no sediment leaves the site. If necessary, additional straw bale barriers and/or filter fence will be placed to eliminate sediment transport. The tire wash station will also be inspected for effectiveness of cleaning the vehicles as they leave the site. If sediment is leaving the site on vehicles, the contractor will be required to modify the truck wash station and to clean the street of all sediment and soil.

Maintenance of the filter fence consists of inspecting the fence after each rainfall event, removing all sediment and repairing the fence as necessary. Straw bale barriers shall also be inspected after each rainfall event. Damaged bales shall be repaired immediately. Any undercutting or end runs shall be repaired immediately to prevent further damage. Sediment deposits shall be removed after each runoff-producing rainfall. All sediment removed from filter fence and straw bale barriers will remain on site to be included under the impervious cap.

5.0 PERMANENT STABILIZATION

Permanent stabilization of the site against erosion and sedimentation will not be required because the site will be capped with an impervious layer. Drainage will be in towards the site at tie-ins with the adjacent properties.

- Tire washing should be done before the vehicle enters a paved street. Washing should be done on an area covered with crushed rock and the wash water should be drained to a sediment retention facility such as a sediment trap or basin.

- The volume of wash water produced by tire washing should be included when calculating the sediment trap or basin size.

Maintenance

- The entrance shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with 2-inch stone, as conditions demand, and repair and/or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately.

- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure II-5.4 Stabilized Construction Entrance

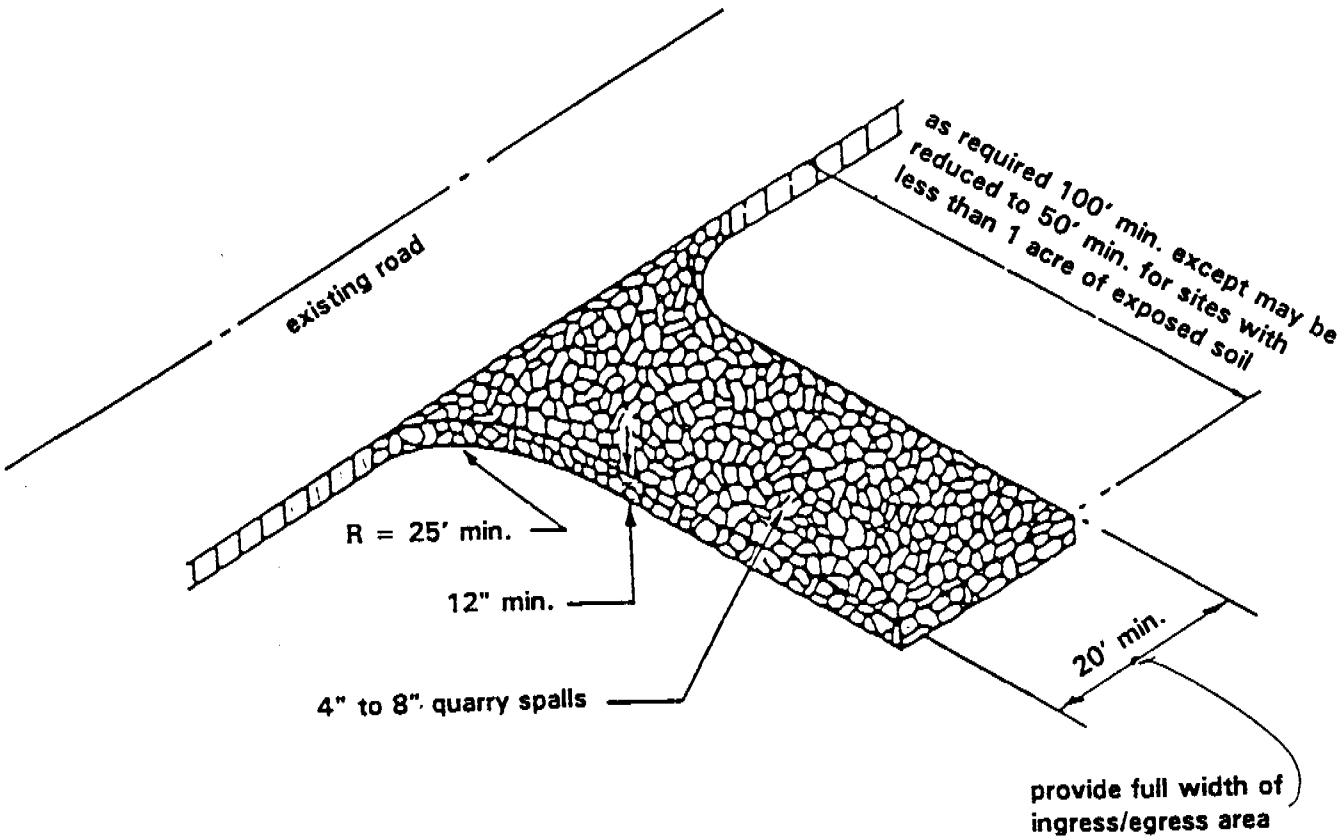


Figure 4 Tire Wash Detail

Figure II-5.18 Filter Fabric Fence Detail

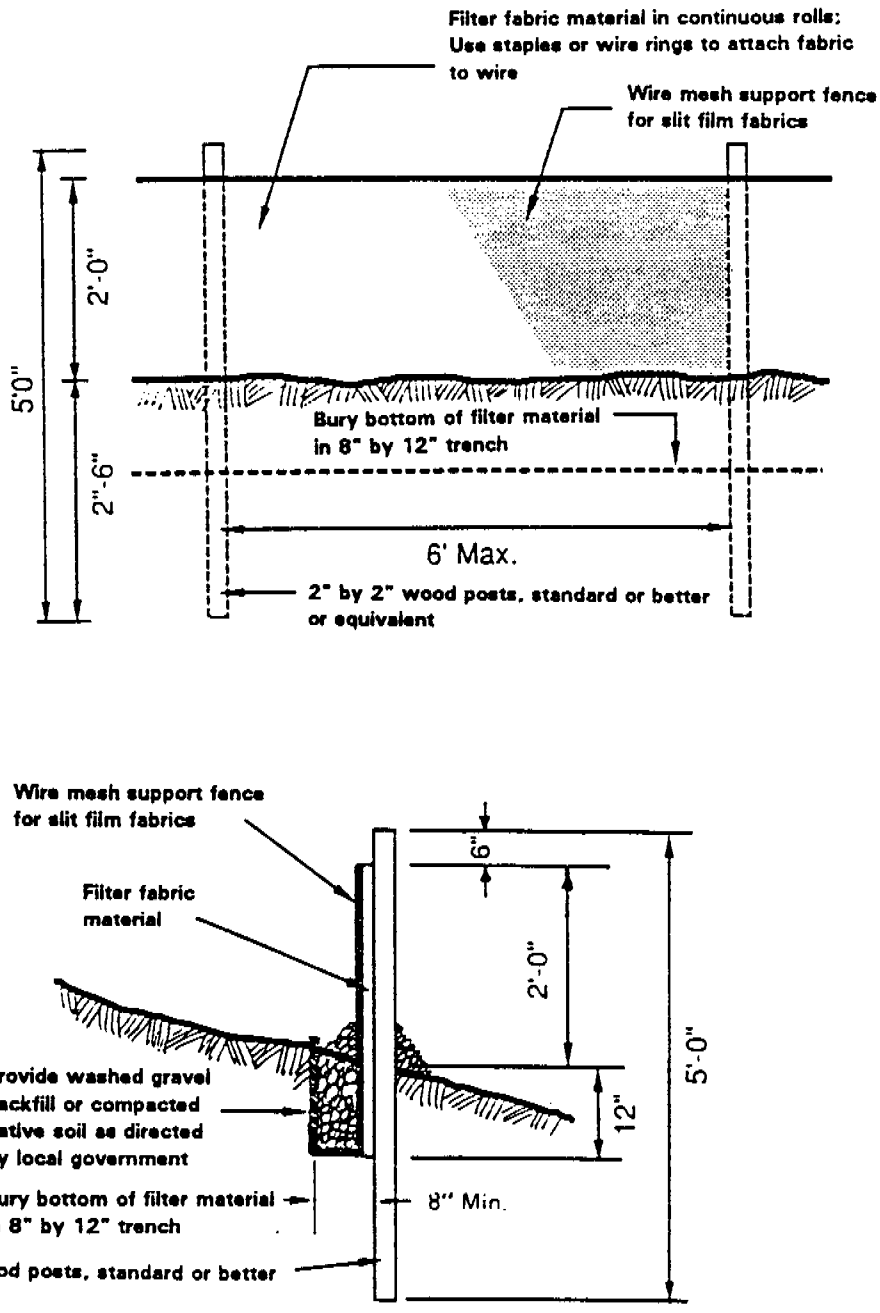
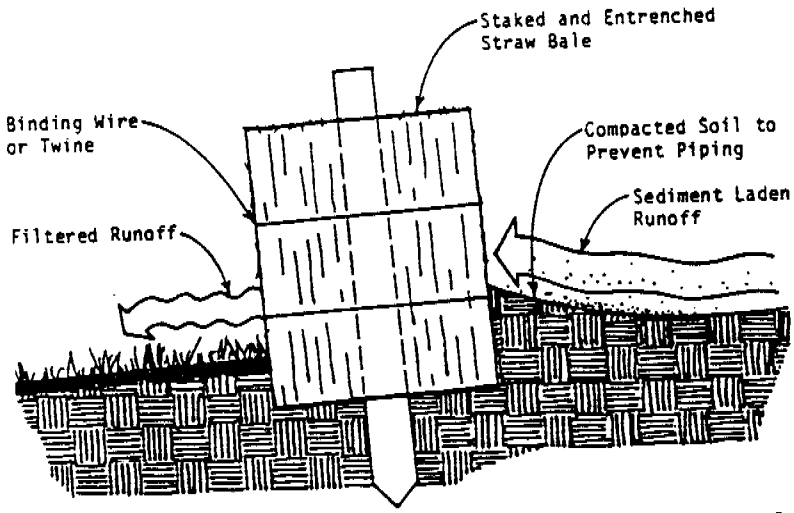


Figure 5 Filter Fabric Fence Detail

Figure II-5.19 Cross-Section of a Properly Installed Straw Bale Barrier



2. The remaining steps for installing a straw bale barrier for sheet flow applications apply here, with the following addition.

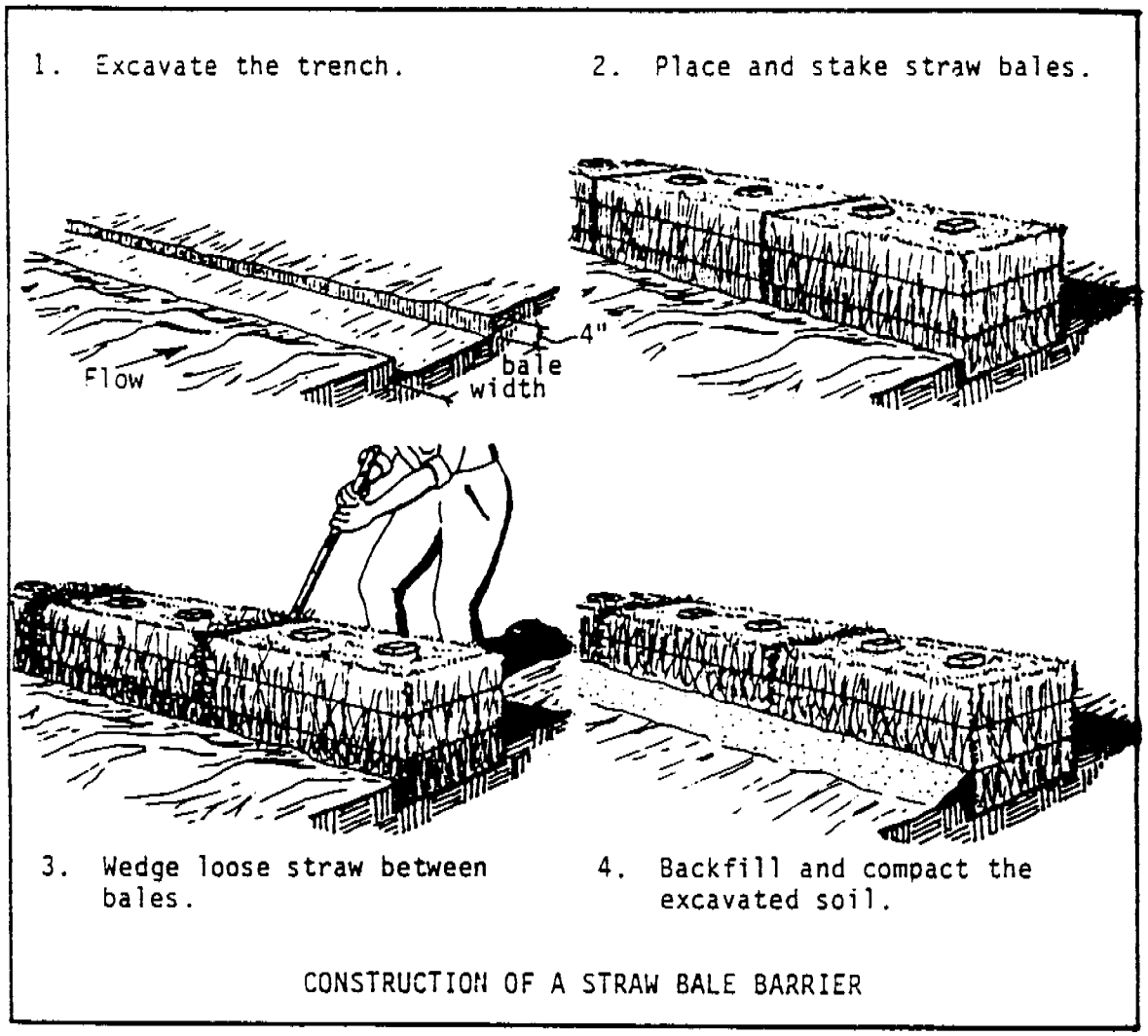
3. The barrier shall be extended to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale (Figure II-5.20) to assure that sediment-laden runoff will flow either through or over the barrier but not around it.

Maintenance

- Straw bale barriers shall be inspected immediately after each runoff-producing rainfall and at least daily during prolonged rainfall.
- Close attention shall be paid to the repair of damaged bales, end runs, and undercutting beneath bales.
- Necessary repairs to barriers or replacement of bales shall be accomplished promptly.
- Sediment deposits should be removed after each runoff-producing rainfall. They must be removed when the level of deposition reaches approximately one-half the height of the barrier.
- Any sediment deposits remaining in place after the straw bale barrier is no longer required shall be dressed to conform to the existing grade, prepared and seeded.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 6 Straw Bale Barrier Section

Figure II-5.20 Proper Installation of a Straw Bale Barrier



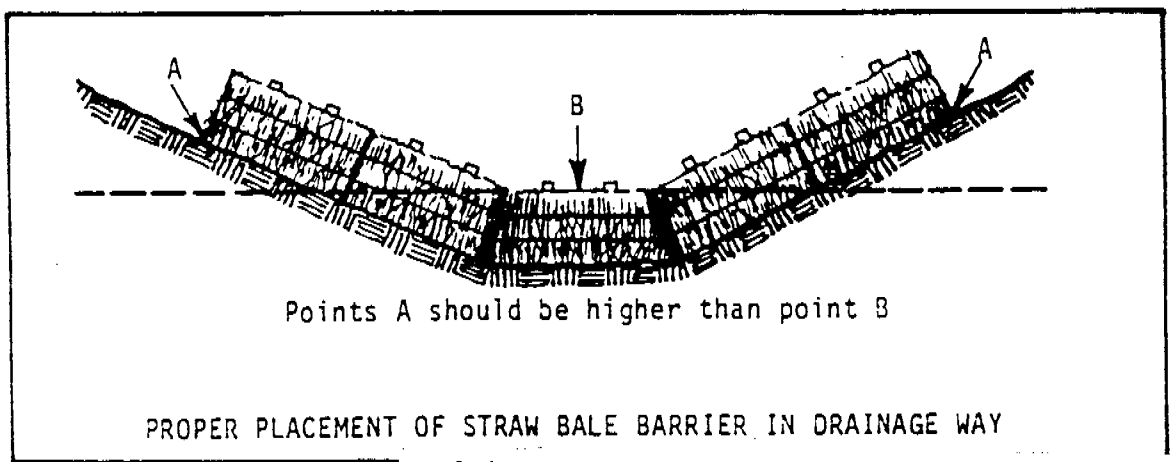


Figure 7 Straw Bale Barrier Installation

DISTRIBUTION

Erosion and Sediment Control Plan
Cascade Timber Log Yard No. 3
Port of Tacoma

March 2, 1994

Copy No. ___

Copies 1 - 4:	Mr. Curtis L. Ratcliffe, P.E. Chief Engineer Port of Tacoma P.O. Box 1837 Tacoma, WA 98401-1837
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Copy 6:	Harding Lawson Associates Seattle, Washington Chronological File

Quality Control Reviewer

_____

Gregory S. Laird,, P.E.
Managing Associate Engineer

APPENDIX F

APPENDIX F

SEPA CHECKLIST

A. Background

1. **Name of proposed project, if applicable:**

Cascade Timber Log Sort Yard No. 3 Cleanup

2. **Name of applicant:**

Port of Tacoma

3. **Address and phone number of applicant and contact person:**

Suzanne Dudziak
c/o Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401-1837
(206) 383-5841

4. **Date checklist prepared:**

February 28, 1994

5. **Agency requesting checklist:**

Port of Tacoma

6. **Proposed timing or schedule (including phasing, if applicable):**

June - October 1994.

7. **Do you have any plans for future actions, expansions, or further activity related to or connected with this proposal? If yes, explain.**

Yes. Future actions will include ongoing groundwater and surface water monitoring.

8. **List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.**

"Geology of the Port of Tacoma"; Hart-Crowser and Associates; 1979.
"Assessment of Log Sort Yards as Metals Sources to Commencement Bay Waterways"; Washington State Department of Ecology; 1983-1984.
"Cascade Timber/Murray Pacific Log Sort Yards Preliminary Investigation Status Report"; Sweet Edwards & Associates; 1987.
"Remedial Investigation and Feasibility Study Report Cascade Timber No. 3 Log Sort Yard"; Harding Lawson Associates; 1993.

9. **Do you know whether applications are pending for governmental approvals of other proposals affecting the property covered by your proposal? If yes, explain.**

Yes; Department of Ecology Consent Decree (currently out for public comment).

10. **List any government approvals or permits that will be needed for your proposal, if known.**

Department of Ecology Consent Decree
City of Tacoma Grading Permit
Storm drainage approval from City of Tacoma

11. **Give brief, complete description of your proposal, including the proposed use and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of you proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include specific information on project description).**

The southern 10.73 acres of the property will be graded and the soil/slag/wood debris will be contained under an asphalt cap. The proposed cap design includes an 8 to 12 inch layer of crushed aggregate base over the rough grade, topped with a 4 to 8 inch layer of asphalt. Catch basins will be installed and stormwater from the cap will be routed to the City of Tacoma's system. Design of the stormwater system will be in accordance with City requirements. See attached plans.

12. **Location of the proposal. Give sufficient information to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps and detailed plans submitted with any specific applications related to this checklist.**

The Cascade Timber Log Sort Yard No. 3 is an 18.57 acre parcel of land (of which, this checklist is concerned with the southern 10.73 acres) owned by the Port of Tacoma, and is located along Maxwell Way between Port of Tacoma Road and Thorne road in Tacoma, Washington.

Legal Description: East 1/2 of the southeast quarter, Section 34, Township 21 North, Range 3 East, Pierce County. The site lies within a heavily industrialized area of the Tacoma tideflats.

B. <u>Environmental Elements</u>

1. **Earth**

a. **General description of the site (underline one): <u>Flat</u>, rolling, hilly, mountainous, other_____.**

b. **What is the steepest slope on the site (approximate percent slope)?**

Approx. 1 %

c. **What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.**

Wood waste, roadbase materials, sand, gravel, soil and ASARCO slag.

d. **Are there surface indications or history of unstable soils in he immediate vicinity? If so, describe.**

No

e. **Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.**

The existing site will be shaped for drainage. A minimal amount of clean bank run material will be imported and placed to assure structural integrity of the remedial cap.

f. **Could erosion occur as a result of grading, filling, construction, or use? If so, generally describe.**

No erosion is anticipated as a result of this work.

g. **About what percent of the site will be covered with impervious surfaces after project completion (for example, asphalt or buildings)?**

100% of the southern 10.7 acres of the site will be paved.

h. **Proposed measures to reduce or control erosion, or other impacts to the earth, if any:**

No erosion is anticipated as a result of this work.

2. **Air**

a. **What type of emissions to the air would result from the proposal (i.e. dust, automobile, odors, industrial, wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities, if known.**

Dust from excavation will be controlled as necessary during work. This may consist of sprinkling. Temporary, emissions from construction equipment will occur.

b. **Are there any off-site source of emissions or odor that may affect your proposal? If so, generally describe.**

No, the site is located in the Port industrial area.

c. **Proposed measures to reduce or control emissions or other impacts to air, if any:**

Sprinkle during excavation, as necessary.

3. **Water**

a. **Surface:**

1) **Is there any surface water body on or in the immediate vicinity of the site, (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.**

No

2) **Will the project require any work over, in, or adjacent to (within 200') the described waters? If yes, please describe and attach available plans.**

N/A

3) **Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.**

N/A

4) **Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities, if known.**

No

5) **Does the proposal lie within a 100-year floodplain? If so, note the location on the site plan.**

No

6) **Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.**

No. The proposal is designed to eliminate current releases of metals into stormwater, thus improving surface water quality.

b. **Ground:**

1) **Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.**

No

2) **Describe waste materials that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals...; agricultural; etc.) Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.**

N/A

c. Water Runoff (including storm water):

1) Describe the source of runoff (including storm water) and the method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

The source of runoff will be stormwater only. Storm drains will be installed and connected to the City of Tacoma's storm drain system which discharges into the Sitcum Waterway.

2) Could waste materials enter ground or surface waters? If so, generally describe.

No. This proposal is designed to prevent contaminants from entering ground or surface waters.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

No impacts are anticipated.

4. Plants

a. Check or circle types of vegetation found on site:
_x_ deciduous tree: alder, maple, aspen, other
___ evergreen tree: fir, cedar, pine, other
_x_ shrubs
_x_ grass
___ pasture
___ crop or grain
___ wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other
___ water plants: water lily, eelgrass, milfoil, other
___ other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

Upland plants which are present on the site will be removed, prior to shaping and grading.

c. List any threatened or endangered species known to be on or near the site.

None known.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

None proposed.

5. **Animals**

a. Underline any birds or animals which have been observed on or near the site or are known to be on or near the site:
birds: hawk, heron, eagle, songbirds, other: _____
mammals: deer, bear, elk, beaver, other:_____
fish: salmon, trout, herring, shellfish, other:_____

b. **List any threatened or endangered species known to be on or near the site.**

None known.

c. **Is the site part of a migration route? If so, explain.**

The site is in the general vicinity of the Pacific flyway.

d. **Proposed measures to preserve or enhance wildlife, if any:**

None proposed. Action will reduce or eliminate input of metals to stormwater.

6. **Energy and Natural Resource**

a. **What kinds of energy (electrical, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.**

N/A

b. **Would your project affect the potential use of solar power by adjacent properties? If so, generally describe.**

No

c. **What kinds of energy conservation features are included in the plans for this proposal? List other proposed measures to reduce or control energy impacts, if any:**

N/A

7. **Environmental Health**

a. **Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, generally describe.**

Environmental health hazards associated with this proposal will be the potential for exposure to workers conducting the remediation tasks. The risk to workers will be the potential to inhale dust containing arsenic and lead, or the potential to ingest arsenic and lead if contaminants remain on hands of workers. All of these issues will be prevented by proper worker training, protection, and monitoring, as discussed below.

1) **Describe special emergency services that might be required.**

There is a potential for injury due to the use of heavy equipment, however, a health and safety plan (HSP) which describes routes to the closest hospital will be read and understood by all workers onsite before the project begins.

2) **Proposed measures to reduce or control environmental health hazards, if any:**

A Health and Safety Plan (HSP) will be prepared and read by all site workers prior to the start of remediation. All workers will have the appropriate OSHA Hazardous Waste and Safety Training. All workers will wear the appropriate protective equipment during the course of the project, as specified in the HSP.

Once this project is completed, a covenant will be filed on the property to restrict its use to industrial only and to restrict penetration of the cap. This will reduce any potential future environmental or health hazards. The cap will be maintained in accordance with an Ecology-approved Operation and Maintenance Plan.

b. Noise

1) **What types of noise exists in the area which may affect your project (for example: traffic, equipment, operation, other)?**

The site is located in a heavy industrial area, therefore, noise would not affect the project.

2) **What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.**

Short-term noise would be generated by heavy equipment operators, but the noise would be consistent with other industrial activities in the area. Also, noise generated by project activities will be addressed in the HSP.

3) **Proposed measures to reduce or control impacts, if any:**

None other than what will be addressed in the HSP.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

The site is currently not in use. Adjacent properties are used for industrial and commercial activities.

b. Has the site been used for agriculture? If so, describe.

No

c. **Describe any structure on the site.**

None

d. **Will any structures be demolished?**

N/A

e. **What is the current zoning?**

The site is situated in and comprised of an area of the city of Tacoma zoned "M-3, Heavy Industrial."

f. **What is the current comprehensive plan designation of the site?**

High Intensity

g. **If applicable, What is the current shoreline master program designation of the site?**

N/A

h. **Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.**

No

i. **Approximately how many people would reside or work in the completed project?**

N/A

j. **Approximately how many people would the completed project displace?**

None

k. **Proposed measures to avoid or reduce displacement impacts, if any:**

N/A

l. **Proposed measures to insure the proposal is compatible with existing and projected land uses and plans, if any:**

This proposal is consistent with existing and projected land uses and plans.

9. **Housing**

a. **Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.**

N/A

b. **Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.**

N/A

c. **Proposed measures to reduce or control housing impacts, if any:**

N/A

10. **Aesthetics**

a. **What is the tallest height of any proposed structure(s), not including antennas; what is the principle exterior building material(s) proposed?**

N/A

b. **What views in the immediate vicinity would be altered or obstructed?**

N/A

c. **Proposed measures to reduce or control aesthetic impacts, if any:**

N/A

11. **Light and Glare**

a. **What type of light and glare will the proposal produce? What time of day would it mainly occur?**

None

b. **Could light or glare from the finished project be a safety hazard or interfere with views?**

No

c. **What existing off-site source of light or glare may affect your proposal?**

None

d. **Proposed measure to reduce or control light and glare impacts, if any:**

N/A

12. **Recreation**

a. **What designated and informal recreational opportunities are in the immediate vicinity?**

None

b. **Would the proposed project displace any existing recreational uses? If so, describe.**

No

c. **Proposed measures to reduce or control impacts on recreation, including `recreation opportunities to be provided by the project or applicant, if any:**

N/A

13. **Historic and Cultural Preservation**

a. **Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, general describe.**

None known

b. **Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.**

N/A

c. **Proposed measures to reduce or control impacts, if any:**

N/A

14. **Transportation**

a. **Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.**

Maxwell Way, Port of Tacoma Road, and Thorne road in Tacoma, WA. Proposed access to the street is shown in the attached plans.

b. **Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?**

No. Closest transit stop is at East 11th & Port of Tacoma Headquarters (Pierce Transit route # 61).

c. **How many parking spaces would the completed project have? How many would the project eliminate?**

N/A

d. **Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).**

No

e. **Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.**

No

f. **How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.**

Vehicular trips per day would be minimal (about 20 trips per day during peak construction times); peak volumes would occur from 7 AM to 7 PM.

g. **Proposed measures to reduce or control transportation impacts, if any:**

No impacts are expected.

15. **Public Services**

a. **Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.**

No

b. **Proposed measures to reduce or control direct impacts to public services, if any.**

N/A

16. **Utilities**

a. **Underline utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other.**

None

b. **Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.**

Utilities proposed are stormwater catch basins and drainage lines discharging to the City of Tacoma's stormdrain system which discharges to Sitcum Waterway. The Port of Tacoma will provide service. General construction activities are described above in Project Description Section A-11.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Suzanne Dufresne

Date Submitted: 3/2/94

CASCADE TIMBER LOG SORT YARD #3
REMEDIATION PROJECT
SEPA CHECKLIST
ATTACHMENTS

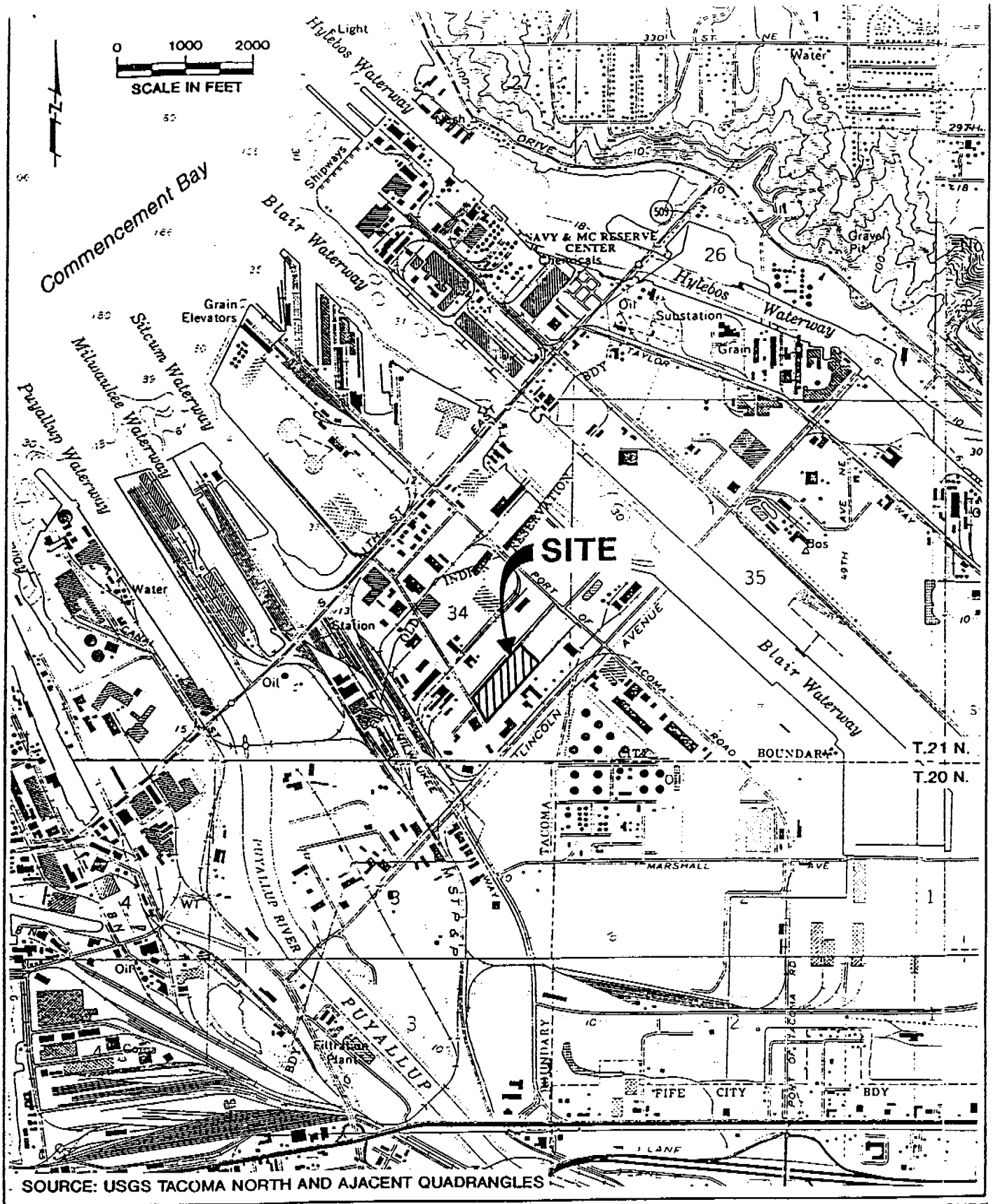


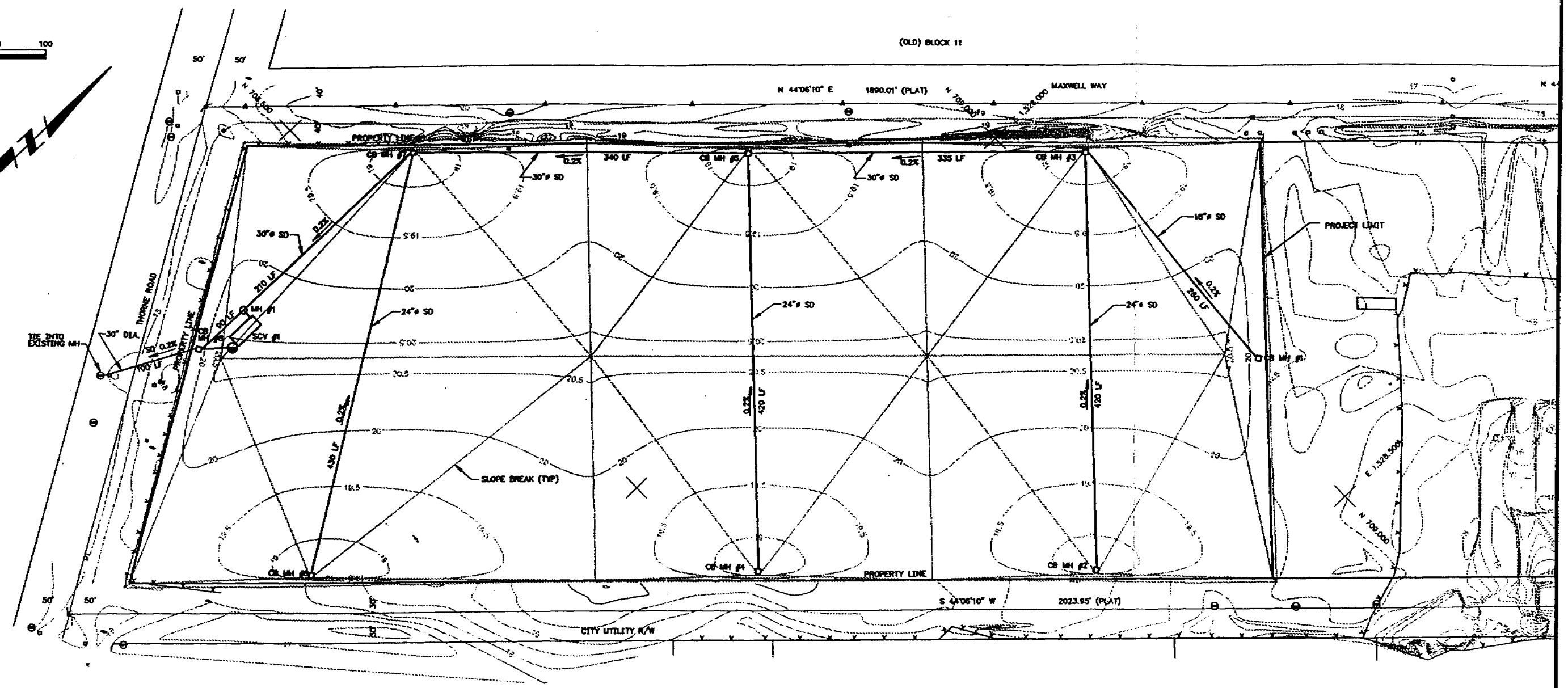
FIGURE 1

Harding Lawson Associates
Engineering and Environmental Services

VICINITY MAP

Cascade Timber No.3
Log Sort Yard

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PS	12183.006		2/93	



NOTE:
1. VERTICAL DATUM IS M.L.L.W.
2. LENGTHS OF PIPE ARE APPROXIMATE AND SHOULD BE FIELD VERIFIED.

PORT OF TACOMA
P.O. BOX 1837 TACOMA, WASHINGTON 98401
(206) 383-5841

CONSULTANTS
Hartleg Lennox Associates
Engineering and Environmental Services
1325 Fourth Avenue, Suite 1800
Phone:(206) 623-0812
Fax:(206) 292-8619

SEAL

APPROVED
CHIEF ENGINEER DATE

CAD/DR DRAWN BY 8/94 DATE
AS-BUILT BY DATE
GIS CHECKED BY 8/94 DATE
MCD PROJ.ENGR. 8/94 DATE

MARK	REVISION	BY	APP.	DATE

CASCADE TIMBER NO.3 LOG SORT YARD
REMEDIATION PROJECT
DRAINAGE PLAN

AUTOCAD FILE NUMBER 507 | C4

DRAWING NO. EP-4670-16
CONTRACT NO. 12183
SHEET NO. X OF XX

PORT of TACOMA U.S.A.★★★

DETERMINATION OF NONSIGNIFICANCE
RCW 197-11-970

Description of proposal: Cascade #3 Log Sort Yard Remediation

Proponent: The Port of Tacoma

Location of proposal, including street address, if any:

Maxwell and Thorne Roads, Tacoma, WA

Lead agency: Port of Tacoma

The lead agency for this proposal has determined that it does not have a probable significant adverse impact on the environment. An environmental impact statement (EIS) is not required under RCW 43.21C.030(2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

___There is no comment period for this DNS.

_X_This DNS is issued under 197-11-340(2); the lead agency will not act on this proposal for 15 days from the date below. Comments must be submitted by: March 18, 1994

Responsible official: John Terpstra

Position/title: Executive Director

Address: P.O. Box 1837

Tacoma, WA 98401-1837

Date March 2, 1994

Signature: John Terpstra

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Commissioners: Robert G. Earley • Jack A. Fabulich • Mike Fletcher • Patrick O'Malley • Jerry M. Thorpe
Executive Director: John J. Terpstra

APPENDIX G

DESIGN PLANS AND SPECIFICATIONS
(Bound Separately)