90 Percent Design
River Sediment Capping Design

Spokane River Beach Cleanup Sites
Myrtle Point Project Site
Spokane County, Washington

for
Washington Department of Ecology

May 3, 2012

GeoEngineers
Earth Science + Technology

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523 East Second Avenue
Spokane, Washington 99202
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File No. 0504-072-00

May 3, 2012

Prepared for:

Washington Department of Ecology
Toxics Cleanup Program – Eastern Regional Office
4601 North Monroe Street
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Attention: David George

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GeoEngineers

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INTRODUCTION

Project Background

Several high-use beach sites along the Spokane River are contaminated with elevated levels of metals (lead, arsenic, zinc and cadmium) as a result of historical mining practices in the Coeur d'Alene Basin. High-use beach sites along the river are of specific concern because exposure risk to the public through direct-contact, inhalation, and ingestion pathways are increased with time spent recreating in the finer-grained, contaminated sediments. The Washington Department of Ecology (Ecology) has previously administered the stabilization of several contaminated sites along the Spokane River. Stabilization typically has been accomplished using engineered capping materials with site-specific gradation and shape specifications designed to minimize direct-contact with the contaminated sediments and minimize the mobilization of contaminated sediments further downstream.

Project Overview

The Myrtle Point site (Project Site) is located on south side of the Spokane River, approximately 2,600 feet downstream of the Trent Avenue Bridge. The intent of this project is to provide sediment stabilization (capping) design for the Project Site. The intent of the design for the Project Site is to stabilize the contaminated sediment with appropriately-sized rock, riparian vegetation and to maintain usable access.

This design has been provided at the request of Ecology, in accordance with our proposal dated October 18, 2011 and our Work Assignment Number C110145L signed October 26, 2011. The services performed under this contract are described in more detail in this report under the Scope of Services section below.

Report Overview

GeoEngineers Inc. (GeoEngineers) has prepared this report to provide a stabilization capping design to limit exposure to existing metals-contaminated sediments and the amount of metals-contaminated sediments migrating into the Spokane River. This report and accompanying attachments describe the methodology and basis for the beach cleanup and stabilization design. GeoEngineers developed this report to support a competitive construction bidding process. It includes plans (drawings) and general construction specifications included in the drawings to support a construction bid process. GeoEngineers developed this report in collaboration with Ecology.

The following sections of this report describe existing site conditions, proposed site conditions, hydrologic and hydraulic analysis, site access and limitations, the capping limits, and site-specific capping material specifications.

Following the body of the report are four appendices: Appendix A, Photograph Log; Appendix B, Hydrologic Analysis; Appendix C, Hydraulic Analysis; Appendix D, 90 Percent Construction Drawings; and Appendix E, Report Limitations and Guidelines for Use. The construction drawings, also referred to herein as "Sheets," graphically support the discussions in this report and are referenced throughout the report as necessary.

SCOPE OF SERVICES

The purpose of GeoEngineers' services is to prepare a final design package for construction. Specifically, the scope of services, pertaining to the design package, included:

Task 0: Project Management

GeoEngineers coordinated with Ecology's technical staff with a 30 percent design submittal as indicated below. GeoEngineers also received comment from Ecology and previously addressed those comments in writing. GeoEngineers tracked monthly invoicing and submitted documentation to Ecology. GeoEngineers maintains an active project file.

Task 1: Develop Joint Remedial Design Work Plan

GeoEngineers performed an initial site visit on September 22, 2011 and developed design concepts for the site. GeoEngineers also reviewed draft conceptual design documents, provided by Ecology, for the site. GeoEngineers submitted a proposal reflecting the developed work plan on October 18, 2011.

Task 2: Site Visits

GeoEngineers' field representatives performed a site visit to the Project Site on November 9, 2011. During the site visit, the site was assessed for appropriate access routes, existing stable material conditions, existing vegetative species, verification of capping limits and river hydraulic conditions. Typical cross sections were generated at the Project Site with an assumed datum.

Task 3: Complete 30 Percent Design

GeoEngineers prepared and submitted 30 percent design drawings for the Project Site to Ecology for review on December 1, 2011. We prepared a response letter to address comments received from Ecology's review prior to preparing the 90 percent design.

Task 4: Complete 90 Percent Design

GeoEngineers incorporated 30 percent design comments, from Ecology, in the development of the 90 percent design package. We are submitting the 90 percent design with this report to Ecology. The 90 percent design includes: plan view illustrations, cross section drawings, material size, riparian planting plans, and construction notes.

Task 5: Complete 100 Percent Design

GeoEngineers will incorporate comments from Ecology on the 90 percent design in the development of the 100 percent design package. We will submit the 100 percent design package which also will include plan view illustrations, cross section drawings, material size and quantity estimates, and riparian planting plans.

SITE DESCRIPTION/EXISTING CONDITIONS

General

The Spokane River is a major tributary to the Columbia River located in eastern Washington. The Project Site is located in Spokane Valley, Washington as shown on Sheet 1 in Appendix D. The Project Site is located on the inside of a meander bend on the south side of the river and is surrounded on three sides by riparian vegetation. The Project Site is approximately seventeen miles downstream of the Post Falls Dam, which is located in Post Falls, Idaho.

Site Reconnaissance

GeoEngineers staff performed a site reconnaissance on November 9, 2011. The Project Site was accessed by the Centennial Trail. During this site visit, we observed features pertaining to the Spokane River locally around the Project Site. GeoEngineers assessed naturally-stable structures, likely locations requiring excavation of metal-contaminated materials, site access (ingress/egress), potential staging areas, and existing riparian vegetative species.

GeoEngineers collected relative elevation data across two transects, generally perpendicular to the river, which represent typical cross sections of the channel bank slope at the Project Site. The transect data was collected relative to an assumed, on-site datum elevation. The datam was located on the northeast corner of an existing concrete pad which supports an existing bench on the south side of the Centennial Trail. The assumed elevation of that datum was 96.39 feet. The cross slope of the site is approximately six feet horizontal to one foot vertical elevation (6H:1V). The channel bank slope information was used for the design material stability analysis. One representative transect is shown on Sheet 4 in Appendix D.

The Project Site includes approximately 125 feet of river frontage. Surface conditions at the site generally are characterized by fine sediment, coarse gravels and cobbles. There is existing vegetation on the Project Site. Refer to Appendix A titled “Photograph Log” for representative photographs of existing site conditions on September 22, 2011 and November 9, 2011.

Geology/Geomorphology

The Project Site is located within the Spokane River floodplain. Between the Washington-Idaho Stateline and downtown Spokane, the Spokane River flows in a shallow, 30-60 foot deep, incised inner valley within a wide, two to three mile wide, flat alluvium-covered valley. The Spokane valley is underlain by coarse, late Pleistocene glacial outburst flood gravels that are as thick as 650 feet and constitute the matrix of the Spokane Valley-Rathdrum Prairie Aquifer (Molenaar 1988). The incised inner valley, within the wide Spokane valley, was eroded by the Spokane River into the landscape left by the last of a series of glacial outburst floods. This incised inner valley consists of stream deposits within the active floodplain of the Spokane River (Box and Wallis 2002).

The Spokane River flows over a cobble to boulder bed for most of its course between the Idaho Stateline and the Project Site. The channel is incised into a thick sequence of Pleistocene outburst flood gravels and the cobble-boulder bed is derived primarily from erosion of the flood gravel deposits. These flood gravels (especially the thalweg and secondary channel deposits) predominately consist of well-rounded, cobble-size materials, but clast sizes range from sand to ten-foot diameter boulders. Silt and finer grain-size material is scarce in the Pleistocene flood

channel deposits. In general, boulders with diameters greater than about one foot are too large to be moved by the present stream and remain as a lag deposit on the stream bed and banks as smaller clasts are moved around them. Where boulders greater than one foot in diameter are exposed, the environment is generally erosive, which is indicated by the general lack of smaller clast deposition (Box and Wallis 2002).

Near the Project Site, the Spokane River's bankfull channel widths vary from approximately 135 feet to 400 feet. The channel slope varies from approximately 0.01 percent to a negative value throughout the river near the Project Site. In general, the existing geomorphic character of the Spokane River, within the Project Site reach, can be summarized as a single-threaded, low-gradient, incised channel.

FEMA Floodplain

The Federal Emergency Management Agency (FEMA) has identified areas of flooding concern for Spokane County near the Project Site. The boundary of the flood limits are presented on FEMA Flood Insurance Rate Map (FIRM) number 53063C0578D, for Spokane County, Washington, effective July 6, 2010. There are FEMA-regulated base flood elevations (BFEs) for the Spokane River at the Project Site.

The Project Site is located within a FEMA Zone AE flood insurance rate zone which is defined by FEMA as an area associated with the one percent-annual-chance flood (100-year base flood) where base flood elevations have been established through a detailed flood study. The detailed flood study is discussed within the FEMA Flood Insurance Study (FIS) report for Spokane County, Washington and Incorporated Areas effective July 6, 2010. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone on the FIRM. There is no floodway associated with this FEMA Zone AE. More accurate base flood elevations are shown on the profile plots within the FIS that show channel thalweg and flood elevations of the 10-, 50-, 100-, and 500-year flood events. Refer to Appendix B titled "Hydrologic Analysis" for a portion of the effective FIRM showing the Project Site.

The proposed construction activities will occur within the FEMA floodplain. This project will require fill placement within a Special Flood Hazard Area. The Flood Hazard Area is located in an "AE Zone" per FEMA Flood Insurance Rate Map 578D. Because is in an "AE Zone" without a regulatory floodway, the project will be limited to a 1/10th of a foot rise in the BFE (City of Spokane Valley [CSV] Code 21.30.090 Part C).

Hydrology

The Spokane River drains portions of eastern Washington and northern Idaho in a westerly direction through the Project Site toward downtown Spokane. The mean elevation of the contributing drainage basin is approximately 3,640 feet. The Spokane River flows out of the northern end of Lake Coeur d'Alene, Idaho. The flow rate of the Spokane River out of the lake is controlled by a bedrock-incised reach of the river and a dam at Post Falls, Idaho. Unrestricted flow on the river closely correlates with the height of the water surface of Lake Coeur d'Alene.

Since 1906 the bedrock incised reach has been blocked by the dam at Post Falls; the northern and southern portions of the dam are gated to allow for control of the lake elevation at selected heights

(partially closed) or for free flow (open), while the middle portion of the dam is equipped with flow-through power turbines (maximum flow rate through turbines is 5,000 cubic feet per second [cfs]). Typically the dam gates are completely opened from December through early June and the lake level and Spokane River flow fluctuate, depending on the inflow rate to Lake Coeur d'Alene. Lake levels and Spokane River flows typically rise due to spring snowmelt in April and May, and begin subsiding by early June. From early June to early September, the dam gates are fixed to control the Lake Coeur d'Alene pool elevation at 2,125 feet above mean sea level, causing the Spokane River outflow to gradually decline through the summer to annual minimum levels in late August and early September. From early September to early December the pool elevation in Lake Coeur d'Alene is gradually lowered (and the Spokane River outflow rate increased) until the dam gates are completely opened and the lake adjusts to its natural level (where inflow to the lake equals outflow from the lake). Between December and March, it is not unusual for several winter-warming events to push the lake level and Spokane River flow up to spring-like levels for short periods (Box and Wallis 2002).

As part of this project, GeoEngineers completed a hydrologic evaluation of the Spokane River at the Project Site. The hydrologic evaluation involved a review of the effective FIS study for Spokane County, Washington. The FIS study estimated multiple annual exceedance flow rates for the Spokane River from a United States Geological Survey (USGS) gauge at Otis Orchards, near the Project Site. The FIS study identifies the 10 percent, the 2 percent, the 1 percent, and 0.2 percent annual chance flood flow rates at the location of the Otis Orchard gauge. The effective 1 percent annual chance flood (base flood) is 52,000 cfs (as defined by FEMA).

GeoEngineers evaluated USGS Gauge number 12422500 to approximate the time period with the lowest flowrate. Low flowrates represent the preferred construction season for Project Site improvements so the majority of the sediment can effectively be capped. Ecology estimated the cap construction for the site will take about 15 days. We evaluated a construction window of about six weeks for cap construction to take place during low-flow conditions. Our analysis indicates low flow conditions typically occur annually between early August and late September. Refer to Appendix B titled "Hydrologic Analysis" for a graph of daily flowrates for gage number 12422500.

HYDRAULIC ANALYSIS

Bank Velocity

GeoEngineers developed a proposed stable capping material gradation based on an approximation of channel velocity over the capping site associated with the one percent chance annual base flood. The USGS provided GeoEngineers with cross-sectional depth and velocity measurements from the Spokane River near USGS Gauge numbers 12420500 and 12421500. The USGS conducted the measurements through various flow conditions (1,000 up to 30,000 cfs) between 2008 and 2011. This information included: total river flow rate, estimated left bank and right bank flow rates, length and depth associated with each bank.

GeoEngineers used this information from the USGS to estimate the flow velocity adjacent to the banks. GeoEngineers estimated the average channel velocity for the base flood using an approximate trapezoidal channel configuration and assumed normal depth calculations. The trapezoidal channel dimensions consisted of the top width of the base flood as measured from the

FEMA FIRMs, the channel depth as measured from the FEMA FIS profiles, average channel gradient measured from the FIS profiles, and average side slopes estimated from the USGS cross sectional information. From these dimensions, a roughness value was back-calculated and used to approximate the reduction in conveyance associated with the addition of the proposed capping material. The effects on conveyance, regarding the maximum allowed increase in BFE, are identified below.

An average channel velocity, associated with the one percent annual chance base flood at the Project Site, was estimated at 11.4 feet per second. GeoEngineers estimated the velocity at the Project Site during the one percent annual chance base flood condition to be approximately 7.6 feet per second (fps). We estimated the channel depth to be 19.9 feet based on the BFE minus the channel elevation taken from the FIS study profiles. Refer to Appendix C titled "Hydraulic Analysis" for bank velocity and depth calculations.

Flow Depth

In addition to average channel velocity at the river bank, it was necessary to estimate the approximate average flow depth over the proposed cap for the Project Site. Again, the approximate trapezoidal channel was used to estimate the flow depth during low flow conditions (2,000 cfs). The difference between the base flood flow depth and the low-flow depth was assumed to be the maximum flow-depth at the toe of the proposed cap. The minimum flow-depth over the cap, during the base flood, was estimated from the maximum depth minus the change in elevation of the proposed cap from the toe toward the top of bank. The approximate elevation change associated with the proposed cap is 5.8 feet based on Sheet 4 of Appendix D.

Shear Stress

Maximum shear stress along the cap was estimated for the base flood event. Shear stress was estimated using the formula:

$$\tau = 0.75 * \gamma * d * S$$

Where 'τ' is the shear stress, 'γ' is the unit weight of water, 'd' is the depth at the toe of the capping material and 'S' is the channel slope as defined in Chapter 8, Part 654 of the National Engineering Handbook developed by the Natural Resources Conservation Service (NRCS 2007). The maximum shear estimate was utilized as a check for the proposed capping design to ensure prevention of lost cap material due to incipient motion.

Increases in Base Flood Elevation

As previously mentioned, Ecology CSV code on capping actions, within the regulated FEMA floodplain states that work done at a Spokane River site cannot increase BFEs by more than 0.1 feet. GeoEngineers estimated the maximum allowed capping height, above existing grade, based on the proposed capping area and associated loss of conveyance to create an increase in the BFE equal to or less than 0.1 feet. This height or thickness is relative to the existing bank surface and was calculated with approximate channel geometry. The approximated channel geometry was trapezoidal in shape with a bottom width of 123 feet and side slopes of 5.32H:1V. The assumed channel side slope used to approximate the increase in BFE, by FEMA, was different than the site-

specific side slope that was either measured by GeoEngineers in the field or obtained from site-specific surveys and used in the calculations to design stable rock cap sizes.

Hydraulic Results

Table 1 includes estimates of the bank velocity, maximum and average flow-depth, and shear stresses at the Project Site during the base flood event. Table 1 also includes an estimate of the maximum allowable height of the capping material above the existing grade to comply with limitations on increases in BFE of 0.1 feet.

TABLE 1. MYRTLE POINT HYDRAULIC RESULTS DURING THE BASE FLOOD EVENT

Bank Velocity (fps)	Max Water Depth (feet)	Average Water Depth (feet)	Shear Stress (pounds per square foot)	Max Cap Height (feet)
7.89	14.1	11.1	0.64	0.65

PROPOSED DESIGN

The proposed cap will cover the existing metals-contaminated sediment located on the Project Site. The cap material was designed to remain stable during the one percent annual chance base flood event on the Spokane River. A rock filter layer is proposed between the in-situ metals-contaminated material and the proposed cap material to reduce the potential for finer contaminated sediments to migrate through the coarser cap material. A design alternative for the rock filter is a woven geotextile fabric. Refer to Appendix D titled "90 Percent Construction Drawings" and Table 2 below for more detailed descriptions of the rock filter.

Due to the large variation in size between the proposed rock cap and metals-contaminated sediment, a rock filter is required to prevent loss of fines through the cap. The United States Department of Transportation Federal Highway Administration, Hydraulic Engineering Circular No.23 (HEC-23) recommends a minimum filter thickness of 0.33 feet (4 inches) for multiple rock gradation layer applications (FHWA 2009). We propose a minimum filter layer thickness of 0.33 feet (4 inches) based on HEC-23 Design Guide 12 criteria (FHWA 2009). The filter layer shall contain material conforming to the gradation as specified in Table 3 below. Crushed aggregate shall not be used. This specification is necessary to avoid fine particles left on crushed aggregates from being washed into the river.

TABLE 2. MYRTLE POINT ROCK FILTER GRADATION

Grain Size Designation*	Gradation Size (feet)	Gradation Size (inches)
D_{15}	0.02 – 0.04	0.29 – 0.43
D_{50}	0.06 – 0.07	0.72 0 0.83
D_{85}	0.07 – 0.08	0.86 – 1.00
D_{100}	0.09 – 0.10	1.1 – 1.2
Thickness	0.33	4.0

* D_{15}, D_{50}, D_{85} and D_{100} indicate that 15 percent, 50 percent, 85 percent and 100 percent of the materials, respectively, are finer than the grain size shown.

Rock capping material will be placed over the rock filter. GeoEngineers calculated the capping material size using various riprap sizing methods identified in the riprap workbook included in Appendix C. These methods estimate adequate riprap sizes based on input parameters including: velocity, flow depth, bank slope, and other general cross-sectional geometry parameters. Given the proposed flat slope of the cap (6H:1V), we utilized United States Army Corp of Engineers (USACE) methods that took into account the side slope of the channel, flow depth and velocity (FHWA 2009). Rock capping material shall be rounded to subrounded granular material. Table 3 displays the proposed rock cap gradation for the Project Site. Proposed rock sizing at the immediate capping location is larger than currently existing material at and near the Project Site.

TABLE 3. MYRTLE POINT ROCK CAPPING GRADATION

Grain Size Designation*	Gradation Size (feet)	Gradation Size (inches)
D15	0.13 – 0.20	1.6 – 2.4
D50	0.33 – 0.38	3.9 – 4.5
D85	0.39 – 0.46	4.7 – 5.5
D100	0.49 – 0.56	5.9 – 6.7
Thickness	0.52	6.3

* D_{15}, D_{50}, D_{85} and D_{100} indicate that 15 percent, 50 percent, 85 percent and 100 percent of the materials, respectively, are finer than the grain size shown.

The total minimum thickness of the cap and filter material is 0.85 feet. This total thickness is greater than the maximum allowed obstruction thickness of 0.65 feet that would increase BFEs by more than 0.1 feet. Excavation, transport, and disposal of metals-contaminated sediment will be required. Approximately 0.3 feet of existing contaminated material will need to be removed to allow the proposed cap to be installed without increasing BFEs more than 0.1 feet. The requirement to haul and dispose of metals-contaminated sediment will be eliminated if the design alternative geotextile fabric filter is installed

The design drawings include a planting plan which includes native riparian vegetation and consists of four riparian plant species. The vegetation shall be planted throughout the Project Site as indicated in the construction plans in Appendix D. After the vegetation is established, we anticipate the associated root mass and plant stems/trunks will lessen flow velocities and shear stress values and will help stabilize the capping material.

PROJECT CONSTRUCTION

Construction Sequencing

There are three potential access routes to the site and the three alternatives are detailed on the construction drawings located in Appendix D. Alternative 1 involves crossing a small piece of land owned by Neighborhood Inc. to the east of the project site and the access route is adjacent to the Centennial Trail (trail). Alternative 2 requires access through private property owned by Holcim (US) Inc. This route would involve accessing City of Spokane Valley property and traveling parallel to the trail. Alternative 3 is the longest access route and involves accessing the trail from the

Trent Avenue Bridge southeast of the project site. Access is gained in this alternative by travelling adjacent to the trail from the bridge to the project site. Local site access will be limited to one location to limit the disturbance to existing vegetation. The trail has a weight restriction of 12,000 pounds. Regardless of the access route selected, traffic control will be required to route trail users away from construction activities.

Prior to site disturbance, sediment control best management practices (BMPs) will be installed around the edges of the construction workspace to contain sediment and spoils within the workspaces. The design of appropriate BMPs is not within GeoEngineer's scope of services. The contractor shall install and maintain appropriate sediment control devices throughout the Project Site, including those associated with construction access, staging and stockpile areas throughout the construction period. Temporary construction and permanent erosion control measures shall be designed, constructed and maintained in accordance with all applicable local, state and federal regulations.

Following the installation of appropriate erosion control BMPs, the contractor will excavate existing metals-contaminated material to a depth of approximately 0.30 feet if a rock filter is installed. Excavated material will be hauled offsite and disposed of at an appropriate waste disposal facility. If a geotextile filter fabric is installed, the ground surface will be graded so that it is smooth and free of mounds, dips or windrows. The geotextile fabric will be anchored at the top and the toe with a 2-foot anchor trench as indicated on Sheet 6.2 in Appendix D. The filter layer will then be placed directly on the remaining in-situ material. The capping material will then be placed and compacted over the filter layer with vibratory plate compaction techniques.

If a geotextile filter is installed, the plants shall be planted by hand and excavated material shall be disposed of on the site beneath the filter layer as indicated on the construction plans. Vegetation will be installed after the fabric is installed. Nursery stock plants will require sequential cutting the fabric, hand excavation and planting as the fabric is rolled onto the existing material. Excess metals-contaminated material shall be disposed of beneath the filter layer as it is unrolled. Live cuttings will be planted following the installation of the geotextile filter. If a rock filter is installed, vegetation will be hand planted following the construction of the cap.

Construction Time Frame

Ecology has indicated that project construction will occur during the low-flow conditions of the Spokane River and that construction will occur within a three week window. GeoEngineers estimated the low-flow conditions of the Spokane River, in the vicinity of the Project Site, occur between the beginning of August and late September.

LIMITATIONS

We have prepared this report for Ecology and their authorized agents and regulatory agencies for the Myrtle Point site.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the fields of river bank stabilization design engineering and environmental engineering in this area at the time this report was prepared. The

conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, expressed or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to the Appendix E titled "Report Limitations and Guidelines for Use" for additional information pertaining to the use of this report.

REFERENCES

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APPENDICES

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APPENDIX A
Photograph Log

View of project site from the south bank of the Spokane River facing southeast (upstream).

Appendix A
Photo Date 09/22/11

Spokane River Beach Cleanup
Myrtle Point Project Site

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A1

View of project site from the south bank of the Spokane River facing northwest (downstream).

Appendix A
Photo Date 11/09/11

Spokane River Beach Cleanup
Myrtle Point Project Site

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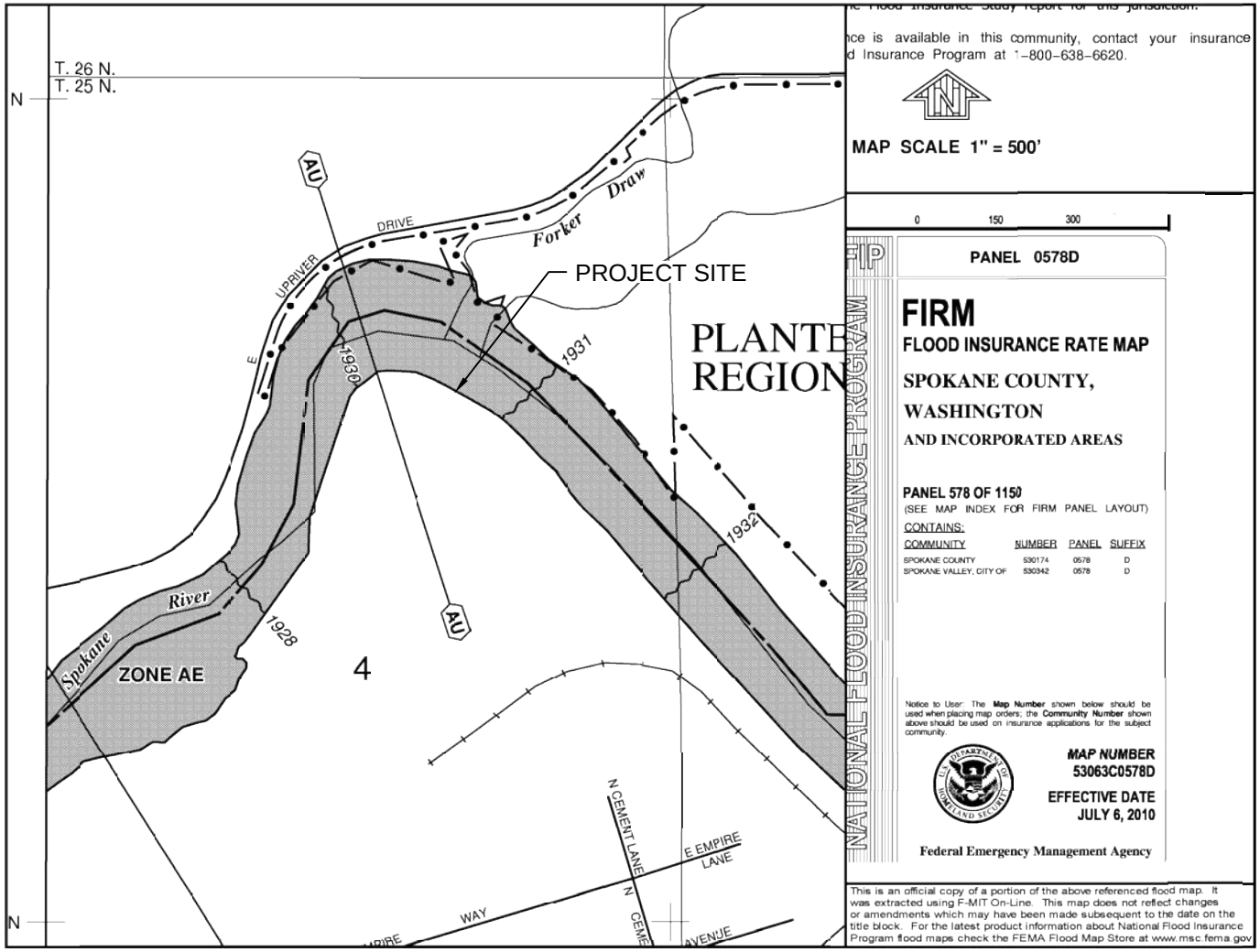
A2

APPENDIX B
Hydrologic Analysis



Appendix B
HYDROLOGIC CALCULATIONS

Spokane River Beach Cleanup
Myrtle Point Project Site

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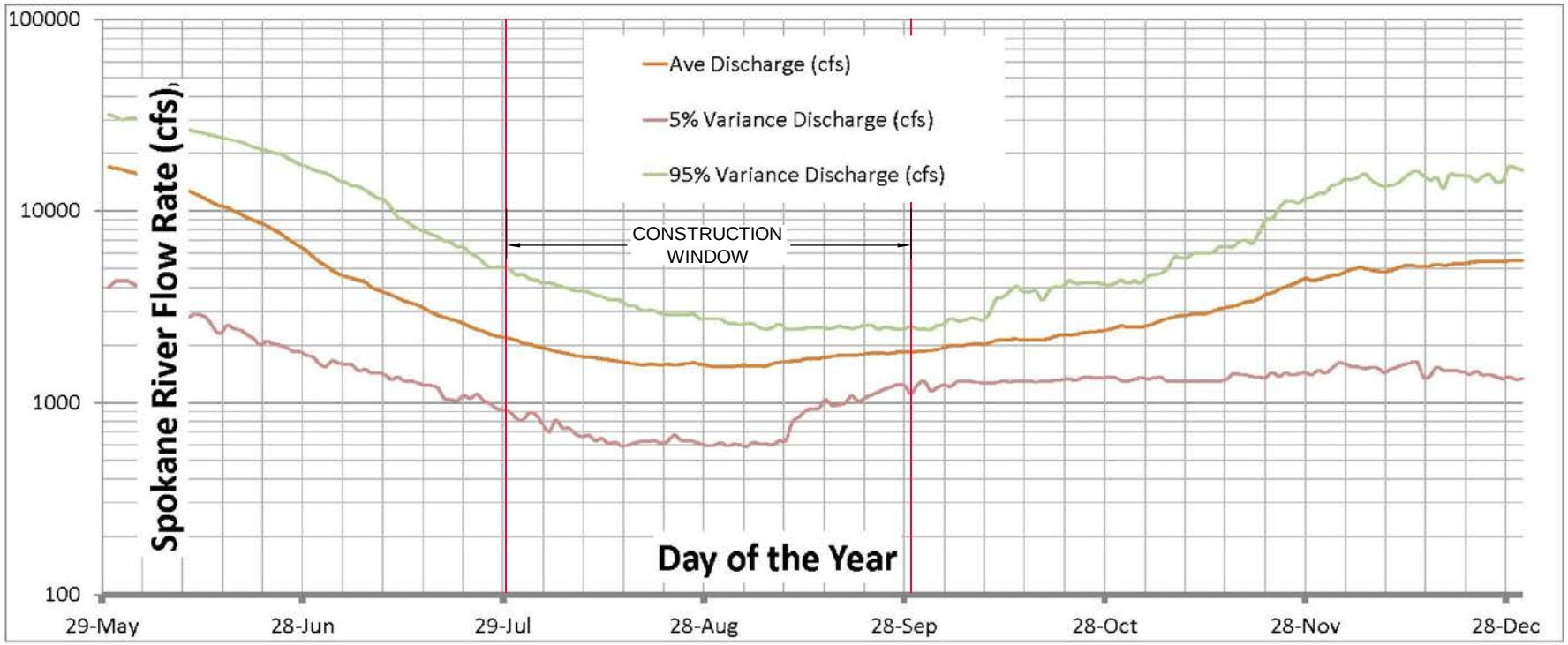
B1



SPOKANE RIVER LOW FLOW PERIOD BASED ON USGS GAUGE12422500
DAILY DISCHARGE

Appendix B
HYDROLOGIC CALCULATIONS

Spokane River Beach Cleanup
Myrtle Point Project Site

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B2

USGS: United States Geological Survey
cfs: cubic feet per second

APPENDIX C
Hydraulic Analysis

Myrtle Point Project Site

Bank Velocity and Capping Thickness Limit Estimation

Project:	Spokane River Sed. Capping	**Site Location**	Myrtle Point Project Site
Project Number:	0504-072-00	**Analyst:**	Ryan Carnie, Jeff Fealko
Watercourse:	Spokane River	**Latest Revision:**	5/2/2012

Base Flood Elevation (ft):	1,930.7	*This value is estimated based on the FEMA flood profiles at the Project Site location.*
Existing Channel Elevation (ft):	1,910.8	*This value is estimated based on the FEMA flood profiles at the Project Site location.*
Max Channel Depth (ft):	19.9	
Top Width (ft):	335.0	*This value is estimated based on the floodplain width at the Project Site location.*
Channel Slope (ft/ft):	0.0010	*This value is estimated based on FEMA flood profiles at the Project Site location.*
FEMA Discharge (cfs):	52,000.0	*This value is based on an avearge discharge from cross sections downstream of the Project Site.*
Artificial Channel Geometry		
Side Slopes (ft/ft):	5.3	*This value is based on an average side slope determination from USGS cross sections at Barker Road and Trent Road.*
Slope Check:	SLOPE IS OK	*This check ensures that the top width is wide enough to allow the given slope to reach the max depth.*
Cross Sectional Area (sf):	4,559.7	*This is the calculated channel area based on a trapezoidal channel.*
Wetted Perimeter (ft):	338.7	*This is the calculated wetted perimeter based on a trapezoidal channel.*
Roughness value:	0.023	*This is the calculated roughness value based on a normal depth calculation for the 100-year FEMA Flood.*
Results		
Average Velocity (ft/s):	11.4	*This is the estimated average channel velocity.*
Conveyance (cfs):	1,676,983.2	*This is the estimated conveyance in the cross section.*
Average Left Bank Velocity (ft/s):	7.6	*This is the average velocity anticipated over the cap area.*
Proposed Cap		
Cap Thickness (ft):	0.65	*This is the maximum thickness of the cap can be to maintain no more than a 0.10 ft rise in base flood elevation.*
Cap Slope (ft/ft):	0.00	*This value is recommended.*
Cap Length Along Slope (ft):	32.0	*This value is estimated from the proposed cap area.*
Area (sf):	4,539.0	*This is the calculated new channel area.*
Wetted Perimeter (ft):	340.0	*This is the calculated new channel wetted perimeter.*
Conveyance (cfs):	1,660,034.0	*This is the calculated new channel conveyance.*
Change in Conveyance (cfs):	-16,949.2	*This is the change in conveyance.*
Percent Change:	-0.010	*This is the percent change in conveyance.*
Change in Water Surface (ft):	0.1	*This is the allowable change in water surface elevation without completing a flood analysis.*
New Area (sf):	4,572.5	*This is the estimated new channel area to accommodate the FEMA flood discharge.*
New Wetted Perimeter (ft):	341.1	*This is the estimated new channel wetted perimeter to accommodate the FEMA flood discharge.*
Discharge (cfs):	52,000	*Goal set this to the original FEMA discharge by changing the cap thickness.*
Bottom Width (ft):	123.3	*This is calculated from approximate trapezoidal channel calculations.*
Depth (ft):	5.8	*This is an input variable to estimate water surface elevations.*
Area (sf):	887.7	*Calculated based on flow depth.*
Wetted Perimeter (ft):	185.7	*Calculated based on flow depth.*
Velocity (ft/s):	2.3	*Calculated based on flow depth.*
Discharge (cfs):	2,030.5	*Calculated based on flow depth.*
Water Elevation (ft):	1,916.6	*Calculated based on flow depth.*
Water Depth Over Cap (ft):	14.1	*This is the water surface difference between the 100-year and low flow discharge of 2,000 cfs.*
Shear Estimate (lbs/sf):	0.6	*This is the approximate shear stress estimate along the capping material during the 100-year discharge.*
Velocity (ft/s):	1.1	*This is the estimated velocity over the capping material.*
Bank Average Depth (ft):	11.1	*This is the average water depth over the cap during the 100-year discharge.*

FEMA: Federal Emergency Management Agency
USGS: United States Geological Survey

USACE Riprap Design Method

Project:	Spokane River Sediment Capping	**Road or Bridge:**	Myrtle Point Project Site
Project Number:	0504-072-00	**Analyst:**	Ryan Carnie
Watercourse:	Spokane River	**Latest Revision:**	05/02/12

General Comments

- This spreadsheet sizes riprap using the methodology set forth in the March, 1989 issue of HEC-11, FHWA-IP-89-016, "Design Of Riprap Revetment". (Also found in HEC-23 under "Design Guideline 12".)
- Refer to the Summary Table and Curve at the end of this workbook for a comparison of the methods analyzed.

Input

10,000	= R = Curve Radius (ft)[1]
335	= W = Channel Width (ft)[1]
6.0	= Z = Sideslope, (H:1'V)[1]
7.6	= $V_{a=}$ Average Velocity (fps)[2]
11.1	= d = Average Depth (ft)[2]
32.2	= Acceleration Due to Gravity (ft/s^2)
2.65	= $G_{s=}$ Specific Gravity[3]
1.20	= Stability Factor[4]
Rounded	= Riprap Shape (Angular or Rounded)
Straight Channel	= Riprap Location (Straight Channel, Outside of Bend, DS of Concrete Channel, or End of Dike)
1.0	= Blanket Thickness Coefficient (Usually 1.0 due to limited data)
Natural Channel	= Natural Channel or Trapezoidal Channel

Output

29.85	= R/W, Radius/Width Ratio
9.46	= θ, Bank Angle (degrees)
1.00	= K1, Bank Angle Correction Factor
0.375	= Cs, Stability Coefficient
1.00	= Cv, Velocity Distribution Coefficient
7.39	= Vdes, Charateristic Velocity for Design (fps)
0.26	= D_{30}, 30% Stone Size (ft)
0.31	= D_{50}, Median Stone Size (ft)
0.49	= D_{100}, Maximum Stone Size (ft)
0.49	= T = Thickness of Riprap Layer (Double if placed under water) (ft)

Footnotes

1. Input based on field observations, measurements and estimates.
2. Input derived from hydraulic model.
3. Specific Gravity is assumed to be 2.65.
4. See Stability Factor information below.

Stability Factor

1.0 - 1.2	Uniform flow; Straight or mildly curving reach (R/W > 30); Impact from wave action and floating debris is minimal; Little or no uncertainty in design parameters.
1.3 - 1.6	Gradually varying flow; Moderate bend curvature (30 > R/W > 10); Impact from waves and/or floating debris moderate.
1.6 - 2.0	Approaching rapidly varying flow; Sharp bend curvature (10 > R/W); Significant impact potential from floating debris and/or ice; Significant wind and/or boat generated waves (1' -2'); High flow turbulence; Significant uncertainty in design parameters.

USACE: United States Army Corp of Engineers

HEC: Hydraulic Engineering Circular

FHWA: Federal Highway Administration

Comparison of Riprap Design Methods

Project: Spokane River Sediment Capping
Project Number: 0504-072-00
Watercourse: Spokane River
Road or Bridge: Myrtle Point Project Site
Analyst: Ryan Carnie
Latest Revision: 5/2/12

General Comments

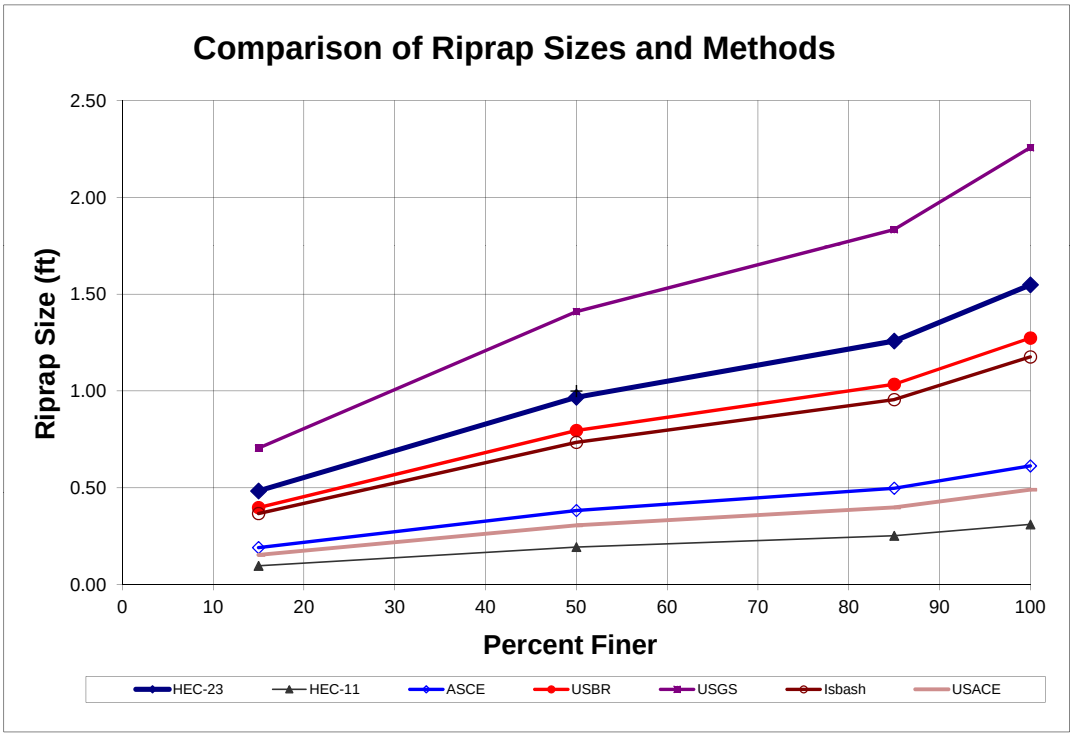
- This spreadsheet compares the riprap sizes calculated using the methods noted.
- The gradations are based upon the AASHTO Method as presented in HEC-23, page DG12.7.
- The data in the table is calculated in previous sheets.

USACE = Riprap design method recommended for this project.

Comparison of Riprap Sizes (in Feet) and Methods

Riprap Size (Percent Finer)	HEC-23	HEC-11	USACE	ASCE	USBR	USGS	Isbash
15	**0.48**	0.10	0.15	0.19	0.40	0.70	0.37
50	**0.97**	0.19	0.31	0.38	0.80	1.41	0.73
85	**1.26**	0.25	0.40	0.50	1.03	1.83	0.96
100	**1.55**	0.31	0.49	0.61	1.27	2.26	1.18
Layer Thickness	**1.55**	0.31	0.49	0.77	1.59	2.82	1.47

Incipient Motion Check		Check 1	Check 2	Correction Ratio
Shear Estimate (lb/sf)	1.3	0.34	0.41	OK

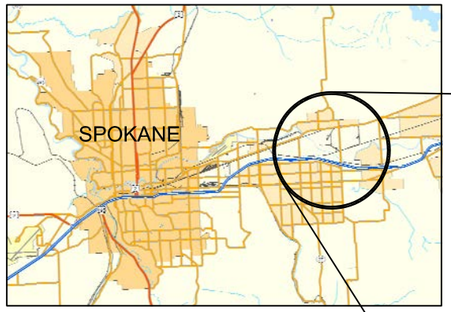


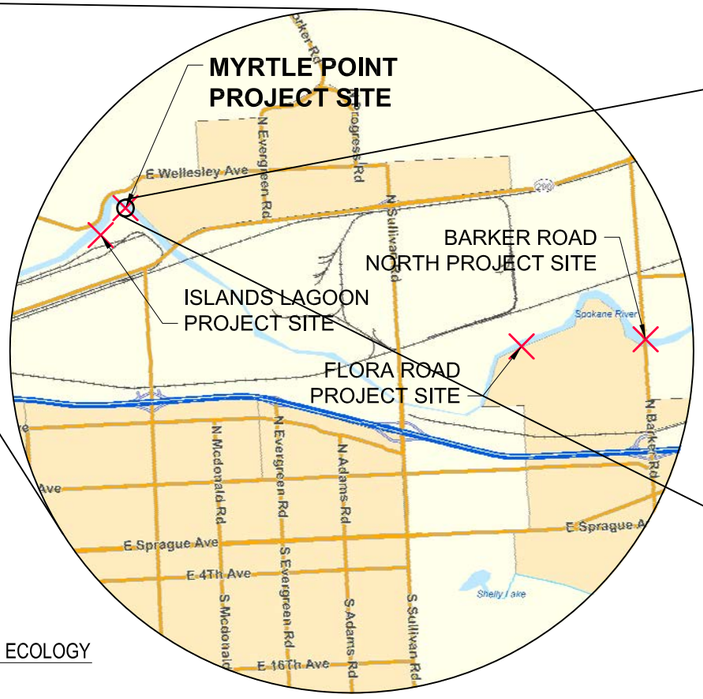
AASHTO: American Association of State Highway and Transportation Officials
USACE: United States Army Corp of Engineers
HEC: Hydraulic Engineering Circular
FHWA: Federal Highway Administration

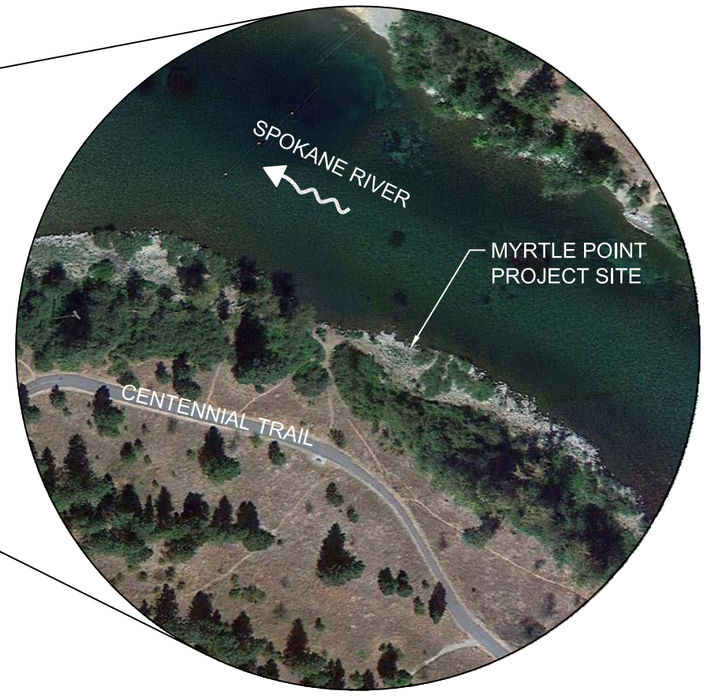
APPENDIX D
90 Percent Construction Drawings

SPOKANE RIVER BEACH CLEANUP SITES

MYRTLE POINT PROJECT SITE
CONSTRUCTION DRAWINGS







SHEET	SHEET TITLE
1	COVER SHEET
2	SITE ACCESS MAP
3	SITE PLAN
4	TYPICAL SECTION
5.1	PLANTING PLAN
5.2	PLANTING PLAN
6.1	GENERAL NOTES
6.2	GENERAL NOTES

CONTACT INFORMATION

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FAX: 509.363.3126

WASHINGTON DEPARTMENT OF ECOLOGY
DAVE GEORGE, P.G., P.H.G.
4601 NORTH MONROE STREET
SPOKANE, WASHINGTON 99205
PH: 509-329-3400
FAX: 509-329-3529

Reference: Base maps obtained from ESRI. Aerial image obtained from Google Earth.

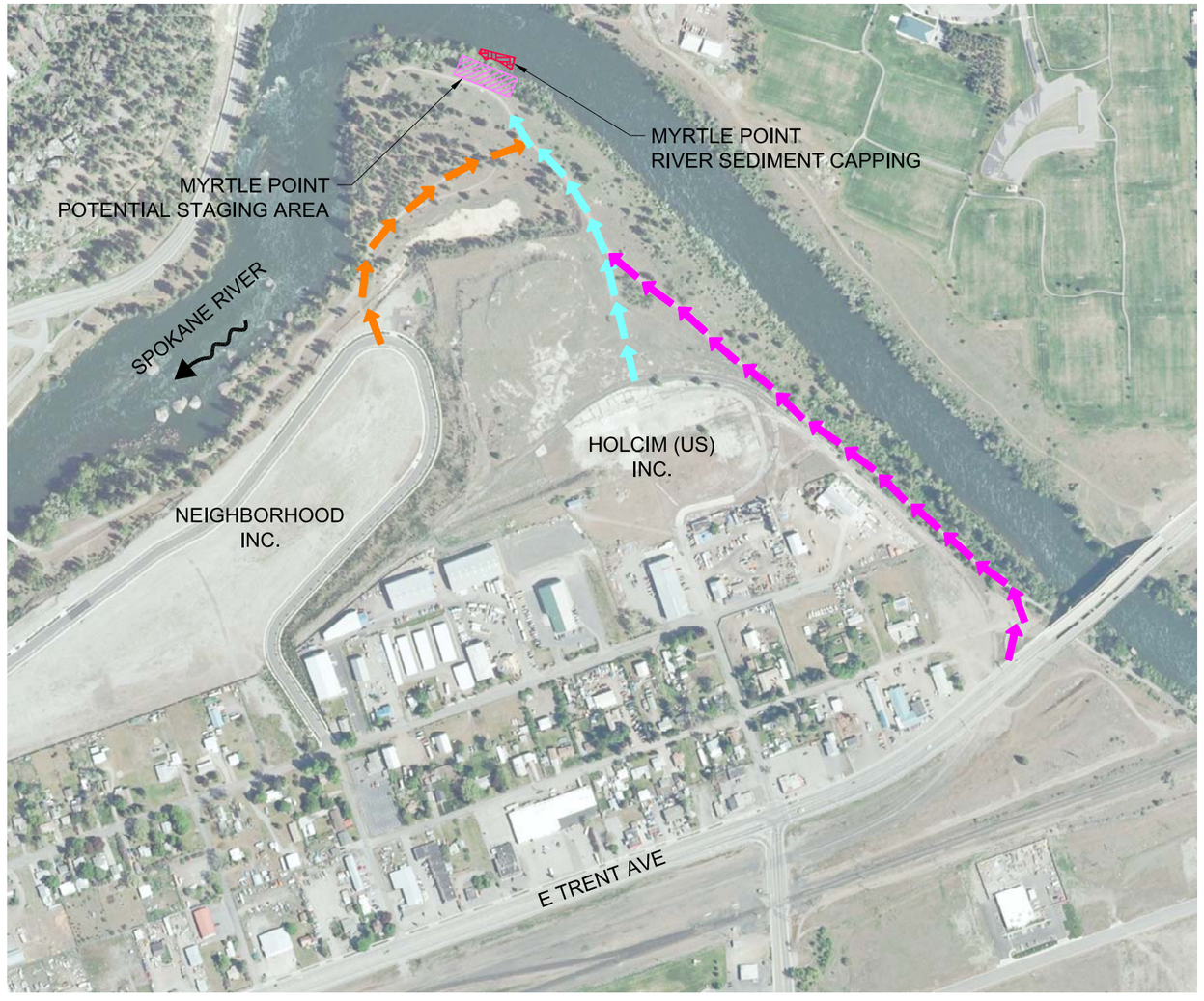
Revision No:	Date:	Description:	Initials:	Designed: JJF
				Drawn: MGF
				Checked: JRS
				Date: 02/07/12
				Project No: 0504-072-00

Spokane River-Myrtle Point
Spokane Valley, Washington
Washington State
Department of Ecology

GeoEngineers
523 East Second Avenue
Spokane, Washington 99202

Cover Sheet
Myrtle Point Beach Cleanup
Construction Drawings

Sheet 1



LEGEND

- APPROXIMATE EXTENT OF CAPPING AREA
- PROJECT SITE ACCESS - Through Neighborhood, Inc, property
- PROJECT SITE ACCESS - Through Holcim (US) Inc. and City of Spokane Valley property
- PROJECT SITE ACCESS - From Trent Bridge along Centennial Trail
- POTENTIAL STAGING AREA

All access routes require crossing the Centennial Trail and access must adhere to 12,000 lb weight restriction on the trail.

N W E S

500 0 500
Feet

Reference: Aerial imgae obtained from ESRI.

Revision No:	Date:	Description:	Initials:	Designed: JJF
				Drawn: MGF
				Checked: JRS
				Date: 02/07/12
				Project No: 0504-072-00

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Site Access Map

Myrtle Point Beach Cleanup
Construction Drawings

Sheet 2

JRH : MGF

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LEGEND

APPROXIMATE EXTENT OF CAPPING AREA

All access routes require crossing the Centennial Trail and access must adhere to 12,000 lb weight restriction on the trail.

N
W E
S

25 0 25
Feet

Reference: Aerial image obtained from Google Earth Pro.

Revision No:	Date:	Description:	Initials:	Designed: JJF
				Drawn: MGF
				Checked: JRS
				Date: 02/07/12
				Project No: 0504-072-00

Spokane River-Myrtle Point
Spokane Valley, Washington
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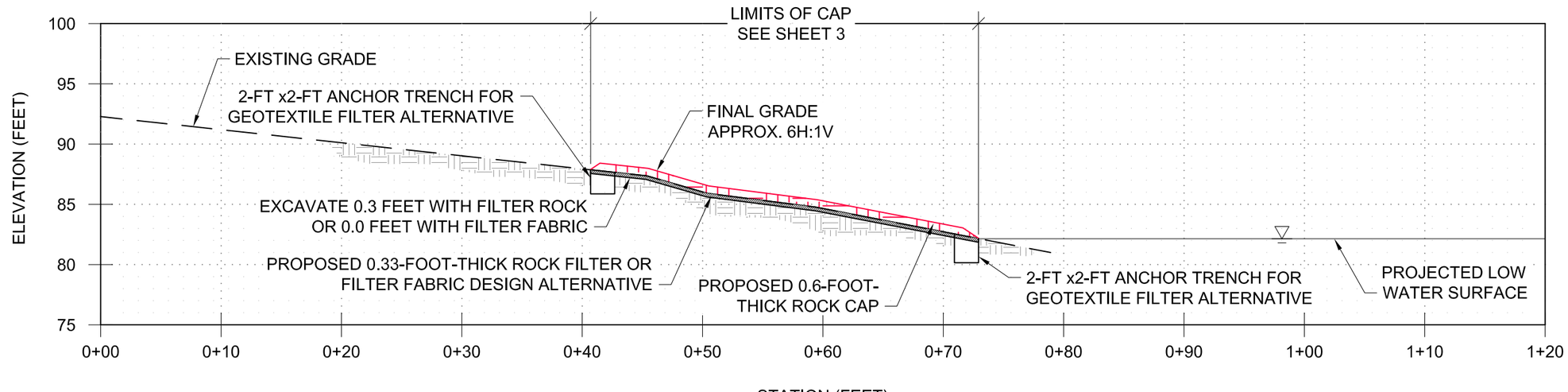
Site Plan

Myrtle Point Beach Cleanup
Construction Drawings

Sheet
3

JRH : MGF

\\BOI\Projects\0\0504072_TEMP SPO\00\CAD\DWG\MYRTLE POINT\11x17\0504072S3.dwg\TAB:SHEET 3 modified on Feb 07, 2012 - 10:48am



CROSS SECTION A

10 0 10
Feet

NOTE: EXCAVATED METAL-CONTAMINATED MATERIAL SHALL BE TESTED AND DISPOSED OF OFF-SITE AT AN APPROVED FACILITY

LEGEND:

- EXISTING GRADE
- PROJECTED LOW WATER SURFACE
- PROPOSED CAP
- PROPOSED ROCK FILTER

	CAPPING GRADATION (INCHES)		FILTER GRADATION (INCHES)	
	MIN	MAX	MIN	MAX
D_{100}	5.9	6.7	1.1	1.2
D_{85}	4.7	5.5	0.86	1.0
D_{50}	3.9	4.5	0.72	0.83
D_{15}	1.6	2.4	0.29	0.43

Revision No:	Date:	Description:	Initials:	Designed: JJF
				Drawn: MGF
				Checked: JRS
				Date: 02/07/12
				Project No: 0504-072-00

Spokane River-Myrtle Point
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Typical Section

Myrtle Point Beach Cleanup
Construction Drawings

Sheet 4

BANK ZONE - 3,285 SQUARE FEET

N
W E
S

30 0 30
Feet

Reference: Aerial image obtained from Google Earth Pro.

Revision No:	Date:	Description:	Initials:	Designed: JJF
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				Date: 02/07/12
				Project No: 0504-072-00

Spokane River-Myrtle Point
Spokane Valley, Washington
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Planting Plan

Myrtle Point Beach Cleanup
Construction Drawings

Sheet
5.1

JRH : MGF

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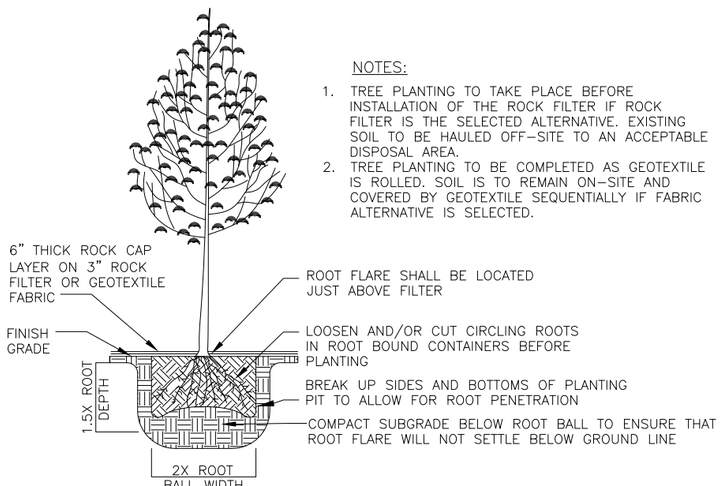
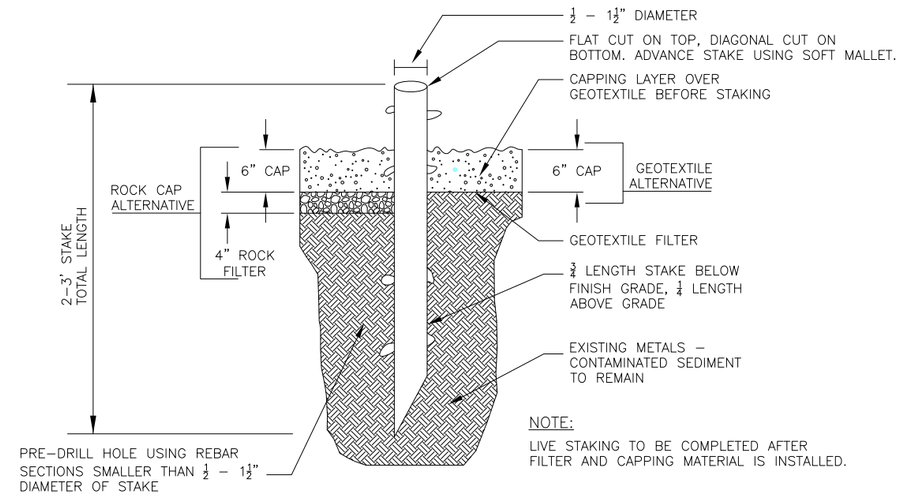
PLANTING APPLICATION		COMMON NAME	INSRUCTIONS	SCIENTIFIC NAME	BANK ZONE SIZE (GALLONS)	BANK ZONE SIZE (CUTTINGS) (FT)	BANK ZONE SPACING (FT ON CENTER)	BANK ZONE SF	BANK ZONE UNITS (1)
1	NURSERY STOCK	BLACK COTTONWOOD	1.) Add topsoil mix and/or organic mulch to disturbed areas. 2.) Re-cap after soil disturbance during planting. 3.) Plant black cottonwood on the landward ⅓ of bank zone area.	*Populus trichocarpa*	1	NA	18	3,285	11
SUBTOTAL:									11
2	LIVE CUTTINGS	COYOTE WILLOW	1.) Plant live cuttings into permanent moisture regime. 2.) Plant immediately if possible. 3.) Plant top end up. 4.) Bottom shall extend minimum of 0.5 feet below normal water elevation in stream. 5.) Potted nursery stock can be substituted for live cuttings. 6.) Similar willow species (Salix) can be substituted based on availability.	*Salix exigua*	NA	4 TO 5	12	3,285	23
		DRUMMOND WILLOW		*Salix drummondiana*	NA	4 TO 5	12	3,285	23
		PACIFIC WILLOW		*Salix lucida*	NA	4 TO 5	12	3,285	23
SUBTOTAL:									69
TOTAL:									**80**

(1) Plotted plants and cuttings measured by individual piece.
FT = FEET, SF = SQUARE FEET



TREE PLANTING DETAIL 1
NTS -



LIVE STAKING DETAIL 2
NTS -

Reference: Aerial image obtained from Google Earth.

Revision No:	Date:	Description:	Initials:	Designed: JJF
				Drawn: MGF
				Checked: JRS
				Date: 02/07/12
				Project No: 0504-072-00

Spokane River-Myrtle Point
Spokane Valley, Washington
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Planting Plan

Myrtle Point Beach Cleanup
Construction Drawings

Sheet
5.2

JRH : MGF

C:_Local project files\BOI 050407200 Myrtle\050407200-S5.dwg\TAB:Planting Table modified on Feb 07, 2012 - 2:57pm

GENERAL NOTES:

1. These designs and drawings have been prepared for the exclusive use of the Washington State Department of Ecology (Ecology) and their authorized agents. No other party can rely on the product of our services unless GeoEngineers Inc. (GeoEngineers) agrees in writing in advance of such use.
2. These plans are intended for construction and construction bidding purposes.
3. The drawings contained within should not be applied for any purpose or project except the one specified; specifically the Myrtle Point River Sediment Capping Site as shown in the Project Area located on Sheet 1 .
4. These designs and drawings are copyrighted by GeoEngineers, Inc. Any use, alteration, deletion, or editing of this document without explicit written permission from GeoEngineers is strictly prohibited. Any other unauthorized use of this document is prohibited.
5. Ecology is advised to contact and to obtain the necessary permits and approvals from all appropriate regulatory agencies (local, state, and federal) prior to construction.
6. The contractor shall construct the sediment capping in accordance with the plans stamped “Approved for Construction.” These plans will be provided to the contractor by the engineer or Ecology prior to construction. Work shall not be done without the current set of approved construction plans.
7. The capping designs depicted herein are approximate and are intended to express the overall design intent of the project. These designs will need to be adjusted in the field during construction in order to meet the specific site conditions and intended function.
8. Geomorphic conditions can change and these designs are based on conditions that existed at the time the design was performed (September-November 2011). The results of these designs may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying these designs to determine if they remain applicable.
9. Design specifics for all typical sediment capping installations shall be confirmed and/or verified by a qualified engineer prior to or during construction.
10. These figures were originally produced in color.

CONSTRUCTION NOTES:

1. All contractors working within the project boundaries are responsible for compliance with all applicable safety laws. The contractor shall be responsible for all barricades, safety devices and control of traffic within and around the construction area.
2. All material and workmanship furnished on or for the project must meet the minimum requirements of project permits, approving agencies, specifications as set forth herein, or whichever is more restrictive.
3. The contractor shall install and maintain appropriate sediment control devices throughout the whole project site, including the construction staging area and stockpile area throughout the project's construction. Temporary construction and permanent erosion control measures shall be designed, constructed and maintained in accordance with all applicable local, state and federal regulations.
4. Excavation and capping activities shall occur during period of low-flow in the Spokane River. Historic stream gage records indicate that period typically falls between August and September and construction timing should coincide with the period of low-flows.
5. Capping and filter materials shall not be installed below the water surface at the time of construction.
6. Discharges entering active streams on-site shall satisfy all state and federal standards and project permit requirements for contaminants and turbidity.
7. The project site shall be closed to the public during construction.
8. Plate compaction techniques shall be used after the capping layer is placed.
9. The capping area shall be staked by the contractor and field verified by Ecology before material is excavated and/or placed.
10. Capping and/or filter material will not be placed in the water.
11. Site shall be graded to appear natural.

EQUIPMENT:

1. Provide equipment of suitable size, weight and traction necessary to perform the work specified herein and that can access the site via the existing access trail.
2. Equipment proposed by the contractor must be accepted by Ecology or its Representative prior to the start of construction.
3. Contractor is responsible for securing their supplies and equipment. Ecology will identify acceptable locations for staging and parking.

EXCAVATION:

1. Excavation of material shall occur only within the proposed capping area.
2. Excavation depth shall be a minimum of 0.3 feet if rock filter is installed. Excavation depth shall not be required if geotextile filter fabric is installed.
3. All excess or unsuitable excavated material shall be designated as waste and shall be tested for contaminants and disposed by the contractor at an acceptable facility. Disposal shall be in an environmentally acceptable manner that does not violate local rules and regulations.

EXAMINATION:

1. Notify Ecology or its Representative immediately of discrepancies between site information and the information on Drawings, should any such discrepancies be identified.

STOCKPILING:

1. The location for staging equipment and stockpiling cap and filter material must be approved by Ecology or its Representative before placement of any material or equipment.
2. Wet and cover stockpiled material to prevent wind erosion as needed.

Revision No:	Date:	Description:	Initials:	Designed: JJF
				Drawn: MGF
				Checked: JRS
				Date: 02/07/12
				Project No: 0504-072-00

Spokane River-Myrtle Point
Spokane Valley, Washington
Washington State
Department of Ecology

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General Notes

Myrtle Point Beach Cleanup
Construction Drawings

Sheet 6.1

JRH : MGF

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FILTER ROCK:

1. Filter material shall consist of well mixed rounded to subrounded granular material, either naturally occurring or processed.
2. Filter material shall be clean and free of trash, corrosive, organic or decomposable material, or other extraneous or objectionable material.
3. Filter material shall not contain metals, petroleum hydrocarbons, or any other contaminants at concentrations exceeding regulatory levels.
4. Filter layer shall be a minimum of 0.33 feet thick and shall be installed in one lift.
5. Filter layer does not require compaction, but the surface of such material shall be finished reasonably smooth and free of mounds, dips or windrows.
6. Filter material shall conform to the following gradation requirements:

SEDIMENT SIZE (INCHES)	PERCENT PASSING
1.1 TO 1.2	100
0.86 TO 1.0	85
0.72 TO 0.83	50
0.29 TO 0.43	15

FILTER MATERIAL:

1. The geotextile filter shall be non-woven monofilament polypropylene yarns and be resistant to naturally encountered chemicals, alkalis and acids.
2. The geotextile filter shall be placed on a soil surface that is finished reasonably smooth and free of mounds, dips or windrows.
3. The geotextile filter shall be placed with the machine direction parallel to the direction of water flow. Adjacent geotextile sheets shall be joined by either sewing or overlapping. Overlapped seams of roll ends shall be a minimum of 12 inches.
4. When overlapping, successive sheets of geotextile shall be overlapped upstream over downstream and/or upslope over downslope.
5. The geotextile filter shall be placed in close contact with the soil, eliminating folds or excessive wrinkles.
6. Anchor the geotextile filter at the top and the top of the slope using a 2-foot deep anchor trench.
7. Geotextile filter material shall conform to the following requirements:

PROPERTY	TEXT METHOD	UNITS	ELONGATION<50%[1]	
			MD	CD
Grab Tensile Strength	ASTM D 4632	Lbs/ft	370	250
Sewn Seam Strength[2]	ASTM D 4632	Lbs	220	
Tear Strength[3]	ASTM D 4533	Lbs	100	60
Puncture Strength	ASTM D 4833	Lbs	950	
Permittivity	ASTM D 4991	Sec^{-1}	0.2800	
Apparent Opening Size	ASTM D 4751	U.S. Sieve	70	
Ultraviolet Stability[4]	ASTM D 4355	Percentage	90	

(1) As measured in accordance with ASTM D 4632.
(2) When sewn seams are required.
(3) The required minimum average roll value tear strength for woven monofilament geotextiles is 56 lbs.
(4) After 500 hours.
ASTM: American Society for Testing and Materials
Lbs/ft: Pounds per foot
Lbs: Pounds
Sec^{-1}: Per second
MD: Machine direction
CD: Cross direction

CAPPING MATERIAL:

1. Cap material shall consist of well mixed rounded to subrounded granular material, either naturally occurring or processed. Individual rocks shall be dense, sound, and free from cracks, seams, and other defects conducive to accelerated weathering. The least dimension of an individual rock fragment shall be not less than one-third the greatest dimension of the fragment.
2. Cap material shall be clean and free of trash, corrosive, organic or decomposable material, or other extraneous or objectionable material.
3. Cap material shall not contain metals, petroleum hydrocarbons, or any other contaminants at concentrations exceeding regulatory levels.
4. Capping layer shall be placed by equipment on the surface and to the depth specified in the drawings. The cap shall be installed to the full course thickness in one operation and in such a manner as to avoid serious displacement of the underlying material. The cap shall be delivered and placed in a manner that ensures the cap installed is reasonably homogeneous with the larger rocks uniformly distributed.
5. Capping layer shall be compacted by at least four passes over the entire surface with a vibratory plate compactor.
6. Cap material shall conform to the following gradation requirements:

SEDIMENT SIZE (INCHES)	PERCENT PASSING
5.9 TO 6.7	100
4.7 TO 5.5	85
3.9 TO 4.5	50
1.6 TO 2.4	15

Revision No:	Date:	Description:	Initials:	Designed: JJF
				Drawn: MGF
				Checked: JRS
				Date: 02/07/12
				Project No: 0504-072-00

Spokane River-Myrtle Point
Spokane Valley, Washington
Washington State
Department of Ecology

GeoEngineers
523 East Second Avenue
Spokane, Washington 99202

General Notes

Myrtle Point Beach Cleanup
Construction Drawings

Sheet
6.2

JRH : MGF

APPENDIX E
Report Limitations and Guidelines for Use

APPENDIX E
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Stream and River Design Engineering Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the Washington State Department of Ecology and their authorized agents and regulatory agencies. The information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. No party other than the Washington State Department of Ecology may rely on the product of our services unless we agree to such reliance in advance and in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our proposal dated October 18, 2011, our Work Assignment Number C110145L signed October 26, 2011, and generally accepted practices in this area at the time this report was prepared. Use of this report is not recommended for any purpose or project except the one originally contemplated.

A Stream or River Design Engineering Report is Based on A Unique Set of Project-Specific Factors

We have prepared this report exclusively for the Spokane River Beach Cleanup Myrtle Point Site in the City of Spokane Valley, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you
- Not prepared for your project
- Not prepared for the specific site
- Completed before important project changes were made

If important changes are made after the date of this report, we recommend that GeoEngineers be given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

Conditions Can Change

This report is based on conditions that existed at the time the study/design was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events, such as construction on or adjacent to the site or by natural events such as floods, earthquakes, slope instability, stream flow fluctuations or stream channel fluctuations. If more than a 60 days have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Report Recommendations and Designs Are Not Final

Do not over-rely on the recommendations included in this report. These recommendations are not final because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual site-specific conditions revealed during construction.

We recommend that you allow sufficient monitoring and consultation by GeoEngineers during construction to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated and to evaluate whether construction activities are completed in accordance with our recommendations. GeoEngineers is unable to assume responsibility for the recommendations in this report without performing construction observation.

The designs depicted herein are approximate and are intended to express the overall design intent of the project. These designs will need to be adjusted in the field during construction in order to meet the specific-site conditions and intended function.

Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the project team (Client, landowners, regulatory agencies and contractor) after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

To help prevent costly problems, we recommend giving contractors the complete report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report's accuracy is limited. In addition, encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Hazards of Instream Structures

Instream structures create potential hazards, including, but not limited to: humans falling from the Structures and associated injury or death; collisions of recreational users' watercraft with the Structures and associated risk of injury or death, with partial or total damage of the watercraft; mobilization of a portion or all of the Structures during high-water flow conditions and related

damage to downstream properties, utilities, roads, bridges and other infrastructure, and injury or death to humans, flooding, erosion, and channel avulsion.

It is strongly recommended that the Client address the necessary safety concerns appropriately. This would include warning construction workers of hazards associated with working in or near deep and fast moving water and on steep, slippery and unstable slopes. In addition, signs should be placed upstream and along the enhanced stream reaches, in prominent locations, to warn recreational users of the potential hazards noted above.

Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

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