WASTEWATER TREATMENT PLANT LAGOON REPURPOSING MARKET ANALYSIS

Prepared for

CITY OF ST. HELENS

July 15, 2016

Project No. 0830.03.02

Prepared by

Maul Foster & Alongi, Inc.

2001 NW 19th Avenue, Suite 200, Portland OR 97209

Wastewater Treatment Plant Lagoon Repurposing Market Analysis

The material and data in this report were prepared under the supervision and direction of the undersigned.

MAUL FOSTER & ALONGI, INC.

Ted Wall, PE
Maul Foster & Alongi, Inc.
Oregon Operations Director/Principal Engineer

Emily Picha
ECONorthwest
Project Manager

CONTENTS

TABLES AND ILLUSTRATIONS

ACRONYMS AND ABBREVIATIONS

CDF	combined disposal facility
City	City of St. Helens
COE	U.S. Army Corps of Engineers
CY	cubic yards
DEQ	Oregon Department of Environmental Quality
Ecology	Washington State Department of Ecology
ECO	ECONorthwest
ECSI	Environmental Cleanup Site Information
FNC	Federal Navigation Channel
FS	feasibility study
GIS	Geographic Information Systems
MFA	Maul Foster & Alongi, Inc.
MNR	monitored natural recovery
NFA	No Further Action
NGVD	National Geodetic Vertical Datum
NPL	National Priorities List
NPV	net present value
PCS	petroleum-contaminated soil
Port	Port of Portland
PSET	Portland Sediment Evaluation Team
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SL1	COE freshwater screening level 1
USEPA	U.S. Environmental Protection Agency

SUMMARY

This summary is not intended as a stand-alone document and should be evaluated in context with the entire document.

As part of its long-term waterfront redevelopment plans, the City of St. Helens (the City) is exploring the option of filling in a portion or all of its wastewater treatment plant lagoon to create a usable landmass, develop continuity between adjacent parcels, and provide the opportunity for significant redevelopment on the waterfront. This opportunity is economically viable only if filling this large space with soil is revenue-positive, which is possible if the lagoon is repurposed as a commercially viable solid waste landfill. The purpose of this analysis is to assess the market demand for a landfill permitted to accept selected sediments and soil. Maul Foster & Alongi, Inc., and ECONorthwest performed the analysis with the objectives of assessing, both qualitatively and quantitatively, the market need for such a facility and refining earlier revenue estimates.

The St. Helens facility would receive only sediment, sludge from its wastewater treatment plant, and soil. No construction debris or putrescible, industrial, or hazardous waste would be accepted.

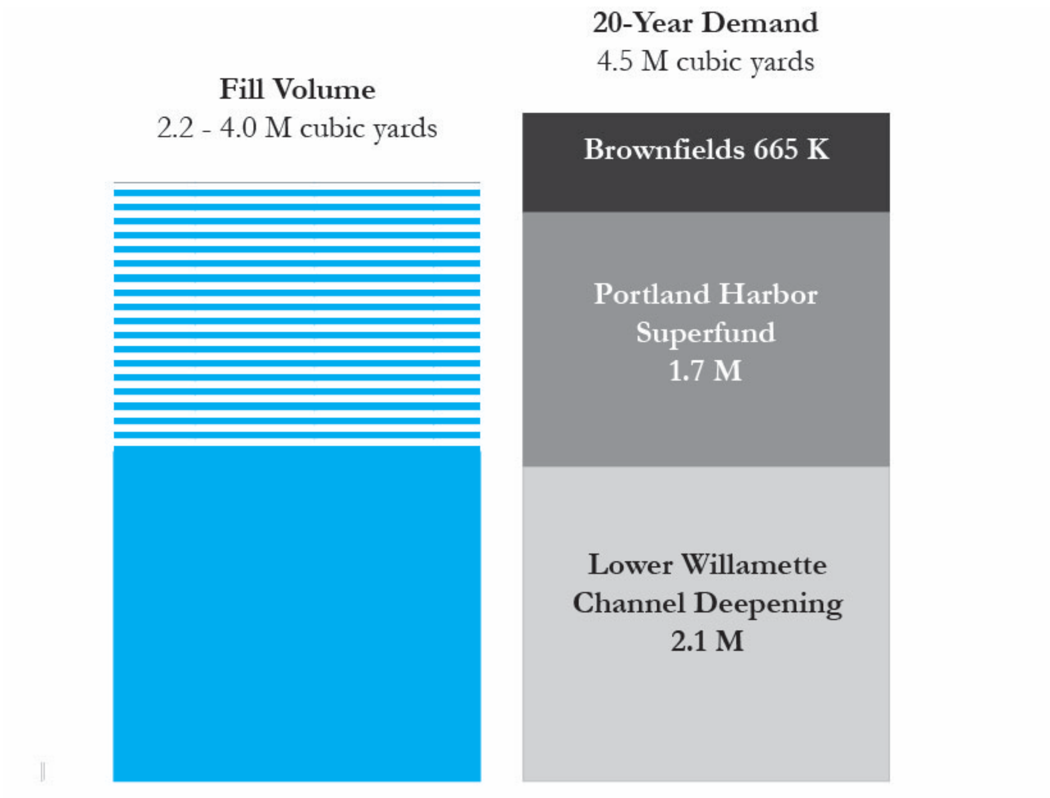
From a technical and regulatory perspective, and with use of proper engineering systems and controls to ensure environmental protection, the site is a viable location for disposal of sediment and soil. While there are multiple competitors that can accept soil from upland sources, there are no competitive facilities with the ability to directly offload sediment from barges. Initial projections suggest significant revenue generation, potentially providing financial support for the City's redevelopment plans, or applied to other City needs.

DEMAND ESTIMATE

Transportation, including transloading (transferring from barge to truck or rail), is a significant cost component for sediment disposal. The potential trade area (source of disposal volumes) for this facility is defined by the three modes of transport used for sediment handling: barge, rail, and road. The largest is the barge trade area, which reaches from the mouth of the Columbia River to River Mile 138 to the east, and to River Mile 26 on the Willamette River.

Significant demand exists for a sediment-disposal facility near the Portland metro area. In this facility's trade area the estimated aggregate demand over a 20-year period is **4.5 million cubic yards (CY)**. This compares to an estimated available filled lagoon disposal volume of 2.2 to 4.0 million CY, shown in the following figure. The available-volume range reflects different fill scenarios and ending ground surfaces.

Estimated Fill Volume and 20-Year Trade Area Demand



The main drivers for disposal demand, in descending order, are: (1) Lower Willamette River channel deepening (2.1 million CY, exclusive of Portland Harbor remediation volumes); (2) Portland Harbor Superfund Site remediation (1.7 million CY); (3) brownfield remediation (665,000 CY); and (4) all other sources (not readily quantifiable).

This demand forecast extends to 20 years, since there are major timing considerations related to the demand. Timing for dredging activity associated with the Portland Harbor Superfund cleanup remains uncertain; the best estimates indicate that dredging will begin in 2022. The U.S. Environmental Protection Agency (USEPA) has indicated that the dredging may take place over approximately six years (although others expect the dredging to take longer). In the Lower Willamette River, navigation channel dredging is expected to increase at some point after the USEPA reaches its formal decision on the Portland Harbor Superfund Site cleanup, and will be spread out over multiple years. The USEPA preliminary decision was issued on June 8, 2016, but the lag between this decision and the renewal of channel deepening is also uncertain. **Overall demand is significant, and with proper planning the facility operations can be phased to align with demand over time.**

The St. Helens facility would have several unique attributes that would create market advantages to capture the market segments listed above:

- **Flexibility in transport mode.** The St. Helens facility would accommodate all three major material delivery modes of transportation—barge, rail, and truck. Only two other landfills in the region can service all three modes, and they are considerably farther from the Portland-Metro region (96 and 170 miles). Our analysis found that the cost of transporting material to the closest barge-accepting facility from a Portland-Metro-area-based example site was approximately $38/ton for the St. Helens facility and $66/ton for the closest competitor.
- **Landfill-adjacent barge-transfer infrastructure that eliminates transload costs.** Transloading is a significant cost component for sediment disposal. The St. Helens facility would be the only site with barge-transfer infrastructure immediately adjacent to landfilling operations, eliminating additional handling and significantly reducing the overall cost as well as environmental impact (greenhouse gas emissions from additional handling). The only competitor near the trade area that has barge-offloading capabilities requires additional handling (offloading from barge onto trucks, with 21 miles of road transport).
- **Close proximity to large demand segments reduces transportation time, costs, and environmental impact.** The St. Helens facility's location would reduce handling and transport costs for many dredging projects. For example, the St. Helens facility would be the barge-appropriate location closest to the Lower Willamette River, which contains an estimated 3.8 million CY of sediment requiring disposal. The current closest barge-appropriate facility is 95 river miles from the center of the Lower Willamette River, compared to the St. Helens facility's 23 miles. Based on travel time alone, the St. Helens facility would also be competitive for disposal of soil from upland sources in the trade area. In addition, close proximity to sediment and soil sources will result in significant greenhouse gas emission reductions.

For the Portland Harbor Superfund site, the USEPA's estimated unit cost for transportation and disposal (including transload facility) is $115/ton, compared to the unit cost of $96/ton for the St. Helens facility, as developed in this market analysis. This delta reflects the market advantages listed above and equates to potential cost reductions of $40M for the Portland Harbor remedial action and $50M for the Lower Willamette River navigation channel deepening.

FINANCIAL MODELING

A preliminary net present value (NPV) estimate for the lagoon repurposing opportunity was based on three representative facility configurations:

1. Partial fill of the lagoon with even overland slopes from the west edge to the east edge of the site
2. Partial fill of the lagoon with plateau top grade
3. Complete fill with plateau top grade

The NPV analysis assessed two fill scenarios:

1. "Time-based" (i.e., a set 15-year facility life)

2. "Fill-rate based" (i.e., a set volume of 200,000 CY of soil and sediment imported per year)

Estimated NPV outputs are as follows:

Scenario	Time-Based NPV 15-year Expectancy	Fill-Rate-Based NPV 200,000 CY/year
1—Partial Fill, Even Slope	$56,000,000	$57,000,000
2—Partial Fill, Plateau Grade	$105,000,000	$93,000,000
3—Maximum Fill	$137,000,000	110,000,000

Marketable land will be created if the lagoon is repurposed, representing a City-owned asset. The NPV analysis did not attempt to estimate or account for this created land.

A "break-even" NPV analysis was also conducted to establish the minimum tipping fees, below which the project likely is infeasible without subsidy:

Scenario	Time-Based Break-Even Tipping Fee ($/ton) 15-year Expectancy	Fill-Rate-Based Break-Even Tipping Fee ($/ton) 200,000 CY/year
1—Partial Fill, Even Slope	28	28
2—Partial Fill, Plateau Grade	20	21
3—Maximum Fill	18	20

The large gap for all scenarios between the break-even tipping fees shown above and the approximate minimum market-based tipping fee projected in this analysis ($58/ton) (note that the NPV values shown above are based on $55/ton to account for market imprecision) reflects a solid market position for the St. Helens facility. Overall, this NPV analysis was preliminary in nature, and the results should be considered approximate. Nonetheless, the output indicates that repurposing the lagoon to meet the City's long-term redevelopment goals is viable.

1 INTRODUCTION

As part of its long-term waterfront redevelopment plans, the City of St. Helens (the City) is exploring the option of filling in a portion or all of its wastewater treatment plant lagoon to create a usable landmass, develop continuity between adjacent parcels, and provide the opportunity for significant redevelopment on the waterfront. This opportunity is economically viable only if filling this large space with soil is revenue-positive, which is possible if the lagoon is repurposed as a solid waste landfill. The purpose of this analysis was to assess the market demand for a landfill permitted to accept selected sediments and soil. Maul Foster & Alongi, Inc. (MFA) and ECONorthwest (ECO) performed the analysis with the objectives of assessing, both qualitatively and quantitatively, the market need for such a facility and refining earlier revenue estimates.

2 BACKGROUND

Sediment dredging is performed on a regular basis in the Pacific Northwest to serve a variety of purposes, including maintaining shipping channels and berthing areas, boat ramps, docks, marinas, and houseboat communities. Dredging is also performed to remove contaminated sediment that poses risk to aquatic life and/or human health.

Dredged sediments are typically disposed of by hydraulically pumping them into the river channel and allowing them to remain naturally in the river system; placing them upland for fill, including habitat restoration; or transferring them upland and placing them in a disposal facility (landfill).[1] Contaminated sediments are typically not permitted for in-water disposal and are therefore disposed of in landfills. Costs to dispose of sediment in a landfill are generally high because of processes associated with treatment (solidification); transportation; transload (such as transfer from barge to upland facilities); dewatering; and disposal fees.

The process for evaluating dredge material disposal options is governed by the U.S. Army Corps of Engineers (COE) through Section 404 of the Clean Water Act. To obtain a Section 404 permit, a project proponent must show that the dredge/fill activities will not significantly degrade the nation's waters. The COE Portland District uses the Sediment Evaluation Framework for the Pacific Northwest (COE et al., 2009) to ensure compliance with the Clean Water Act.

Under this framework, the quality of sediment to be dredged is characterized through sampling and analysis; the Portland Sediment Evaluation Team (PSET), consisting of representatives from the COE, Region 10 of the U.S. Environmental Protection Agency (USEPA), the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Oregon Department of Environmental Quality (DEQ), and the Washington State Department of Ecology (Ecology), reviews the results of

[1] Confined disposal facilities (CDFs) are commonly used for dredged-material disposal throughout the United States and elsewhere. No public CDFs exist in the trade area studied; landfills are the only available option for contaminated-sediment disposal.

the sediment sampling to determine whether the proposed dredge material may be disposed of in water. If the PSET determines that the material is unsuitable for in-water disposal, the material must be placed upland in an environment where its effluent will not affect the nation's waters.

After conversion to a landfill, the City of St. Helens wastewater treatment plant lagoon could serve as a disposal facility for dredged sediments from throughout the region (viable trade area) that (1) are not regulated hazardous waste, and (2) are not eligible for unconfined disposal. Current estimates show that between 2.2 and 4.0 million cubic yards (CY) of soil and consolidated sediment could be disposed of in the lagoon, creating the land mass and open space desired by the City.

3 APPROACH

For this study, MFA and ECO assumed that the St. Helens facility would receive only sediment, sludge from its wastewater treatment plant, and soil. No construction debris or putrescible (liable to decay), industrial, or hazardous waste[2] would be accepted.

3.1 Competitor Research

MFA generated an inventory of active regional landfill facilities to identify potential competitors to the St. Helens facility, using public source data and interviews with facility personnel. MFA selected facilities for further research, based on their proximity to the city, available modes of transportation for import of sediment, landfill size (available volume), accepted waste types, and published tipping fees. To complete the inventory, MFA extracted data from solid waste disposal permits, waste management plans, financial assurance documentation, and other public records.

3.2 Competitor and Trade Area Analysis

The first step in the competitor analysis involved identifying the trade areas in which it would be less costly for customers to move waste (via either barge, rail, or truck) to the City's facility than to competing facilities in the region (see Figure 1).

Using Geographic Information Systems (GIS), MFA developed a trade area model to calculate, for any given area, the least costly mode and distance that a potential customer would use to dispose of waste. The model uses the following inputs: the location of the potential St. Helens facility, the location of all pertinent landfill competitors, a detailed travel network, and a cost approximation for traveling along the network. Different travel networks were used in the model, depending on each trade area's mode of transportation. The upland trade area analyzed the road network, including all travel impediments such as speed limits, intersections, and roadways impassable for a hauler. The barge trade area included a customized network of river channel center-lines. Similarly, the competitor disposal facilities in each area were assessed based on their ability to accept a particular mode of material

[2] Hazardous waste as defined by the federal Resource Conservation and Recovery Act (RCRA) and State of Oregon statute.

transportation. For example, the barge trade area was calculated using only those competitors that are able to accept waste via barge.

3.2.1 Barge Trade Area

The barge territory was delineated by calculating the cost of delivery along the river network to facilities that accept waste via barge, i.e., the St. Helens facility and the Wasco County Landfill.[3] The resultant barge trade area includes all navigable portions of the Willamette River from its confluence with the Columbia to roughly 26 miles upstream to the Willamette Falls in Oregon City (see Figure 2). The Columbia River portion of the trade area reaches from the mouth of the Columbia River to Bridal Veil, Oregon. Potential customers east of Bridal Veil will find it more cost effective to travel upstream to the Wasco County Landfill or the Finley Buttes Landfill. The barge trade area encompasses all navigable waterways, which include branches and side channels such as the Multnomah Channel.

3.2.2 Truck/Upland Trade Area

The truck/upland trade area pertains to brownfields and other cleanup actions involving soil removal and landfill disposal. This trade area was delineated using the cost of traveling along the road network via hauler. The upland trade area is somewhat constrained, with relatively close competition from the Cowlitz County Headquarters Landfill to the north and Waste Management Hillsboro Landfill to the south. The upland trade area covers most of Columbia County and extends marginally into Washington, Multnomah, and Clatsop counties. Larger municipalities in the upland trade area include St. Helens, Columbia City, Scappoose, Vernonia, and Rainier.

3.2.3 Rail Trade Area

The rail trade area was constructed from the U.S. Department of Transportation's railroad GIS spatial network. It includes the potential St. Helens landfill and competitor landfills that accept waste via railroad. MFA assumed that only sites in immediate proximity of the rail line (i.e., within approximately 500 feet) would be more suitable for rail than truck transport.

For this analysis, the railroad service territory is limited to 150 miles. However, in special cases, a disposal facility might receive waste transported via rail from much larger distances. The 150-mile railroad service territory stretches eastward from the mouth of the Columbia River for a distance comparable to the barge service territory that terminates near Bridal Veil, Oregon. This trade area stretches south into Multnomah, Hillsboro, and Clackamas counties in Oregon, and extends north into Clark County, Washington.

3.3 Material Handling and Transportation Cost Estimate

Many factors, including project size, equipment used, and site conditions, affect the costs of sediment- and soil-removal operations in excavation and dredging projects. MFA developed a cost estimate that

[3] The Finley Buttes Landfill in Boardman, Oregon, also can accept barged sediment after it is transloaded at an offloading facility in The Dalles, Oregon, or in Boardman. However, given the additional cost for travel (83 miles, one way), it was not necessary to include it in this analysis.

provides a comparison of sediment transportation and disposal for the three primary transportation modes (truck, rail, direct barge), using a fixed set of assumptions for materials processing before transportation. The transportation and disposal cost estimate assumed a hypothetical project site at the center of the Portland industrial waterfront[4] (River Mile 6.5), then compared modes of transportation to the most feasible disposal facility for that mode.

MFA developed a unit cost per ton for each mode of transportation to the nearest accessible facility. This analysis held variable factors constant by assuming a fixed set of costs up to the point at which the material is removed from its original location and placed in an alternative location.[5] In this way, the model considered only those cost components directly influenced by the available means of transport (truck, rail, barge) for each disposal location evaluated. Cost estimate assumptions were based on research of publicly available information, previous project experience, and information obtained from regional landfill operators.

Following this process, MFA estimated costs per ton for direct barge to a transload facility near The Dalles, Oregon, and then trucking to the nearest landfill (also near The Dalles); direct barge to the proposed St. Helens facility; truck transportation to Hillsboro, Oregon; and rail transportation to a landfill facility in The Dalles.

Results are discussed in Section 4.

3.4 Demand Analysis

To assess potential market demand, our team compiled and assessed publicly available records (e.g., COE dredging permits) and contacted representatives from different market sectors, conducting interviews to (1) understand the need for future dredging and (2) determine how much of that material might require disposal.

Market sectors included ports, the COE, waterfront industrial lands, marinas and houseboat communities, and upland sources (e.g., brownfields). The MFA team conducted a total of 13 interviews with representatives of these market sectors.

An estimate of the sediment that will be dredged during future Lower Willamette River navigation channel deepening and that likely will require upland disposal was conducted as described below.

The USEPA's proposed plan for the Portland Harbor Superfund site (see Section 4.2.1) designates areas in which capping or removal are not required as part of the remedial action. These areas are designated for monitored natural recovery (MNR). Some portion of the aggregate MNA area is in the

[4] This location was chosen because it generally represents the center and highest density of potential users.

[5] For example, if sediment is dredged and transported to a disposal facility via barge (reflecting a disposal facility with barge offload capabilities), the cost analysis begins with transportation of that material. Conversely, if the sediment is dredged, placed on a barge, and offloaded to an upland staging/dewatering and truck or rail loading area (reflecting a disposal facility without barge offloading capabilities), the cost analysis begins at the point at which the sediment is rehandled from the barge to the staging/dewatering location. Cost estimate considerations for sediment handling (as applicable) include sediment dewatering, wastewater treatment, temporary access improvements, application of sediment solidification amendment, and sediment transload.

COE-designated navigation channel. Some areas in this channel will require dredging to maintain adequate depths for commercial transport. The following describes the screening process for identifying sediment volumes in the MNR-designated navigation channel that are likely to require landfilling (as opposed to open-water placement) when removed.

- All sediment data were acquired from the USEPA Feasibility Study (FS) database (Appendix A of USEPA, 2016).[6]
- Sediment data were filtered to include only those sample locations that occur in the COE navigation channel and at depths up to the allowable maintenance dredge depth of -43 feet (National Geodetic Vertical Datum [NGVD] 1929). In addition, sample locations in dredge/capping areas, as identified by the USEPA, were excluded from this analysis. In this way, only sample locations in MNR areas in the navigation channel were evaluated.
- All sample locations were binned into quarter-mile stretches for the study area (River Mile 1.9-11.8). For each quarter-mile stretch, the average concentration of chemicals (e.g., arsenic) or chemical groups (e.g., total polycyclic aromatic hydrocarbons) was calculated. For calculation purposes, non-detect data were assigned the value equal to the reporting limit.[7]
- Consistent with COE protocols as outlined in the Dredged Material Evaluation and Disposal Procedures User Manual and the Sediment Evaluation Framework (COE, 2015; COE et al., 2009) the resulting concentrations were compared to the COE freshwater screening level 1 (SL1). Sediment above SL1 is unsuitable for open-water disposal.[8]
- The screening process assumed that if one or more chemicals or chemical groups exceeded SL1, then sediment in that stretch would require upland disposal.
- For quarter-mile stretches exceeding SL1, the corresponding volume was calculated based on existing surface bathymetry down to -43 feet. These volumes were then summed to estimate the total dredge volume expected to require upland disposal.

3.5 Net Present Value Analysis

This analysis was completed to establish a preliminary net present value (NPV) estimate for the conversion of the lagoon to a permitted landfill. Estimated costs were developed for design, permitting, construction, operation, closure, and post-closure care. Cost estimates and revenue projections were prepared for three representative configurations (see Appendix A) as follows:

1. Partial fill of the lagoon with even, overland slopes from the west edge to the east edge of the site
2. Partial fill of the lagoon with plateau top grade

[6] While these are the most recent available data, in some cases they are several years old, and existing or future sediment conditions may differ.

[7] Averages are considered appropriate for evaluation, as sediment sampling under COE protocols typically involves compositing multiple samples into one sample for analysis.

[8] COE protocols allow for additional bioassay testing to establish site-specific toxicity, i.e., to override this conclusion.

3. Complete fill with plateau top grade

Scenario 1 represented the lowest available airspace, with 1.5 million CY, and Scenario 3 had the highest, with 2.6 million CY, exclusive of the volume needed for existing sludge (Appendix A). Airspace is defined as the actual volume that is available to be displaced by imported materials. When sediment is dredged, significant amounts of water are mixed with the sediment as it is excavated and placed on a transport barge. Some water is removed through dewatering efforts on the barge; however, large amounts of water remain, to eventually be disposed of with the sediment. Accordingly, the estimates used in this NPV analysis assume a 20 percent volume increase resulting from dredge excavation. Sediment dewatering and consolidation are also assumed in this NPV analysis. Specifically, based on research, a consolidation ratio of 1.8:1.0 was applied. Accounting for both the volume increase factor (1.2) and the dewatering/consolidation factor (1.8) results in a combined ratio of 1.5:1.0 in situ (in-river) to in-place (in landfill), meaning that 1.5 CY of in situ sediment will consume 1 CY of airspace in the landfill.[9]

Cost estimates assume that the facility will be constructed similar to a municipal waste landfill: with a bottom liner, leachate collection systems, top liner and soil cover, stormwater control systems, and other systems and accessory structures that may be found at a typical disposal site. The baseline cost estimates include all major facility construction, operation, and closure/post-closure elements, and include a 30 percent contingency to account for cost components not incorporated in this preliminary assessment.

Market research (see Sections 4.1.2 and 4.3) suggests that a tipping fee of approximately $58 can be expected. To account for uncertainty in this input parameter, a tipping fee of $55 was used in the NPV analysis.

The NPV analysis looked at two fill scenarios, the first being "time-based" (i.e., a set 15-year facility life), and the second being "fill-rate based" (i.e., a set volume of 200,000 CY of sediment/soil imported per year) (see Appendix B). Costs and revenue generation were spread over time, with initial construction in 2022. Design, permitting, and construction costs were split over the first four years (2018–2021), with operational costs and revenue spread across the appropriate time period (depending on fill rate). Facility closure costs were spread over the final four years of operation and the first year thereafter. Post-closure care extended from that point through an additional 30 years. (Thirty years is a typical required post-closure care period for landfill facilities.) Inflation and discount rates were applied for the total period.

Marketable land will be created if the lagoon is repurposed, representing a City-owned asset. This NPV analysis did not attempt to estimate or account for this created land value.

---

[9] The bar graph Section 4.2 reflects this adjustment, i.e., the available landfill volume values shown equal 1.50 x available airspace.

4 FINDINGS

4.1 Competitors

MFA identified ten regional landfills as major competitors to the proposed St. Helens facility, based on modal facilities, proximity to the hypothetical dredging site (located at River Mile 6.5 in the Lower Willamette River), and waste-acceptance criteria.

The operators for the selected regional landfills include national corporations (Waste Management, Waste Connections, and Allied/Republic Services) and individual counties (Lane County and Cowlitz County). Table 1 lists the landfills and their respective operators, and Table 2 lists each landfill's 2014 statistical data, including permitted capacity and annual processed tonnage.

While there are competitor facilities that can accommodate material arriving via a range of transportation modes, the St. Helens facility is the closest facility to the Portland metro area that could accommodate all modes of transportation.

4.1.1 Waste Streams

MFA identified the actual type and amount of waste each competitor landfill accepts as well as the extent to which each landfill reached or exceeded its annual permitted acceptance quota in 2014. For the purposes of this study, we assumed that the St. Helens facility would receive sediment, sludge from its wastewater treatment plant, and soil only. No construction debris or organic, industrial, or hazardous waste would be accepted.

Landfill facilities included in the research are categorized as RCRA Subtitle D facilities, which are permitted to receive household waste, and may also be permitted to receive nonhazardous sludge, industrial solid waste, and construction and demolition debris. In addition, Chemical Waste Management of the Northwest is a RCRA Subtitle C landfill, which means that it can accept more types of waste, including hazardous waste. Each Subtitle D landfill has a solid-waste permit that explicitly states the types of materials accepted. Table 3 includes a tabulation of each landfill's accepted waste types.

Facilities in Oregon and Washington are required to report waste annually. Required information includes tonnage and accompanying category of waste. Table 4 uses these data to show what percentage of landfilling is associated with municipal waste versus "relevant waste"; relevant waste refers to waste likely to be accepted at the St. Helens facility, including additional daily cover, soil, dredged sediment, and sludge.

Municipal waste comprises most of the waste handled across most regional landfills. In 2014, the Hillsboro Landfill acquired the most relevant waste by percentage at 44 percent; it should be noted that 41 percent of it is considered petroleum-contaminated soil (PCS). Columbia Ridge Landfill accepted the most relevant waste by tonnage in Oregon; again, most of it is considered PCS (20% of total waste). Roosevelt Landfill, the largest landfill by annual operation, accepted 27 percent relevant waste, or over 600,000 tons. Wasco County, considered the largest competitor for dredged wet sediment, accepted 38,000 tons of relevant waste (DEQ, 2014.)

Each of the competitor landfills possesses Special Waste permits that allow them to receive certain materials for beneficial use such as daily cover (instead of using clean soil for daily cover).[10] Materials commonly accepted for beneficial use include PCS, contaminated sediment, wastewater treatment sludge, and shredded tires. Beneficial-use materials are typically accepted at rates lower than those for standard municipal solid waste, as they are needed for landfill operations.

Waste stream data provide insight into the actual type and amount of waste each landfill accepts. It is understood that the waste stream data are from one year of operation, and may not be fully representative of long-term trends; however, these data provide insight into current market conditions. All landfills nearly reached or exceeded their annual permitted acceptance quotas in 2014, indicating that each landfill is needed in the current market.

4.1.2 Tipping Fees

MFA analyzed the key drivers for tipping fees at competitor facilities in the trade area. A tipping fee is the cost charged by the disposal facility owner to place waste in the landfill. Several factors influence tipping fees, including:

- The location of the disposal facility in relation to the project location. A large distance from the project site to the landfill can lead to decreased tipping fees in an attempt to offset transportation costs.
- Climate at the disposal facility, which can determine operational and projected closure costs. Facilities located in wetter areas require different, and often more expensive, operational and closure costs than facilities in arid climates.
- Waste type and condition. Contaminated-soil disposal costs usually differ from costs for wet sediment and sludge.
- The waste generator's planned disposal volume. In general, more waste results in lower tipping fees.
- Transportation method. For instance, acceptance of material by train or barge may result in an increased tipping fee to account for facilities and operations associated with offload and transload.

The National Solid Waste Management Association provides the following equation to calculate a projected national tipping fee for municipal waste (NSWMA, 2012):

$$Y=1.2402*X-2,448$$

Y represents the tipping fee, and X represents the calendar year. Hence, for 2016, the fee is \$52/ton. Published standard competitor landfill tipping fees for municipal waste have a mean rate of \$55/ton; the national tipping fee equation is comparable. In the trade area, tipping fees range from \$22/ton

[10] Daily cover is the layer of soil or other approved material that is placed on top of a day's deposition of waste.

(Columbia Ridge Landfill) (JRMA and GBB, 2013) to $96/ton (Hillsboro Waste Management Landfill) (Waste Management, 2016). Table 2 lists the results of our research into tipping fees and each landfill's available modes of transportation. Although a tipping fee can be estimated, it is generally determined by the market and landfill needs (i.e., beneficial uses and need for daily cover). A landfill facility is not required to charge a standard fee for each load; contracts are often negotiated between a facility and a waste generator.

4.1.3 Cost Estimates

Costs for handling and disposal were estimated for four scenarios that represent the most likely disposal options for the hypothetical project located at River Mile 6.5 on the Willamette River (see Figure 3). These estimates offer a comparison of potential costs for direct competitors to the proposed St. Helens facility. A weight of 1,500 tons of wet sediment was assumed for each scenario. Each scenario is described below.

Rail to Landfill—The Dalles, Oregon

The cost estimate assumes that sediment is transloaded from the dredging barge to modular containers (drop boxes) at a hypothetical transload facility near the point of origin. The sediment is offloaded, dewatered, and containerized. Containers are loaded on railcars and shipped to a disposal facility in The Dalles. Containerized sediment is transferred from the rail area and disposed of by the facility. There is a single rate, influenced by travel distance, per railcar.[11] The costs estimated for this scenario are based on a direct quote for a similar regional project, adjusted for location. For a cost summary, see Table 5.

Truck to Landfill—Hillsboro, Oregon

The cost estimate assumes that sediment is transloaded from the dredging barge at a hypothetical transload facility near the point of origin. Sediment is offloaded, dewatered, and treated with solidification amendment, then placed in trucks for transport. The estimate assumes a daily cost for a truck and driver; each truck is assumed to haul four 33-ton loads to the disposal facility. For a cost summary, see Table 6.

Barge to Transload Facility and Truck Transport to Landfill—The Dalles, Oregon

The cost estimate assumes that dredged sediment is transported from the point of origin by direct barge to a permitted waste transfer and transload facility in The Dalles, Oregon. The total in-water travelling distance is 95 river miles; the round-trip is assumed to take two days. The sediment is then transloaded from the barge, treated with a solidification amendment, and loaded onto haul trucks and transferred to the disposal facility (17-mile round-trip). For a cost summary, see Table 7.

Barge—St. Helens, Oregon

The cost estimate assumes that dredged sediment is hauled by direct barge from the hypothetical site to the St. Helens facility. Sediment is offloaded directly from the barge to the landfill, with no

[11] Rail transport rates are relatively variable and do not always directly correlate to travel distance on a regional level.

additional treatment or dewatering (some dewatering before offload is still performed, as shown in the cost estimate). The landfill would be designed to handle final dewatering of wet materials in place. The cost estimate assumes 23 miles of in-water travel. For a cost summary, see Table 8.

4.1.4 Competitor Scenario Summary

Costs calculated in the estimates show that, among these scenarios, the St. Helens facility is the most efficient and cost-effective disposal option for sediment. In descending order, the total calculated costs per ton to handle and transport sediment are as follows (excluding tipping fees):

- Truck to landfill in Hillsboro, Oregon—$81 per ton
- Rail to landfill in The Dalles, Oregon —$76 per ton
- Barge/transload/truck to landfill in The Dalles, Oregon—$66 per ton
- Direct barge to St. Helens Disposal Facility—$38 per ton

Findings from this analysis included the following:

- Close proximity to anticipated dredge material sources creates an advantage by reducing transportation times, which in turn may increase efficiency for dredge project operations.
- The St. Helens landfill would be the only facility with a barge transfer immediately adjacent to landfilling operations, eliminating additional transload and transportation processes and significantly reducing the overall cost as well as environmental impact (greenhouse gas emissions from additional transportation).

4.2 Market Sectors

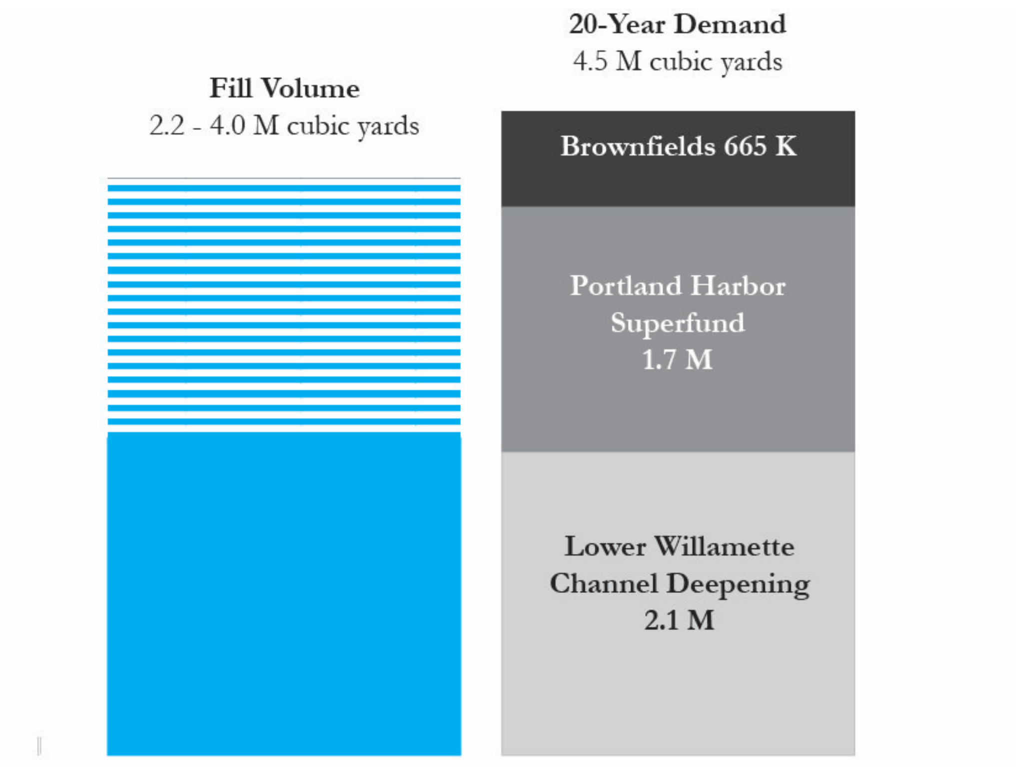
This section provides information on the market sectors for materials, including an estimate (where possible) of the potential volume of sediment and soil generated from each sector over time. This study found that the major market sectors for the St. Helens facility would be waterfront industrial users and upland sources. Secondary sources would be ports, and marinas and houseboat facilities. The following table shows key market sectors, estimated demand, likely transport method, and key considerations for each market sector.

Key Market Sectors by Estimated Demand

Market Sector	Estimated 20-Year Demand (CY)	Likely Transport Method	Key Considerations
Waterfront Industrial: Portland Harbor	1.7 M	Barge	• Remedial design may affect estimated loads
Waterfront Industrial: Federal Navigation Channel (FNC)	2.1 M	Barge	• Maintaining target depths in the channel is a priority for the COE • Confined disposal likely will be necessary for some of the material
Upland Sources	665K	Truck or Rail	• Timeframe for waste generation is primarily market driven
Ports	Not available	Barge	• Historically, dredged sediment has been suitable primarily for in-water or upland disposal • Overall small demand
Marinas and Houseboat Facilities	Not available	Barge	• Overall small and uncertain demand for material disposal
TOTAL	4.5 M		

The figure below shows the estimated available fill volume range compared to the aggregate key market sector demand.

Estimated Fill Volume and 20-Year Trade Area Demand



4.2.1 Waterfront Industrial Lands

Waterfront Industrial Lands includes the following significant sources of material:

- Portland Harbor Superfund sediment (also known as National Priorities List [NPL] sediment)
- FNC dredged sediment

National Priorities List Sediment

MFA reviewed the Final Portland Harbor Proposed Plan and FS developed by the USEPA (USEPA, 2016). The USEPA has recommended implementation of Alternative I, which includes removal/dredging, supported by capping and MNR for sediment and riverbank restoration. Most of the sediment to be dredged is outside the FNC. This alternative describes costs and volumes of sediment to be removed and appropriate for disposal at the St. Helens facility[12] as follows:

- 1,678,600 CY of sediment generated over six years (i.e., 279,767 CY/year).
- Transportation and disposal costs[13] (barging to transload facility, and transportation to and disposal at landfill) of $85 per ton (converts to $107/CY). Adjusted for in-barge-stabilization with diatomaceous earth, the overall per-ton cost is $111.[14]
- The assumed rail transportation mode requires construction of a transload facility in the Portland Harbor area, estimated in the FS at $10,528,998. The associated cost is approximately $4 per ton, making the adjusted transportation and disposal cost $115 per ton.[15]
- The St. Helens facility has a projected transportation cost of $38/ton (see Section 4.1.4) and a projected minimum tipping fee of $58/ton (see Section 4.3), for a total of $96/ton. This $19/ton variance represents an approximate reduction $40M for the Portland Harbor remedial action.

Consistent with USEPA guidance, the costs and volumes in the FS are estimated at a +50/-30 percent level of accuracy. Regardless of this level of precision, the NPL sediment represents a significant and reliable market source of material and revenue.

---

[12] "Appropriate for disposal at the St. Helens facility" refers to those sediments within the NPL site not regulated as hazardous waste under federal or state hazardous waste regulations, i.e., not RCRA-regulated wastes. Furthermore, significant uncertainty regarding estimated riverbank soil volumes to be removed prevents development of useful cost projections for this material at this time. Riverbank soil volumes are not included in this analysis.

[13] The USEPA does not provide separate transportation and disposal costs. However, the USEPA assumed receiving facility is the Roosevelt Landfill, located approximately 145 miles from the Portland Harbor site, as compared to 23 miles (St. Helens).

[14] The USEPA FS and this market analysis both adjust the in situ volumes (and weights) to account for water addition that occurs through dredging. These adjustments are reflected in the unit costs applied in the USEPA FS and this market analysis.

[15] The $111/ton value is used here since stabilization (i.e., dewatering) is expected to be necessary.

Federal Navigation Channel Sediment

The FNC includes the area between the confluence of the Willamette and Columbia rivers and the Broadway Bridge in downtown Portland (Port, 2016). The Port of Portland (Port) sponsors dredging with federal funding and operates the dredge *Oregon*. Much of the Columbia River sediment dredged by the Port has been placed in the uplands of West Hayden Island. However, based on the significant community resistance to upland, unconfined placement (e.g., Post Office Bar sediment [Sallinger, 2011]), we anticipate that not all FNC sediment from the Lower Willamette River will be appropriate for further disposal at West Hayden Island, and that the St. Helens facility would represent a reasonable alternative.

The FNC has not been dredged since 1997. Maintenance dredging has been deferred pending the NPL site Record of Decision (ROD); the target depth is 43 feet below mean sea level (NGVD 1929). The estimated volume of navigation channel sediments likely to require upland disposal was established following COE protocols as outlined in the Dredged Material Evaluation and Disposal Procedures User Manual and the Sediment Evaluation Framework (COE, 2015; COE et al., 2009). As noted above, areas identified by the USEPA for dredging and capping were excluded from the volume calculations. The current estimated volumes are:

- USEPA proposed plan MNR total volume in the navigation channel is 6,555,417 CY.
- Of that total, 2,303,896 CY exceeds applicable thresholds (SL1).
- The USEPA proposed plan dredge volume in the navigation channel is 192,204 CY.
- The volume of maintenance dredge sediment that (1) is likely to require landfilling, and (2) is not otherwise removed as part of the remedial action is 2,111,692 CY (2,303,896 CY – 192,204 CY), or approximately 32 percent of the total MNR volume.

Adjusting Factors:

1. It is possible that contaminant levels in some of the estimated 2,111,692 CY will pass bioassay tests, allowing for in-water disposal.
2. It is also possible that some portion of the 2,111,692 CY could be used as upland, unconfined fill, i.e., it passes DEQ's Clean Fill Policy criteria.
3. The USEPA's proposed plan includes extensive bank improvements that will require excavation and off-site disposal. The volume of soil associated with this portion of the remedy has not been quantified by the USEPA and therefore cannot be accounted for in this market analysis.

Factors 1 and 2 counteract Factor 3. Consequently, no adjustment to the estimated volume of 2,111,692 CY is warranted.

Applying the projected cost reduction of transportation and disposal of this material of $19/ton (see NPL sediment summary above) to this estimated volume shows a potential cost reduction of approximately $50M.

Historically, the COE has generated between 500,000 and 750,000 CY of sediment from the FNC every three years (166,667 to 250,000 CY per year). It is not clear if the deferred demand for dredging will increase this production rate, or if regulatory constraints (e.g., fish windows) will offset or constrain such an increase.

The MFA team anticipates that sediment dredging will begin after completion of the Portland Harbor Dredged Material Management Plan (Port, 2016) and resolution of the ROD, likely 2018 or later.

Maintenance of the FNC to the target depth remains a high priority for the COE and the Port. Therefore, this market sector appears significant and reliable.

4.2.2 Upland Sources

As described previously, MFA evaluated the potential for generation of contaminated soil by known and potential brownfield sites in the truck/upland trade area. This area was defined by calculating a cost of travel, relative to competing landfills, to the St. Helens facility for trucks transporting contaminated soil from brownfield sites (see Figure 1).

The trade area comprises 458,155 acres of land, primarily in Columbia and Clatsop counties, but also extends into a portion of Washington and Multnomah counties. There are 224 known brownfield sites (listed in DEQ's Environmental Cleanup Site Information [ECSI] and/or Leaking Underground Storage Tank databases) in the upland trade area (ECO, 2014; ECO and MFA, 2015). Almost all are located in the urbanized areas of Columbia County—St. Helens, Scappoose, and Vernonia. The unincorporated areas of the other three counties do not contain known brownfield sites.

Because the MFA analysis is focused on soil, we removed from the subject population those sites that had contamination impacting groundwater only. In addition, we removed sites where DEQ had determined that no additional cleanup was necessary and for which a No Further Action (NFA) status determination had been issued. Removing those sites results in a total of 37 applicable sites representing 846 acres of land. The total area of impacted soil was assumed to be 42 acres (5% of 846 acres). The level of analysis completed for this study did not allow for review of the known sites and the actual need for remediation through soil removal. Therefore, recognizing that some known sites may not require soil removal, we reduced the total area of contaminated soil by 25 percent, resulting in 32 acres. Assuming an average depth of removal of 10 feet, the total volume of contaminated soil assumed to be subject to removal and disposal is approximately 512,000 CY.

To capture the potential for additional contaminated soil from currently unknown brownfield sites (i.e., assuming that DEQ has not identified all brownfield sites in the study area), we applied an extrapolation ratio of 30 percent to the known population of applicable (nongroundwater) brownfield sites to obtain an estimate of unidentified brownfields (i.e., 0.3 x 37 sites = 11 sites). Based on these additional 11 sites, we used the average site size of the known population of applicable sites (i.e., 23 acres), applying the 5 percent assumption noted above, to project an additional 13 acres of contaminated soil. As with the known population of sites, we reduced the total area by 25 percent to account for the likelihood that not all would require remediation through soil removal, for a total of 153,000 CY.

Added to the known volume of contaminated soil, the total future potential volume of contaminated soil from upland brownfields in the trade area is 665,000 CY, as shown in the following table.

Upland Contaminated Soil Assumptions

Output	Known Brownfield Sites		Unknown Brownfield Sites	
	Assumption	**Result**	**Assumption**	**Result**
Sites	ECSI database sites less sites with NFAs	37 sites	Extrapolation ratio of 30% applied to 37 known sites	11 sites
Acres	Total acres of known ECSI sites without NFAs	846 acres	Average site size of known sites (23 acres) multiplied by unknown sites	253 acres
Brownfields with impacted soil	5% of known brownfield acres	42 acres	5% of estimated unknown brownfield acres	23 acres
Site acres that require soil removal	75% of acres with impacted soil	32 acres	75% of acres with impacted soil	17 acres
Contaminated soil volume	32 acres with 10 feet of soil to be removed	512,000 CY	17 acres with 10 feet of soil to be removed	153,000 CY

Total estimated contaminated soil:
665,000 CY

Based on this estimate, upland brownfield sites in the trade area should be considered a relatively significant source of fill material.

4.2.3 Ports

Port facilities in the trade area include Ilwaco, Warrenton, Astoria, Tongue Point, Westport, Longview, Rainier, Kalama, St. Helens, Vancouver, Portland, and Camas-Washougal.

Ports are a relatively small share of the overall dredging activity in the trade area. Many are advantageously located on areas of rivers where swift currents naturally move sediment, a process called scouring. In these areas, water depths are achieved naturally. If natural scouring does not occur, ports must dredge to maintain their desired water depths.

The volume of dredged material varies from project to project. Interviewees quoted ranges from 5,000 to 30,000 CY per dredging event. Frequency of maintenance dredging also varied among ports. Some indicated that dredging was required every two to three years, others, up to ten years. Under current regulations, many of these dredged materials are eligible for unconfined disposal and thus are not candidates for the St. Helens facility.

One interviewee indicated that some maintenance projects can involve impacted sediment; however, these projects are small and infrequent. All interviewees indicated that no materials had been disposed of in a landfill for at least five years.

In regard to future projections and any pent-up demand, several of the ports referred to the Portland Harbor Superfund site remedy and the Lower Willamette navigation channel deepening, both of which are discussed in Section 4.2.1. Ports also indicated that continued restrictions are expected to make in-water and upland disposal options less likely in the future, thus increasing the demand for landfill disposal.

It appears that there will be some demand[16] for contaminated-sediment disposal in the future, although it is difficult to quantify at this time and likely is relatively minor in comparison to other sources.

4.2.4 U.S. Army Corps of Engineers

According to the COE, deepening of the Columbia River navigation channel from Bonneville Dam to Astoria averages approximately 6 to 8 million CY per year. In the reach from Bonneville to Vancouver, four or five shoals are dredged per year; and downstream of Vancouver, approximately three shoals per year. Each shoal or area can range from 1,000 to 500,000 CY and is dredged annually or every five years, depending on the area.

On the Willamette River, the COE has dredged only one shoal in the last five years. This is primarily because of the status of the Portland Harbor Superfund site and costs associated with disposal. The interviewee echoed what others have said: that there is a pent-up demand for maintenance sediment in the Lower Willamette (Section 4.2.1).

As with the ports, all material dredged in the last five years has been suitable for in-water or upland disposal, and therefore it is not likely that Columbia River maintenance dredge material would be a candidate for the St. Helen's facility. In addition, deepening of the Columbia to 43 feet is complete and the COE predicts a decrease in dredged volume in the near future.

4.2.4.1 Section 404 Permits

In addition to conducting dredging, the COE administers dredging permits for private industry and other entities (i.e., ports) via Section 404 of the Clean Water Act. MFA submitted a Freedom of Information Act document request to the COE for all Section 404 permits applied for in the last five years for river miles in the trade area. Documents provided by the COE are summarized in Table 9. Consistent with information gathered from other market sectors, the vast majority of dredge material removed was suitable for in-water or upland disposal. Of all the permitted dredging projects, only two generated material that required disposal in a landfill, and both projects involved maintenance dredging in the Portland Harbor.

Based on information gathered from the COE and their 404 permits, it does not appear that there is a significant source of dredge sediment requiring landfilling (now or in the future) outside the Portland Harbor.

4.2.5 Marinas and Houseboat Communities

There are 45 marinas in the trade area (32 in Oregon and 13 in Washington). Almost half (21) are in Portland. All of the marinas are relatively small: 37 are under 2,500 square feet, and the other eight

---

[16] MFA prepared a Confined Disposal Facility Feasibility Study for Columbia River Estuary Taskforce that, although dated (MFA, 2008), indicated that regional demand in the Lower Columbia (and specifically Port of Astoria and Port of Ilwaco) would exhaust a 220,000-CY landfill within eight to 15 years.

marinas are between 2,500 and 10,000 square feet. The trade area also has 73 boat ramps, most of which are associated with a marina, yacht club, or moorage.

Most of the boat ramps provide access to either the Columbia River or the Willamette River. Fifty-nine of the 73 boat ramps are in Oregon, 24 of those in Portland. Figure 2 shows the types and locations of these facilities in the trade area.

Similar to ports, marinas and houseboat communities are a relatively small share of the overall dredging activity in the trade area. Marinas and houseboat communities that maintain desired water depths typically face one of two scenarios: they may be advantageously located on parts of rivers where scouring occurs; or, if natural scouring does not occur, they must dredge to maintain their desired water depths.

One interviewee indicated that public facilities are likely to be redesigned to minimize future dredging—for example, the new design at Gleason Boat Ramp, which includes an extended pier that prevents sediment accumulation.

The volume of dredged material varies greatly from project to project. Smaller marinas and houseboat communities typically dredge about 5,000 CY at a time. However, larger projects can dredge more material. When dredging is needed, it is commonly repeated every five to ten years, and occasionally as infrequently as every 20 years. Under current regulations, many of these dredged materials are eligible for unconfined disposal and thus are not candidates for the St. Helens facility.

Interviewees indicated that dredging is becoming increasingly difficult for three main reasons:

- Disposal: Notwithstanding past practices in which unconfined disposal was acceptable, interviewees identified disposal as an increasing challenge, and therefore avoid dredging when possible.
- Permitting process: The complexity of the permitting process (due, in part, to the number of agencies involved) continues to be a problem and expense to houseboat communities and marinas looking to dredge.
- Stricter regulations: Dredging permits are issued for certain work windows to limit impact on fish and wildlife, and the dredging work window continues to narrow. In addition, DEQ and Ecology have lowered contamination thresholds for in-water and upland unconfined disposal sites.

Marinas and houseboat communities are a small share of the potential demand segments for upland disposal because (1) volumes tend to be relatively small, and (2) dredging is needed only infrequently. Further, our interviews indicate that these facilities avoid dredging as much as possible by design changes or other means.

4.3 Net Present Value

Although competitor tipping fees can be used for market awareness, they should not be used solely for determining new tipping fees, as this number often differs by project. Instead, for the purposes of the NPV analysis, the estimated tipping fee was established as follows:

1. Because of its location and its barge off-loading/transload capabilities, the most viable competitor for sediment disposal projects is the Wasco County Landfill[17]. Its reported tipping fee range is $30 to $100/ton. As seen in Section 4.1.4, the delta between St. Helens facility transport unit cost from the Portland industrial riverfront ($38/ton) and the Wasco County Landfill site ($66/ton) is $28/ton. Combining the minimum Wasco County tipping fee with the transport delta represents an approximate minimum tipping fee that the St. Helens facility could expect, $58/ton. Also, as noted above, published standard competitor landfill tipping fees for municipal waste have a mean rate of $55.
2. A value of $55/ton was used in the NPV, representing a conservative, low-end estimate.

The NPV analysis input parameters and primary assumption summaries are provided in Appendix B, with outputs as follows:

Scenario	Time-Based NPV 15-year Expectancy	Fill-Rate-Based NPV 200,000 CY/year
1—Partial Fill, Even Slope	$56,000,000	$57,000,000
2—Partial Fill, Plateau Grade	$105,000,000	$93,000,000
3—Maximum Fill	$137,000,000	110,000,000

All scenarios had a positive NPV, increasing with total volume available for disposal. This outcome reflects the fact that facility costs are offset by increased disposal volume, as the facility construction and closure requirements for each scenario are very similar.

Marketable land created by repurposing of the lagoon would represent a City-owned asset. The NPV analysis did not attempt to estimate or account for this created land value.

A "break-even" NPV analysis was also conducted to establish the minimum tipping fees below which the project likely is infeasible without subsidy, with results as follows:

Scenario	Time-Based Break-Even Tipping Fee ($/ton) 15-year Expectancy	Fill-Rate-Based Break-Even Tipping Fee ($/ton) 200,000 CY/year
1—Partial Fill, Even Slope	28	28
2—Partial Fill, Plateau Grade	20	21
3—Maximum Fill	18	20

The large gap for all scenarios between the break-even tipping fees shown above and the approximate market-based tipping fee projected in this analysis ($58/ton) reflects a solid market position for the St. Helens facility.

This NPV analysis was preliminary in nature, and the results should be considered approximate. Nonetheless, along with findings presented elsewhere in this report, the NPV output indicates that repurposing the lagoon to meet the City's long-term redevelopment goals is viable.

[17] Logistical limitations associated with large-scale use of the Wasco County Landfill may make other facilities viable in comparison to this facility. Nonetheless, it remains an appropriate competitor for this market analysis.

5 CONCLUSIONS

Significant demand exists for a soil- and sediment-disposal facility near the Portland metro area. In the facility trade area and in aggregate, the estimated demand over a 20-year period is 4.5 million CY. This compares to an estimated disposal volume of the St. Helens facility of 2.2 to 4.0 million CY.

The St. Helens facility would have several unique attributes that create distinct advantages to capture the market segments, including flexibility in transport mode, landfill-adjacent barge-transfer infrastructure that eliminates transload costs, and close proximity to large demand segments.

From a technical and regulatory perspective, and with use of proper engineering systems and controls to ensure environmental protection, the site is a viable location for disposal of sediment and soil. There are no competitive facilities with the ability to directly offload sediment from barges, but multiple competitors that can accept soil from upland sources. Initial projections suggest that revenue generation would be significant, supporting the City's redevelopment plans or applied to other City needs.

Close proximity to the primary sediment and soil sources reflects a significant greenhouse gas reduction opportunity.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

REFERENCES

COE, USEPA, Ecology, DNR, DEQ, IDEQ, NMFS, and USFWS. 2009. Northwest regional sediment evaluation framework. Prepared by U.S. Army Corps of Engineers—Seattle District, Portland District, Walla Walla District, and Northwestern Division; U.S. Environmental Protection Agency Region 10; State of Washington Department of Ecology; State of Washington Department of Natural Resources; Oregon Department of Environmental Quality; Idaho Department of Environmental Quality; National Marine Fisheries Service; and U.S. Fish and Wildlife Service. May.

COE. 2015. Dredged material evaluation and disposal procedures user manual. Prepared by Dredged Material Management Office. U.S. Army Corps of Engineers, Seattle District. November.

DEQ. 2014. Quarterly disposal data by type. Oregon Department of Environmental Quality, Portland, Oregon. January 11.

ECO. 2014. Economic impacts of Oregon's brownfields programs. Prepared for Oregon Business Development Department by ECONorthwest. October.

ECO and MFA. 2015. Brownfields in Oregon: characterization and assessment. Prepared for Metro and Oregon Brownfields Coalition by ECONorthwest and Maul Foster & Alongi, Inc. February.

Hurley, D. 2014. Discussion/in the matter of amending Chapter 60 of Lane manual to revise system benefit and disposal fees for Lane County solid waste services. Agenda for Lane County Board of Commissioners. June 24.

JRMA and GBB. 2013. Yamhill County waste disposal/management alternatives update 2014. Prepared for Yamhill County Solid Waste by J.R. Miller & Associates and Greshman, Brickner and Bratton, Inc. December 13.

LWG. 2012. Portland Harbor RI/FS, draft feasibility study. Prepared for The Lower Willamette Group by Anchor QEA, LLC, Windward Environmental, LLC, Kennedy/Jenks Consultants, Integral Consulting, Inc. March 30.

NSWMA. 2012. Municipal solid waste landfill facts. National Solid Wastes Management Association, Washington, DC. October.

Port. 2016. Willamette River dredged material management plan. Port of Portland. https://www2.portofportland.com/Inside/DredgeMaterialManagementPlan (accessed date). July 13.

Sallinger, Bob. 2011. Electronic mail (re: Audubon comments on PO Bar BUD) to H. Pence. April 18.

USEPA. 2016. Portland Harbor RI/FS Feasibility Study. U.S. Environmental Protection Agency Region 10 and CDM Smith. June.

Waste Management. 2016. Tualatin Valley waste recovery disposal rates and information. http://wmnorthwest.com/landfill/landfillcities/hillsboro/recycling.html (accessed March 25, 2016).

Whiteman, L. Republic Services. 2015. E-mail communication (re: pricing for disposal of sediments at Roosevelt Landfill) with J. Nielsen, CDM Smith Inc. July 28.

TABLES

Table 1
Competitor Basic Information
City of St. Helens

Landfill	Landfill Operator	Landfill Location			
		Address	City	State	Zip
Coffin Butte	Allied/Republic Services	28972 Coffin Butte Rd	Corvallis	OR	97330
Columbia Ridge	Waste Management	18177 Cedar Springs Lane	Arlington	OR	97812
Chemical Waste Management of the Northwest	Waste Management	17629 Cedar Springs Lane	Arlington	OR	97812
Finley Buttes	Waste Connections	73221 Bombing Range Road	Boardman	OR	97818
Cowlitz County Headquarters	Cowlitz County	3434 South Silver Lake Rd.	Castle Rock	WA	98611
Hillsboro	Waste Management	3205 SE Minter Bridge Road	Hillsboro	OR	97123
Riverbend	Waste Management	13469 SW Highway 18	McMinnville	OR	97128
Roosevelt	Allied/Republic Services	500 Roosevelt Grade Rd	Roosevelt	WA	99356
Short Mountain	Lane County	84777 Dillard Access Road	Eugene	OR	97405
Wasco County	Waste Connections	2550 Steele Road	The Dalles	OR	97058

Table 2
Competitor Statistics
City of St. Helens

Landfill	Total Permitted Capacity	Remaining Capacity	Projected Life Remaining	Waste Accepted[a,b]	Tipping Fee[c]	Modes of Transportation		
	(CY)	(CY)	(Years)	(Tons)	(Dollars)	Truck	Rail	Barge
Coffin Butte	80,000,000[d]	NA	47	496,077	$60-70[e,f,g]	Y	Y	N
Columbia Ridge	783,154,000[d]	291,748,000	144	2,287,149	$22-33[f]	Y	Y	N
Chemical Waste Management	NA	3,700,000	100+	NA	NA	Y	Y	N
Finley Buttes	NA	NA	100+	848,253	$45-50	Y	Y	Y
Cowlitz County Headquarters	54,800,000	26,218,92[d]	105	412,032	$45-55[h]	Y	Y	N
Hillsboro	NA	12,385,000	35.5	413,530	$26-96[i]	Y	N	N
Riverbend	NA	1,371,790	10[j]	457,082	$45-55[e,g]	Y	N	N
Roosevelt	244,600,000	81,000,000[d]	40	2,353,508	$50-60[k]	Y	Y	N
Short Mountain	110,860,000[d]	44,270,000	90+[l]	228,717	$70-80[g]	Y	N	N
Wasco County	NA	NA	NA	445,780	$30-100 [f,m]	Y	Y	Y

NOTES:

CY = cubic yard.

N = NO.

NA = not available.

Y = YES.

[a]Oregon landfills waste reported to Oregon Department of Environmental Quality for 2014 calendar year.

[b]Washington landfills waste reported to Washington State Department of Ecology for 2013 calendar year.

[c]Tipping fees were found during competitor research via public documentation or directly from disposal facility personnel. All tipping fees are for contaminated soil, unless specified.

[d]Capacity converted using factor of 1,000 pounds/CY.

[e]For municipal solid waste.

[f]JRMA, 2013.

[g]Hurley, 2014.

[h]Cowlitz County, 2015.

[i]Upper bound from WM, 2016.

[j]Remaining life is unknown because of ongoing expansion activities; number is extrapolated.

[k]Whiteman, 2015.

[l]Estimated by dividing remaining capacity by annual tonnage.

[m]Upper bound represents municipal solid waste.

Table 3
Competitor Accepted Wastes
City of St. Helens

Landfill	Accepted Material				
	Hazardous Wastes	Dredged Sediments	Industrial/ Special Wastes	Contaminated Soil	Woodwastes/ Treated Wood
Coffin Butte	N	NA	Y	Y	N
Columbia Ridge	N	Y	Y	Y	Y
Chemical Waste Management	Y	Y[a]	Y	Y	Y
Finley Buttes	N	Y	Y	Y	NA
Cowlitz County Headquarters	N	Y	Y	Y	Y
Hillsboro	N	N	Y	Y	Y
Riverbend	N	N	Y	Y	NA
Roosevelt	N	Y[a]	Y	Y	Y
Short Mountain	N	N	Y	Y	NA
Wasco County	N	Y	Y	Y	Y

NOTES:

CERCLA = Comprehensive Environmental Response, Compensation and Liability Act.

N = NO.

NA = not available.

Y = YES.

[a]Accepts wet sediment.

Table 4
Competitor Waste Stream Analysis
City of St. Helens

Landfill	Waste Accepted[a,b,c] (Tons)	Total Relevant Waste[d] (Tons)	Percent of Relevant Waste	Total Municipal Waste[a,b] (Tons)	Percent Municipal Waste
Coffin Butte	496,077	43,843	9%	364,242	73%
Columbia Ridge	2,287,149	582,916	25%	1,319,948	58%
Finley Buttes	848,253	135,495	16%	520,133	61%
Cowlitz County Headquarters	412,032	32,478	8%	98,649	24%
Hillsboro	413,530	180,314	44%	81,973	20%
Riverbend	457,082	39,333	9%	378,756	83%
Roosevelt	2,353,508	640,465	27%	1,313,608	56%
Short Mountain	228,717	10,915	5%	217,843	95%
Wasco County	445,780	38,906	9%	168,856	38%

[a]Oregon landfills waste reported to Oregon Department of Environmental Quality for 2014 calendar year.

[b]Washington landfills waste reported to Washington State Department of Ecology for 2013 calendar year.

[c]Waste accepted = Total Relevant Waste + Municpal Waste + Other (e.g. construction debris).

[d]Total Relevant Waste refers to categorized waste, including daily cover, contaminated soil, dredged material, and sludge.

Table 5
Rail to Wasco County Landfill
City of St. Helens

Description:

Estimate based on hypothetical site, see text. One thousand five hundred tons of dredged sediment is placed in a material barge and transloaded to a sediment-handling facility near Willamette River mile 6.5. Sediment is then placed in containers and loaded onto a railcar. Waste is transported to disposal facility.

Handling Considerations:

Generated water management on barge.

Sediment dewatering/water management facility on land.

Rehandle containers on site.

Site Considerations:

Temporary facilities required for upland sediment handling (project-specific).

Transportation Considerations:

Estimated rail travel distance is 86 miles.

Rail travel is expected to take two days round-trip.

One thousand five hundred tons of sediment will require 11 railcars.

	Unit Item	$/ton	
1	Temporary Facilities and Controls	$	5.30
2	Temporary Access Improvements	$	5.45
3	Sediment Dewatering	$	17.52
4	Water Treatment	$	20.17
5	Sediment Transload	$	10.00
6	Transport	$	17.60
	Total	$	76.04

Table 6
Truck to Hillsboro Landfill
City of St. Helens

Description:

Estimate based on hypothetical site; see text. Dredged sediment is placed in material barge, transloaded to a sediment-handling facility near Willamette River Mile 6.5, dewatered, then loaded onto trucks for transportation to Hillsboro, OR.

Handling Considerations:

Dredge water management on barge.

Additional sediment dewatering/water management facility on land.

Sediment is rehandled on land to load trucks.

Site Considerations:

Temporary facilities required for upland sediment handling (project-specific).

Transportation Considerations:

Round-trip mileage is expected to be 44 miles.

Each truck is expected to make four trips to the landfill, 33 tons each.

Twelve trucks are required to dispose of 1,500 tons of sediment in one working day.

	Unit Item	$/ton
1	Temporary Facilities and Controls	$ 5.30
2	Temporary Access Improvements	$ 5.45
3	Sediment Dewatering	$ 17.52
4	Water Treatment	$ 20.17
5	Sediment Solidification/Amendment	$ 10.50
6	Sediment Transload	$ 10.00
7	Transport	$ 12.00
	Total	$ 80.94

Table 7
Barge/Truck to Wasco County Landfill
City of St. Helens

Description:

Estimate based on hypothetical site; see text. One thousand five hundred tons of dredged sediment is placed in barge and transported directly to a transload facility, and hauled by truck to the Wasco County Landfill.

Handling Considerations:

Dredge water management on barge.

Transloaded at landfill-owned dock and trucked to disposal facility.

Solidification amendment required at transload facility before loading to truck.

Transportation Considerations:

Estimated in-water travel is 95 miles.

The round-trip is expected to take two full working days.

Transportation of barge will take one full tug and crew.

Truck transportation from transload facility to landfill is 21.4 miles round-trip.

	Unit Item	$/ton
1	Sediment Dewatering	$ 17.52
2	Water Treatment	$ 15.00
3	Barge Transport	$ 10.93
4	Transload at Landfill Facility and Truck Transport to Landfill	$ 8.00
5	Sediment Solidification Amendment	$ 15.00
	Total	$ 66.45

Table 8
Barge to St. Helens Landfill
City of St. Helens

Description:

Estimate based on hypothetical site; see text. Dredged sediment is placed in barge and transported directly to landfill.

Handling Considerations:

Generated water management on barge (part of dredge operation).

Offload from barge directly to landfill.

Transportation Considerations:

Estimated in-water travel is 23 miles to St. Helens.

Round-trip is expected to take one day or less.

Transportation of barge will take one full tug and crew.

	Unit Item	$/ton	
1	Sediment Dewatering	$	17.52
2	Water Treatment	$	15.00
3	Transport	$	5.47
	Total	$	37.99

Table 9
Section 404 Permit FOIA Request Summary (2010–2015)
City of St. Helens

Applicant	Permit No.	Purpose	Location	Date	Volume (CY)	Disposal	Notes
Waverly Marina Assoc.	NWP-1998-612-2	Maintenance	Willamette RM 17	Aug-10	906	Upland	
Port of Cascade Locks	NWP-1999-283	Maintenance	Columbia RM 149.1	Sep-12	2000	In-water	
Marion County, Wheatland Ferry Landing	NWP-1999-559-4	Maintenance	Willamette RM 72	Mar-12	2500 (annually)	In-water	Permit for five years.
Landco, LLC	NWP-1999-599-1	Obtaining sand and gravel for commercial and industrial use	Columbia RM 119-120.5	Nov-11	200,000 (annually)	Upland	Permit for five years. This was a permit transfer from Rinker Materials to Landco, LLC.
Rose City Yacht Club	NWP-1999-853-4	Maintenance	Columbia RM 109.1	Nov-11	9,000 (annually)	Upland	Permit for five years. Disposal was to an adjacent upland settling pond.
Rose City Yacht Club	NWP-1999-853-2			Oct-09			Permit modification—changed dredge method.
United States Gypsum Company	NWP-1999-124-5	Maintenance	Columbia RM 65.5	Mar-05	10,000	In-water	
Port of Portland	NWP-2000-984-5	Maintenance	Willamette RM 4.5 and 4.8	Aug-13	35,000	In-water and Upland	Terminal 4. Volume is total, but spread out over five years. Material disposed of upland on Hayden Island.
Port of Longview	NWP-2000-39	Maintenance	Columbia RM 66	Nov-11	20,000 (annually)	In-water	Permit for nine years.
Tyee Yacht Club	NWP-2002-413	Maintenance	Columbia RM 108.7	Nov-11	4,000 (annually)	Upland	Permit for ten years.
Multnomah County Drainage District No.1	NWP-2003-688	Erosion repair, slope stabilization	Columbia Slough	Jan-07	--	Upland	0.009-acre project, no volume provided.
Port of Astoria	NWP-2004-369-9	Maintenance	Columbia RM 13	Dec-13	89,000	In-water	
Vigor Industrial Inc.	NWP-2007-195	Maintenance	Willamette RM 8.2	Jul-15	65,000	Landfill	Site in Portland Shipyard area of the Swan Island Lagoon. Material was disposed of at Wasco County Landfill in The Dalles.
Portland Rowing Club	NWP-2008-645-1	Maintenance	Willamette RM 16.8	Jun-11	30,000	Upland	Material disposed of at Ross Island.
Tomahawk Destiny Association	NWP-2009-621-2	Maintenance	Columbia RM 106	Oct-12	12,000 initially; 8,000 (annually)	Upland	Permit for ten years. Material disposed of on Hayden Island.
Columbia Crossings, LLC	NWP-2010-141-1	Maintenance	Columbia RM 107	Feb-11	20,000	Upland	
Columbia Crossings, LLC	NWP-2010-141-4	Maintenance	Columbia RM 107	Nov-12	60,000	Upland	Material disposed of at "Nebraska site" on Tomahawk Island.
Shore Terminals, LLC	NWP-2012-302-2	Maintenance	Willamette RM 5.1	Jan-14	45,288	Landfill	Finley Buttes Landfill in The Dalles.
Port of Portland	NWP-2014-21	Maintenance	Columbia RM 109.4	Jul-14	10,000	In-water	
Macadam Bay	NWP-2015-197	Maintenance	Willamette RM 16.8	Jul-15	25	In-water	
Port of Longview	NWP-2015-332	Maintenance	Columbia RM 60	Nov-15	4,500	In-water	

NOTES:
CY = cubic yards.
FOIA = Freedom of Information Act.

FIGURES

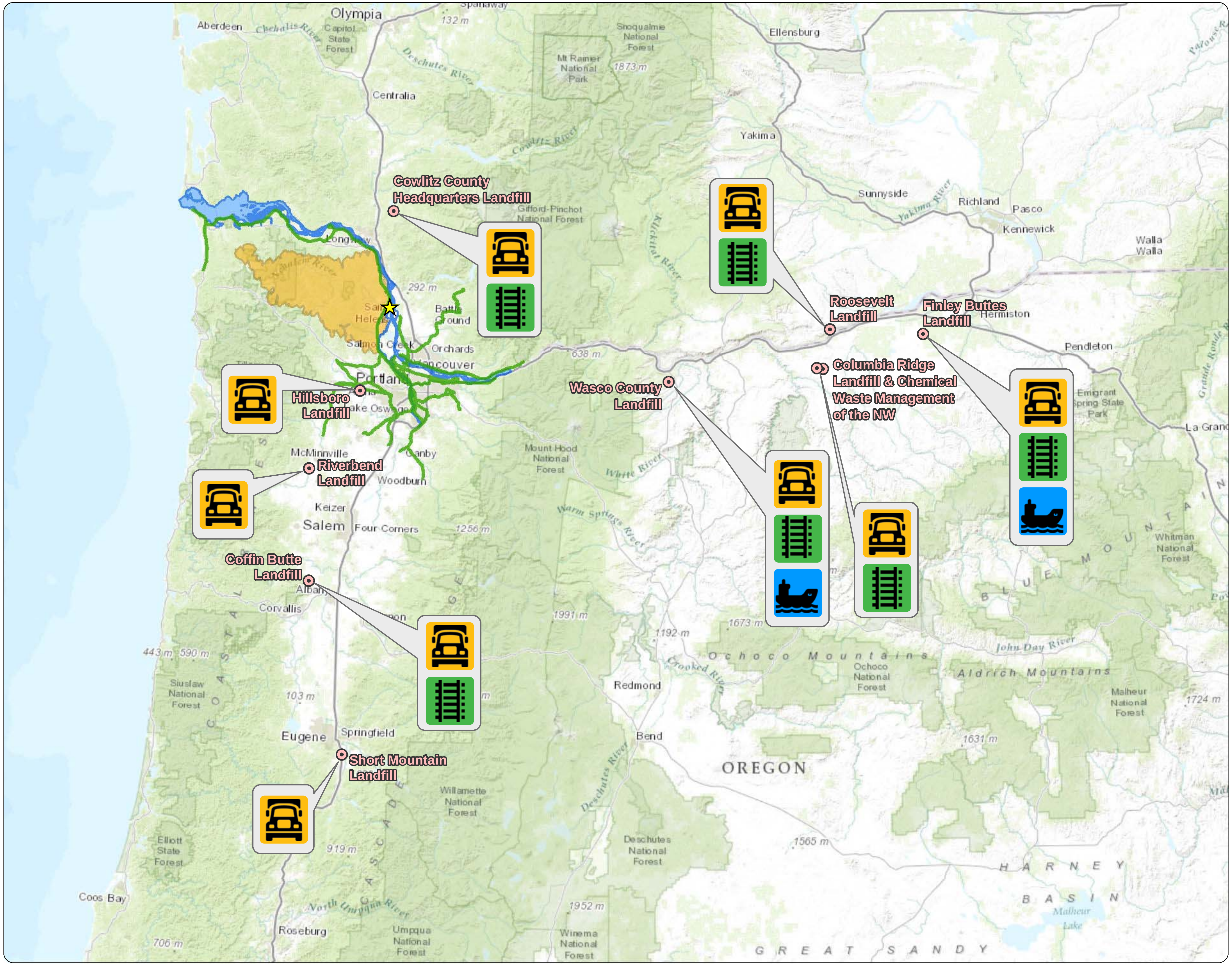


Figure 1
Trade Areas and Competitors

City of St. Helens
St. Helens, Oregon

Legend

- Project Site
- Competitor Landfill
- Trade Area - Truck
- Trade Area - Rail
- Trade Area - Barge

Competitor Landfill Modes of Transportation

- Truck
- Rail
- Barge

0 10 20
Miles

Source: Terrain Basemap and Reference obtained from Esri ArcGIS Online

MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfoster.com

Path: \\internal.mfainc.org\fs\ARCGIS.NET\0830.03 City of St. Helens\01\Projects\Meeting 012016\Fig1_Trade Areas and Competitors_v2_2.mxd
Print Date: 3/11/2016
Approved By:
Produced By: jschane
Project: 0830.03.01

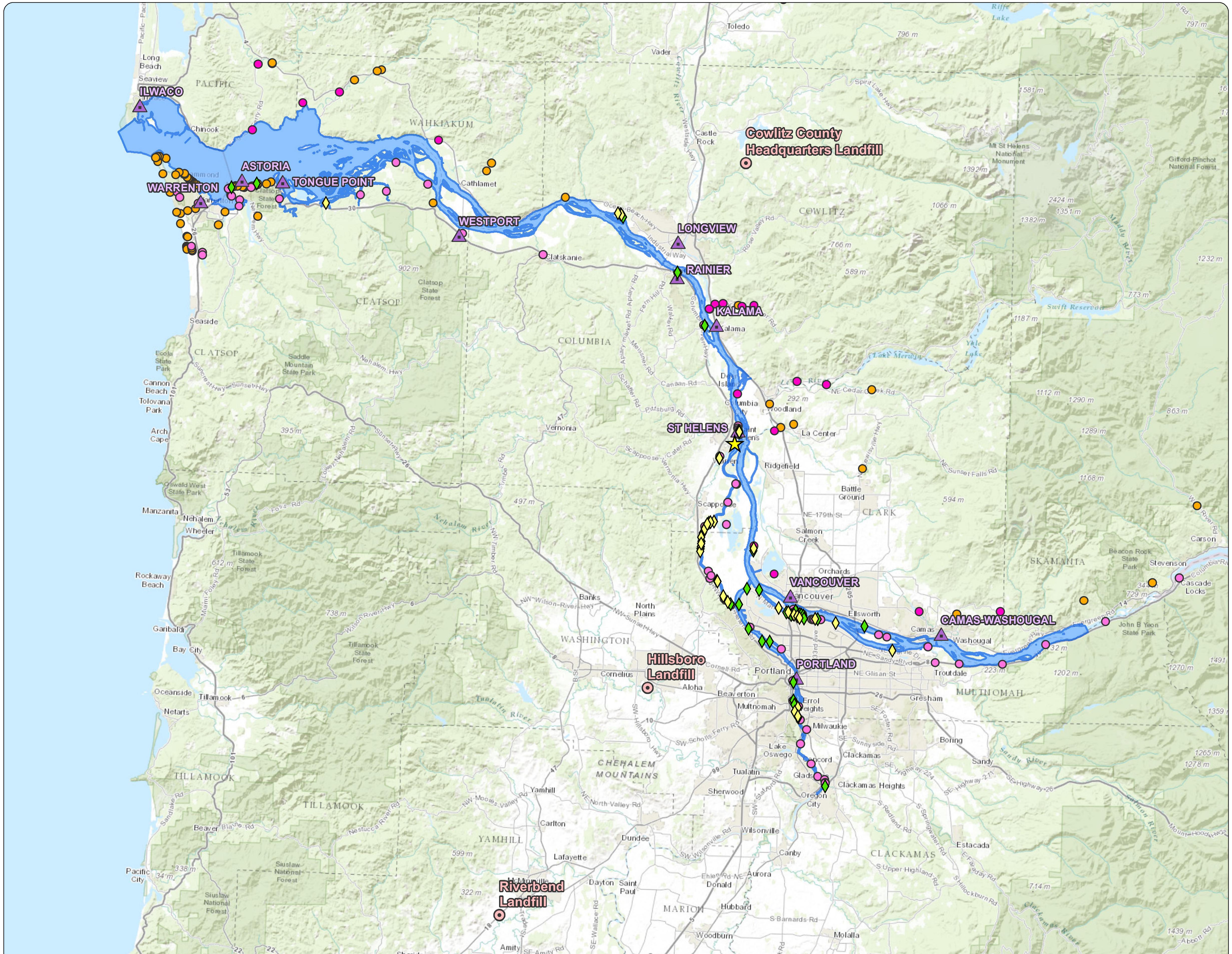


Figure 2
Barge Trade Area

City of St. Helens
St. Helens, Oregon

Legend

- Project Site
- Houseboat Community
- Marina
- Port
- Boat Access
- Other Public Access
- Trade Area - Barge

0 5 10
Miles

Source: Terrain Basemap and Reference obtained from Esri ArcGIS Online

MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfoster.com

Path: X:\0830.03 City of St. Helens\01\Projects\Meeting 012016\Fig2_Barge Trade Area.mxd
Print Date: 7/15/2016
Approved By:
Produced By: rcallihan
Project: 0830.03.01

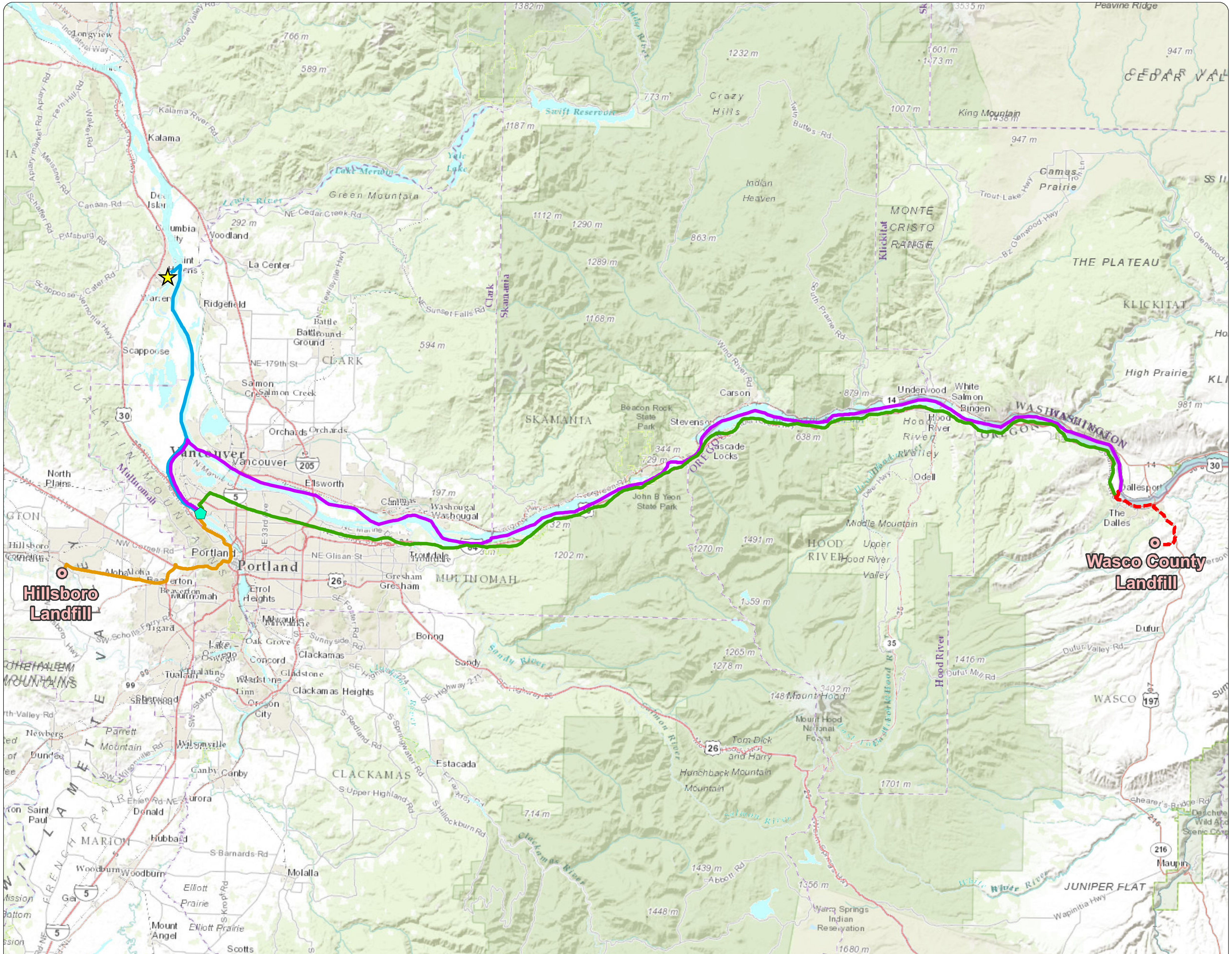


Figure 3
Cost Estimate Routes

City of St. Helens
St. Helens, Oregon

Legend

- Project Site
- Competitor Landfill
- River Mile 6.5

Cost Estimate Routes

- Barge to St Helens (23 miles)
- Barge to Wasco (95 miles)
- Transload/Truck to Wasco (21 miles round trip)
- Rail to Wasco (86 miles)
- Truck to Hillsboro (44 miles round trip)

0 5 10
Miles

Source: World Topo Basemap and Reference obtained from Esri ArcGIS Online

MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfoster.com

Project: 0830.03.01 Produced By: abrasch Approved By: Print Date: 3/28/2016 Path: X:\0830.03 City of St. Helens\01\Projects\Fig3_Cost_Estimate_Routes.mxd

APPENDIX A

LAGOON FILL SCENARIOS

Filepath:G:\00_MFA Civil 3D\00_PROJECTS\0830.03 - City of St. Helens\PLANS\2016 Revisions\St Helens CDF-Option 1 (2016).dwg

Printed by:Jacob Faust

Date:7/14/2016 9:48:21 AM

MAUL FOSTER ALONGI
360.694.2691 (phone) | www.maulfoster.com

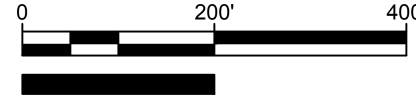
0 200' 400'

NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

Scenario 1 - Final Grade

St. Helens Wastewater Treatment Plant Lagoon Repurposing

St. Helens, Oregon



NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

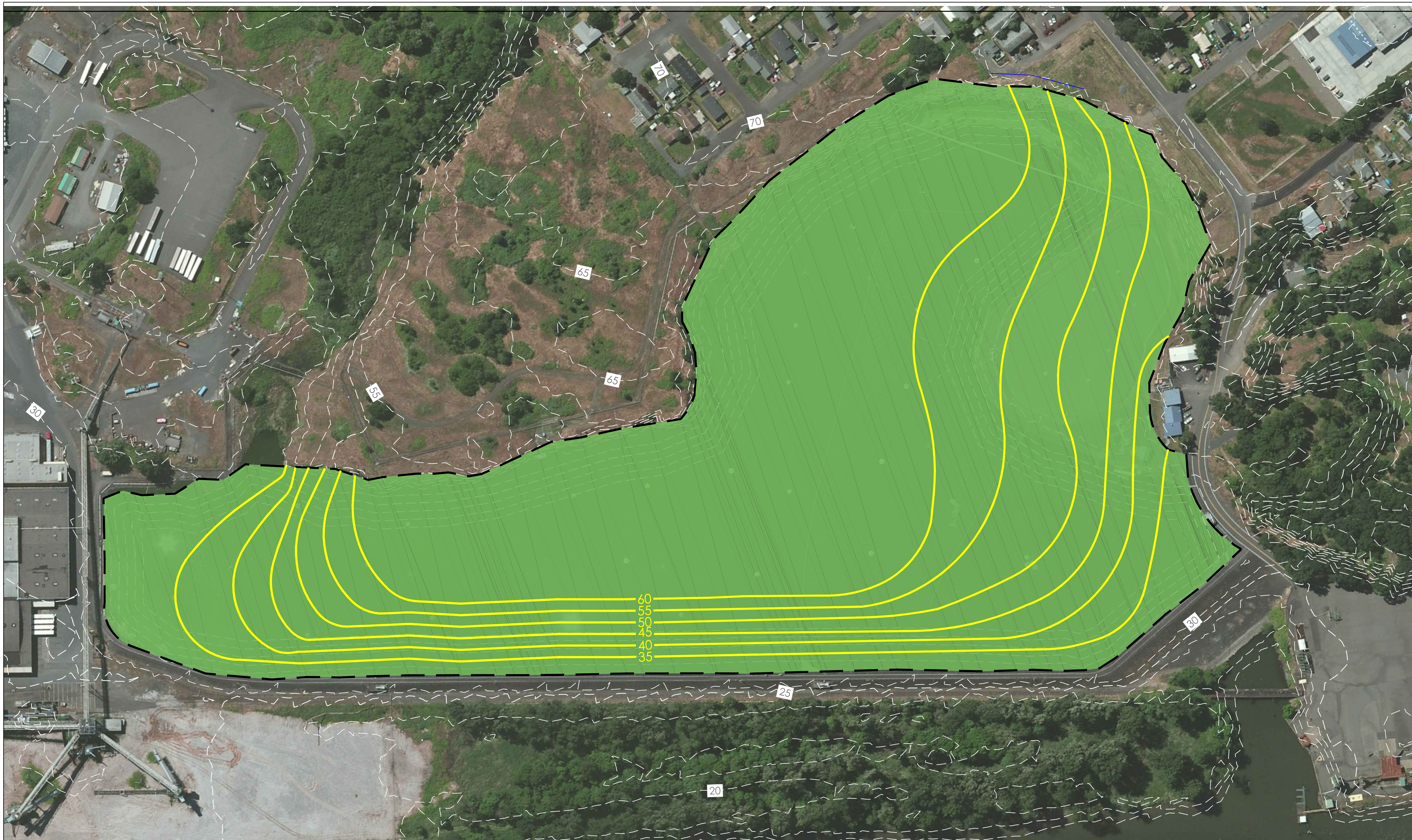
Scenario 2 - Final Grade

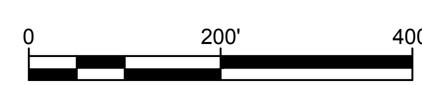
St. Helens Wastewater Treatment Plant Lagoon Repurposing

St. Helens, Oregon

MAUL FOSTER ALONGI
360.694.2691 (phone) | www.maulfoster.com

Filepath:G:\00_MFA Civil 3D\00_PROJECTS\0830.03 - City of St. Helens\PLANS\2016 Revisions\St Helens CDF-Option 2 (2016).dwg
Printed by:Jacob Faust
Date:7/14/2016 9:53:07 AM





NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

Scenario 3 - Final Grade

St. Helens Wastewater Treatment Plant Lagoon Repurposing

St. Helens, Oregon

MAUL FOSTER ALONGI
360.694.2691 (phone) | www.maulfoster.com

APPENDIX B

NET PRESENT VALUE ANALYSIS

Cost and Revenue Projection, Time Critical Based Scenario

7/12/2016

Option	Disposal Volume (LCY)	Design and Permitting	Facility Construction Cost	Operation Period		Operation Duration (Yrs)	Annual Operation Cost	Closure Cost	Post-Closure Period (Yrs)	Annual Post-Closure Cost (30 Yrs)
1 - Partial, Even Slope	2,670,000	$5,400,000	$35,139,000	2022	2036	15	$812,500	$ 26,910,000	30	$110,000
2 - Partial, Plateau Grade	3,840,000	$5,400,000	$35,139,000	2022	2036	15	$1,025,000	$ 26,910,000	30	$110,000
3 - Maximum Fill	4,740,000	$6,120,000	$40,131,000	2022	2036	15	$1,187,500	$ 30,160,000	30	$120,000

Option	Annual Gross Revenue	Total Gross Revenue	Net Revenue	NPV
1 - Partial, Even Slope	$11,650,000	$174,750,000	$97,213,500	$56,114,376
2 - Partial, Plateau Grade	$16,760,000	$251,400,000	$170,676,000	$104,733,475
3 - Maximum Fill	$20,680,000	$310,200,000	$218,496,500	$136,530,097

Discount rate:	6.0%	
Inflation Rate:	2.4%	
Time for fill operational period defined as:	15	years
Tipping fee	55	$/ton
Unit weight of imported sediment	1.19	ton/LCY
Contingency	30%	

Annual Volume Production Rate based on defined time range for fill operations

Disposal volume based on 1.8x consolidation factor for dredge import

Existing lagoon sludge consolidation included in cost and volume estimates

Gross and net revenue values are NPV-based

Closure occurs over last four years of operating life and one year thereafter

Cost and Revenue Projection, Continuous Volume Based Scenario

7/12/2016

Option	Disposal Volume (LCY)	Design and Permitting	Facility Construction Cost	Operation Period		Operation Duration (Yrs)	Annual Operation Cost	Closure Cost	Post-Closure Period (Yrs)	Annual Post-Closure Cost (30 Yrs)
1 - Partial, Even Slope	2,670,000	$5,400,000	$35,139,000	2022	2035	13.35	$812,500	$26,910,000	30	$110,000
2 - Partial, Plateau Grade	3,840,000	$5,400,000	$35,139,000	2022	2041	19.20	$812,500	$26,910,000	30	$110,000
3 - Maximum Fill	4,740,000	$6,120,000	$40,131,000	2022	2045	23.70	$812,500	$30,160,000	30	$120,000

Option	Annual Gross Revenue	Total Gross Revenue	Net Revenue	NPV
1 - Partial, Even Slope	$13,090,000	$174,751,500	$98,555,625	$57,052,714
2 - Partial, Plateau Grade	$13,090,000	$251,328,000	$170,379,000	$93,295,106
3 - Maximum Fill	$13,090,000	$310,233,000	$217,085,750	$110,234,283

Discount rate:	6.0%	
Inflation Rate:	2.4%	
Annual Volume Production Rate	200,000	CY/Year
Tipping fee	55	$/ton
Unit weight of imported sediment	1.19	ton/CY
Contingency	30%	

Annual Volume Production Rate based on defined time range for fill operations
Disposal volume based on 1.8x consolidation factor for dredge import
Existing lagoon sludge consolidation included in cost and volume estimates
Gross and net revenue values are NPV-based
Closure occurs over last four years of operating life and one year thereafter

St Helens Lagoon Repurposing NPV 2016.07.12 Volume Based