# *Appendix C*

## Summary of Engineering Characteristics

BLASLAND, BOUCK & LEE, INC.
*engineers, scientists, economists*

# Appendix C – Summary of Engineering Characteristics

This appendix provides a summary of the engineering characteristics and geology presented in the Terminal 4 Early Action characterization report (BBL, 2004). In addition, the results of a preliminary seismic site-response analysis are presented. The seismic site-response analysis was performed to provide estimates of seismic parameters required as input for analyses related to the feasibility of a confined disposal facility (CDF) in Slip 1 at Terminal 4 (see Appendix K – CDF Feasibility).

## C.1 Engineering Characteristics

A subsurface investigation program was conducted in 2004 to fill data gaps and provide adequate information and data for the EE/CA. The results of the investigation are presented in the Terminal 4 Early Action characterization report (BBL, 2004). A summary of the information presented in the characterization report is provided in this appendix.

The subsurface investigation conducted in 2004 consisted of a field exploration and laboratory testing program. The following geotechnical explorations and monitoring wells were performed:

- 4 in-water mud rotary geotechnical borings;
- 10 in-water cone penetrometers;
- 1 upland mud rotary geotechnical boring;
- 1 upland seismic cone penetrometer; and
- 7 hollow-stem auger monitoring wells.

The locations of the explorations are shown on Figure C-1. In addition to the geotechnical explorations and monitoring wells, vibracore samples were collected for chemical analyses. The vibracoring was supplemented by 11 shallow in-water mud rotary borings. The locations of the sediments cores and chemical analysis results are presented in Appendix E. During the field exploration program, disturbed and relatively undisturbed samples were collected. Geotechnical laboratory testing was conducted to classify the soil and sediment samples and to estimate soil properties.

The following sections discuss the geology in the Terminal 4 area and the engineering characteristics of the sediments and soils encountered during the subsurface investigation. The information collected during the field investigation and subsequent laboratory program was compiled to establish a conceptual geologic model. This model delineates the various soil layers that have the same or similar geologic and geotechnical engineering descriptions and likely the same engineering characteristics. The conceptual geologic model is presented in geologic /geotechnical cross sections that provide an interpretation of the soil stratigraphy. The locations of the cross sections are provided on Figure C-1 along with the locations of the explorations. The cross sections are provided on Figures C-2 through C-4.

### C.1.1 Site Geology

Based on local geology maps, the following geologic units have been identified at the Terminal 4 area:

- **Artificial Fill.** Based on comparison of older and current topography, some of the upland soils at the site appear to be fill. These soils consist mainly of brown sand that was likely placed during construction of Slip 1 and Slip 3 and other construction activities.

- **Recent Sediment.** Typically very soft organic silt and clay recently deposited by alluvial processes and continually reworked.

- **Unconsolidated Alluvial Deposits.** Natural river deposits and older glacial flood deposits within the low-lying Portland Basin of the Willamette Valley. This deposit was encountered during the EE/CA field program for the complete depth of most of the explorations.

- **Troutdale Gravel.** The hydrogeologic unit description for the well-graded silt through cobble/boulder-sized gravel observed in samples from deep wells at Terminal 4. Maps of the Troutdale Formation, which is a diagnostically well-cemented sand and gravel, indicate the formation is in proximity to the Removal Action Area, but possibly not at the Removal Action Area (McFarland and Morgan, 1997). This is consistent with the results of monitoring well drilling/sampling, which led to observations of sediment/soil resembling the Troutdale Formation, but without strong cementing. Some minor cementing was noted in samples during the field program, possibly indicating the deposits have been reworked by the river.

- **Sandy River Mudstone Formation.** This deposit is predominantly fine-grained, consisting of siltstone and claystone, which were not encountered in explorations for the EE/CA.

- **Columbia Basalt Group.** This deposit is indicated on local geology map, but was not encountered in explorations for the EE/CA.

### C.1.2 Generalized Subsurface Conditions

The following soil units were encountered in the explorations performed at the site:

**Brown, Loose to Medium Dense Sand (Upland Explorations).** All upland explorations encountered brown, loose to medium dense (occasionally dense) sand below the ground surface beneath surficial coverings. The thickness of the sand layer ranges from approximately 17 to 35 feet. Based on grain size analyses, the sand contains approximately 5% to 15% fines. This material likely consists of fill that was placed during construction of Slip 1 and Slip 3.

**Very Soft Organic Silt and Clay (Recent Sediment/In-Water Explorations).** This material was generally encountered in the top portion of the in-water explorations. The thickness of the very soft organic silt and clay layer varies widely and is discussed in more detail in Section C.1.3.

**Very Soft to Medium Stiff Organic and Inorganic Silts and Clays (Upland Explorations).** These cohesive soils were encountered mainly to the east of the historical shoreline and east of Slip 1 and Slip 3 (Figure C-1). Monitoring wells T4-MW03 and T4-MW05 encountered a 10- to 20-foot layer of sand and silt interbedded within this deposit. The cohesive soils encountered in monitoring wells T4-MW02 and T4-MW03 are likely the bottom of historical Gatton's Slough (refer to Figure C-1) and reach substantial depths of 140 to 180 feet.

**Interbedded Silt and Sand (Medium Stiff to Stiff/Medium Dense).** This material was encountered east of historical Gatton's Slough in explorations CP03, CP04, CP10, and GEO4L. It appears that this unit is somewhat of a transition zone between the dark grey sand containing small amounts of fines located to the west of historical Gatton's Slough and thicker deposits of cohesive material on the upland side farther to the east. The interbedded silts and sands were encountered below recent soft sediments in the CPTs and below fill and a layer of silt in boring GEO4L. The CPTs encountered this material to their termination depths, between 63 and 80 feet. GEO4L encountered very stiff to hard silt and medium stiff organic silt below a depth of 80 feet.

**Dark Grey, Loose to Medium Dense Sand.** Large portions of the Terminal 4 area located west of historical Gatton's Slough are underlain by dark grey sand with fines contents (i.e., silt and clay-sized particles) ranging from about 3% to 8%. This sediment/soil was deposited by natural riverine depositional processes, but the alluvial deposits here are also associated with glacial catastrophic floods. This deposit was generally encountered below the fill in the upland explorations and below the surficial sediments in the in-water explorations. The sand is generally in a medium dense state to fairly great depths of up to 100 feet and deeper. Loose to medium dense sands were encountered at shallower depths.

**Gravel (Troutdale Gravel).** Deposits of gravel and mixtures of gravel and sand were encountered in the deep monitoring wells below the dark grey native sands. This deposit likely consists of the Troutdale Formation. The top of this deposit was generally encountered at depths ranging from 145 to 200 feet.

### C.1.3 Thickness of Recent Soft Sediments

Thirty-two vibracores were recovered in Slip 1, Slip 3, Wheeler Bay, at Berth 401, and north of Berth 414, primarily to obtain sediment samples for chemical analyses. In addition, piston borings and in-water borings were utilized to recover additional sediment samples to augment the vibracore sampling. These exploration data were also used to estimate the thickness of the recent soft sediments and their engineering characteristics. The vibracore and piston sampling locations are presented in Appendix E of this report.

The thickness of the recent soft sediments in each of the areas is discussed below.

- Slip 1: The soft sediment cover generally ranges from about 0 foot to 3 feet. Almost half of the sediment cores did not encounter any soft sediment and recovered predominantly sand. A thick deposit of surficial cohesive material was encountered in front of Berth 405 near the east end of Slip 1 (vibracores VC09 and VC15). The thickness in this area exceeds 13 to 15 feet.

- Slip 3: The majority of explorations in Slip 3 encountered practically no soft sediment cover overlying the grey sands. A deep cohesive deposit was encountered in front of Berth 411 (vibracore VC24). The thickness in this area exceeded 12 feet. A few other vibracores (VC26 and VC32) encountered 3.5 to 4 feet of cohesive material.

- Wheeler Bay: The thickness of soft sediment in Wheeler Bay increases approaching the open waters of the river. Sediments closer to the land are approximately 3 to 5 feet in thickness, while cohesive soil deposits closer to the river exceed 12 feet in thickness.

- Berth 401: Based on two vibracores, the soft sediment in this area is approximately 1 foot thick.

- North of Berth 414: Based on two vibracores, the soft sediment thickness in this area is between about 2 and 4 feet.

### C.1.4 Geotechnical Engineering Characteristics

The results of the subsurface investigation and laboratory program were used to characterize the sediments and soils encountered in the explorations. This appendix provides a summary of the geotechnical characteristics of the soils and sediments identified above and shown on the cross sections provided on Figures C-2 through C-4. Additional and more detailed discussions of the engineering characteristics are presented in the characterization report (BBL, 2004).

The soil units identified in the Terminal 4 area have the following general characteristics:

**Brown, Loose to Medium Dense Sand (Upland Explorations).** This soil unit likely consists of fill and was encountered in the upland borings across Terminal 4. The sand contains fairly small amounts of fines (5% to 15%). The grain-size characteristics of the sand are fairly uniform across Terminal 4. Based on experience with similar material of similar density, the saturated portions of the sand are likely prone to liquefaction during strong seismic shaking. Liquefaction can generally result in significant strength reduction and could potentially cause fairly large settlements and slope failures during and following seismic shaking. The liquefaction potential of these soils will be further analyzed during the EE/CA and subsequent design. Appropriate seismic design parameters required for such analyses have not yet been established and are not the purpose of this report.

**Very Soft, Organic Silt and Clay (Recent Sediments).** Based on laboratory tests performed on samples from the in-water borings, the recent sediments overlying the grey, loose to medium dense sands consist predominantly of very soft organic silt and clay with liquid limits ranging from about 70 to nearly 100 and moisture contents ranging from 67% to 106%. The fines content of these sediments generally ranges from 51% to 96%, with average fines content ranging from 75% to 85% in the five areas identified in Section C.1.3.

Consolidation tests were performed on two samples consisting of very soft organic silt and clay. The results indicate that these soils are highly compressible and would likely settle significantly under structural loads or the weight of fill, e.g., a berm or cap. Based on consolidation and plasticity results, as well as on testing conducted in the field (including pocket penetrometer tests, torvane tests, and Standard Penetration Resistance), it is expected that these soils are normally consolidated and have very low undrained shear strengths. The undrained strength of the very soft sediments is estimated to be on the order of about 20 to 140 pounds psf.

**Very Soft to Medium Stiff Organic and Inorganic Silts and Clays (Upland Explorations).** Because this soil unit was encountered east of Slip 1 and Slip 3, its geotechnical engineering characteristics would affect only upland structures underlain by this material. Relatively large portions of this material consist of organic clay and silt with liquid limits ranging from 46 to 55 and moisture contents between 46% and 52%. These plasticity data indicate that this material exhibits relatively high compressibility. Due to the estimated, relatively high compressibility of this soil, heavy upland structures and fill placed on these deposits could potentially be subject to excessive time-dependent consolidation settlements. The presence of the material affects hydrogeologic aspects at the Terminal 4 area. Gatton's Slough deposits, located within and at the head of Slip 1, add complexity to engineering and hydrogeologic characteristics in this area.

**Interbedded Silt and Sand (Medium Stiff to Stiff/Medium Dense).** Based on boring GEO4L, this unit contains interbedded layers of sand, silt of varying plasticity (non-plastic to plasticity index of 30), and organic cohesive soils with liquid limits exceeding 50. SPT and CPT data indicate that the sands are likely in a medium dense state (SPT N-values ranging from about 10 to 15). The cohesive soils appear to be in a medium stiff to stiff state (SPT N-values ranging from about 5 to 10). Based on strength testing (unconsolidated-undrained triaxial compression), this material may be normally consolidated to slightly overconsolidated at depths below 60 feet. Since the in-water soils have not been exposed to drying, it is likely that the cohesive material underlying the eastern portions of Slip 1 and Slip 3 is also in a normally consolidated to slightly overconsolidated state. Portions of these soils likely exhibit moderate compressibility. Undrained shear strength of the cohesive soils likely varies with depth based on the state of consolidation. The liquefaction potential of this soil deposit will be evaluated once the seismic design parameters have been established for this project.

**Dark Grey, Loose to Medium Dense Sand.** The presence of this soil unit affects a large portion of the area to the west of Gatton's Slough. Based on the grain size data collected in this soil unit, the material generally has fines contents ranging from 3% to 8%. Based on in-situ SPT and CPT data, this material is in a medium dense state (SPT N-values of 10 to 30) to depths exceeding about 80 to 110 feet. High Standard Penetration Resistances encountered at shallower depths in monitoring wells T4-MW01 and T4-MW06 may not be representative based on the results from adjacent explorations. Lower densities in the loose range (SPT N-values of 4 to 10) were encountered at shallower depths below surficial covering that consisted of recent sediments in the in-water explorations and fill in the upland explorations. The loose grey sand layer ranges between 3 and 14 feet in thickness.

Liquefaction potential is typically assessed based on the Standard Penetration Resistance (SPT N-value) and the fines content of granular soils. The combination of fairly low density and small fines content of this material makes the saturated portions of the sand potentially prone to liquefaction during strong seismic shaking, resulting in excessive settlement and loss of strength. The loose deposits and large portions of the medium dense material could potentially liquefy during a design-level seismic event. Further discussions on liquefaction are provided in Appendix K – CDF Feasibility.

**Gravel (Troutdale Gravel).** Because of the great depth at which this soil unit was encountered, the Troutdale mainly affects hydrogeologic aspects of this project and is not likely to impact structures or construction activities at the surface.

## C.2 Seismic Design Parameters

The Terminal 4 Removal Action Area is located within a seismically active region of the Pacific Northwest. A site-specific seismic response analysis was performed to estimate ground accelerations and other seismic parameters for the design seismic events. We also performed liquefaction analyses to estimate the extent of liquefaction during the design events. The results of these analyses were used for preliminary stability analyses that were performed to assess the feasibility of technologies selected for the site. In particular, the seismic parameters were used to assess the stability of a CDF containment berm as part of the CDF feasibility assessment presented in Appendix K.

### C.2.1 Design Seismic Events

There are no established requirements or guidelines to select appropriate design seismic events for the design of remedial design components such as CDFs at USEPA Superfund sites, the site response analysis for two events of different magnitude of seismic shaking was performed, in a manner similar to the design utilized for other CDFs in the Pacific Northwest:

- 72-year return period (50 percent of exceedance in 50 years); and
- 475-year return period (10 percent of exceedance in 50 years).

### C.2.2 Site-Specific Seismic Response Analysis

The computer program ProShake was used to perform one-dimensional equivalent-linear site response analyses. ProShake was developed based on the computer program SHAKE, which was originally developed by Schnabel, et al. (1972). ProShake requires input of a design soil profile consisting of unit weight, shear wave velocity, and soil-type specific modulus reduction and damping curves. Based on an assessment of potential seismic sources, ground motion time histories are selected as input as well.

#### C.2.2.1 Seismic Source Characterization

The tectonic setting of western Oregon and Washington is dominated by the Cascadia subduction zone where the offshore Juan de Fuca plate is subducted by the North American plate (Weaver and Shedlock, 1989). Three seismic source components result from the subduction zone setting: (1) Crustal fault earthquakes, (2) intraplate earthquakes, and (3) interplate earthquakes (Mabey and Madin, 2003).

There are several crustal faults in the Portland area that represent a significant contribution to the seismic hazard at the site. These faults include the Portland Hills, Oatfield, East Bank, and other faults (Wong et al., 2000). The crustal faults are believed to produce earthquake magnitudes ranging from about 6.0 to about 7.3 at relatively shallow depths.

Intraplate earthquakes occur within the subducting Juan de Fuca plate as it is forced downward beneath the North American plate. Several of such earthquake events have occurred in the recent past (e.g., Olympia, 1949, SeaTac, 1965, and Nisqually, 2001). The intraplate earthquakes are believed to produce magnitudes ranging from about 6.8 to 7.5 at depths ranging from about 45 to 60 kilometers.

Interplate (also known as megathrust) earthquakes occur at shallower depths within the interface of the plates along the coast line and are believed to produce magnitudes on the order of 8.0 to 9.0. No such event has occurred in the recent 200-year history of the area. However, there is evidence that a megathrust event occurred along the Oregon and Washington coast in the 1700s.

#### C.2.2.2 Design Soil Profiles

We generated several design soil profiles to represent the subsurface conditions at the site. The design profiles were based on the results of our recent subsurface investigation (BBL, 2004) and information provided on local geology maps (Beeson et al., 1991). The depth to bedrock at the Terminal 4 site was obtained from earthquake-hazard geology maps (Madin, 1990). Shear wave velocity profiles within the alluvial sands underlying the site were established based on measurements taken during seismic cone penetration testing in 2004 (BBL, 2004). Velocities for deeper layers of soil and rock were obtained from Wong et al. (2000).

We modeled the following layers underlying the site:

- Surficial soils and alluvial sands;
- Troutdale formation (gravel) – elevation -145 feet to -270 feet (CRD);
- Sandy River Mudstone – elevation -270 feet to -345 feet (CRD); and
- Bedrock (Basalt) – below elevation -345 feet (CRD).

The site response analysis was performed in part to obtain input parameters for stability assessment of the CDF containment berm. The berm stability analyses are presented in Appendix K – CDF Feasibility. To obtain ground accelerations and other parameters within and below the CDF containment berm, additional layers to the basic soil profile were included representing the berm material. Soil parameters for these layers were estimated based on experience. A total of three design soil profiles were created to represent the conditions in front of the berm (equivalent to in-water conditions at the present time) and with the berm in place (i.e., sections through the berm at the center of the berm and at midslope.)

#### C.2.2.3 Input Ground Motions

Strong ground motion records consisting of acceleration time history data are available to the public from several sources (e.g., COSMOS Virtual Data Center and PEER Strong Motion Database). Based on the seismic source characterization presented above, we selected six ground motions that fit the characteristics (i.e., mechanism, magnitude, and distance) of the sources that contribute to the seismic hazard at the site. The peak ground accelerations (PGA) of the input ground motions were scaled to match the peak ground accelerations for firm rock sites obtained from the 2002 USGS National Seismic Hazard Mapping Project (USGS, 2002). Since PGA values for the 72-year event (i.e., the operational level event) were not available, a PGA value of 0.08g was used, which is a slightly more conservative value. For the 475-yr event (CLE), a PGA of 0.2g was used.

Based on the USGS data the major contributions to the seismic hazard at the site come from sources at distances ranging from only a few kilometers (km) to about 40 km and magnitudes ranging from about 5.0 to 7.0, as well as from sources at distances ranging from about 80 to 130 km with magnitudes ranging from about 8.3 to 9.0.

Table C-1 presents the ground motion records that were used for the ProShake analysis.

**Table C-1 – Strong Ground Motions Used in Site Response Analysis**

| Record | Mechanism | Date | Distance in km | Magnitude | PGA in g |
|---|---|---|---|---|---|
| Northridge, California | Crustal (Reverse) | January 17, 1994 | 37 | 6.7 | 0.32 |
| San Fernando, California | Crustal (Reverse) | February 9, 1971 | 19 | 6.6 | 0.20 |
| Michoacan, Mexico | Subduction (Interplate) | September 19, 1985 | 27 | 8.1 | 0.14 |
| Nisqually, Washington | Subduction (Intraplate) | February 28, 2001 | 75 | 6.8 | 0.15 |
| SeaTac, Washington | Subduction (Intraplate) | April 29, 1965 | 79 | 6.5 | 0.20 |
| Olympia, Washington | Subduction (Intraplate) | April 13, 1949 | 60 | 7.1 | 0.28 |

### C.2.2.4 Results of Seismic Response Analyses

The input parameters presented above were used in conjunction with the computer program ProShake to estimate ground accelerations and cyclic stress ratios at the site. Tables C-2 and C-3 summarize the results of the analyses for the 72-year event and the 475-year event, respectively. The tables present the results for the three relevant soil profiles that were introduced above.

**Table C-2 – Summary of ProShake Results for the 72-Year Event**

| | No Berm | With Berm Section at Midslope | With Berm Section at Crest |
|---|---|---|---|
| **PGA in g** | 0.18 | 0.12 | 0.11 |
| **Variation of Peak Acceleration Within Berm in g** | N/A | 0.08-0.12 | 0.06-0.11 |
| **Variation of CSR within Top 50 Feet of Alluvium** | 0.12-0.34 | 0.06-0.12 | 0.04-0.43 |

**Table C-3 – Summary of ProShake Results for the 475-Year Event**

| | No Berm | With Berm Section at Midslope | With Berm Section at Crest |
|---|---|---|---|
| **PGA in g** | 0.27 | 0.16 | 0.21 |
| **Variation of Peak Acceleration Within Berm in g** | N/A | 0.10-0.16 | 0.09-0.21 |
| **Variation of CSR within Top 50 Feet of Alluvium** | 0.13-0.51 | 0.10-0.16 | 0.05-0.06 |

The results of the site-response analysis were used as input in preliminary pseudostatic earthquake slope stability and liquefaction analyses that were performed to assess the technical feasibility of the confined disposal facility. The slope stability and liquefaction analyses are presented in Appendix K – CDF Feasibility.

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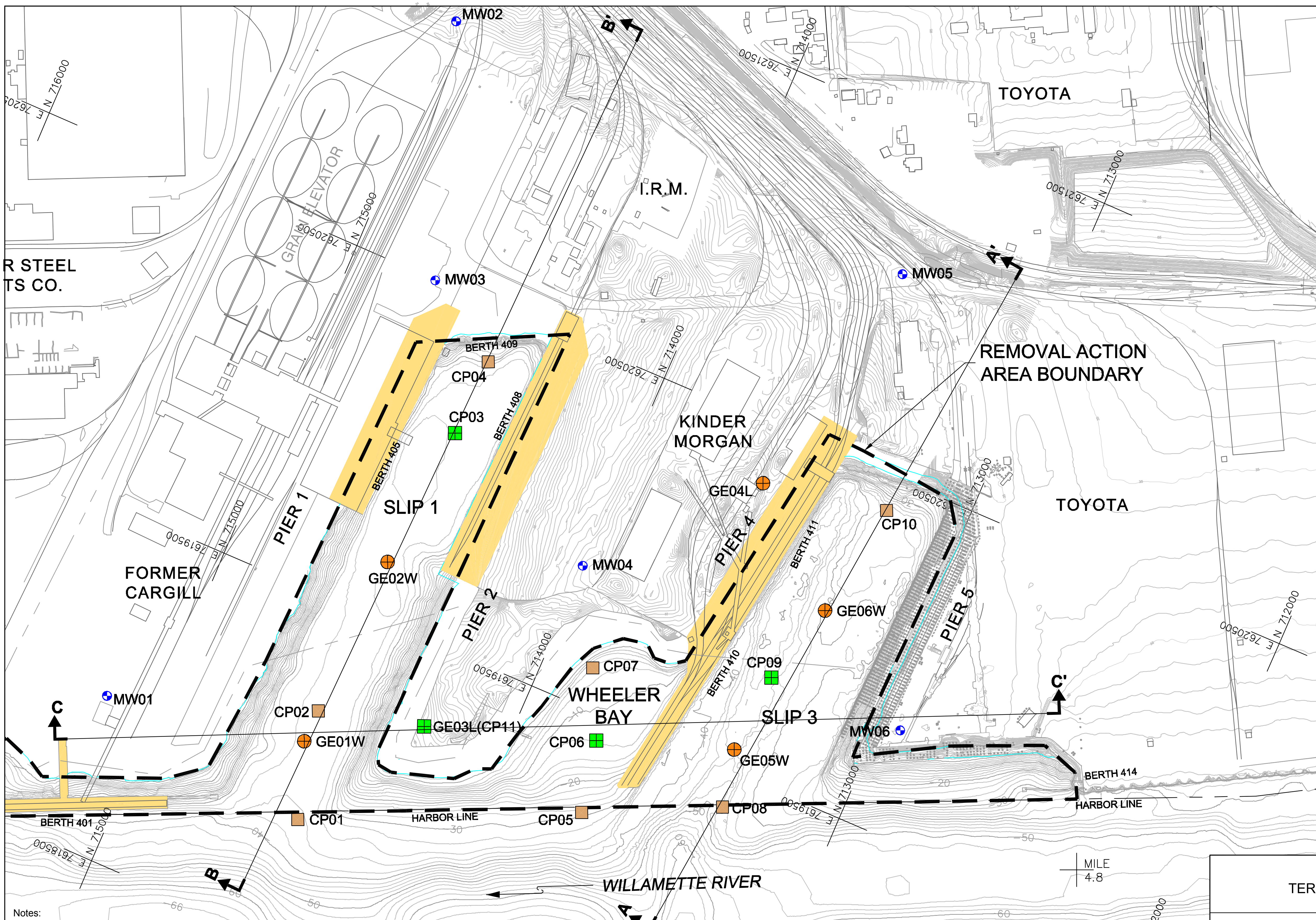


| EVENT ELEVATION | DATUM COMPARISON |
|---|---|
| EL +14.9 FT CRD (OHW) | |
| EL +1.7 FT CRD (OLW) | EL +0.0 FT CRD |
| | EL -1.7 FT CRD (USC&GS 1947, NGVD, MSL, APPROX.) |
| | EL -3.1 FT CRD (CITY OF PORTLAND, APPROX.) |
| | EL -5.2 FT CRD (NAVD 1988, APPROX.) |

CRD: Columbia River Datum

USC&GS: US Coast & Geodetic Survey

NGVD: National Geodetic Vertical Datum

NAVD: North American Vertical Datum

OHW: Ordinary High Water Between Willamette River Mile 4 and 5

OLW: Ordinary Low Water at River Mile 4.5

MSL: Mean Sea Level (1947 Adjustment)

Example Conversion: NGVD=CRD+1.7

Notes:

1. Upland topographic vertical datum is NGVD; Bathymetric vertical datum is CRD.
2. Site Plan is based on drawings provided by the Port of Portland.
3. Shoreline boundary for Ordinary High Water is approximate.
4. Willamette River Mile reference marks are approximate.
5. Diurnal tide range during low river stages is 2.2 feet at St. Johns and 2.4 feet at Portland.
6. Datum conversion tables to CRD provided by Port of Portland.
7. Ordinary Low Water elevation provided by USACE.
8. Ordinary High Water elevation provided by Port of Portland.

Existing Piers

Field-Verified Geotechnical Boring Location

Field-Verified Cone Penetrometer Location

Field-Verified Seismic Cone Penetrometer Location

Field-Verified Monitoring Well Location

DRAFT DOCUMENT

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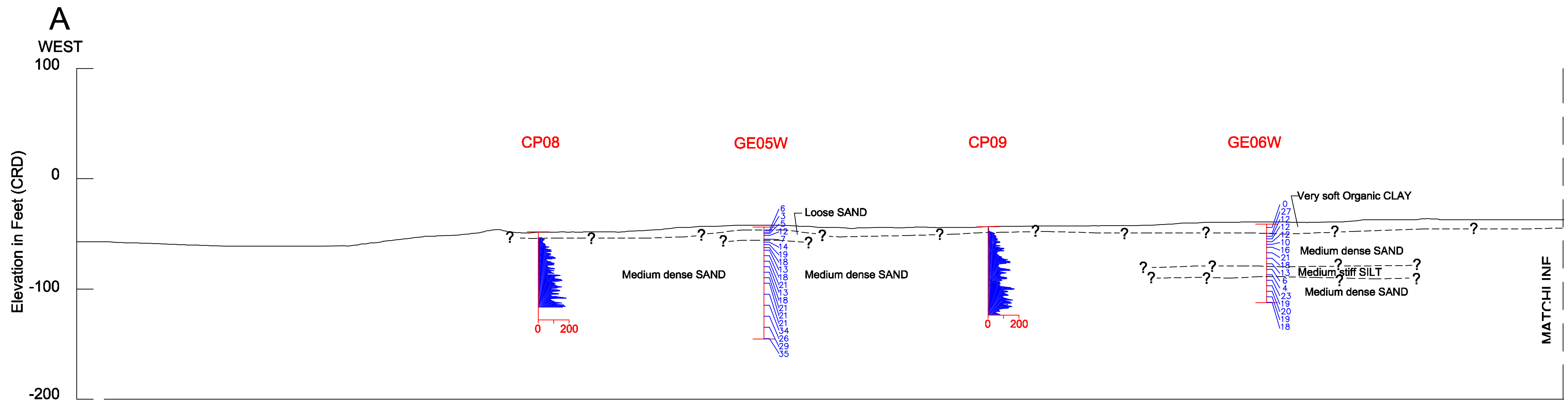
PORT OF PORTLAND
PORTLAND, OREGON
TERMINAL 4 EARLY ACTION
EE/CA REPORT

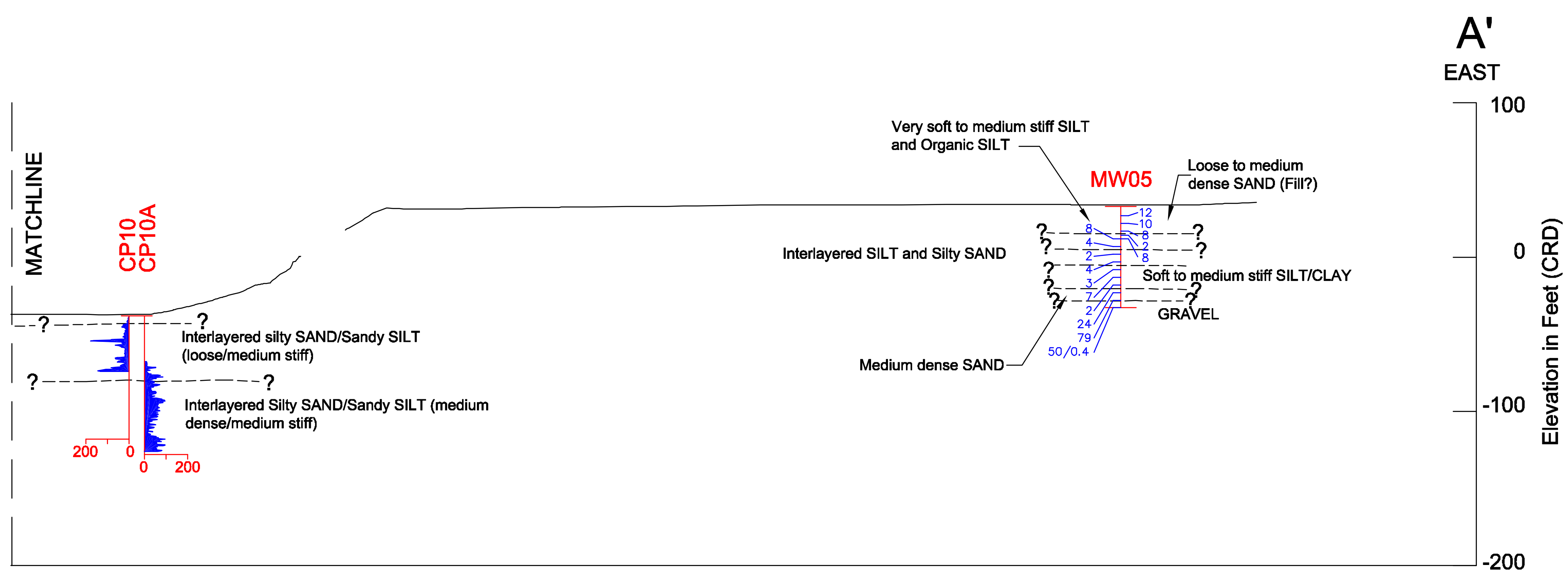
CROSS SECTION LOCATION MAP
GEOTECHNICAL EXPLORATIONS

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE
C-1

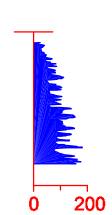
DWG NAME: G:\project\Clients\BBL\Terminal 4\t4_024 (EECA_C-1).dwg
DATE: 12/02/04 12:44pm



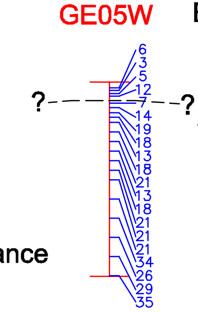

Legend

CP08 Exploration ID




Cone Tip Resistance in tsf

GE05W Exploration ID



Geologic Contact Approximate

Standard Penetration Resistance in Blows per Foot

0 100 200
Scale in Feet

Note: Vertical Datum is Columbia River Datum (CRD).

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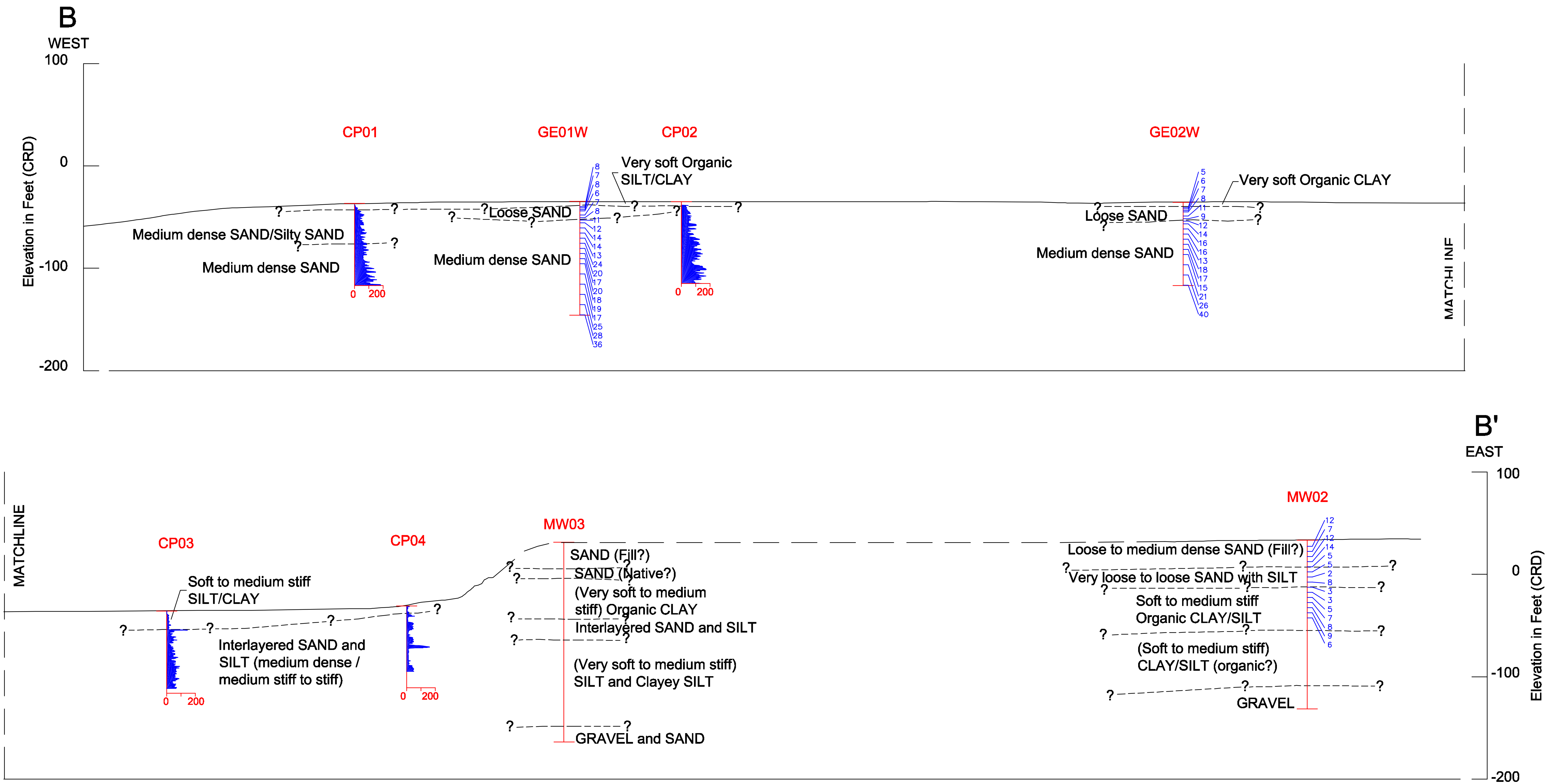
PORT OF PORTLAND
PORTLAND, OREGON
TERMINAL 4 EARLY ACTION
EE/CA REPORT

CROSS SECTION A-A' (SLIP 3)
GEOTECHNICAL EXPLORATIONS

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
C-2

DWG NAME: G:\project\Clients\BBL\Terminal 4\t4_031(EECA C-2 to C-4).dwg
DATE: 12/02/04 12:52pm




Legend

CP08 Exploration ID

GE05W Exploration ID

Geologic Contact Approximate

Standard Penetration Resistance in Blows per Foot

Cone Tip Resistance in tsf (0 200)

Scale in Feet: 0 100 200

Note: Vertical Datum is Columbia River Datum (CRD).

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PORT OF PORTLAND
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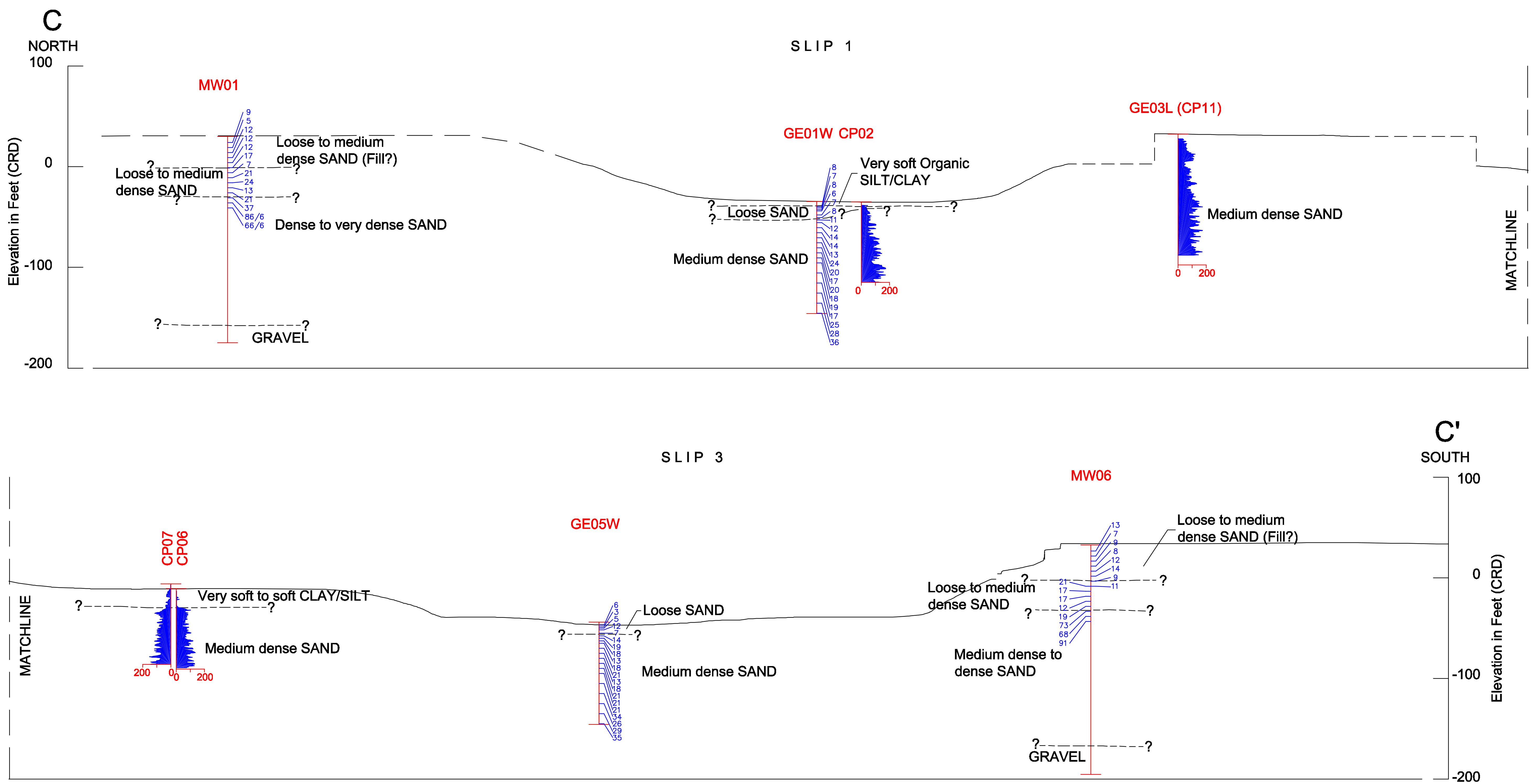
TERMINAL 4 EARLY ACTION
EE/CA REPORT

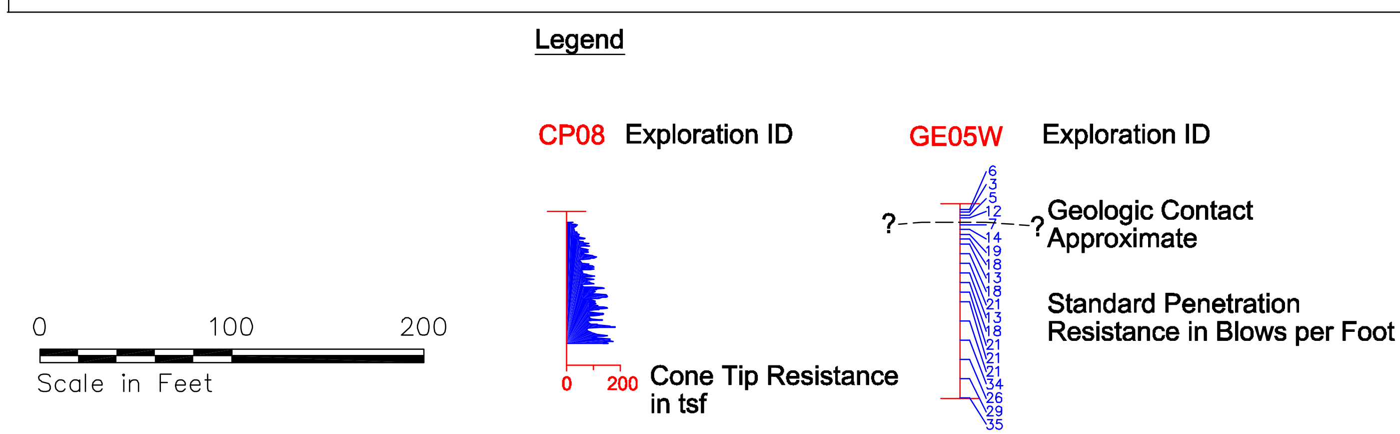
CROSS SECTION B-B' (SLIP 1)
GEOTECHNICAL EXPLORATIONS

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
C-3

DWG NAME: G:\project\Clients\BBL\Terminal 4\t4_031(EECA C-2 to C-4).dwg
DATE: 12/02/04 12:52pm




Note: Vertical Datum is Columbia River Datum (CRD).

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CROSS SECTION C-C'
GEOTECHNICAL EXPLORATIONS

BBL
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FIGURE
C-4

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DATE: 12/02/04 12:52pm