Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

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March 28, 2014

Port of Kalama
Mr. Jacobo Salan
380 West Marine Drive
Kalama, Washington 98625

Re: Construction Recommendations and Infiltration Testing Results Report
Port of Kalama Marina Parking and Waterfront Park Improvements
Kalama, Washington
CWE W.O. #: 14035

Mr. Salan:

As requested, Columbia West Engineering, Inc. is pleased to submit this construction recommendation and infiltration testing results report for the proposed Port of Kalama Marina Parking Area and Waterfront Park Improvements in Kalama, Washington. The purpose of this report is to provide general earthwork recommendations, soil infiltration rate observations and subsequent recommendations for site planning and stormwater management. The specific scope of services was outlined in a proposal contract dated March 3, 2014. This report is subject to the limitations expressed in Appendix D.

Site Location and Description

As indicated on Figures 1 and 2, the subject site is comprised of two study areas and includes a portion of two parcels (Nos. 41056 and 412640100) totaling approximately 22 acres. The northern study area is occupied by the Port of Kalama Administrative Office Building and Marina Parking area. The southern study area includes the northern portion of the Marina Waterfront Park.

The site is located at 380 West Marine Drive in Kalama, Washington, northwest of the intersection with North Hendrickson Drive. The subject site lies on an embankment constructed in 1963 by the US Army Corps of Engineers during Columbia River channel dredging operations intent on deepening the navigation channel for deep-draft vessels. The site is generally flat except for the rip-rap protected shoreline slopes adjacent to the river. According to preliminary survey data provided by the client, site elevations range from approximately 23 feet above mean sea level (amsl) in the Marina parking area to approximately 2 feet amsl at the Columbia River water level. The regulatory jurisdictional agency is City of Kalama. The approximate latitude and longitude are N 46° 00’ 25” and W 122° 50’ 54” and the legal description is a portion of the NE ¼ of Section 18, T6N, R1W, Willamette Meridian.

Proposed Development

Correspondence with the client indicates proposed development in the northern study area includes paving the existing gravel marina parking area and adding shallow infiltration basins along the perimeter of the parking lot. Proposed development in the southern study area includes construction of a small amphitheater southwest of the existing bathroom facility in the Marina Waterfront Park. Construction of the amphitheater is anticipated to consist of excavating a sunken stage area, installation of an infiltration system for stormwater, and terracing of a minor fill slope for audience seating. Columbia West has reviewed preliminary grading plans and understands that minor cut and fill areas may be proposed. This report is based upon proposed development as described above and may not be applicable if modified.

Site Geologic and Soil Conditions

According to the *Geologic Map of the Mount St. Helens Quadrangle, Washington and Oregon (Washington Division of Geology and Earth Resources, Open File Report 87-4, 1987*), near-surface soils are expected to consist of Holocene alluvium (Qal). However, historical research of the Port of Kalama Marina indicates that the site was constructed with dredge sand material derived from the US Army Corp of Engineers' channelizing efforts within the adjacent Columbia River beginning in 1963.

The *Soil Survey of Cowlitz County, Washington (United States Department of Agriculture, Soil Conservation Service [USDA SCS], November 1972)* identifies surface soils as primarily Pilchuck loamy fine sand. Pilchuck soils are generally fine- to medium-textured and excessively well drained. Pilchuck soils typically have very rapid permeability, low to moderate water capacity, severe erosion hazard where subject to flooding, and moderate shear strength.

Field Exploration and Soil Description

As indicated in Figure 2, subsurface exploration for the infiltration testing and construction recommendations was conducted on March 14, 2014 and consisted of six test pit explorations (TP-1 through TP-6) to a maximum depth of 12 feet below existing ground surface. Additional subsurface exploration included three hand-auger explorations to a maximum depth of 8.25 feet. Test pits were excavated with a track-mounted excavator and a rubber-tired backhoe.

Observed soils underlying the gravel parking area in the northern study area consisted of grey, dry, medium dense, non-plastic poorly graded sand to the maximum depth explored. The upper 12 to 24 inches of sandy soil appeared to contain higher amounts of silt. The soil underlying the Marina parking area is interpreted to be dredge sand fill material.

Observed soils underlying the Marina Waterfront Park in the southern study area consisted of approximately 4 feet of silty sand fill material mixed with silt/clay lenses and sparse construction debris underlain by poorly graded sand dredge fill to the maximum depth explored of 12 feet.

Representative soil samples were collected from the depth of the infiltration tests. Selected samples were submitted for laboratory analysis for USCS soil classification. Analytical test reports are provided in Appendix A and exploration logs are presented in Appendix B. Soil classification information is provided in Appendix C.

Groundwater

Groundwater was not encountered within the subsurface exploration and is anticipated to coincide with the elevation of the Columbia River. Seasonal and dam-release river level and tidal fluctuations within the nearby Columbia River may influence local groundwater conditions. Groundwater levels are also often subject to seasonal variance and may rise during extended periods of increased precipitation. Perched groundwater may also be present in localized areas. Structures and drainage design should be planned accordingly.

Infiltration Analysis

Seven infiltration tests were conducted at the site at depths of 2 to 5.5 feet below original ground surface. The single-ring, falling head infiltration test method was used. Tests were conducted by filling the apparatus with water, allowing the soil sample to saturate, and recording time and drop measurements at regular intervals. Using Darcy's Law for saturated flow in homogeneous media, the coefficient of permeability was then calculated to develop estimated infiltration rates. Estimated infiltration rates have been reported without application of a factor of safety.

Summary of Infiltration Results

As indicated in Table 1, the infiltration tests were conducted at various depths in poorly graded sand (SP) soils. The tested infiltration rates ranged from 17 to 74 inches per hour. Soil laboratory

analytical test reports are provided in Appendix A. Soil classifications presented in Table 1 are based upon laboratory analysis when available. Infiltration rates are presented as a coefficient of permeability (k) and have been reported without application of a factor of safety.

Table 1. Estimated Infiltration Rates (Coefficient of Permeability (k).

Infiltration Test No.	Location	Soil Type*	Estimated Infiltration Rate (Coefficient of Permeability in inches/hour)	Approximate Test Depth	Depth to Groundwater (3/14/2014)	Passing No. 200 Sieve (%)*
IT-1.1	TP-1	***SP, Poorly graded SAND	74	4 FT	Not encountered	N/A**
IT-2.1	TP-2	***SP, Poorly graded SAND	43	2 FT	Not encountered	N/A**
IT-3.1	TP-3	*SP, Poorly graded SAND	25	2 FT	Not encountered	1.3
IT-3.2	TP-3	*SP, Poorly graded SAND	60	4 FT	Not encountered	0.1
IT-4.1	TP-4	***SP, Poorly graded SAND	20	3.5 FT	Not encountered	N/A**
IT-5.1	TP-5	***SP, Poorly graded SAND	17	5 FT	Not encountered	N/A**
IT-6.1	TP-6	*SP, Poorly graded SAND	34	5.5 FT	Not encountered	0.6

* Soil Type and Passing No. 200 Sieve (%) based upon laboratory analysis. ** N/A = not analyzed ***Visual Classification

Infiltration System Recommendations

Columbia West provides the following recommendations for design and construction of the proposed stormwater management systems in the northern and southern study areas:

- Infiltration facilities should be protected from erosion, especially during construction. Improperly designed or constructed systems may become fouled or plugged with mud or micaceous sediment.
- If infiltration is considered, excavation and preparation of stormwater disposal facilities should be closely monitored by a geotechnical engineer and an appropriate factor of safety should be applied to the infiltration rates provided in Table 1 prior to use in design calculations. An emergency overflow discharge point should be provided.
- Due to variations in fill materials encountered at the site, as well as seasonally fluctuating groundwater conditions, infiltration rates are anticipated to vary throughout the site. Therefore, infiltration rates should be verified by additional testing during construction when subgrade soils are exposed. All subgrade soils should be observed by the geotechnical engineer to verify soil index properties pertaining to infiltration are similar to those at the tested locations.
- The elevation of the groundwater table is likely to have significant impact upon soil infiltration rates. The potential for reduced infiltration or partially submerged systems during flood events should be understood.
- Site soil conditions and localized infiltration capability may be highly variable. Limited one-day infiltration testing may not be an accurate predictor of long-term, post-developed system performance for sites with complex and highly variable soils. It

should be understood that the systems may require additional infiltration capacity if future conditions indicate the systems are not functioning according to original tested and designed parameters.

- This Infiltration Testing Results Report does not address potential geotechnical issues related to the effects of stormwater infiltration adjacent to site slopes. Columbia West understands that slope stability has been addressed by a separate consultant in a site-specific report.

Earthwork and Utility Construction Recommendations

Construction of the amphitheater in the southern study area is anticipated to consist of minor cut and fill areas. Vegetation should be cleared and topsoil stripped from areas identified for structures and site grading. Stripped topsoil should be removed, or used only as landscape fill in nonstructural areas with slopes less than 25 percent. Previously disturbed soil, debris, or unsuitable fill encountered during grading or construction activities should be removed completely and thoroughly. Demolished structures should be removed entirely. This includes old foundations, utilities, and associated unconsolidated soils. Excavation areas should be backfilled with engineered structural fill. Generally, site grading activities should be performed in accordance with requirements specified in the 2012 International Building Code (IBC), Chapter 18 and Appendix J.

In order to reduce the potential for soil creep or movement in amphitheater slopes, engineered structural fill should be placed in loose lifts not exceeding 12 inches in depth and compacted using standard conventional compaction equipment. Existing fill soils observed in the vicinity of the proposed excavation area appeared suitable for use as structural fill provided they are properly moisture conditioned and compacted. The soil moisture content should be within two percentage points of optimum conditions. A field density at least equal to 95 percent of the maximum dry density, obtained from the standard Proctor moisture-density relationship test (ASTM D698), is recommended for silt and clay structural fill placement. For engineered structural fill placed on sloped grades, the area should be benched to provide a horizontal surface for compaction. The post-construction maximum depth of topsoil or landscape fill placed or spread at any location onsite should not exceed one foot.

Utility installation may require subsurface excavation and trenching. Excavation, trenching and shoring should conform to federal Occupational Safety and Health Administration (OSHA) (29 CFR, Part 1926) and *WISHA* (WAC, Chapter 296-155) regulations. Site soils may slough when cut vertically and sudden precipitation events or perched groundwater may result in accumulation of water within excavation zones and trenches. These areas should be dewatered in accordance with appropriate discharge regulations.

Utilities should be installed in general accordance with manufacturer's recommendations. Utility trench backfill should consist of crushed aggregate or other coarse-textured, free-draining material acceptable to the client, City of Kalama, and the site geotechnical engineer. Trench backfill material within 18 inches of the top of utility pipes should be hand compacted (i.e., no heavy compaction equipment). The remaining backfill should be compacted to at least 95 percent of maximum dry density as determined by the standard Proctor moisture-density test (ASTM D698). Clean, free-draining, fine bedding sand is recommended for use in the pipe zone. With exception of the pipe zone, backfill should be placed in loose lifts not exceeding 12 inches in thickness.

Compaction of utility trench backfill material should be verified by nuclear gauge field compaction testing performed in accordance with ASTM D6938. It is recommended that field compaction testing be performed at 250-foot intervals along the utility trench centerline at the surface and midpoint depth of the trench. Compaction frequency and specifications may be modified for non-structural areas in accordance with recommendations of the site geotechnical engineer.

Conclusion and Limitations

This geotechnical report was prepared in accordance with accepted standard conventional principles and practices of geotechnical engineering. This report pertains only to material tested and observed, and is based upon proposed site development as described in this report. The information, opinions and recommendations of this report are intended for use during the design phase of the project. This report is not an environmental assessment and should not be construed as a representative warranty of subsurface site conditions. The results and observations of this investigation are directly applicable and specifically accurate only for the exact tested locations on the date of the tests. If infiltration is proposed at areas or depths other than the locations tested, the results of this investigation may not be applicable for design. The discovery of adverse environmental conditions, or subsurface soils that deviate significantly from those described in this report, should immediately prompt further investigation. The above statements are in lieu of all other statements expressed or implied.

This report was prepared solely for the client and is not to be reproduced without prior authorization from Columbia West. It is recommended that the conclusions and recommendations of this report be incorporated throughout the design process by all involved parties. Columbia West is not responsible for independent conclusions or recommendations made by others based upon information presented in this report. Additional limitations and important information about this report are provided in Appendix D. This information should be carefully read and understood by the client and civil/site plan engineer.

Columbia West appreciates the opportunity to provide geotechnical services. Please call me at 360-823-2900 if you have any questions or need additional information.

Sincerely,

COLUMBIA WEST ENGINEERING, Inc.

Lance V. Lehto, PE, GE
President

LVL:ASR

Attachments: Figures
Appendices A through D

References

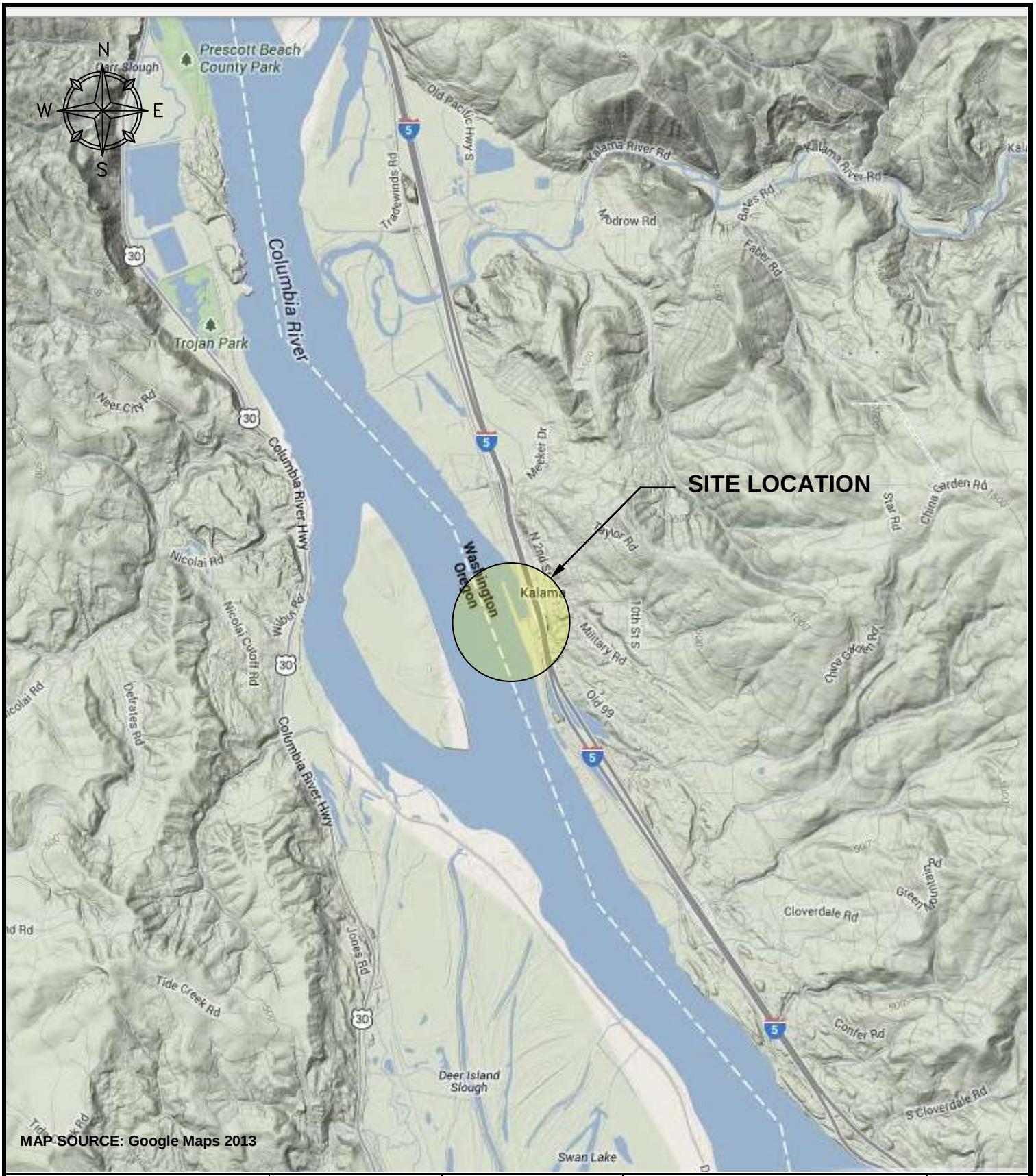
Cowlitz County NetMaps (http://www.cowlitzinfo.net/netmaps25/index.html).

Hinchliff, Catherine, "*A group of Kalama residents meets to organize Port of Kalama on December 22, 1919.*" *http://www.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=9736.*

Phillips, William M., *Geological Map of the Mount St. Helens Quadrangle, Washington and Oregon*, Washington State Department of Natural Resources, Division of Geology and Earth Resources, Open File Report 87-4, 1987.

Soil Survey of Cowlitz Area, Washington, United States Department of Agriculture Soil Conservation Service, February 1974.

FIGURES



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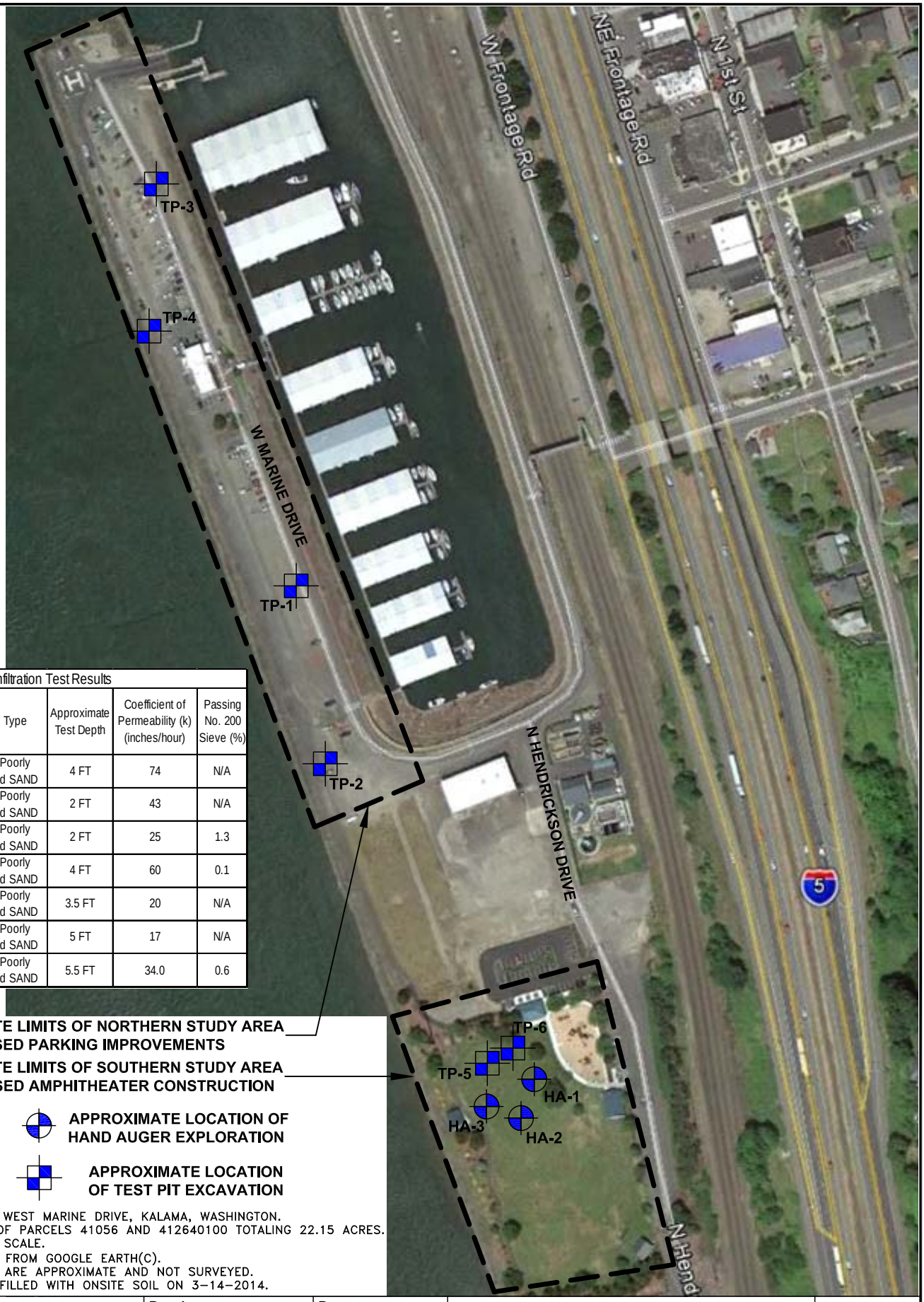
Design	Drawn: ASR		
Checked: LVL	Date: 03/20/14		
Client: POK	Rev	By	Date
Job No.: 14035			
CAD File: FIGURE 1			
Scale: ~1:50,000			

SITE LOCATION MAP

PORT OF KALAMA MARINA AND WATERFRONT PARK IMPROVEMENTS
KALAMA, WASHINGTON

FIGURE 1



Infiltration Test Results

Test Number	Test Pit Location	Soil Type	Approximate Test Depth	Coefficient of Permeability (k) (inches/hour)	Passing No. 200 Sieve (%)
IT-1.1	TP-1	SP, Poorly graded SAND	4 FT	74	N/A
IT-2.1	TP-2	SP, Poorly graded SAND	2 FT	43	N/A
IT-3.1	TP-3	SP, Poorly graded SAND	2 FT	25	1.3
IT-3.2	TP-3	SP, Poorly graded SAND	4 FT	60	0.1
IT-4.1	TP-4	SP, Poorly graded SAND	3.5 FT	20	N/A
IT-5.1	TP-5	SP, Poorly graded SAND	5 FT	17	N/A
IT-6.1	TP-6	SP, Poorly graded SAND	5.5 FT	34.0	0.6

APPROXIMATE LIMITS OF NORTHERN STUDY AREA AND PROPOSED PARKING IMPROVEMENTS

APPROXIMATE LIMITS OF SOUTHERN STUDY AREA AND PROPOSED AMPHITHEATER CONSTRUCTION

APPROXIMATE LOCATION OF HAND AUGER EXPLORATION

APPROXIMATE LOCATION OF TEST PIT EXCAVATION

NOTES:
1. SITE LOCATION: 380 WEST MARINE DRIVE, KALAMA, WASHINGTON.
2. SITE IS A PORTION OF PARCELS 41056 AND 412640100 TOTALING 22.15 ACRES.
3. DRAWING IS NOT TO SCALE.
4. BASE MAP OBTAINED FROM GOOGLE EARTH(C).
5. TEST PIT LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
6. ALL TEST PITS BACKFILLED WITH ONSITE SOIL ON 3-14-2014.

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Design:	Drawn: ASR		
Checked: LVL	Date: 3/25/14		
Client: POK	Rev	By	Date
Job No: 14035			
CAD File: FIGURE 2			
Scale: NONE			

SUBSURFACE EXPLORATION LOCATION MAP

PORT OF KALAMA MARINA PARKING AND WATERFRONT PARK IMPROVEMENTS
KALAMA, WASHINGTON

FIGURE 2